

# **Allocate Capital and Measure Performances in a Financial Institution**

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## **ABSTRACT**

This paper provides a model for allocating capital and measuring performances for financial institutions. The methodology relates the economic valuation of the balance sheet to the market value of the firm. In so doing, each business unit is evaluated on an economic basis, and the capital allocated to these units is related to the risk premiums that the market demands. The paper's results have broad applications for corporate managers, risk managers, and other market participants in managing financial institutions to increase shareholders' value.

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## Introduction

For the purposes of this paper financial institutions are defined as banks and insurance companies that derive their incomes by borrowing from multiple liabilities and investing in assets. These incomes are generated from the spread between the assets and liabilities on their balance sheets. According to Saunders (1997), there are 1,840 life insurance companies and 10,384 commercial banks in the United States. In recent years, these banks and insurance companies, and financial institutions all over the world, as well, are increasingly focusing their attention on management by enhancing shareholders' value. Subsequently, there is a compelling need to efficiently manage the capital while effectively managing the risk exposure on their balance sheet.

Allocating capital directly to business units is an integral part of managing shareholders' value of a financial institution. The use of capital determines the rate of growth of a product or business. Capital allocation has recently become an important area of research because in part, regulatory agencies have proposed or are considering alternative risk-based capital requirements. If these risk-based capital requirements are not well designed, these regulations may result in inefficient use of capital and an increase in the cost of financial services to the economy.

Another reason for interest in capital allocation is the result of the growing popularity of implementing VaR (value-at-risk) measures to the banks' or insurance companies' balance sheet. As a result, management is exploring the use of profitability measures adjusted for risks. Various measures are used or proposed, however, there is very little research linking these measures to the corporate goal of maximization of shareholders' value. The relationship between the risk measures of the balance sheet to the risk management of the firm and the firm value, while taking the future growth of the firm, taxes, and multiple business units into account is rarely understood. Generally speaking, risk management is seldom linked to corporate decision making.

Despite the importance of the subject matter, scant research has been devoted to developing a model of a financial institution that can relate optimal allocation of capital to maximization of shareholders' value. Froot and Stein (1995), Stein (1996) and James (1996) consider capital allocation an internal capital market in which businesses are allocated capital with the objective of mitigating the cost of external financing. These papers focus on the cost of capital for capital budgeting and not on integrated modeling of the balance sheet and the firm value.

Copeland et al. (1994) discuss the importance of shareholders' value as a performance measure for the management of a bank. However, they did not discuss how required surplus should be allocated in such a way as to maximize shareholders' value. Matten (1996) describes a capital allocation procedure, but the approach does not deal with profitability measures for individual businesses. Matten contends that this is more a management philosophy rather than one based on an analytical framework.

This paper provides an analytical framework to formulate a solution for this type of a management issue. Using this framework, appropriate performance measures can be constructed. Further, we can develop a more consistent framework to analyze the required surplus for ongoing financial institutions. More specifically, this paper will propose a model of a financial institution that relates the balance sheet to the market value of the firm, taking into account the required surplus, the cost of capital, and growth of the firm. As a result, the model can address some of the questions posed in allocating capital, such as:

- Taking the required surplus into account, how should we decide on the profitability of a product?
- How do we measure the additional returns of some risky assets in the portfolio when required surplus is taken into account?

- What is an appropriate measure of profitability after adjusting for risks that would maximize shareholders' wealth?

The broader applications of this model include measuring the value of a firm, for purposes of merger and acquisition, and use as a framework for transfer pricing and measuring the profitability of the business of financial institutions.

Some of the results of this paper follow:

1. Commonly used performance measures, for example, risk adjusted return on capital (RAROC), and return on risk adjusted capital (RORAC) may not be consistent with stockholders' value. This paper provides a consistent top down approach in determining the benchmarks and integrates the bottom up valuation process of the balance sheet as proposed in Equation (15).
2. Using typical insurance company data, we show that the required surplus should not exceed 15 percent, the 2 percent option charge costs 20 basis points in capital, the convexity charge costs 34.7 basis points per unit convexity, and the cost of holding equity is 3 percent on the equity return.
3. Allocation of capital and target returns to individual business units is related to the VaR numbers, and enables the risk management function to relate to the corporate function in the maximization of shareholders' value.
4. A framework for determining the market valuation of liability and transfer pricing of assets and liabilities is given. Specifically, the relationship between the market surplus value to the liability spreads off the transfer-pricing curve is established, and subsequently provides a framework for determining the appropriate spreads. In turn, this relationship enables us to determine the asset and liability benchmark portfolios.

Consequently, the results of this paper should be useful for risk managers who can integrate their risk measures into capital allocation. Corporate managers will find the model useful because it relates shareholders' value to the firm's performance. The approach for rational performance measures used here can be helpful for line managers. For Treasury Departments a performance measure for its interest rate management role is proposed. Regulators and rating agencies, will find that this paper contains a methodology for calculating the cost of the required capital to the firms. Regulators can then evaluate the trade-off between the cost of regulation to the industry and the increase in informational efficiency to the capital market. This is a particularly important issue today as banking and insurance industries have separate regulatory agencies, but are increasingly competing in the same market. Misguided rules and regulations on capital adequacy will quite likely have an effect on the competitiveness of one industry relative to another. For product pricing, for which managers have to simulate future cashflows under stochastic interest rate scenarios and discount the future payments to present value, the framework in this paper can provide the appropriate discount rate. This may not necessarily be the cost of equity but dependent upon the risk of the product.

The paper proceeds as follows: Section A will present the model providing the assumptions of the Corporate Model. Section B will derive the model results, which include the valuation model, cost of capital model, the corporate model, and the performance measure. Section C will compare the performance measures with some of the commonly suggested measures. Section D will analyze the cost of the required surplus. Section E will provide a numerical example in analyzing the balance sheet of an insurance company. The conclusion in Section F contains the implications of the results to the market participants related to the bank and insurance industry.

#### **A. Assumptions of the Corporate Model**

The corporate model is a specification relating the firm's income and corporate decisions (for example, optimal capital structure) to the firm's value which provides the analytical framework to capital

investment decisions and other corporate decisions. The standard valuation model proposes that the firm value is the present value of the after tax income of the firm discounted by the cost of capital that is related to the risk of the firm's income. The corporate model proposed in this paper extends the standard valuation of a firm (Modigliani and Miller) to that of a financial institution. The extensions are given as follows:

- (1) The net income of the firm relates to the balance sheet items of a financial institution. Since the balance sheet of a financial institution may be viewed as a portfolio, there is a significant relationship between the institution's income and the balance sheet.
- (2) Surplus is related to the financial institution's value. Capital (or surplus) of a financial institution differs from that of a manufacturing firm because it is used to support the financial risks of the institution. An increase of the surplus leads to the reduction in the probability of default but raises the cost of holding unused capital. This paper specifies these relationships.
- (3) Financial institutions have multiple business units. The corporate model extends the standard valuation model to multiple business units, including the allocation of risk capital, the valuation of each unit of business and the determination of performance measures.

**A.1. Asset value can be determined.** Assets are assumed to be loans, private placements, and public bonds. The asset value is determined to be the market value, calibrated (or relatively valued) to the public bond prices or the new purchase prices. The portfolio value is  $A$ .

**A.2 Liability value (L)** is determined by a cash flow model. Reitano (1997) and others have described the market valuation of liability. For the purpose of this paper, liability value is determined by:

- (1) the projection of expected cash outflow, where the projections are forward looking and therefore do not incorporate profit release, amortization of acquisition cost, for example as part of the cashflow of the liability;
- (2) the cashflows of the liabilities based on the in-force business, such that the growth of the business is captured by the growth of the balance sheet;
- (3) the discounting of the cashflow is determined by the required option adjusted spread (OAS), as described in Ho, Scheitlin, and Tam (1994), using arbitrage-free modeling;
- (4) the required OAS of the in-force business is determined by new sales, being consistent with the marking to market approach. Discussion of discounting liability is beyond the scope of this paper; a detailed discussion can be found in Ho, Scheitlin and Tam.

**A.3 Surplus is defined as:**

$$S = A - L \tag{1}$$

For simplicity, we assume an all-equity firm with no long-term bond funding in the capital structure. For banks, Basle Accord uses a two-tier concept for capital. Tier one consists of investment capital and reserves and tier two includes subordinated debts not used for the business. In this sense, we assume that there is no tier two capital. All liabilities are products sold as part of the business operation. Although banking literature, often refers to surplus as equity for the purpose of this paper, we will reserve the term "equity" to mean the stock equity of the firm. Generally speaking, firms would reduce the surplus to a minimal level. For this reason, for the analysis of this paper, we assume that the surplus is at an optimal level. For example, a surplus level may be required by regulators or rating agencies, or may be necessary for the firm's growth plan.

**A.4 Market assumption.** We assume a flat yield curve of rate  $r$ . This assumption is used simply for the clarity of the paper presentation and does not affect the study results. For our analysis,  $r$  is the transfer pricing rate. The spread (OAS) off this transfer pricing rate is extremely important. We assume that the weighted average spread of the asset and of the liability are  $t_a$  and  $t_l$  respectively. And therefore we have the following equations:

$$r_a = r + t_a \quad (2)$$

$$r_l = r - t_l \quad (3)$$

Clearly, the firm should strive to attain higher spreads off the transfer rate.

**A.5 Growth assumption.** The growth (annually through new production) of the liability will be  $g$ . As a result, the surplus and asset will also grow at this constant rate. For clarity of the exposition, we assume that growth is constant. That is, we assume that the balance sheet will grow at a constant rate for all items. For practical implementation, future new product growth can be modeled as time dependent.

**A.6 Cost of capital assumption.** The cost of capital of the business for this risk class  $c$  is assumed constant. The risk of the business is defined as the risk of both asset and liability, including the surplus (whether it is required or optimal surplus). Also included is the future growth of the business, which may be called the franchise risk. According to Modigliani and Miller theory (1958), the discount rate should be related to the risk class and separated from the leverage level of the capital structure. Appendix A provides a description of the Modigliani - Miller Theory.

**A.7 Tax assumption.** We assume the corporate tax rate to be  $t$ . In this analysis, we do not need to make the distinction between capital tax rate and the income tax rate. The personal tax rate does not affect the analysis. In this sense, the model is a partial equilibrium model where we take the observed tax rate as given and assume that these tax rates are at equilibrium. The model ignores the differences in tax reserves resulting in varied timing of tax payments. We assume that taxes are paid immediately upon receipt of income. The model can be adjusted for changes in the tax base without affecting the basic model.

These assumptions are basic to corporate finance theory. The main extensions from the basic corporate finance theory are assumptions A.1 - A.3. A.1 is based on the arbitrage-free valuation models that have been widely used in practice and in research. The asset spreads are determined by these models. A.2 is based on the growing literature on marketing valuation of liability or balance sheets. A.3 is the central concern of this paper. We will show how the cost of surplus affects the firm's value and how the firm should allocate risk capital across the separate business units of the firm.

## B. Model Results

In this section, we will first derive the formulation of the income and valuation models of the firm. We will then determine the expected rate of return of the equity capital. Finally, assuming that the firm has multiple business units, we will derive the allocation of the equity to each business unit and their target returns.

**Proposition 1.** Let  $I$  be the annual pre-tax income. Then:

$$I = Sr_a + Lsp \quad (4)$$

where  $sp$  is the spread income between asset and liability; i.e.:  $sp = t_a + t_l$

**Proof:**

The asset return is given by  $Ar_a$ . The liability expenses are  $Lr_l$ . Since the operating income is the asset returns net of the liability expenses, we have,

$$I = Ar_a - Lr_l \quad (4a)$$

But by definition of the surplus, we have

$$A = L + S \quad (4b)$$

Substituting Equation (4b) for Equation (4a), eliminating A and applying Equations (2) and (3), we get the desired result. QED

Proposition 1 presents the intuitive result that the operating income of the firm is the return on the surplus and the spread income from the in-force products. This result is particularly apparent for insurance companies where assets are assigned to the in-force business of each product. However, such is not the case for many banks and insurance companies where they are not organized by matching asset and liability along product lines. This result shows that we can analyze these banks and insurance companies in this matched fashion.

### Proposition 2. Valuation Model

Let the value of the firm be E. The acquisition cost of the products for the growth is assumed to be covered by the premium received. Maintenance costs are already accounted for in the pricing of the liability. Therefore, the cost of growth is the accumulation of surplus that cannot be released. The franchise value of the firm is the growth of the in-force business that can maintain the spread in the income. Given the cost of capital of the business is c, then the firm's value E is given by:

$$E = (Sr_a (1 - t) + Lsp (1 - t) - gS) / (c - g) \quad (5)$$

#### Proof:

At the end of the first year, the free cashflow to shareholders is the after-tax income net of the increase in surplus (i.e:  $I(1 - t) - dS$ , where  $dS$  is the increase in surplus at the end of the year as a result of the growth in the in-force—or volume of—business). The increase of surplus has to be funded by the after-tax income or the sale of equity. For the end of the second year, the free cashflow is the same as that of the first year with a growth of g. The firm's value is the present value of this infinite future cashflow discounted by c. In noting that the surplus must also grow at a constant rate of g, we have the funding of the surplus at the end of a period  $gS(t)$ , where  $S(t)$  is the surplus value at the beginning of the period. By summing the infinite series, we get the desired result. QED.

This model is commonly used in the constant dividend model for stock valuation. The main point of interest is the treatment of the surplus and the specification of the income by the spread between asset and liability. For this reason, equation (5) can also be used to evaluate projects when a new business requires investment, which in this case is the surplus (or capital). The project can be considered as profitable if the net present value (NPV) is positive, or  $NPV = E - S > 0$ . This approach provides a method for accounting for the cost of risk capital for the spread business where there is no explicit cost in the investment. Instead of using the opportunity cost of the initial investment in risk capital and projecting such costs into the future, this methodology enables us to calculate the NPV on the present value basis.

While the surplus grows at a constant rate of g and it is expected that the surplus will be large in the distant future, the present value is negligible if the growth rate is less than the cost of capital. The results clearly show the impact of the required surplus to the firm's value, as the cost is represented by the term  $gS$ . When the firm has no growth, the model seems to suggest that a higher surplus would lead to a higher firm value. If we increase the surplus by, say  $dS$ , we must raise the funds through equity. Assume that at the margin, we do not change the risk class of the firm. If we denote the change in equity value to the shareholders prior to the sale of new shares to be  $dE'$ , then Equation (5) says that we should have:

$$(c - g)(dE' + dS) = r_a (1 - t) dS - g dS$$

In arranging the terms and solving for  $dE'$ , we have

$$dE' = - [c - r_a (1 - t)] dS / (c - g) < 0 \quad (5a)$$

Therefore, consistent with practical considerations, an increase of surplus is a cost to the firm related to the cost of capital and the asset returns. Equation (5a) shows that the increase in surplus is proportional to the decrease in the equity value, and the multiplier is the ratio of the cost of capital net of the after-tax risk-free rate to the cost of capital net of the growth rate. If the after-tax risk-free rate equals the growth rate, then the change of surplus is directly proportional to the change in equity value.

Some banks and insurance companies have related their stock price to the surplus value over time and have shown that they are correlated. Equation (5) provides the model behind this relationship. Further we can use equation (5) for cross-sectional comparison. Since E, S and L are in principle observable across public banks and insurance companies, through cross-sectional analysis, we can estimate the profitability of the financial institutions by estimating the asset returns and spreads.

**Corollary 1. Cost of Capital Model**

$$c = [r_a (1 - t) - g](S/E) + sp (1 - t)(L/E) + g \tag{6}$$

This cost of capital model can be derived directly from the valuation model. It provides us the first step in determining the “top-down” calibration procedure. On the one hand, the cost of capital can be estimated by determining the discount rate that equates the present value of the future after-tax income to the observed market value of the equity. On the other hand, the cost of capital of the firm can be estimated by the market returns using the Capital Asset Pricing Model (CAPM), or related portfolio theory, which has been extensively described in investment research. S and L can be calculated from the balance sheet using the valuation model. E can be observed in the stock price. Therefore the cost of capital model can be calibrated (in the sense that the constant growth rate and other income data are used such that the cost of capital is consistent with the CAPM model) to the market to ensure consistency with the market parameters. At the same time, growth rate has to be consistent with market reality. This approach of using such as implied growth rate has been discussed in Grinold and Kahn.

The model shows that when the market value E is large, the market expects a high growth potential for the firm or that the market discount rate has decreased. Equation (6) gives precisely such a relationship.

We can now extend the analysis to a firm with several business units. While the cost of capital of the financial institution can be estimated from the market either by portfolio theory or by market equity value, the cost of capital and the contribution of value of each business unit to the total firm value cannot be estimated in the same manner. For management purposes, many financial institutions seek to assign capital to each business unit to manage its own business risk and returns. It becomes necessary to determine an appropriate framework for assigning capital and value to each business unit.

In a perfect capital market, where we assume that there are no transaction costs, agency costs or bankruptcy costs, we can view each business unit as an independent company. There is no reason to consider the issue of optimal capital allocation. In the case where we do have bankruptcy costs and agency costs there is an optimal level of capital required.

Assume that there are N business units and each business unit is denoted by a subscript i. Suppose the required surplus is specified. These surplus numbers are either determined by regulation or by management optimal decisions. For example, one rule, as Matten suggests, may be defined as the ratio of the VaR of each business to the sum of all the VaR numbers.

$$S_i = S \text{ VaR}_i / \sum \text{VaR}_i \tag{6a}$$

While equation (6a) is not derived formally from an optimization model, there is some justification for this formulation. Basle capital requirement for banks is a multiple of the VaR of the surplus. VaR is the maximum potential loss on the balance sheet within a certain confidence level over a certain time horizon. Using VaR as a measure for determining the surplus is consistent with an implicit

assumption of a certain bankruptcy cost or agency cost. The exact formulation of such a model is beyond the purpose of this paper.

Equation (6a) suggests that each business unit should also manage its risk based on the maximum potential loss, and in so doing optimally minimize the expected costs in reallocating the capital and agency costs as a trade-off against the cost of holding excess surplus. Equation (6a) suggests that the confidence level is set such that the total surplus assigned to all units is equal to the firm's surplus. Therefore equation (6a) assures that each business unit faces the same probability of a loss exceeding the surplus. This is an efficient monitoring system no different than trading limits on the trading floor. This way, a consistent methodology is used for measuring downside risks across all business units.

An alternative formulation for the allocation of surplus is to recognize that there is no "bankruptcy cost" for individual business units. The firm as a whole holds the surplus because each business unit contributes to the total risk to the firm. Therefore, the cost of holding the surplus should be charged back to each unit. As a result, the surplus assigned to each unit is the proportion of the surplus that equals the contribution of risk to the firm.

See, for example, Ho (1997) or Matten (1996) for derivation of the marginal contribution of risk to VaR. VaR beta is the portion of risk attributed to each unit, where the risk is VaR. Similarly, if we assume that beta is the firm risk, then we can calculate the contribution of risk to the beta from each business. The following proposition provides the formulation of the allocation of capital and benchmark target returns to each of the businesses taking the risk allocation into account. So,

$$S_i = \text{VaR } \beta_{i1} * S / \text{VaR} \quad (6b)$$

The main issue is that this surplus number for each business is not derived by any formal optimal solution within the context of this model. For practical purposes, these numbers are given to the model. The important relationship is that all the surpluses of the businesses should be the total surplus. That is:

$$S = \sum S_i \quad (6c)$$

Next we consider the allocation of risk. Management first determines the appropriate definition of risk to the firm. A corporate financial theory suggests that the appropriate risk with which management should be concerned is the systematic risk (beta). This theory argues that a firm is in fact a portfolio of business units, and therefore, investors may consider the stock price as the value of a portfolio of stocks. Any unsystematic risk of each business unit can be diversified away by the investors. Therefore, corporate managers should be concerned with the beta of the firm as a measure of risk to enhance shareholders' value. If we assume a perfect capital market and each unit is a firm, then CAPM should apply to each unit. And thus we have:

$$c_i - r = \beta_{i1} (r_m - r) \quad (6d)$$

Then

$$\begin{aligned} E_i (c_i - r) &= E_i \beta_{i1} (r_m - r) \\ &= E_i \beta_{i1} (c - r) / \beta_{i1} \\ &= w_i E (c - r) \end{aligned} \quad (6d)$$

where  $w_i = E_i \beta_{i1} / (E \beta_{i1})$

We note that the sum of  $w_i$  equals one.

Equation (6d) suggests that the allocation of risk can be achieved by decomposing the beta to its component parts attributed to each unit, and then assign the excess return to each of the units.

However, many managers consider total risk (standard deviation of the equity net of the unsystematic risk of the stock) to be the main risk as discussed above, taking bankruptcy costs and agency costs into account. For this model, therefore, we are concerned with the decomposition of the risk assigned to each business unit. This decomposition is the proportion of the firm risk allocated to each business unit represented by  $w_i$ , such that  $1 = \sum w_i$

For example, if the risk is defined as VaR, then

$$w_i = \text{VaR } \beta_{i1} / \text{VaR} \quad (6e)$$

More generally, a linear (convex) combination of equations (6d) and (6e) may be used depending on the utility function of management.

### Proposition 3. Corporate Model

Assume that the firm value is  $E$ , and the  $S_i$  and  $w_i$  have been assigned to each business unit, then the cost of capital  $c_i$ ,  $c$ , and the equity value  $E_i$ , are determined the following set of equations (referred as the corporate model.)

$$E = \sum E_i \quad (7)$$

$$E c = \sum E_i c_i \quad (8)$$

$$c_i = S_i r_a (1 - t) / E_i + L_i s p_i (1 - t) / E_i - g_i S_i / E_i + g_i \quad (9)$$

$$c_i - r = w_i E (c - r) / E_i \quad (10)$$

Equation (7) simply states that the total value of each business unit is the firm's value. Equation (8) says that the cost of capital of the firm is the weighted average cost of capital of each business unit. Equation (9) is the valuation model of each business unit according to Proposition 2. Equation (10) assigns the excess expected return of the firm to each business unit according to the risk allocation of  $w_i$ .

#### Proof:

First we make the observation that if we put  $F = Ec$  and  $F_i = c_i E_i$  in the equations (7) - (10), we will eliminate the unknowns  $c$  and  $c_i$ . The system of equations becomes a system of linear equations. There are  $N$  business units and therefore there are  $2N + 2$  variables and  $2N + 1$  equations. But the system of equations is not independent. Indeed, if we sum up the equations (10) over the total index, the equation will equal a combination of Equations (7) and (8). The system of equations in fact has a rank of  $2N + 1$ . QED.

For clarity of the exposition, we will consider the special case where the growth rate is the same across all business units. Let  $Y_i = S_i r_a (1 - t) + L_i s p (1 - t) - g S_i$ , and the corporate model can be arranged:

$$E_i = Y_i / (r - g) - (\sum Y_j / (r - g) - E) w_i \quad (11)$$

$$c_i = Y_i / E_i + g \quad (12)$$

$$c = \sum Y_i / E + g \quad (13)$$

This set of equations shows that the unknowns are well specified by the known parameters on the right-hand side. Furthermore, the model in this special case can provide us with better insights into the reasonableness of the model.

Equation (11) provides useful insight into the capital allocation problem. The equation shows how risk capital is allocated according to the risk decomposition. The equity allocated to a business unit depends on two components. The first term is the present value of income discounted at the risk-free rate. The second term is the portion of risk premium (in dollar terms) assigned to this business. And therefore

Equation (11) says that the value of the business unit is the risk neutral value adjusted for the risk capital assigned to the unit. Equation (11) offers an intuitive explanation of how the risk allocation is used to determine the equity value of each unit. For example, suppose a business unit does not add risk to the firm, (that is,  $w_i = 0$ ), then the value of the business to the firm should be the after-tax income discounted by the risk-free rate, which is exactly specified by the model.

Equation (12) determines the cost of capital for each business unit. When the business unit adds little risk to the firm, the equity value will be high, and therefore the cost of capital will be low. As a result the firm will encourage more investment into that business unit. More specifically, consider the sale of a product with volume  $L$  requiring a surplus  $S$ . The income is generated from a constant spread perpetuity which is a standard implicit assumption for RORAC.

Then the project is profitable if the net present value (NPV) of the project is positive. That is:

$$NPV = Y_i / c_i - S > 0$$

where:

$$Y_i = S r_a (1 - t) + L sp (1 - t)$$

That is, we require:

$$Y_i / S > c_i \tag{14}$$

Equation (14) is the return on capital calculated on a gross basis. That is, the after-tax income does not deduct the cost of financing the surplus. The equation provides the return on the investment, which is the surplus. This analysis provides us a performance measure of business units on a risk-adjusted basis, as we can re-write Equation (14) as:

$$Y_i / C_i > r \tag{15}$$

Where  $C_i$  is the risk-adjusted capital defined as  $Sc_i / r$ , Equation (15) is a return on risk-adjusted capital (RORAC) measure. Commonly, the risk adjusted capital is defined as (earnings at risk) /  $r$ . This approach fails to capture the diversification or hedging effect of the earnings of the business. Another performance measurement is defined as the ratio of the income to the surplus. Within the context of the model, this approach does not adjust for the risk nor does it assume that the cost of capital is the risk-free rate. Since the cost of capital can exceed the risk-free rate by 50 to 100 percent, Equation (15) underscores the importance of risk adjustment to the performance measurements for enhancing shareholders' value. The above analysis is summarized by the following proposition.

**Proposition 4. Performance measures**

Let  $Y$  be the income of a block of business units and  $S$  be the required (optimal) surplus the firm will hold for this block. Let  $c$  be the cost of capital allocated to this business unit, then the performance measure is given by Equation (15).

The proof of Proposition 4 has been given above. We should note that VaR or EaR analytics may be used two ways in this performance measure. First, VaR analytics may be used for determining the risk decomposition ( $w_i$ ) resulting in the specification of the cost of capital, according to equation (6e). Second, EaR and VaR may be used to determine the required or optimal surplus according to equation (6a)

Business units should use the cost of capital as the discount rate for the NPV analysis. Equation (15) can be used to evaluate the performance on a risk-adjusted basis. If the performance measure falls below the risk-free rate, then the performance is reducing the stockholders' value. In combining this result

with the corporate model, the model suggests that the business unit's performance has to be evaluated by volume growth, which must be higher than the growth rate of  $g$ . Indeed, suppose a project provides a return  $y$  on the surplus, and therefore:

$$Y = Sy$$

And if we substitute this equation for equation (15), we derive the result that corporate finance theory would suggest that a profitable project requires that  $y > c_i$ . Therefore, equation (15) is consistent with the standard financial theory.

### C. Comparing This Benchmarking to Other Performance Measures

Several performance measures for business units have often been suggested. Let us consider some of the alternative measures using return on risk adjusted capital (RORAC) and compare with the RORAC measure proposed in Equation (15) within the context of the proposed corporate model. Let us consider:

- RORAC (1) = return / (total available equity X EaR of the business / EaR of the firm)
- RORAC (2) = (returns - opportunity cost of regulatory capital) / EaR
- RORAC (3) = returns X risk free rate / EaR

where EaR is earnings at risk.

These measures suffer the following pitfalls:

1. These approaches are ad hoc. There is nothing suggested by a financial model providing a link between these measures to the firm's value.
2. They do not incorporate diversification or natural hedging effects.
3. They do not identify volume growth as part of the performance measure. If the stock value has incorporated the growth expectation and the business unit does not meet that target, the stockholders' value will fall.
4. They do not link the market cost of capital to the VaR or EaR measures. As a result, the performance measures cannot properly relate to the shareholders' value. Equation (15) appropriately links the top-down approach to the bottom-up approach in risk measures ensuring consistency between market returns and expected returns via the corporate model.
5. They only offer a measure of comparison without setting a hurdle rate suggesting which performances are unacceptable. Equation (15) uses the risk-free rate.

### D. Analyzing the Cost of Required Surplus

#### 1. Product Profitability

A product that has a positive spread may not be a profitable product for the financial institution. This is because there is a required surplus that requires the allocation of capital. Further, the risk of the product may result in lowering the equity value of the financial institution. Suppose a marginal increase in a sale of liability leads to a marginal increase in surplus and the relationship is:

$$dS = k dL \tag{16}$$

The increase of surplus (dS) (for simplicity) is assumed to be externally financed. The change of the equity value of the original shareholder is given as dE.

$$(dE + dS)(c - g) = r_a (1 - t) dS + sp (1 - t) dL - g dS \quad (17)$$

For the product to be profitable at the margin, we require  $dE > 0$  or:

$$sp (1 - t) > k [c - r_a(1 - t)] \quad (18)$$

That is, the after tax returns for \$1 increase in new business should exceed the funding cost of the required surplus for the marginal increase in liability. The funding cost being the cost of capital net of the after tax return of the asset returns.

## 2. Risk Capital

When we change the mix of the investment portfolio, we may require a higher surplus. Therefore the increase in the asset return has to be higher than the marginal cost of the increase in surplus. For example, for banks, the Basle Accord requires 8 percent on the specific risk of equity position to be held as risk capital. Similar risk capital requirements are also imposed on insurance companies. Suppose that the increase in surplus is related to the change in return by:

$$dS = A b d r_a \quad (19)$$

A is the asset value and b is the proportional increase in surplus (with respect to the asset) for each unit increase in asset rate of returns. For example, if b equals 2.0, then an increase in 1% rate of return in assets would require a 2% increase in the surplus as a percentage to the asset.

$$(dE + dS)(c - g) = S (1 - t) d r_a + r_a(1 - t) dS + d r_a (1 - t) L - g dS$$

$dE > 0$  implies that:

$$(1 - t) > b [c - r_a(1 - t)] \quad (20)$$

That is, the cost of funding the increase in surplus should be less than the after tax of \$1 value. The left-hand side of equation (20) is the after tax value of the \$1.

## 3. Convexity charge

Suppose we sell dX non-callable and buy callable and the trade leads to an increase in required surplus, dS. Suppose the requirement is:

$$dS = e dX \quad (21)$$

Suppose e equals 1%, and that means for an increase of the portfolio position in callable bonds, we require a surplus of 1% of the increase in the value. The trade results in a change in the average portfolio return. So, the increase in the portfolio return is:

$$d r_a = dX (r_1 - r_2) / A$$

where  $r_i$  are the returns of the portfolio, with bonds with convexity and without convexity.

Then we have:

$$(r_1 - r_2) (1 - t) > e [c - r_a(1 - t)] \quad (22)$$

Equation (22) can be applied for S&P convexity charge. Specifically, S&P requires a surplus equal to the short-fall of value of a bond with negative convexity compared to an option-free bond of the same duration with a shock of 300-basis-point parallel shift of the yield curve. This is called the convexity charge. We have:

$$50C (0.03)^2 dX = dS$$

where the number 50 comes from the definition of convexity within the context of this paper. Using equation (21), we therefore have,

$$e = 50C (0.03)^2$$

Hence, substituting this equation to equation (22) we have:

$$(r_1 - r_2) > 50C (0.0009)[c - r_a(1 - t)] / (1 - t) \quad (23)$$

That is, the funding cost time the convexity factor should be less than the after tax increase returns of the portfolio after using the option embedded bonds. Note that the increase in the portfolio returns are based on option adjusted basis, excluding the increase of yield due to selling the options.

These analytical results will be used in the following section to analyze the cost of holding surplus for an insurance company.

## E. Numerical Example

To illustrate the methodology, we use a hypothetical insurance company's financial data to present an example. We will call this company Performance Insurance Company, and will discuss the pertinent financials of the firm. Then we will use a beta decomposition method to identify the appropriate beta for the life company. As a result, we focus our analysis of the life company and show how we can calculate the cost of required surplus numbers using the analytical results of Section D.

### 1. Market Data and Performance Insurance Company Financial Data

First we analyze the company business units and market financials. The company has three main business units: life, financial services and asset management. The company is publicly traded with the stock price currently at 90, and the number of shares outstanding being 74 million. Therefore the market capitalization is \$6,660 million. There is negligible long-term debt outstanding from the capital structure point of view. We may consider the company as an "all equity" company in this sense.

The stock volatility is 20.96 percent. The beta of the stock is 0.84, using S&P index as the market index. We assume that the risk-free rate for Capital Asset Pricing Model to be 6 percent. The excess return of S&P index over the risk-free rate (the risk premium) is 6.90 percent. Then the cost of capital for the company is:

$$\begin{aligned} c &= 6.00 + 0.84(6.90) \\ &= 11.796\% \end{aligned}$$

### 2. Beta Decomposition

Using historical returns of each of the businesses, we can calculate the contribution of each business to the stock beta (see Grinold and Kahn.) For this example, the management considers beta of the stock as a correct measure of risk. Hence the corporate model is based on the decomposition of the beta risk. The decomposition ( $w_i$ ) are given by:

**Table 1**

	$w_i$	$\sigma$	$E_i/E$	$(c_i - r)/ \text{risk premium}$
<b>Life</b>	0.47	17.68	0.46	1.03
<b>Financial Services</b>	0.31	15.53	0.32	0.96
<b>Fixed Income Management</b>	0.22	16.96	0.22	0.27

Alternative measures of risks may be considered. For example, management may consider the risk of stock volatility. In this case, we can calculate the contribution of risk to the volatility of the stock, particularly as it relates to the net of the unsystematic risk. **Sigma** shows that the volatility of each business can be calculated. We can then determine the risk contribution of each business unit in relation to stock volatility using their correlations to stock returns.

Now we apply the corporate model and we can determine the  $E_i$  and  $c_i$ , where the results are presented as  $E_i / E$  and  $(c_i - r) / \text{risk premium}$  in their derived form. We show that **Life** is a major line of business, and we also see that it is somewhat risky with beta 1.03.

There are other factors contributing to stock value, for example, trading activities and leverage. However, these factors are shown to be somewhat insignificant.

### 3. *Life Business Analysis*

The life business sells term life, annuities, and GICs. Market valuation of the liability (L) is calculated to be \$30,665 million. The market valuation of the assets (A) in the general account is calculated to be \$31,555 million. The surplus (defined as A-L) is therefore \$890 million. We will assume that this surplus is the required surplus. According to the risk allocation discussed above, the equity (E) of the Life Business is \$3,063 million ( $\$6,660 \times 0.46$ ).

These numbers show that S/E and L/E (the surplus ratio and the liability ratio) are 0.29 and 10.01. The tax rate (t) is estimated to be 22 percent.<sup>1</sup>

The cost of capital is calculated to be:

$$c = 0.06 + 1.03 (.069) = 13.107\%$$

The asset returns on average ( $r_a$ ) is 6.50 percent, the spread net of all expenses on a before-tax basis is 1 percent, and the growth rate (g) is 5.1 percent. Under these estimates of the parameters, we find that the expected return agrees with the required return (the cost of capital). The process of estimating these parameters is called calibrating the corporate model.

Namely, according to the expected returns model, Equation (9):

$$\begin{aligned} c &= 0.29 (0.065)(0.78) + 10.01 (0.01)(0.78) + .051 (1 - 0.29) \\ &= 12.9\% \end{aligned}$$

In summary, the analysis shows that the Life Business is assigned \$3,063 million equity for its contribution of net income and risks to Performance Insurance, and a target return of 12.9 percent on an after-tax basis. To achieve this performance, the investment return has to reach 6.5 percent and the spread 1 percent with a growth of the in-force business of 5.1 percent. The asset management and the liability management are both given the asset benchmark and liability benchmark portfolio to outperform. The

<sup>1</sup> The tax rate is the marginal corporate tax rate. We should note that the tax rate used in this example is for illustrative purposes and is somewhat low in today's tax environment.

asset and liability benchmark portfolios will incorporate these target returns and the business unit will also be responsible for the growth. Asset liability management, trading, and treasury department may add excess returns to these target performance benchmarks by taking market timing risks. These returns will be attributed to them as they outperform their respective benchmarks. The out-performing of benchmarks as used in transfer pricing is discussed by Wallace (1997).

Using VaR analytics, according to equation (6e), we can determine the contribution of risk by each business unit to the Life general account. Therefore, we can decompose the risk of the Life Business to Term Life, Annuities, and GICs. Using this decomposition of risks and the value of the Life Business (\$3,063 million), by applying the corporate valuation model, we can determine the equity and hence the cost of capital to each product line. That in turn determines the revenue target and growth target of each product line. This procedure therefore ensures the consistency of the top down approach in setting the performance benchmarks and the bottom up valuation process. It is important to note that both top down and bottom up processes are calibrated by market data, and thus we are assured to enhance stockholders' value by appropriately incorporating market assessments of risks and time value of money.

#### 4. *Cost of Required Surplus*

When we sell a particular product, a certain surplus is required. A high level of required surplus would make the product unprofitable. In applying product profitability equation (18), we have:

$$k < 15.82\%$$

This means that for the Life business, if the product requires more than 15.82 percent in reserve, then the sale of the product would decrease the firm's equity value, assuming that the product maintains a spread of 100 basis points as specified in this numerical example.

On the asset side, rating agencies and regulators are imposing a higher required surplus for holding assets with embedded options. These assets include callable bonds and mortgage backed securities. Suppose we need to hold an additional 2 percent of such assets as surplus, then we can calculate the additional returns of these assets to justify their purchase. It is important to note that, the additional returns are not identified by the increase in current yield, or higher yield attributed to the option cost. The additional return is an increase in returns on an option adjusted basis (increase in OAS).

Assuming a 2 percent capital charge for callable bonds and using equation (20), we have:

$$0.02 = dS/A = b d r_a < (1 - t) d r_a / [c - r_a(1-t)]$$

$$d r_a > 20.0 \text{ bps}$$

The results show that an option embedded bond has to provide an additional 20.0 basis points to pay for the cost of surplus.

Similarly, some insurance companies are considering investment in equity to provide higher returns. However, risk-based capital requires a significant required surplus for the holding in equity. When using equity, we assume the charge to be 50 percent. Then, we have:

$$0.5 = b dr$$

and we have, using the above analysis,

$$dr > 5\%$$

That is, the equity return has to deduct 5 percent for the capital charge.

Finally, we can also apply the analysis to calculate the convexity charge determined by S&P rating agency. Using equation (23), we have:

$$r_1 - r_2 > 0.00451C$$

The result shows that the charge is 45.1 basis points for each convexity unit lower than the corresponding option-free bonds. Typically, a current coupon FNMA passthrough has convexity of -0.6. That means the change in convexity is about -0.77. (The convexity of a bond with similar duration is 0.17.) The convexity charge is therefore 34.7 basis points. Since this charge is calculated on an option-adjusted basis, we need to deduct this charge from the FNMA OAS. Currently, FNMAs are trading with OAS at a tight spread of 38 basis points. We can see that S&P convexity charge is onerous

To a large extent, both insurance companies and banks in managing balance sheets use fewer liquid assets to gain higher spreads, since providing insurance and banking products requires less turnover in the investment portfolio. Managing a balance sheet in this sense is different from managing a hedged fund for total returns, for example. However, if regulators and rating agencies require excessive surplus for the industry to perform this market intermediation, the effect would be making both banking and insurance companies less competitive in the market place. Further, these rules and regulations may also affect the competitiveness of insurance and banking relative to each other. The numerical example in this section illustrates the seriousness of the cost of holding surplus to the insurance industry.

## F. Conclusion

This paper provides a model in capital allocation and performance measurement that is consistent with the maximization of shareholders' value. The analytical framework is consistent with a partial equilibrium model, ensuring consistent relative valuation according to Modigliani and Miller theory. While this paper focuses on stockholder value, the framework is appropriate to non-public companies as well, including mutual insurance companies and regional banks. Much has been discussed about how the information of public companies can be used for the management of private companies. (See Copeland and Weston, 1979). These discussions can be used to support the hypothesis of this paper.

Many issues challenging the participants in the banking and insurance industries were addressed. For the corporate managers, this paper shows that they should undertake a development of an integrated capital allocation and performance measurement system. To date, capital allocation or surpluses for business units are often determined either by regulatory rules or by some rule-based methodology. They are often not consistent with market valuation and corporate planning. The proposed corporate model integrates the planning and performance measures to maximize the shareholders' value. Capital allocation is not a passive process determined by regulation, but an active process, encouraging the business units to compete for funds.

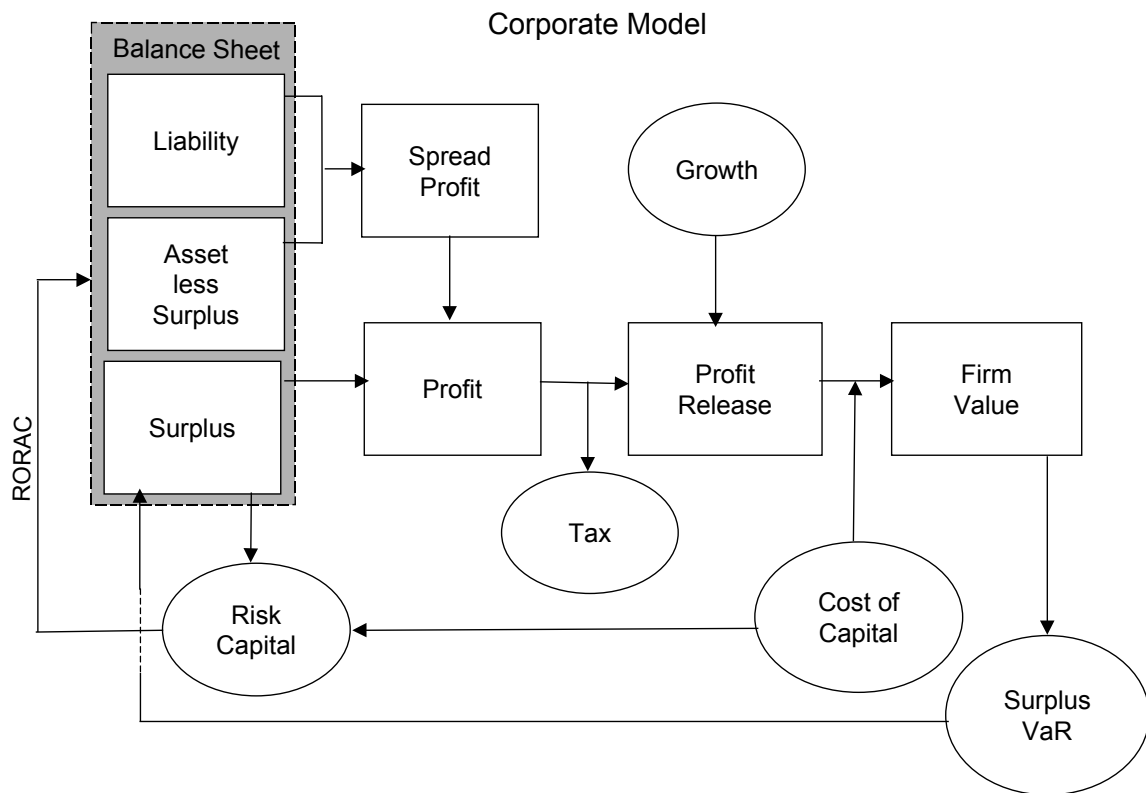
Asset Liability management and Treasury functions are integral parts of the management process of a bank or insurance company. Yet, to date, often there is no clear assignment of authority and accountability for these functions within the process. In part, this is the result of the paucity of clear measures of the performances of these functions. The corporate model enables financial institutions to develop benchmarks and transfer pricing systems that can attribute performances to these functions. Further the corporate model can be used to evaluate innovations for managing the balance sheet risk as exemplified by Stalder and Straub (1998).

For risk management, this study provides a framework for integrating risk measures and analysis with corporate management, specifically, capital allocation and determination of the cost of capital. As a result, risk management provides a corporate function beyond the risk-monitoring role. This paper also offers alternative measures to commonly used RORAC. Commonly used RORAC does not take diversification or natural hedging into account. Subsequently, we are overstating the cost of risk relative to the risk of the firm. If we scale the risk to each business unit such that the sum of the adjusted earning at risk equals the total risk of the firm, then we are not rewarding the businesses that act as natural hedging or

diversifying the firm's risk. The proposed measure in this paper eliminates this and other shortcomings of these measures.

It has been revealed that line managers have two related performance targets for achieving the goal of increasing shareholders' value. One is to achieve the growth target of sales and the other is achieving the risk-adjusted return exceeding the hurdle rate. The formulation of these targets has also been provided. These targets may be represented by benchmark portfolios (portfolios that satisfy corporate performance targets), and the business units' performance is measured against these portfolios.

The corporate model presented here is used to provide a framework of analysis and numerical results to illustrate the cost of some of the regulations and rules to the banks and insurance companies. The results suggest that these rules can be quite onerous and they may result in uneven treatment of capital market participants. The cost of these public policies may have a significant long-term impact on the industry, as financial services are rapidly becoming globally integrated and globally competitive. The diagram below summarizes the relationships between the balance sheet and the firm's value via the corporate model.



For product pricing, corporate planning, and merger/acquisition this paper offers profitability measures that are consistent with market valuation and, as a result, pricing and planning are directly related to the market valuation of the shareholders' value. To date, both in product pricing and corporate planning, income simulation or free cashflow projections are used. Often, these approaches simulate future after-tax free cash flows under some assumptions about the market place. For example, the choice of discount rates is often ad hoc. Firms may often use a discount rate that represents the firm's cost of equity, irrespective of the risk of the product, or marginal contribution of the product risk to the firm, or independent of the debt equity leverage level of the firm. These assumptions violate the basic relative valuation of the capital market, leading to misallocation of the bank or insurance companies' capital. In contrast, the corporate

model uses the market observable information to relate to their decisions and therefore the measures are related to stockholders' values.

This research begins to address the many important issues confronting banks and insurance companies today. There are many directions in which future research may extend. One extension may be including the accounting impact of the tax effects. Book accounting (STAT or GAAP) is important in the management of financial institutions. Adjustments to these implications can be made to this basic approach. Girard has shown how one can capture of the differences between the accounting numbers and the market numbers in the cashflow analysis. Another extension may be to use the corporate model presented here to empirically estimate the model parameters, enabling research to compare the cost of funds across insurance and banking industries.

## Appendix A

### Modigliani - Miller Theory

The theory assumes that:

1. The market is frictionless
2. Individuals can borrow and lend at the risk-free rate
3. There is no bankruptcy cost
4. Firms issue only two types of claims: risk free debt and equity
5. Corporate taxes are the only form of government levy (i.e. there are no wealth taxes on corporations and no personal tax).

Then the theory using arbitrage arguments states that the firm value is not effected by the leverage other than the tax shield on the debt, as the interest cost can be deducted as an expense. This theory implies that the discount rate of a business or a project should depend on the risk of that business or that project, and not necessarily the cost of equity of the firm. Also, the cost of equity increases with the debt equity ratio of the firm and therefore the cost of equity depends on the firm's capital structure.

## References

- Copeland, Tom; Koller, Tim; Murrin, Jack; *Valuation: Measuring and Managing the Value of Companies*, McKinsey & Company, Inc., John Wiley, publishers, New York, New York, 1994.
- Froot, K. and Stein, J., "Risk Management, Capital Budgeting and Capital Structure Policy for Financial Institutions: An Integrated Approach," NBR Working Paper #5403, 1995.
- James, Christopher, "RAROC Based Capital Budgeting and Performance Evaluation: A Case Study of Bank Capital Allocation," The Wharton School, University of Pennsylvania, 1996.
- Girard, Luke N., "Fair Valuation of Liabilities—Are the Appraisal and Option Pricing Methods Really Different?" *Risks and Rewards*, No. 25, pp. 1,5-7, March, 1996.
- Grinold, Richard C., and Kahn, Ronald N., *Active Portfolio Management: Quantitative Theory and Applications*, Richard D. Irwin, Inc., 1995.
- Ho; Scheitlin, Alex and Tam, Kin; "Total Return Approach to Performance Measurement" in E. I. Altman and I. T. Vanderhoof, editors, *The Financial Dynamics of the Insurance Industry*, Burr Ridge, IL, Irwin, 1995.
- Ho, "Using VaR to Manage a Bond Portfolio," in *Value at Risk: A New Tool for the Risk Management of Financial Institution*, Korean Institute of Finance, publication forthcoming.
- Matten, Chris, *Managing Bank Capital: Capital Allocation and Performance Measurement*, John Wiley & Sons, Ltd. Publishers, West Sussex, England, 1996.
- Modigliani, F., and M. H. Miller, "The Cost of Capital, Corporation Finance, and the Theory of Investment," *American Economic Review*, June 1958, pp. 261-297.
- Reitano, Robert R., "Two Paradigms for the market Value of Liabilities", *North American Actuarial Journal*, Volume 1, Number 4, October 1997.
- Saunders, Anthony, *Financial Institutions Management: A Modern Perspective*, Second Edition, The McGraw-Hill Companies, 1997.
- Stalder, Marco and Staub, Bernhard, "Managing Early Repayment Risk", publication forthcoming, *Balance Sheet*, Spring 1998.
- Stein, J., "Internal Capital Markets and Competition for Corporate Resources," forthcoming, *Journal of Finance*.
- Wallace, Marsha, "Performance Measurement Using Transfer Pricing", Transamerica working paper, July 1997.