Required Rates of Return for Corporate Investment Appraisal in the Presence of Growth Opportunities

Ian R. C. Hirst, (I.Hirst@hw.ac.uk), Heriot-Watt University
Jo Danbolt, (J.Danbolt@accfin.gla.ac.uk), University of Glasgow
Edward A. E. Jones, (Eddie.Jones@ed.ac.uk), University of Edinburgh

Abstract

Traditional methods of estimating required rates of return overstate hurdle rates in the presence of growth opportunities. We attempt to quantify this effect by developing a simple model which: (i) identifies those companies that have valuable growth opportunities; (ii) splits the value of shares into 'assets-in-place' and 'growth opportunities'; and (iii) splits the equity β into β for 'assets-in-place' and 'growth opportunities'.

We find growth opportunities for UK companies over the 1990-2004 period to average 33% of equity value. Incorporating the effect of growth opportunities, the average cost of capital for investment purposes falls by 1.05 percentage points.

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Address for correspondence:
Jo Danbolt, University of Glasgow, Department of Accounting and Finance, 65-73 Southpark Avenue, Glasgow G12 8LE, Scotland, UK.

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1. Introduction

This paper builds on an argument that was first proposed in a classic paper by Myers and Turnbull (1977). They note that the market value of the firm is made up of: (i) The present value of cash flows from assets-in-place, and (ii) the present value of growth opportunities. They further note that growth opportunities have option-like characteristics, and that this has implications for rates of return that incorporate the measurement of systematic risk. The conclusion of their paper reads as follows:

> "The risk (β) of an option is not the same as the risk of the asset the option is written on. Usually it is greater. If so, the larger the option value relative to the value of assets-in-place, the greater is the systematic risk of the firm's stock. Thus the systematic risk of the firm's stock is an overestimate of the beta for tangible assets, and a rate of return derived from common stock β's will be an overestimate of the appropriate hurdle rate for capital investment whenever firms have valuable growth options. The practical and theoretical difficulties created by this phenomenon are obvious". (Myers and Turnbull, 1977, p. 332).

This paper attempts to tackle these 'practical and theoretical difficulties'. Our main contribution is to develop a simple model, based on standard pieces in the toolkit of financial theory, to split the β of a company's shares into the two elements of 'assets-in-place β' and 'growth opportunities β'. We also adjust the cost of capital for the presence of growth opportunities, and explore the properties of the model by applying it to a large sample of UK companies.

Myers and Turnbull's argument, as well as our model, suggests growth opportunities should affect required rates of return whichever investment appraisal method is chosen. To illustrate the magnitude of the growth opportunities effect, we look specifically at the change in the value of the weighted average cost of capital (WACC) when growth is taken into account.

In the light of Myers and Turnbull's analysis, it can be seen that the traditional method of calculating the cost of capital for investment in new assets based on the weighted average cost of capital calculation is doubly flawed. Not only does it use the wrong β for equity committed to new assets; it also uses the wrong weights when combining the costs of debt and equity. The weight given to equity should be based solely on the market value of equity derived from assets-in-place, omitting the market value of the company's growth opportunities.

Our model identifies those cases (a case is a firm-year) in which companies have valuable growth opportunities. We define a growth company as one that is expected to be able to grow its dividend per share, in real terms, on a long-term basis. Assuming an equity risk premium of 6%, we find valuable growth opportunities for 51% of all cases. For these companies we find that growth opportunities account, on average, for 33% of equity value.

The conventional method of calculating cost of capital suggests growth firms have higher hurdle rates than firms with lower levels of growth opportunities. However, why should investors require higher returns from companies with growth opportunities, or accept lower returns when investing in a low-growth company? Our analysis suggests that there is in fact no such relationship – rather the reverse. When adjusted for the error identified by Myers and Turnbull, required rates of return for investment in assets-in-place are on average lower for companies with high levels of growth opportunities.

Adjusting WACC for the presence of growth opportunities lowers the hurdle rate for new investments by an average of 1.05 percentage point, from 11.08% to 10.02% in nominal terms (assuming an equity risk premium of 6%), or from 7.38% to 6.33% in real terms (adjusting for the effect of inflation). The results are somewhat sensitive to the assumed value of the equity risk premium, with larger adjustments assuming a higher risk premium. As would be expected, the adjustment to WACC is larger for companies with higher levels of growth opportunities, rising to 2.03 percentage points for the decile of observations with the highest levels of growth opportunities. Our model suggests the level of growth opportunities has varied over the economic cycle. Still, while the *level* of the weighted average cost of capital has fluctuated over time (with varying interest rates), the *adjustment* from the traditional to the adjusted cost of capital in the presence of growth opportunities appears to have remained relatively stable over our sample period.

The remainder of the paper is organised as follows: In section 2 we review relevant prior work, while in section 3 we develop and solve the set of equations used in our model for splitting the equity beta. Section 4 develops the model for adjusting the cost of capital for the presence of growth opportunities. In section 5 we apply the model to a sample of 2,571 firm years for UK listed companies, while in section 6 we explore some of the properties and sensitivities of the model. The final section sets out our conclusions.

2. Literature and theoretical foundations

Recognition that share value is divided into assets-in-place and growth opportunities dates back to work by Miller and Modigliani in 1961[1]. Kester (1984) demonstrates a practical method of decomposing share prices into the value of assets-in-place and growth opportunities. A development of this model has been given prominence in Brealey and Myers (1991 and subsequent editions). On a per share basis (where the value of one equity share is P_s), the share value due to assets-in-place (P_a) is given by:

$$P_a = \frac{EPS}{K_s}$$

The earnings-per-share (EPS), valued in perpetuity, are assumed to generate the value of the firm's assets-in-place. This cash flow stream is discounted at a rate K_s (the cost of equity capital), which is derived from CAPM (using the company's equity β).

The element of the share price due to growth opportunities, P_g, is then derived as:

$$P_g = P_s - P_a$$

Both Kester (1984) and Brealey & Myers (2003) use this model to show (based on samples of eight to fifteen companies) that growth opportunities constitute a large fraction (often above one-half) of the value of major company shares. The Kester/Brealey&Myers method[2], by valuing the assets-in-place at a discount rate based on equity β, ignores the central insight of Myers and Turnbull. The risk level for assets-in-place is not the same as the risk level for total equity. The Kester/Brealey&Myers method is a well established technique for measuring growth opportunities, but it is not satisfactory for our purpose. To develop the Myers and Turnbull analysis, we shall need a model which measures not just values for 'assets-in-place' and 'growth opportunities', but also generates the β values associated with each component.

Miles (1986) has the objective of examining the effects of growth options on firm β. Using both CAPM and Black-Scholes option theory, Miles builds a theoretical model which relates the share β, (β_s), to the assets-in-place β, (β_a). There is no attempt to apply the model to actual companies, which would be difficult, since the model requires numerical values for the elasticity of expectations and other variables, which are not directly observable. The numbers used in a table showing the relationship between the two β's are illustrative rather than empirically based.

A paper by Ben-Horim and Callen (1989) is perhaps closest in method to the present paper. They recommend the use of Tobin's Q to estimate future growth opportunities. They use the dividend discount model, as we shall do, and they demonstrate their model by applying it to a major US corporation. However, Ben-Horim and Callen do not use an asset-pricing model and are concerned only to measure the cost of equity capital defined as the return expected by investors in the shares.

Pindyck (1988) is representative of a number of papers which have offered mathematical solutions to very specific models of the firm. The Pindyck model includes a stochastic demand function for the firm's product as well as a cost function. Particularly noteworthy is his statement:

> "Thus an implication of the model is that, for many firms, the fraction of market value attributable to the value of capital in place should be one-half or less" (p. 979).

However, Pindyck's conclusions regarding the proportion of value attributable to growth opportunities does not appear to be the result of substantial empirical estimation. Rather, the paper is largely theoretical, and uses variables that are difficult to measure. The paper provides some, rather tenuous, empirical support for only one of the variables in his model, namely product price volatility.

Chung and Charoenwong (1991) examine the effect of a firm's growth opportunities on its specific risk using the Black-Scholes option-pricing model. The authors are concerned to demonstrate the general relationship, although their model could be employed at the level of the individual firm. However, Chung and Charoenwong use the book value of equity to measure the proportion of equity accounted for by assets-in-place. This is a problematic simplification. If the firm's value is partly composed of the NPV of future projects, it is surely reasonable to assume that current projects also have a positive NPV and that their market value exceeds their book value.

While prior studies, as discussed above, have addressed the measurement of growth opportunities, they do not address Myers and Turnbull's (1977) central concern that the traditional method of calculating the cost of capital based on equity β provides an overestimate of the appropriate hurdle rate for companies with valuable growth opportunities. In this paper, we aim to address this gap in the literature, by constructing a simple model – based on existing finance theories and models – for splitting the equity β into the components attributable to assets in place (β_a) and growth opportunities (β_g). We address this in the following section.

3. A model for splitting the equity β

The model is built on the following assumptions:

1. The company grows at a constant rate, g. This growth rate applies to the book value of debt, equity and all categories of assets and liabilities. It also applies to cash flows, earnings and dividends. Growth is value creating, and new projects, like existing projects, have positive NPV's. New projects are funded with the same mix of debt and equity as existing projects and this gearing ratio remains constant throughout a project's life. The dividend is set at such a level that no new shares need to be issued, and all of the variables growing at rate g are measured on a 'per share' basis. Growth is measured in real terms. The Gordon (1959) dividend-discount model can therefore be used to value the firm's shares. These assumptions create a simple and tractable model. We recognise that the dividend discount model is still valid in the presence of

share issues and share buybacks, but we do not incorporate these features into our model.

2. Asset prices are set using the standard capital asset pricing model (CAPM)[3].

3. As the company grows, its new investment projects have the same characteristics as its existing projects[4]. All projects have the same β based on the market-related risk of the present value of their future cash flows. They retain this project-β throughout their lives. Similarly, all growth opportunities have the same β, which remains constant up to the point at which they are converted, by corporate investment, into assets-in-place. At the point when investment takes place, the growth opportunity plus the (book) value of the equity investment needed to implement it are put together to become the new asset-in-place. The β of the assets-in-place (β_a) is the weighted average of the β of the growth opportunity (β_g) and the β of the cash investment (β_c). The β of cash is zero.

4. The company's debt is risk free and the book value of debt is equal to its market value. Potential future investments (i.e., the growth opportunities element) have no debt capacity. All debt is linked to assets-in-place. Given these assumptions and a constant debt-equity ratio, the level of debt plays no part in the model for the derivation of the two betas. However, corporate debt will be relevant when using the β's to derive corporate required rates of return.

We use the following definitions. The variables in bold are those we seek to estimate, while those in normal typeface are assumed to be directly observable or measurable:

D_0 The annual dividend per share, assumed to be paid just prior to the accounting year-end. (We obtain the data for the empirical analysis from Datastream).

$\mathbf{D_1}$ The next annual dividend per share, due to be paid one year from the current date.

P_s The share price as at the accounting year end (obtained from Datastream).

$\mathbf{P_a}$ The component of the share price justified by assets-in-place.

$\mathbf{P_g}$ The component of the share price justified by growth opportunities.

E The accounting year end book value of equity (per share) (obtained from Datastream).

$\mathbf{K_s}$ Investors' required rate of return on the firm's shares.

$\mathbf{K_a}$ Investors' required rate of return on equity funds used in the firm's assets-in-place.

K_f The risk free rate of interest. (We proxy this by the yield on long-term government bonds, as discussed further below. The data is obtained from Datastream).

$\mathbf{K_g}$ Investors' required rate of return on the component of the share price justified by growth opportunities.

K_m The expected return on the market portfolio. (We take this as given, although we explore the sensitivity to this assumption, as discussed further below).

β_s The beta of the firm's shares. (Obtained from the London Business School Risk Measurement Service, edited by Dimson and Marsh).

$\boldsymbol{\beta_a}$ The beta of the equity associated with the firm's assets-in-place[5].

$\boldsymbol{\beta_g}$ The beta associated with the market value of the firm's future growth opportunities.

Our objective is to show how, based on our assumptions, the other variables can be calculated from the six observed variables. Equations linking the variables are given below.

From the CAPM, we can calculate the required rate of return on the firm's equity as follows:

$$\boldsymbol{K_s} = K_f + \beta_s (K_m - K_f) \qquad (1)$$

The constant growth, dividend discount model, gives a value for the share as:

$$P_s = \frac{\boldsymbol{D_1}}{\boldsymbol{K_s - g}} \qquad (2)$$

Since the dividend grows in proportion to the other dimensions of the company, next year's dividend can be estimated as:

$$\boldsymbol{D_1} = D_0 (1 + \boldsymbol{g}) \qquad (3)$$

The price of the share is made up of the assets-in-place and the growth opportunities components:

$$P_s = \boldsymbol{P_a} + \boldsymbol{P_g} \qquad (4)$$

The firm could decide to abandon its growth opportunities. This would not be a value maximising decision, but it is a theoretical possibility. The 'price' of taking up the growth opportunities next year is E*g (i.e., the company grows its equity base at a rate g). If the growth opportunities were abandoned, the dividend would be increased by this amount. The expectation for this new level of dividend is that it would remain constant (subject to normal business risk) and can be valued as a level perpetuity discounted at the assets-in-place rate:

$$P_a = \frac{D_1 + E * g}{K_a} \qquad (5)$$

Note that the logic of this equation only works when growth opportunities are non-negative. Growth opportunities have option-like characteristics. They could, hypothetically, be abandoned and the company could carry on at its existing scale and profitability. If an equivalent 'contraction opportunity' or 'contraction option' existed it would never be exercised. The model is asymmetric. It can be applied to corporate growth but it cannot be applied to firms that are shrinking in scale. This asymmetry is a general characteristic of the 'growth opportunities' literature. Since Myers and Turnbull's observation relates specifically to companies which possess valuable growth opportunities, this feature of the model is not a problem for our purpose.

The required rate of return for assets-in-place is derived, by way of CAPM, from the beta of assets-in-place:

$$K_a = K_f + \beta_a (K_m - K_f) \qquad (6)$$

Given that a share is effectively a portfolio composed of the assets-in-place and the growth opportunities, the share beta will be a weighted average of the betas of the two components:

$$\beta_s = \frac{P_a}{P_s}\beta_a + \frac{P_g}{P_s}\beta_g \qquad (7)$$

At the point in time when a growth opportunity is converted into an asset in place, the β of the 'package' (the growth opportunity plus the equity funding (cash) needed for conversion) is equal to the β of the newly created asset-in-place. We treat the 'package' as a portfolio of two assets, and note that the β of cash (β_c) is zero.

The value of assets-in-place (P_a) exceeds the book value of equity (E) by the NPV of current projects (the assets-in-place). From our assumptions, the ratio of NPV (for the growth opportunity) to associated equity is the same at the point of investment as throughout the rest of the project's life. In addition, this ratio is the same for all the projects that make up the company's assets-in place. We have already argued that the β of assets-in-place (β_a) will be the weighted average of the β of growth opportunities (β_g) and the β of the cash needed to realise the opportunities.

What are the weights in this relationship? When the investment takes place, the total value of the new asset-in-place is made up of the amount of equity (cash) invested plus the value of the 'opportunity' (which is the investment's NPV). The proportion of the value that comes from the 'opportunity' is therefore:

$$\frac{Value\ of\ \ new\ assets-in-place \quad - \quad Value\ of\ \ equity\ investment}{Value\ of\ \ new\ assets-in-place}$$

From our assumptions, this proportion remains the same throughout the life of any project and is the same for all projects undertaken by the firm. The proportion can therefore be written as:

$$\frac{Value\ of\ \ all\ assets-in-place \quad - \quad Book\ value\ of\ \ all\ company\ equity\ investment}{Value\ of\ \ all\ assets-in-place}$$

Or, expressed on a per share basis:

$$\frac{P_a - E}{P_a}$$

Hence

$$\boldsymbol{\beta}_{\mathbf{a}} = \frac{\mathbf{P_a} - E}{\mathbf{P_a}}\boldsymbol{\beta}_{\mathbf{g}} + \frac{E}{\mathbf{P_a}}\beta_c$$

Recognising that β_C is zero, this simplifies to:

$$\boldsymbol{\beta}_{\mathbf{g}} = \frac{\mathbf{P_a}}{\mathbf{P_a} - E}\boldsymbol{\beta}_{\mathbf{a}} \tag{8}$$

This has given us a set of eight equations, and eight unknown variables: $\mathbf{P_a}$, $\mathbf{P_g}$, **g**, $\mathbf{D_1}$, $\mathbf{K_s}$, $\mathbf{K_a}$, $\boldsymbol{\beta}_{\mathbf{a}}$ and $\boldsymbol{\beta}_{\mathbf{g}}$.

The nature of the eight equations is such that the system can be solved relatively simply. The variables of particular interest here, β_a and β_g can be derived as follows:

1. As detailed in the Appendix, by substitution between equation (1), (2) and (3), the value of g is found to be:

$$g = \frac{K_f + \beta_s(K_m - K_f) - \frac{D_0}{P_s}}{1 + \frac{D_0}{P_s}} \tag{9}$$

2. D_1 is then derived from equation (3).

3. As shown in the Appendix, by substitution between equations (4), (5), (6), (7) and (8), an expression for P_a is derived as:

$$P_a = \frac{D_1 + E * g + \frac{P_s * E * \beta_s(K_m - K_f)}{P_s - E}}{K_f + \frac{P_s * \beta_s(K_m - K_f)}{P_s - E}} \tag{10}$$

4. The value of P_g is then calculated from equation (4).

5. The value of β_a is, as shown in the Appendix, derived from equations (7) and (8) as:

$$\beta_a = \frac{P_s(P_a - E)}{P_a(P_s - E)}\beta_s \tag{11}$$

6. Finally the value of β_g is then derived from equation (8).

4. Adjusting the cost of capital

When a company invests in new assets-in-place, the appropriate required rate of return must – as argued by Myers and Turnbull (1977) – be based on the risk of assets-in-place. For the equity element of funding, this is measured by the beta for assets-in-place (β_a) and not the beta for the share (β_s). The set of equations in the previous section provides a means of estimating β_a. With this, we use CAPM to adjust the cost of equity capital from that for the whole share (K_s) to the cost of equity capital for assets-in-place (K_a). The equity beta of assets-in-place would be useful whether project appraisal used the weighted average cost of capital (WACC), adjusted present value (APV) or project-specific rates. However, for illustrating the impact of adjusting the required rate of return for corporate investment appraisal in the presence of growth opportunities, we will concentrate on the adjustment to WACC.

The traditional WACC not only uses an inappropriate cost of equity capital (based on K_s rather than K_a), but also uses inappropriate weights of debt and equity. The weights used in calculating the cost-of-capital for acquiring new assets should be the proportions used for financing new assets. Market value weights are normally, and correctly, used – but the market value of equity should not include the growth opportunities element. The value of equity should therefore be based on P_a rather than P_s.

It should be noted that in the model for splitting the equity β outlined above, all growth rates, interest rates and required returns are real rates. However, we recognise that the WACC is not only a nominal rate by convention, but also that the 'after tax' adjustment for the cost of debt logically relates to the nominal cost of debt. We therefore move in the calculations that follow from real to nominal interest rates. The costs of equity for both conventional and adjusted WACC simply rise by the level of forecast inflation – i.e., we replace the rate on index-linked gilts by the rate on nominal gilts in the CAPM calculations. For the cost of debt we use the nominal rate of return on an index of corporate bonds, as calculated by Datastream[6].

For the calculation of WACC, additional information is required on the company's gearing and tax rate. We collect data on companies' liabilities (including both long-term and short-term liabilities, as well as preference shares), and assume a corporate tax rate (t) of 30%.

The traditional weighted average cost of capital formula ($WACC_s$), can be stated as:

$$WACC_s = \frac{Equity}{Equity + Debt} * Cost\ of\ equity + \frac{Debt}{Equity + Debt} * Cost\ of\ debt * (1 - t)$$

or, using the same terminology as for our equations above, this equation can be stated as:

$$WACC_s = \frac{P_s}{P_s + Debt} * K_s + \frac{Debt}{P_s + Debt} * K_{Debt} * (1 - 0.30) \qquad (12)$$

where Debt refers to the level of debt (on a per share basis), and K_{Debt} to the pre-tax cost of debt.

As argued by Myers and Turnbull (1977), the traditional WACC uses both an incorrect cost of equity capital and an inappropriate gearing ratio. The adjusted WACC can be stated as follows:

$$WACC_a = \frac{P_a}{P_a + Debt} * K_a + \frac{Debt}{P_a + Debt} * K_{Debt} * (1 - 0.30) \tag{13}$$

We next explore the implications of these adjustments empirically, based on a sample of UK companies. We acknowledge, however, a number of limitations of our model. These stem mainly from the assumptions and limitations of the theories we have used as building blocks for our model. The dividend discount valuation model is useful for companies with a steady rate of prospective growth, and which also offer dividends as a substantial element in shareholder return. We are unable to apply our model to companies not paying dividends[7]. Our model has been built on simple standard models drawn from the finance literature. We recognise the substantial and well-known limitations of the constant-growth dividend discount model, of accounting measurements of assets and equity in place, and of the CAPM.

We believe, however, that – in addition to providing a new theoretical model for splitting the equity beta and adjusting the cost of capital in the presence of growth opportunities – our model can usefully be applied to a large sample of companies to give an indication of the empirical significance of Myers and Turnbull's insight for companies' investment hurdle rates.

5. Applying the model

To explore the applicability of the model, we collect data for the UK Financial Times All-Share constituent companies over the 1990-2004 period[8]. We are able to obtain the accounting and market data from Datastream, and match this with beta estimates from the London Business School Risk Measurement Service (edited by Dimson and Marsh), for a sample of 5,059 firm-years. We obtain interest rate data from Datastream. Our model assumes knowledge of the equity risk premium. There is, however, considerable controversy as to what the level of the equity risk premium is. In the calculations that follow we assume the equity risk premium to be 6%, which is towards the middle of the estimates put forward in the literature. We explore the sensitivity of the model to the assumption regarding the level of the equity risk premium in section 6.

Since our model assumes a constant rate of growth for all the firm's basic metrics, we have to exclude cases with a zero or negative value of equity (143 cases) and with zero dividends (571 cases). As detailed in Table 1, we also remove 630 cases where the book value of equity exceeds the share price. In the model, this would imply that existing projects have negative NPV and no company would want to grow through scaling-up under these circumstances. Finally, we remove 1,144 cases of 'non-growth' companies for which the model does not generate a positive value for growth opportunities. We define a growth company as one that is expected to be able to grow its dividend per share, in real terms, on a long-term basis. This requirement is an onerous one: it is not surprising that many companies are unable to meet it. While the restrictive assumptions of the model may have led to the rejection of some growth companies from our final sample (particularly among the zero-dividend cases), the major reason why companies are not included is that they lack valuable growth opportunities and therefore do not suffer from the bias introduced to required rate of return calculations as a result of growth opportunities. Our model is able to identify and measure positive real growth opportunities for 2,571 firm-years, representing 50.82% of the initial population of 5,059 observations.

Table 1 about here

The results are reported in Table 2. We find the average proportion of equity value accounted for by assets-in-place to be 66.73%, with a residual 33.27% of equity value accounted for by the value of growth opportunities. Our model provides somewhat lower estimates for the value of growth opportunities than has generally been suggested by prior (US) studies[9]. Still, they account for a significant proportion of company value for the majority of companies, suggesting that the impact of adjusting the cost of capital in the light of such growth opportunities may be non-trivial.

Table 2 about here

Our calculations require adjustment to both weights and costs of equity in the WACC calculation. The decomposition of the equity β gives us a β for assets-in-place (β_a) averaging 0.82 compared to β_s of 0.97. The application of our model also results in a reduced average weighting for the equity component in the company capital structure (from W_s of 0.83 to W_a of 0.78), leading to a reduction in the average cost of equity capital (from K_s of 12.30% to K_a of 11.45%, assuming an equity risk premium of 6%). The impact of these recalculations is to move from an average traditional WACC of 11.08% to an adjusted WACC of 10.02% – a reduction of 1.05 percentage points – when the cost of equity capital is calculated using our model[10].

In the calculations above, we have modelled a company that only invests in one category of asset. Not all investments, of course, are pure asset investment. If it were possible for a company to acquire growth opportunities on their own, then the model suggests using a required return based on the risk of growth opportunities (β_g). If the company was making an acquisition decision where the target company's mix of growth opportunities and assets-in-place exactly matched its own, then the traditional WACC would give the appropriate rate.

6. Properties of the model and sensitivity analyses

The results reported in Table 2 are based on averages, and using a 6% equity risk premium. We next explore: (i) The sensitivity to the assumed equity risk premium; (ii) the sensitivity of the adjustment to the weighted average cost of capital to the level of growth opportunities; and (iii) the properties of growth opportunities over time.

6.1. The Equity Risk Premium.

Our calculations have so far been based on an assumption of a 6% equity risk premium. There is, however, considerable controversy as to what equity risk premium to apply in the estimation of the discount rate. A full discussion of this literature is beyond the scope of this paper (see e.g., Dimson *et al.*, (2001, 2003) and Siegel (2005)). However, while the historic long-term equity risk premium for the UK (based on 1919-1995 data) is, according to BZW (1996), approximately 9%, a number of studies argue that this is too high an estimate of the likely *future* equity risk premium, due to survivorship biases and other measurement errors. Several estimates have been put forward, including Fama and French (1999) who suggest the equity risk premium may be approximately 6% and O'Hanlon and Steele (2000) who propose 4% to 5%. Dimson *et al*, (2001, 2003) suggest the risk premium may have been between 4.5% and 6.5% up to 2001, but may be as low as 2.5% to 4% in the future. Claus and Thomas (2001) suggest it may be as low as 3% to 5%, although their estimates are based on implied discount rates for share prices during the late 1990s, when stock markets were arguably excessively high. We next explore the sensitivity of the models for calculating the percentage of value attributable to growth opportunities and the adjustment to the WACC to changes in the level of the assumed equity risk premium.

As reported in Table 3, our model is somewhat sensitive to the assumed risk premium. Reducing the equity risk premium lowers the discount rate and increases the estimated value of assets in place. This in turn leads to a reduction in the proportion of value accounted for by growth opportunities. Lowering the equity risk premium by 1 percentage point to 5%, 139 observations (representing 2.75% of the population) from the main analysis no longer yield positive estimates for the value of growth opportunities. For this reduced sample of 2,432 observations (representing 48.07% of the population of firm-years), growth opportunities, on average, account for 32% of firm value. The mean WACC adjustment amounts to 0.84 percentage points.

Table 3 about here

However, increasing the risk premium to 7%, 121 observations (2.39% of the population) excluded from the main analysis reported in Table 2 (and reproduced in Table 3) now yield positive estimates for the value of growth opportunities. For this enlarged sample of 2,692 observations (representing 53.21% of the population), growth opportunities on average account for 34% of equity value, and the mean adjustment to WACC amounts to 1.27 percentage points.

Altering the equity risk premium thus alters the number of firm-years for which our model can be applied. It does, however, also change the estimated level of growth opportunities for each firm-year observation. For the balanced sample of 2,432 observations for which we obtain positive values of growth opportunities regardless of whether the assumed equity risk premium is 5%, 6% or 7%, we find a percentage point change in the level of the equity risk premium alters the mean level of growth opportunities by more than two percentage points: A rise in the equity risk premium from 5% to either 6% or 7%, results in the mean proportion of equity value accounted for by growth opportunities rising from 32% to 35% or 37%, respectively.

An increase in the assumed level of the equity risk premium also influence the mean adjustment to the cost of capital in the presence of growth opportunities. While the mean adjustment (based on the sample of 2,432 firm-years) to WACC amounts to 0.84

percentage points assuming a 5% equity risk premium, this rises to 1.11 and 1.39 percentage points, assuming a 6% or a 7% risk premium, respectively.

6.2. The Level of Growth Opportunities.

The previous section suggests the adjustment to the cost of capital from the traditional to the revised WACC is – as we would expect – larger the higher the estimated level of growth opportunities. In this section we further explore this relationship.

In Table 4 we split the sample into deciles based on the estimated levels of growth opportunities. The Pearson correlation between the percentage of equity value accounted for by growth opportunities and the change in the estimated cost of capital is high, at 0.658 (Spearman rank correlation of 0.655)[11]. The adjustment to the weighted average cost of capital rise monotonically from a low of 0.21 percentage points for the decile with the lowest growth opportunities (averaging 2.73% of equity value) to a high of 2.03 percentage points for the decile with the highest levels of growth opportunities (averaging 78.23% of equity value).

Table 4 about here

We find there to be little variation in the equity β between the growth opportunities deciles. However, consistent with the theories of Jensen and Mekling (1976) and Myers (1977)[12], and empirical evidence by e.g., Titman and Wessels (1988) and Rajan and Zingales (1995), we find the high growth companies to have significantly less gearing than the companies with lower levels of growth opportunities. W_s (the proportion of equity in the balance sheet) rises from 78% for companies with low levels of growth opportunities, to 92% for the decile of companies with the highest levels of growth opportunities.

Conventionally measured WACC ($WACC_s$) also rises with growth opportunities, from 10.33% for the lowest growth decile to 11.97% for the highest. These numbers, however, need careful interpretation. The highest growth observations in our data set tend to come from the years prior to 2000 when interest rates were high. Our low growth observations tend to come from the final years of our data, when interest rates were substantially lower. To remove the influence of varying interest rates, the table also shows the 'WACC premium' – the value of WACC less the nominal risk free interest rate – both for conventional calculation and after Myers-Turnbull adjustment.

The conventional picture shows that high growth companies have a higher cost of capital (measured by the WACC premium). Their cost of capital is higher because they use more equity in their capital mix (78% at decile 10 compared to 92% at decile 1) and their equity, despite the lower gearing, is still just as risky. Equity β is effectively constant across the deciles (0.98 for decile 10 and 0.98 again for decile 1). The result is that the conventional WACC premium rises from 4.28% for decile 10 to 5.29% for decile 1.

After Myers-Turnbull adjustment the picture looks very different. For financing assets-in-place we find no tendency for higher growth companies to use less gearing. No 'pecking order' or 'agency' theory is needed to explain the low gearing of growth companies. There is no low gearing. Assets-in-place are financed with the same debt-equity mix by companies across the growth spectrum. The distinction is that growth companies have valuable growth opportunities, which, we argue, are not debt financed.

Table 4 also shows that the assets-in-place equity β is lower for companies with higher growth prospects. The combined effect of the lower β and the unchanged gearing is that the adjusted WACC premium actually falls as growth potential rises. It falls from 4.07% for decile 10 to 3.26% for decile 1. This result has more intuitive appeal than the traditional picture. Why should the hurdle rate be higher for investments by a high growth company than for investments by a low growth company? Surely, other factors equal, there is less risk investing in a market which may be volatile but which has an underlying tendency to grow, compared to investment in a volatile market without expected growth. After Myers-Turnbull adjustment, the numbers are consistent with this argument.

6.3. Time-Series Variations in the Levels of Growth Opportunities.

The pooled results – as reported in Table 2 – suggest growth opportunities on average account for 33% of share value. However, our fifteen-year sample period includes periods of very different economic climates, and we next explore the properties of our model estimates over the sample period.

As can be seen from Figure 1, our results suggest that the average level of growth opportunities increased slowly during the 1990s, from 33% in 1990 to a peak of 39% in 2000, before falling to a low of 24% in 2003. These time-series patterns appear to reflect changes in dividend yields driven by changes in the level of share prices. As our model is based in the dividend discount model, a decrease in the dividend yield – caused by rising share prices or reduced dividends – results in a decrease in the estimated value of assets in place, with a commensurate increase in the value of growth opportunities. With rising share prices, the mean dividend yield for the sample firms fell from a high of 3.88% in 1990 to a low of 2.08% in 2000. However, with share prices subsequently falling, there was an increase in average dividend yield, reaching a high of 2.74% in 2003.

Figures 1 about here

Adjusting WACC for the presence of growth opportunities on average lowers the cost of capital from 11.08% to 10.02% in nominal terms, or from 7.38% to 6.33% in real terms (adjusting for the effect of inflation), assuming an equity risk premium of 6%. However, over the sample period, we have seen a radical reduction in interest rates – both due to a fall in inflation and due to the market demanding lower real rates of return. The nominal interest rate on long-term government bonds fell from a high of 11.5% in 1990 to less than 5% from 2001 onwards. We have also seen a drastic fall in the *real* rate, from more than 4% during the early 1990s to less than 2% in 1999, falling to a low of 1.7% in 2004. With falling (government) interest rates, we have also seen a general reduction in the credit spread, with the difference in yield on corporate and government bonds falling from 1.3 percentage points in 1990 to 0.7 points in 2004. As a result of the falling interest rates, there have also been large reductions in the average weighted average cost of capital. However, as can be seen from Figure 2, while the *levels* of both the traditional and adjusted WACC – whether measured in either nominal or real terms – have fallen significantly over time, the mean *adjustment* to the cost of capital, in the presence of growth opportunities, has remained stable over the economic cycle.

Figure 2 about here

7. Conclusions

This paper is based on the well-established division of share value into growth opportunities and assets-in-place. It has built on the insight of Myers and Turnbull (1977) who showed that, in the presence of growth opportunities, the risk level of the company's assets will differ from the risk level of its shares. The required rate of return for asset investment should be adjusted accordingly.

We have constructed a model, based on standard elements in finance theory, which splits the equity β of a company into a growth opportunities element and an assets-in-place element, and apply this model to a sample of 2,571 UK companies over the 1990-2004 period. Our results suggest (assuming an equity risk premium of 6 percentage points) that assets in place on average account for 66.73% of equity value, leaving a residual 33.27% attributable to growth opportunities.

Using the traditional method for calculating hurdle rates, we find the cost of capital to be generally higher for companies with high levels of growth opportunities. This finding is closely linked to the lower gearing levels associated with high growth.

After making a Myers-Turnbull adjustment, we find that companies across the growth spectrum use the same proportion of debt and equity to finance assets-in-place and that high growth companies have lower required returns for asset investments. The result follows from the observation that the risk (β) associated with equity investment in new assets is lower for high growth companies.

Controlling for the effect of growth opportunities lowers the cost of capital for investment appraisal by an average of 1.05 percentage points, from 11.08% to 10.02% in nominal terms (assuming an equity risk premium of 6%), or from 7.38% to 6.33% in real terms (adjusting for the effect of inflation). The adjustments increase with the level of growth opportunities, rising from a low of 0.21 percentage points for the decile of firms with low values of growth opportunities, to 2.03 percentage points for the decile with the highest levels of growth opportunities. When adjusted for the error identified by Myers and Turnbull, required returns are inversely related to the level of growth opportunities.

Our model is somewhat sensitive to the assumed level of the equity risk premium, and the number of firm-years for which we identify positive growth opportunities increase with the risk premium. The adjustments to the cost of capital would also be somewhat higher assuming a higher equity risk premium.

Analysis of the time-series properties of growth opportunities suggests that the level of growth opportunities has varied over the economic cycle. However, while the *level* of the cost of capital also varies significantly over time (e.g., with varying interest rates), our analysis suggests the *adjustment* to the cost of capital to take account of the effect of growth opportunities has remained stable over time.

When they first recognised that growth opportunities had significant implications for the required rates of return, Myers and Turnbull (1977) referred to the "practical and theoretical difficulties" of making appropriate adjustments. Growth opportunities are difficult to measure accurately, and the dividend discount model used here, like other methods, has substantial limitations. Our analysis is, we believe, the first to try and quantify the implications of Myers and Turnbull's observations about growth opportunities, and we have demonstrated that, for companies with large growth opportunities, these implications are on a scale that has practical significance.

Appendix

The derivation of equation (9) is as follows:

- Substituting between equations (2) and (3) gives $P_s = \frac{D_0(1+g)}{K_s - g}$

- hence $K_s - g = \frac{D_0}{P_s} + \frac{D_0 * g}{P_s}$

- hence $g\left(1 + \frac{D_0}{P_s}\right) = K_s - \frac{D_0}{P_s}$

- hence $g = \frac{K_s - \frac{D_0}{P_s}}{1 + \frac{D_0}{P_s}}$

- Using equation (1) to substitute for k_s gives $g = \frac{K_f + \beta_s(K_m - K_f) - \frac{D_0}{P_s}}{1 + \frac{D_0}{P_s}}$

The derivation of equation (11) is as follows:

- Substituting the value of β_g from equation (8) into equation (7) gives

- $\beta_s = \frac{P_a}{P_s}\beta_a + \frac{P_g}{P_s}\frac{P_a}{P_a - E}\beta_a$

- $\beta_s = \frac{P_a}{P_s}\beta_a\left(1 + \frac{P_g}{P_a - E}\right)$

- $\beta_s = \frac{P_a}{P_s}\beta_a\frac{P_a - E + P_g}{P_a - E}$

- hence $\beta_a = \frac{P_s(P_a - E)}{P_a(P_a - E + P_g)}\beta_s$

- Using equation (4) we get

- $\beta_a = \frac{P_s(P_a - E)}{P_a(P_s - E)}\beta_s$

Equation (10) can then be derived as follows:

- Substituting the expression for β_a (above) into equation (6) gives
- $K_a = K_f + \frac{P_s(P_a - E)}{P_a(P_s - E)}\beta_s(K_m - K_f)$
- Equation (5) is $P_a * K_a = D_1 + E * g$
- Substituting K_a into this gives
- $P_a * K_f + \frac{P_a * P_s(P_a - E)\beta_s(K_m - K_f)}{P_a(P_s - E)} = D_1 + E * g$
- Hence $P_a\left(K_f + \frac{P_s * \beta_s(K_m - K_f)}{P_s - E}\right) - \frac{P_s * E * \beta_s(K_m - K_f)}{P_s - E} = D_1 + E * g$
- Hence we reach equation (10)
- $P_a = \frac{D_1 + E * g + \frac{P_s * E * \beta_s(K_m - K_f)}{P_s - E}}{K_f + \frac{P_s * \beta_s(K_m - K_f)}{P_s - E}}$

The derivations of the other equations are entirely clear.

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Table 1
Sample

Firm-years for which accounting, market value and beta data is available:	5,059
Less:	
- Zero or negative value for book equity (E)	143
- Zero dividends	571
- Book value of equity exceeding share price ($E>P_s$)	630
	3,715
- Calculated value of growth opportunities (P_g) negative	1,144
Sample	**2,571**

Notes:
The analysis is based on financial information for Financial Times All-Share constituent companies with accounting year-ends between 1 January 1990 and 31 December 2004. As the model incorporates the dividend discount model, companies with zero dividends are removed. Our model is unsuitable for companies with negative or zero book values or where the book value exceeds the market value of equity. Similarly, if companies have discretion in whether or not to exercise their growth options, growth opportunities should not have negative value.

Table 2
Growth Opportunities, Beta Coefficients and Cost of Capital

	N	Mean	Median	Std. Dev.	Min.	Max.	Q1	Q3
$\%P_a$	2,571	66.73	70.02	23.17	1.92	100.00	51.04	86.54
$\%P_g$	2,571	33.27	29.98	23.17	0.00	98.08	15.46	48.96
g	2,571	7.91	7.90	1.69	2.77	13.17	6.77	9.01
W_s	2,571	0.83	0.88	0.17	0.08	1.00	0.77	0.96
W_a	2,571	0.78	0.82	0.20	0.08	1.00	0.69	0.93
K_s (%)	2,571	12.30	12.05	2.36	5.84	20.21	10.58	13.86
K_a (%)	2,571	11.45	11.09	2.32	5.71	19.31	9.73	13.02
β_s	2,571	0.97	0.97	0.25	0.23	1.99	0.81	1.12
β_a	2,571	0.82	0.82	0.22	0.21	1.79	0.67	0.97
β_g	2,571	1.48	1.29	0.93	0.27	24.81	1.02	1.71
$WACC_s$ (%)	2,571	11.08	10.94	2.44	4.33	20.04	9.31	12.73
$WACC_a$ (%)	2,571	10.02	9.77	2.37	4.29	18.81	8.25	11.66
Adj to WACC	2,571	1.05	0.91	0.79	0.01	4.50	0.45	1.44

Notes:
The table is based on an assumed equity market risk premium of 6%. $\%P_a$ refers to the percentage of share price attributable to assets-in-place, and $\%P_g$ to the percentage attributable to growth opportunities. W refers to the proportion of equity in the weighted average cost of capital (WACC), based either on the traditional WACC calculation (W_s) or on the revised (W_a) model. K_s and K_a refer to the overall cost of equity and the cost of equity for assets-in-place, respectively. β_s, β_a and β_g are the beta coefficients for the share (equity), for assets-in-place, and for growth opportunities, respectively. Finally, we calculate the WACC based on the traditional model, and on our revised model.

Table 3
Sensitivity Analysis to Equity Risk Premium

	N	Percent of population	Mean	Median	Std. Dev.	Min.	Max.	Q1	Q3
ERP 5%									
$\%P_a$	2,432	48.07	67.65	71.23	23.08	2.12	100.00	52.05	87.29
$\%P_g$	2,432	48.07	32.35	28.78	23.08	0.00	97.88	12.71	47.95
$WACC_s$ (%)	2,432	48.07	10.33	10.11	2.29	4.25	18.52	8.65	11.88
$WACC_a$ (%)	2,432	48.07	9.49	9.20	2.25	4.23	17.55	7.78	11.06
Adj to WACC	2,432	48.07	0.84	0.70	0.66	0.00	3.85	0.34	1.16
ERP 6%									
Maximum sample									
$\%P_a$	2,571	50.82	66.73	70.02	23.17	1.92	100.00	51.04	86.54
$\%P_g$	2,571	50.82	33.27	29.98	23.17	0.00	98.08	15.46	48.96
$WACC_s$ (%)	2,571	50.82	11.08	10.94	2.44	4.33	20.04	9.31	12.73
$WACC_a$ (%)	2,571	50.82	10.02	9.77	2.37	4.29	18.81	8.25	11.66
Adj to WACC	2,571	50.82	1.05	0.91	0.79	0.01	4.50	0.45	1.44
Balanced sample									
$\%P_a$	2,432	48.07	64.96	68.14	22.56	1.92	99.83	49.19	83.96
$\%P_g$	2,432	48.07	35.05	31.86	22.56	0.17	98.08	16.01	50.81
$WACC_s$ (%)	2,432	48.07	11.14	11.01	3.43	4.33	20.04	9.38	12.77
$WACC_a$ (%)	2,432	48.07	10.03	9.78	2.38	4.29	18.65	8.24	11.68
Adj to WACC	2,432	48.07	1.11	0.96	0.78	0.02	4.50	0.51	1.47
ERP 7%									
Maximum sample									
$\%P_a$	2,692	53.21	66.05	69.50	23.34	1.76	99.97	50.21	85.65
$\%P_g$	2,692	53.21	33.95	30.51	23.34	0.03	98.24	14.36	49.79
$WACC_s$ (%)	2,692	53.21	11.82	11.76	2.63	4.40	21.56	9.96	13.58
$WACC_a$ (%)	2,692	53.21	10.55	10.28	2.53	4.34	19.81	8.69	12.24
Adj to WACC	2,692	53.21	1.27	1.12	0.92	0.00	5.36	0.56	1.74
Balanced sample									
$\%P_a$	2,432	48.07	62.84	65.85	22.25	1.76	99.83	46.98	81.36
$\%P_g$	2,432	48.07	37.16	34.16	22.25	0.17	98.24	18.64	53.02
$WACC_s$ (%)	2,432	48.07	11.94	11.91	2.60	4.40	21.56	10.10	13.65
$WACC_a$ (%)	2,432	48.07	10.54	10.32	2.51	4.34	19.81	8.68	12.26
Adj to WACC	2,432	48.07	1.39	1.23	0.89	0.03	5.36	0.72	1.82

Notes:

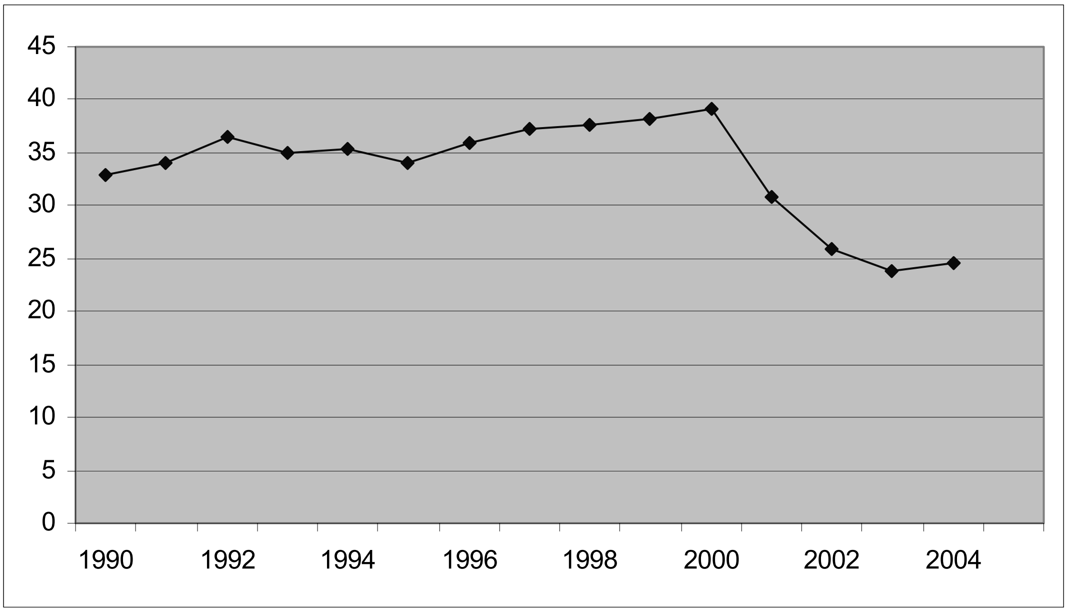
The table explores the sensitivity of our estimates of the percentage of equity accounted for by growth opportunities, and the adjustment to the weighted average cost of capital, to the assumption regarding the level of the equity risk premium. Percent of population refers to the percentage of firm-years (from the population of 5,059 firm-years, as specified in table 1) with valuable growth opportunities, based on our model. $\%P_a$ refers to the percentage of share price attributable to assets-in-place, $\%P_g$ to the percentage attributable to growth opportunities, $WACC_s$ to the weighted average cost of capital based on the traditional equation and $WACC_a$ to the weighted average cost of capital corrected to take into account the presence of growth opportunities. Equations are as specified in the paper.

Table 4
Sensitivity to Level of Growth Opportunities

	%P_g	**β_s**	**β_a**	**W_s**	**W_a**	**K_s**	**K_a**	**$WACC_s$**	**$WACC_a$**	**R_f**	**$WACC_s - R_f$**	**$WACC_a - R_f$**	**Adj to WACC**
Deciles													
1 (high growth)	78.23	0.98	0.79	0.92	0.76	12.57	11.40	11.97	9.94	6.68	5.29	3.26	2.03
2	60.60	0.95	0.77	0.87	0.77	12.47	11.38	11.48	9.94	6.76	4.72	3.18	1.54
3	49.16	0.97	0.78	0.84	0.76	12.39	11.28	11.14	9.75	6.59	4.55	3.16	1.38
4	40.51	0.96	0.77	0.85	0.80	12.31	11.04	11.24	9.91	6.53	4.72	3.38	1.33
5	33.36	0.98	0.81	0.84	0.79	12.40	11.38	11.17	10.01	6.53	4.63	3.48	1.15
6	26.62	0.97	0.81	0.86	0.82	12.50	11.58	11.44	10.45	6.70	4.74	3.75	0.99
7	19.86	0.93	0.80	0.82	0.79	12.10	11.32	10.82	10.01	6.50	4.33	3.51	0.81
8	13.55	0.96	0.85	0.80	0.78	12.11	11.47	10.69	10.06	6.38	4.31	3.68	0.63
9	8.02	0.99	0.90	0.76	0.75	12.26	11.78	10.50	10.05	6.35	4.15	3.70	0.44
10 (low growth)	2.73	0.98	0.94	0.78	0.77	11.93	11.70	10.33	10.12	6.05	4.28	4.07	0.21

Notes:
The table reports mean values, for deciles based on the proportion of value accounted for by growth opportunities. %P_g refers to the percentage attributable to growth opportunities, β_s to the beta coefficient for the share, β_a to the beta for assets in place, W_s to the proportion of equity finance in the traditional weighted average cost of capital calculation, and W_a to the proportion of equity finance in the adjusted weighted average cost of capital calculation, K_s to the traditional cost of equity capital, K_a to the cost of equity for assets-in-place, $WACC_s$ to the weighted average cost of capital based on the traditional equation and $WACC_a$ to the weighted average cost of capital corrected to take into account the presence of growth opportunities. Equations are as specified in the paper.

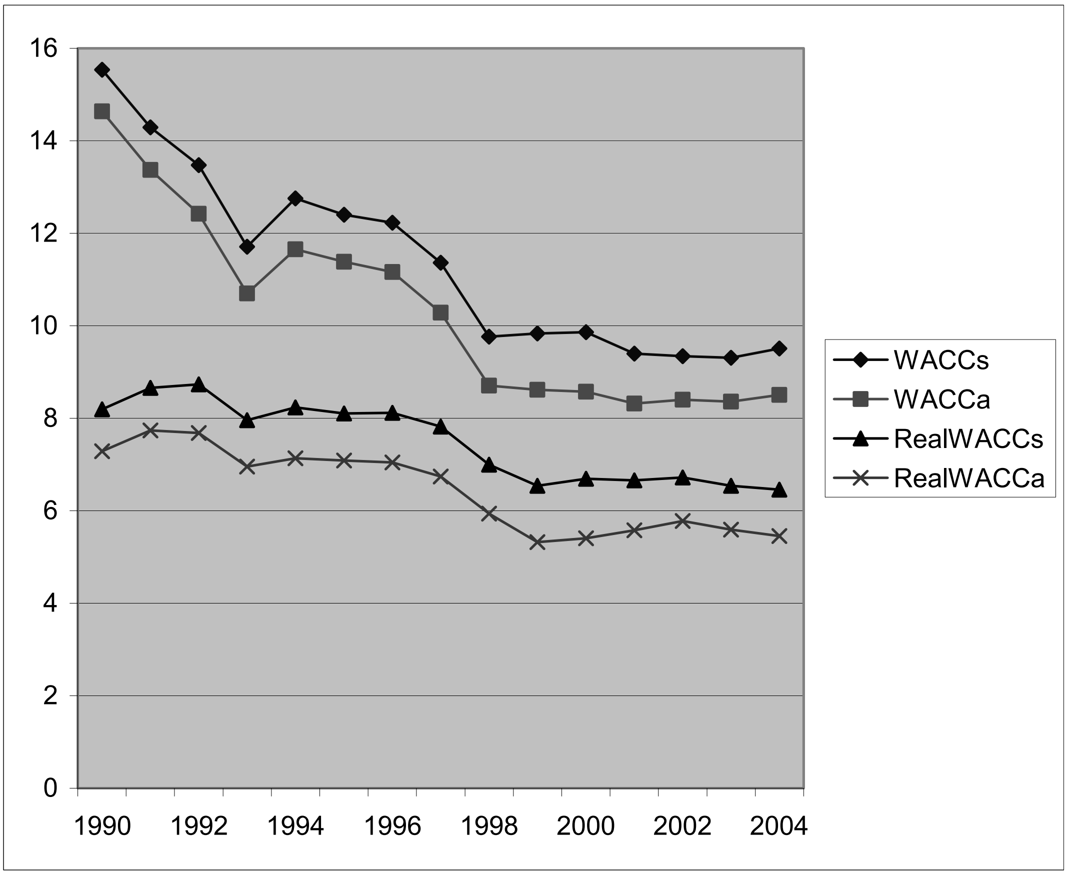
Figure 1
Percentage Growth Opportunities



Notes:
The diagram shows the time-series variation in the estimated mean percentage of share prices accounted for by growth opportunities. The estimations are based on an assumed equity risk premium of 6%, as in Table 2.

Figure 2

Percentage Weighted Average Cost of Capital



Notes:

The diagram shows the time-series variation in the mean values of the weighted average cost of capital, estimated using the traditional ($WACC_s$, as in equation 12) and the adjusted ($WACC_a$, as in equation 13) model, as discussed in the text. $WACC_s$ and $WACC_a$ are stated in nominal terms, while $RealWACC_s$ and $RealWACC_a$ are stated in real terms.

Notes

[1] Miller and Modigliani present various methods of share valuation, including the "*investment opportunities approach*". Under this approach, the worth of the enterprise to an investor "…will depend only on: (a) the "normal" rate of return he can earn by investing his securities (i.e., the market rate of return); (b) the earnings power of the physical assets currently held by the firm; and (c) the opportunities, if any, that the firm offers for making additional investments in real assets that will yield more than the "normal" (market) rate of return". (p. 416).

[2] For a critical evaluation of the Kester/Brealey&Myers method, see Danbolt *et al.* (2002).

[3] We acknowledge that the CAPM framework has been subject to criticism and is based on unobservable variables. However, while estimation is subject to some uncertainty, CAPM is to date the industry standard for calculating expected rate of return benchmarks (see e.g., the Civil Aviation Authority's reports (2001a, b) on price caps). Alternatives to CAPM, such as multi-factor models also suffer from problems of determining which factors to include (e.g., Fama and French, 1993; Chen *et al.*, 1986). The present paper requires an *ex-ante* model of expected return and hence it is appropriate to employ a CAPM framework.

[4] New projects are assumed to be identical to the company's existing projects. This is consistent with Pindyck (1988), who assumes the growth opportunities are real options to add more units of capacity in the future.

[5] Note we are using the term beta of assets-in-place to refer to the beta of equity used (alongside debt) to finance assets-in-place. It is not an 'asset beta' created by ungearing an equity beta.

[6] For the risk free interest rate we use the redemption yields on British government index linked Gilts over 5 years and on (nominal) ten year Gilts, respectively, while for company interest rates we use the yield on the Datastream index for corporate bonds.

[7] This is a relatively small problem for the UK, where the vast majority of companies pay substantial dividends. In their study of dividend payments in the UK during the 1990s, Renneboog and Trojanowski (2005) found 85% of listed companies to pay dividends, with dividends averaging more than 3.1% of market capitalisation, or 20.3% of earnings before interest and tax. Share repurchases were found to be relatively uncommon, on average used by less than 6% of UK companies. These firms also tended to pay substantial dividends. Share repurchases averaged only 0.35% of market capitalisation, or 2.33% of EBIT.

[8] Our sample includes companies with financial year-ends between January 1, 1990 and December 31, 2004.

[9] Kester (1984) found growth opportunities (for a sample of 15 companies) on average to account for more than 50% of company value; Kester (1986) found

growth opportunities (based on a sample of nine companies) to average 49%; and Pindyck (1988) suggests that growth opportunities may exceed 50% for many companies.

[10] These estimates of average WACC rates are nominal. Additional analysis, not reported in the table, suggests the average *real* WACC (adjusting for the effect of inflation), falls from 7.38% to 6.33%.

[11] These correlation coefficients are calculated based on the percentage point change in the cost of capital, calculated as [WACC traditional – WACC adjusted]. As a robustness test, we have also estimated correlations based on the percentage (rather than percentage point) change in the cost of capital, estimated as [(WACC traditional – WACC adjusted)/WACC traditional]. The correlation coefficients for this specification are very similar, at 0.648 (0.638).

[12] Growth opportunities may exacerbate information asymmetries between managers/companies and lenders. Lenders may be reluctant to provide finance if there is a potential for asset substitution or under investment (i.e., funds being diverted from positive NPV investments to alternative uses).