On accounting flows and systematic risk

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The body of work that relates accounting numbers to market measures of systematic equity risk was largely undertaken in the 1970s and early 1980s. More recent proposals on changes in accounting disclosure of risk mean that a rigorous theoretical model of the relationship between accounting measures and market measures of risk is timely. In this paper, such a model is developed. In addition, the assumptions required to develop the model are explicitly identified and explored. The model that has been developed highlights a clear relationship between accounting and market measures of risk. This relationship may prove particularly useful in situations where market data (security prices) are limited or not available for risk estimation, but where accounting data do exist.

Introduction

Work that relates accounting numbers to market measures of systematic equity risk was largely undertaken in the 1970s and early 1980s (Ryan 1997). More recent proposals on changes in accounting disclosure of risk (Scholes 1996) mean that a theoretically sound model of the relationship between accounting measures and market measures of risk is timely. In addition, the finding that earnings variability is the accounting variable related most strongly to systematic equity risk (Beaver, Kettler & Scholes 1970; Rosenberg & McKibben 1973; Myers 1977) suggests that a disaggregation of this number into the operational aspects of a firm that drive the earnings number might improve the empirical relationship between accounting estimates of beta and its market realisation. In this paper, a rigorous theoretical model of the relationship between accounting flow variables and systematic market risk of equity is developed.

Identification of this relationship is helpful on a number of fronts. Firstly, the instability of market betas over time means that ex post measures of market risk are not good predictors of future risk. Identification of an appropriate relationship between accounting variables and market risk could lead to improved predictive models of future market risk. Secondly, financial models of risk (such as the Capital Asset Pricing Model (CAPM)) do not identify the operational factors and environmental contingencies that influence risk. An accounting model gets closer to the identification of economic fundamentals that drive such relationships. Finally, interest in this relationship is further fuelled by being of practical use in situations where market estimates of risk are unavailable. Conventionally, these have been considered as situations such as the estimation of risk for private companies, initial public offerings or divisional capital budgeting. However, the transformation of former command economies to market economies and the growth in the number of developing economies where security markets are not fully developed creates a situation where theoretical models of risk assessment that can be used in the pricing of companies for privatisation purposes are at a premium.

The remainder of the paper is set out as follows: the previous literature in this field is briefly reviewed; the model is then developed, along with preliminary consideration of the relationship between the theoretical model developed and its empirically testable equivalent; and concluding remarks are made in the final section.

Previous research

Work in this field can be usefully divided between theoretical and empirical studies. The empirical work has largely been unguided by a theoretical model (Foster 1986). This has resulted in regressions of market measures of market beta on various accounting measures of risk (Beaver et al. 1970; Pettit & Westerfield 1972; Breen & Lerner 1973; Rosenberg & McKibben 1973; Thompson 1974; Lev 1974; Lev & Kunitzky 1974; Bildersee 1975; Beaver & Manegold 1975) or the use of accounting number analogues to market-derived measures of

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risk (Hill & Stone 1980). Given the lack of rigorous theory underlying these various models and the often high correlation between the accounting variables, these studies identify quite different significant explanatory variables. What does appear common across the studies, however, is that earnings variability is the most significant accounting variable in explaining risk, that both accounting variables and other information are useful in the assessment of risk, and that substantial room remains for additional research (Ryan 1997).

The theoretical work began with Hamada (1972) and Rubinstein (1973), who identified the multiplicative impact of financial leverage on the beta of the levered firm. Their, by now, well known result is that:

$$\beta_L = (1 + \frac{DFL}{1 - DOL}) \beta_U$$

where:

- $\beta_L$ = the levered firm's common stock beta,
- $\beta_U$ = the unlevered firm's common stock beta,
- DFL = the degree of financial leverage,
- DOL = the degree of operating leverage,
- $\delta$ = the corporate income tax rate,
- $D$ = the market value of debt, and
- $E$ = the market value of common equity.

Whilst was called operating risk, Rubinstein (1973) recognised that it reflected the combined effects of operating leverage, the pure systematic influence of economy-wide events and uncertainty surrounding the firm's operating efficiency. Lev (1974) separated operating leverage from the other two variables and found it to be individually significant.

Mandelker & Rhee (1984) explicitly incorporate measures of the degree of operating and financial risk into their theoretical model and arrive at the following relationship:

$$\beta_t = \beta_U + \lambda DFL + \delta DOL + \epsilon$$

where:

- $\beta_t$ = the levered firm's common stock beta,
- $\lambda$ = the degree of financial leverage (degree of operating and financial leverage) rather than market stock numbers (level of operating and financial leverage).
- DFL = the degree of financial leverage
- DOL = the degree of operating leverage
- $\delta$ = the corporate income tax rate
- $D$ = the market value of debt, and
- $E$ = the market value of common equity.

A major contribution of the Mandelker & Rhee (1984) model over Hamada (1972) and Rubinstein (1973) type models is that they utilise leverage values based on accounting flow numbers (degree of operating and financial leverage) rather than market stock numbers (level of operating and financial leverage). In the Hamada model, for example, both the value of debt and equity are stock measures and, theoretically, should be market values. However, Bowman (1980) found that the market value of debt was not significant in assessing the effect of financial leverage on risk, but this may be attributable to the noise in his estimates of the market value of private debt (Ryan 1997). The difficulty of finding a market value of debt in many cases has led researchers (for example, Chance 1982) to use accounting book (stock) values of debt in leverage estimates. The use of book values is a major limitation on the subsequent leverage measures, as it effectively constrains the leverage measure to be a static one that is unable to respond and reflect the changing relative costs of equity and debt. The use of flow equivalents avoids this problem, even when using accounting data, and ensures that the resultant leverage measures are dynamic and responsive to changes in the economic environment.

Defining the degree of total leverage (DTL) as the percentage change in net income that results from a 1% change in sales, the degree of financial
leverage (DFL) as the percentage change in net income that results from a 1% change in earnings before interest and taxes, and the degree of operating leverage (DOL) as the percentage change in earnings, before interest and taxes (operating income), that results from a 1% change in sales, we have, by definition, that:

\[ \text{DTL} = \text{DFL} \times \text{DOL} \]

Unfortunately, the Mandelker & Rhee (1984) model suffers from two problems as a rigorous, accounting-based theoretical model of levered risk. Firstly, the impact of utilizing accounting proxies for market measures of return is not explicitly recognised within the model and, secondly, their measure of the intrinsic business risk of the company incorporates both an accounting measure of profit and a market measure of value. The former is subject to accounting manipulation under different codes of generally accepted accounting principles (GAAP), while the latter is a non-accounting measure of value. Our intention in the next section is to develop a rigorous model that defines basic business risk utilising only published accounting data as free from accrual adjustments, which may vary from jurisdiction to jurisdiction, as possible.

**Model development**

Our model builds from the basic accounting equality:

\[
\text{NI} = (S - VC - FC - I)(1 - t)
\]

where: \( \text{NI} = \) net income,
\( S = \) sales,
\( VC = \) variable costs,
\( FC = \) fixed costs,
\( I = \) interest payments, and
\( t = \) the company average and marginal tax rate.

and thus, taking present values, leads to:

\[
\text{PV(NI)} = (\text{PV(S)} - \text{PV(VC)} - \text{PV(FC)} - \text{PV(I)})(1 - t)
\]

Applying the linear additivity of systematic risk (Brealey & Myers 1993) and replacing \( \text{NI}/(1-t) \) by earnings before interest and tax (EBIT) minus interest, equation (2) can be expressed as:

\[
\text{PV(NI)} = \text{EBIT} - \text{I}
\]

Where:

\[
\text{Cov}(\text{change in dividend adjusted value of equity, change in dividend adjusted value of total market equity}) = \text{Covariance}(\text{change in dividend adjusted value of total market equity})
\]

\[
\text{Variance}(\text{change in dividend adjusted value of equity, change in dividend adjusted value of total market equity})
\]

\[
\text{Covariance}(\text{change in sales, change in dividend adjusted value of total market equity}) = \text{Variance}(\text{change in dividend adjusted value of total market equity})
\]

\[
\text{Covariance}(\text{change in variable costs, change in dividend adjusted value of total market equity})
\]

\[
\text{Covariance}(\text{change in fixed costs, change in dividend adjusted value of total market equity})
\]

\[
\text{Covariance}(\text{change in debt value, change in dividend adjusted value of total market equity})
\]

Under the normal (see, for example, Brealey & Myers 1993) simplifying assumptions that:

1. \( \text{Cov} = \), and
2. \( \text{Variance} = \),

equation (3) simplifies to

\[
\text{PV(NI)} = \text{EBIT} - \text{I}
\]
The coefficient of represents 1 plus a stock measure of total leverage. In order to convert this model into one that uses the flow measure of degree of total leverage, two further assumptions need to be made:

3. the discount rate on all variables is equal, and
4. the growth rate on all variables is equal.

Given the presence of interest and fixed costs, the appropriate discount rate would appear to be the risk free rate, and the presence of interest would indicate a zero level of growth. However, it is only the equality of these rates, rather than their values, that is important, and under these conditions, equation (4) simplifies to:

\[ \text{DTL}_f = \text{the degree of total leverage based on actual accounting data and assuming riskless debt and fixed costs.} \]

Thus we now have a model for levered based upon disclosed accounting variables. The model is, of course, very similar to the Mandelker & Rhee (1984) model, except that their measure of intrinsic business risk has been replaced in this model by a measure of sales risk. These can readily be shown to be equivalent, but the present formulation has the advantage of relying only on sales rather than profit and does not include any market-based variables. In addition, the assumptions that are necessary in order to arrive at this accounting based estimate of risk have been identified explicitly. By so doing, it is possible to investigate the likely impact of each of the assumptions on this estimate of systematic equity risk.

**Assumption 1:**

The possibilities of bankruptcy mean that debt is not totally riskless, and DTLf thus overestimates the true impact of total leverage on common equity. The extent of the overestimation will be directly, and linearly, related to the bankruptcy risk of debt. With regard to fixed costs, their composition is likely to be dominated by asset charges (depreciation) and (un)employment costs. While the former are unlikely to vary with general market movements, the latter risks will be absorbed by the workforce to a greater or lesser extent, dependent upon the extent of employment protection legislation. Additionally, in capital-intensive industries, any employment influences are likely to be dominated by depreciation charges, so that any impact on the estimate of equity risk is likely to be small. The net effect of risky fixed costs would again be to overestimate . The required correction would be an additive adjustment to DTL that is proportional to measures of solvency and liquidity and inversely proportional to corporate employment legislation protecting employees against unemployment.

Thus: \[ \hat{\text{DTL}} = (\text{DTL} - k_1) \]

**Assumption 2:**

On the assumption that prices include an element for variable costs, fixed costs and profit, the risk of sales revenue is likely to be greater than that of variable costs. The extent to which it exceeds will depend on the competitive nature of the industry in which a firm operates. In highly competitive industries, the importance of fixed costs and profit in the pricing equation will be smaller than in less competitive industries, and any difference between and would thus not be large. In any event, exceeding will lead to an under-estimate of the true risk of common equity by using equation (5). Again, the adjustment will be inversely proportional to industry competition and an additive adjustment to .

Thus: \[ \hat{\text{DTL}} = (\text{DTL} - k_1 + k_2) \]

**Assumption 3:** the discount rate on all variables is equal

Whatever the risk of debt and fixed costs, by definition, the risk and therefore the discount rate on EBIT will be larger. Thus, both the numerator and denominator of the coefficient of in equation (5) will decrease by the same amount. As the coefficient in equation (5) is greater than 1, this change will result in a decrease in the coefficient. In this case, the impact on the estimate of is multiplicative on and inversely proportional to \((\text{f}_{\text{EBIT}} - \text{f}_{\text{FC}})\). The most convenient indicator of this difference is likely to be the degree of operating leverage itself.

Thus: \[ \hat{\text{DTL}} = (1 + k_3)\text{DTL} - k_1 + k_2) \]

**Assumption 4:** the growth rate on all variables is equal

Improving efficiency and economies of scale should ensure that the growth of earnings before interest and taxes should exceed the growth in fixed costs and debt. This will result in a decrease in the numerator and denominator of the coefficient of in equation (5) and thus a decrease in the
Thus: \[ (1 + k_3 - k_4)DTL - k_1 + k_2 \]

**Concluding remarks**

In this paper, a theoretically valid model to estimate the systematic risk of a company’s equity has been developed. By commencing the analysis from the fundamental accounting equality, it is possible to generate a forecasting model that utilises accounting measures to the fullest extent. This is considered important because of the number of significant situations where market measures are unavailable. The model nevertheless still contains a measure of systematic sales risk that depends upon a market, but not a company-specific, measure of return. It is clearly an empirical, rather than a theoretical, issue for further research as to whether accounting proxies of such a measure provide suitable and accurate measures of systematic sales risk such that a pure accounting model can be developed.

The model generated is similar to that of Mandelker & Rhee (1984). However, their model weights the degree of total leverage by a measure of intrinsic business risk rather than sales risk. While the former turns out to be a simple linear function of the latter, the inclusion of this additional factor necessarily leads to increased measurement error on their measure of intrinsic business risk over the present simple sales risk. In addition, Mandelker & Rhee do not identify the specific assumptions made in order to convert market measures included in the fundamental equity beta definition into accounting proxies. By developing the present model from the fundamental accounting equality, it is possible to identify at each stage the assumption that needs to be made to arrive at the equivalent of their estimation model. This allows further theoretical refinement to identify the specific adjustments required. The identification of suitable proxy measures for these adjustments will be the subject of future empirical work.

**References**


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