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Report on

"Risk Free Interest Rate and Equity and Debt Beta Determination in the WACC"

Prepared for the ACCC by

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Scope of Report

This report provides comments as requested in the terms of reference for the consultancy on

(a) the appropriate choice of maturity for the risk free rate to be used in estimation of the WACC for use in the building block model method of determining access prices

(b) the suitability of various procedures for determining equity and debt betas for use in calculation of the WACC.

In doing so, several other comments are made on the building block approach which are relevant to (a) and (b) above.

In preparing this report I have had access to a draft paper by the ACCC on the WACC, the Draft Regulatory Principles (DRP) produced by the ACCC in 1999, other material on the ACCC website, including consultancy reports by Martin Lally (and commentary on that report by Bob Officer), the Allen Consulting Group, and NECG. In addition, I have drawn upon other academic and professional literature, some of which is subsequently referenced.

Structure of the Report

The report initially makes comment on the use of the "Plain Vanilla WACC" as part of the Building Block Approach, since this is important for consideration of the core issues to be discussed. Then, the role of the risk free interest rate in the determination of WACC is discussed and commentary provided on the maturity choice which is appropriate. Also discussed is the timing of the determination of the risk free rate. The suitability of alternative approaches to estimating the cost of debt is then considered, followed by a discussion of alternative approaches to estimating the cost of equity.

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The Building Block Approach and the "Plain Vanilla WACC"

Recommendation: Use of a building block approach based on a "Plain Vanilla WACC" is currently the most practical approach for dealing with the complexities introduced by the tax system.

Analysis

The DRP adopts a target revenue specification for returns to the entity, which is after tax but which incorporates the value of franking credits which can be written (ignoring complications caused by working capital and additions to capital) as:

$$TR_t = OC_t + D_t + r_e(1\text{-}b) K_{t-1} + r_b\, b\, K_{t-1} + T_t - FC_t \qquad (1)$$

In this expression, b and (1-b) are the ratios of debt and equity respectively to assets, and r_e and r_b the costs of equity and debt. Denoting $r_o = r_e(1\text{-}b) + r_b.b$ as a (non standard) WACC (sometimes referred to as a "vanilla" WACC), the target revenue equation permits a return on funds employed (r_oK_{t-1}) plus return of capital D_t, plus coverage of operating costs OC_t, plus payment of company taxes (T_t) less the value of any franking credits distributed (FC_t). Note that TR_t refers to a target revenue calculation in which the tax cash flows explicitly distinguished as T_t are total tax cash flows including the effect of the tax shield from interest on debt. For this reason, the cost of debt enters as a before tax cost.

It can be demonstrated that the appropriate rate of return concept to use for this definition of target revenues, to ensure that the cash flows generate a zero NPV is the "vanilla WACC". Note that

- The cost of debt in the "vanilla WACC" is before tax
- The tax amount allowed for in the derivation of cash flows is calculated to include the effect of the interest tax shield (i.e. actual tax paid is used)
- The value of franking credits generated are netted against tax paid, because the cost of equity is a "partially grossed up" rate of return which incorporates the value of franking credits distributed with dividends.

This approach has the advantage of dealing with tax issues explicitly in the cash flows. Explicit modelling of tax can be incorporated, and the effect of assumptions made about such things as the value of franking credits are made transparent.[1]

One consequence of adopting this approach also needs to be stressed. The cost of equity capital (r_e) is defined as a "partially grossed up" rate of return concept which includes the valuation of franking credits distributed with dividends. This is not a rate of return observed (even ex post) in the market place, since the valuation placed by investors on franking credits is unknown.

Given the unobservability of r_e, how can it be estimated and why should it be used rather than an observed rate of return? The rationale behind the use of this concept lies in assumptions made about the underlying CAPM model of determination of expected returns on risky assets. Implicitly, it is assumed that a CAPM of the conventional form can be derived and applied if equity returns are defined this way – with the consequence that equivalent investor-level taxation applies to both risk free and (so defined) equity returns. Indeed, it can be rigorously shown that under certain assumptions a CAPM of the form;

$$r_e = r_f + \beta_e [E(r_m) - r_f] \tag{2}$$

can be derived in which both r_e and r_m are partially grossed up returns.[2]

This, however, introduces another problem of the need to obtain an estimate of $E(r_m)$ in order to apply the CAPM, when, again, r_m (a partially grossed up return) is not observable. The approach adopted is to assume that the return premium demanded after investor level tax for risky assets over risk free assets has been unchanged by the introduction of imputation. Define k_m as the return on the equity market excluding the market value of franking credits received. Then $r_m = k_m + FCV$ where FCV is the franking credit value. FCV is implicitly defined as the additional amount of cash income which would be required by investors, to offset the investor level tax consequences, if dividends received did not have franking credits attached.

Prior to imputation, equity returns did not, by definition, include franking credits and thus $r_m = k_m$ pre imputation. Also equity returns and interest were taxed similarly.[3] It

[1] This type of approach, which incorporates all tax effects in the cash flows has been labelled the "Capital Cash Flow" approach by Ruback (2002) who outlines the merits of the approach.
[2] The "Monkhouse" model of the CAPM under dividend imputation (Monkhouse, 1993) generates an equation of this form as I have demonstrated in an earlier report for the ACCC.

was possible to observe historical values for the MRP = ($k_m - r_f$) which after investor level tax would be MRP_{at} = ($k_m - r_f$)(1-t_p) where t_p is the investor tax rate. Post imputation, it is argued, the MRP_{at} should be unchanged (or at least unaffected by imputation). Since equity returns now include franking credits, the after tax return on equity is calculated by applying the investor tax rate to the "partially grossed up" return. Thus the MRP_{at} = ($r_m - r_f$)(1-t_p) and the MRP, defined as (r_m-r_f) post imputation should equal the pre imputation MRP defined (and calculated) as ($k_m - r_f$). Based on this argument it is possible to estimate the cost of equity defined as a partially grossed up return (r_e) by using the CAPM and an historically based estimate of the MRP. In practice, the assumption that the actual MRP observed pre imputation is applicable to current times or that the after tax MRP was unaffected by the introduction of imputation are open to debate.

The Choice of Maturity for the Risk Free Rate

Recommendation: The maturity chosen for the risk free rate should be equal to the length of the regulatory determination period (5 years in the case under consideration).

Preamble:

The risk free rate (r_f) is a key ingredient in the determination of the WACC. The issue of which maturity risk free rate to use has been raised in three possible contexts.

(a) It is necessary to make a choice of maturity of r_f for use in the CAPM equation (3) for the required return on a risky asset (r_a) ;

$$r_a = r_f + \beta_a [\ MRP\ ] = r_f + \beta_a [\ E(r_m) - r_f\ ] \tag{3}$$

where β_a is the asset's beta, MRP is the market risk premium defined as the excess of the expected (required) return on the market portfolio over the risk free rate.

(b) The fact that some historical estimates of the MRP have calculated its value using a particular risk free maturity has led some to argue that consistency requires use of the same maturity r_f in the CAPM

[3] In practice, differential tax treatment of capital gains meant that the tax treatment was not equal.

(c) To calculate the cost of debt for a regulated company, it is necessary to make some assumption about the appropriate maturity (and/or duration) of that debt and, typically, estimate the cost of debt by applying a margin to the risk free rate for the same maturity (duration).

These three issues will be considered in turn. It is important to be aware that the major reason for contention surrounding this issue is the premise that long term interest rates will, on average, exceed short term interest rates for reasons other than expectations of future increases in interest rates. If that is the case, use of a longer term risk free rate in calculating the WACC will lead to higher regulatory cash flows than if a short term rate is used. If, however, the gap between long and short rates reflects only expectations of future interest rate levels, the effect of choosing a particular maturity risk free rate as a benchmark to be applied at all times is minimal. Except in the unrealistic case where interest rates are expected to forever increase or forever decrease, expectations of future interest rate changes can be positive or negative and average out, over the long run, to zero. In that case, the choice is of no consequence except for two factors. One is differences in the interest rate risk characteristics of the regulated asset (to be discussed later). The second is that the temporal pattern of cash flows will differ depending on the outcomes realised for long and short term rates which eventuate.

The view that long term rates typically exceed short term rates corresponds to the premise that the implied forward interest rate (which will be the rate available in the market for futures or forward contracts) exceeds the expected value of the spot rate for that future date, by a term premium which is, on average, positive. In symbols:

$$ {}_0f_{t,t+k} = E_0\,[\,r_{t,t+k}] + P \qquad (4)$$

where ${}_0f_{t,T}$ is the forward rate observed at date 0 for the period commencing at t with maturity k; $E_0\,[\,r_{t,t+k}]$ is the expectation at date 0 of the interest rate which will prevail at date t for maturity k; P is the term premium. In practice P will vary over time and can be positive or negative. If the “expectations hypothesis” holds, the mean of P is zero, whereas the premise that long rates typically exceed short rates implies a mean for P which is positive. This means that there will be ongoing positive expected profits from “riding the yield curve” by financing long term assets by issuing short term securities. Actual profits or losses will, of course, differ, from those expected so that P can be interpreted as compensation for a systematic (priced) source of risk.

Analysis

(a) The CAPM and the risk free rate.

The CAPM is a single period model, which is applied to multiperiod cash flows. There is little guidance from theory as to what is the length of the period involved in the CAPM (and thus the maturity of the risk free rate), nor how to best adapt the model to the valuation of multiperiod cash flows.

However, it is possible to demonstrate that the appropriate maturity for use in the building block model used by the ACCC is equal to that of the regulatory period. To do this, it is useful to adopt the approach recommended by Grinblatt and Titman (2002), which approaches the CAPM from the perspective of determination of a "tracking portfolio" (abbreviated here to TP) for a risky asset.[4] Rearranging equation (3) gives

$$r_a = r_f (1 - \beta_a) + \beta_a \ E(r_m) \qquad (5)$$

which states that the expected return on the risky asset is equal to the expected return on a portfolio comprising $(1 - \beta_a)$ of a risk free security and β_a of the market portfolio. Such a portfolio is called a "tracking portfolio". The actual return on the asset will differ from that on the tracking portfolio because of the idiosyncratic risk of the asset, but this latter risk (by definition) is not priced. Since it involves purchase of a risk free security and the market portfolio, the TP is fairly priced (has a zero NPV). The TP can be set up to match the expected dollar returns on the asset and a comparison made between the outlay required on the TP and the value of the asset. Alternatively, a portfolio of equal value can be established and the expected dollar returns compared. Over a multiperiod horizon it is necessary to rescale the TP each period to reflect any cashflows generated by the asset which are not reinvested.

[4] A tracking portfolio is one which has the same systematic risk characteristics and will have the same expected return as the asset in question. The actual return may differ if the asset (or the TP) has idiosyncratic risk and a TP should aim to minimise the tracking error of the actual returns. If there were no idiosyncratic risk, such that the actual returns of the TP and the asset were always equal, the TP would correspond to a replicating portfolio as commonly used in derivative asset pricing.

Suppose a TP is established which has the same expected dollar returns as the asset. If the cost of the tracking portfolio is less than the cost of the asset, the asset has a negative NPV (and thus not worth investing in). If the cost of the tracking portfolio is more than the cost of the asset, the asset has a positive NPV.

Alternatively, consider a TP which is established which costs the same as the asset. If the expected returns of that portfolio are never more, and sometimes less, than those of the asset, the asset has a positive NPV. Conversely, if the TP generates expected dollar returns which are always greater than the asset, the asset has a negative NPV.

In the current context, it is necessary to determine the appropriate maturity for the risk free asset which gives the best tracking portfolio, and which will ensure that the regulated asset has an initial NPV of zero (is fairly priced).

To undertake that analysis, assume that a regulated asset with a 4 year life and initial value of $200 is involved, and that the regulator operates with a 2 year horizon. At date zero, target cash flows are determined for dates 1 and 2 which provide a return of capital (according to the agreed depreciation schedule) and a return on capital, based on date 0 interest rates. At date 2, the target cash flows for dates 3 and 4 are determined based on date 2 interest rates. This structure is chosen to reflect the actual situation of an asset life longer than a single regulatory period, and several years within each regulatory period. (It would be possible to adapt the analysis to a 5 year regulatory period at the cost of additional complexity and no additional insights. It is also assumed, for simplicity – and without loss of generality, that there are no operating costs).

Assume for simplicity (and without loss of generality) that the depreciation schedule involves $50 return of capital per year. The regulatory asset base (RAB) will thus be $150 at date 1, $100 at date 2, $50 at date 3, $0 at date 4. Assume that the asset beta is 0.4, such that a tracking portfolio will involve 60% of a risk free (zero beta) security and 40% of the market portfolio.

Consider first the case where the regulator calculates allowable cash flows using a 2 period risk free rate in the CAPM equation to determine a required rate of return on the asset. At date 0, the required return to apply for years 1 and 2 is r_a^0.

The tracking portfolio which involves an initial outlay equal to the RAB at date 0 comprises 60% ($120) of a two year risk free security and 40% ($80) of the market portfolio.[5] At date 1, the target cash flow for the regulated asset is a return of capital of $50 and return on capital of r_a^0 .200. This is an expected return, and the actual return may differ because (a) of idiosyncratic risk associated with the asset and (b) the actual return on the market (with which the actual asset return is correlated) may differ from the return expected at date 0. The tracking portfolio had an expected return of r_a^0 .200 at date 1. For it to generate the same expected cash flow and to maintain its relationship with the regulated asset for the next period, it is necessary to withdraw an amount of cash, such that its date 1 value is $150 and its composition remains 60:40. This withdrawal matches the cash flow of the return of capital to the regulated asset and ensures that the date 1 value of the TP matches the RAB. This involves selling $30 of the risk free security and some amount of the market portfolio. At date 0 it expected that the amount of the market portfolio to be sold at date 1 will be $20, but the actual amount will depend upon the actual return on the market (with which the regulated asset's actual return is correlated).

At date 2, the tracking portfolio is expected to deliver a return of r_a^0 .150. The risk free securities mature at this date, and $30 capital can be redeemed (leaving $60) and some amount of the market portfolio sold such that its value is $40. At date 2, the regulator resets the required rate of return to r_a^2 (based on date 2 interest rates). The tracking portfolio is then re-established by investing $60 in 2 year risk free bonds and $40 in the market portfolio. At date 3, cash is withdrawn and the portfolio rebalanced as at date 1, and at date 4 the portfolio liquidated.

This tracking portfolio provides an expected set of cash flows which equals that of the underlying asset under the regulatory determination. The actual cash flows may differ for two reasons. One is the idiosyncratic risk of the asset. The second is that the tracking portfolio has some exposure to interest rate risk associated with the sale at date 1 of bonds with maturity date 2. To avoid that interest rate risk, the TP would require purchase at date 0 of $30 of a one year bond and $90 of a two year bond. If

[5] This assumes that the beta of a two year bond is zero. In practice this is not the case and the portfolio weights should be adjusted to reflect the bond's beta. Alternatively, the tracking portfolio should be established using a (one year) bond with a zero beta.

there is a term premium in the yield curve such that $r_{01} < r_{02}$, the TP would generate less cash flows than the regulated asset. This reflects the use of a two year risk free rate, rather than some average of the one and two year rates, and is relevant for later discussion of interest rate risk.

It is clear that in this case, an outlay of $200 (the initial asset value) on a tracking portfolio (with the same risk) provides an expected set of cash flows which matches those of the regulated asset. The asset is thus fairly priced or, equivalently, the target cash flows provide adequate compensation for risk.

This demonstrates that use of an interest rate with maturity equal to the regulatory horizon in deriving the required return for the regulated asset generates expected cash flows which are fairly priced.

Consider now the case where the regulator determines the allowable rate of return r_a^0 using the four year risk free rate.

To create a tracking portfolio which has the same expected cash flows as the regulatory asset and no interest rate risk at date 2 (the next regulatory reset date) it is necessary to purchase 2 year risk free bonds and the market portfolio. As before, at date 1 the portfolio will be readjusted to match the return of capital of $50 by sale of $30 of bonds and $20 from the market portfolio. At date 2 the remaining 2 year bonds mature, cash is extracted from the portfolio to match the return of capital and funds reinvested in two year bonds and the market portfolio.

There is no interest rate risk from liquidating bonds in this TP at the regulatory reset date or at the end of the asset's life (but the same risk as in the earlier case at dates 1 and 3 from sale of bonds at those dates).

Will the TP cost the same amount to establish as the RAB? If $r_{02} = r_{04}$ (a flat yield curve) the TP cost and RAB are equal. Suppose $r_{02} < r_{04}$ solely because of expectations of an increase in short term interest rates, and that (perhaps unrealistically) there is no expectation of a change in long term rates. In that case, a purchase of $120 of two year bonds and $80 of the market portfolio will give an expected dollar return on the TP which will be less than that of the asset over years 1 and 2. Thus, it will be necessary to purchase a larger value of two year bonds such that the initial cost of the tracking portfolio exceeds $200. However, at date 3 it will be (expected to be) possible to extract a larger amount of cash from the TP than occurs with the regulated asset. This occurs because $E_0[r_{24}] > r_{04} = E_0[r_{26}]$. The higher two year rate expected to prevail at date 2, and downward sloping yield curve, creates an interest rate benefit for the TP which offsets the cost incurred in the first regulatory period.

However, if it is believed that typically $r_2 < r_4$, due to a positive (non-expectations induced) term premium[6], the yield on two year bonds is expected to be below that on four year bonds at date 2, and no such offset occurs. If the expected cash flows over dates 1 and 2 have been matched, a further injection of funds will be required at date 3 to enable purchase of sufficient two year bonds to match the regulatory cash flows based on the four year bond rate. Thus, since the TP costs more to establish than the RAB the set of regulated cash flows is such that regulated asset is overvalued.

As an alternative, consider establishing a TP involving purchasing \$120 of 4 year risk free bonds and \$80 of the market portfolio. The bonds are coupon paying bonds selling at par. This TP generates an expected dollar return equal to that of the regulated asset for date 1 and as before, the portfolio is readjusted at date 1. However, at date 2, the TP readjustment for the bond component involves selling \$90 of (now) 2 year bonds to withdraw \$30 cash and purchase \$60 of 4 year bonds paying the 4 year risk free rate prevailing at date 4. The sale price of those bonds is uncertain and involves interest rate risk. It is however possible to hedge that risk at date 0 by selling the bonds forward. However, the sale proceeds will be less than the face value if the yield curve is upward sloping at date 0.[7] Thus, the TP which is established for the same price as the RAB and structured to avoid the interest rate risk at the regulatory reset date, does not generate expected cash flows as large as the regulated asset.

This demonstrates that using a maturity for the risk free asset which exceeds the regulatory horizon, provides excess returns for the regulated asset if it is believed that there typically is a positive term premium in the yield curve which is unrelated to interest rate expectations.

[6] This could reflect higher systematic risk associated with longer term bonds which leads to a higher expected return on such

[7] This is easily demonstrated in the case of zero coupon bonds where the forward rate is $(1+{}_0f_{24})^2 = (1+r_{04})^4/(1+r_{02})^2$. The forward sale price will be $(1+r_{04})^2/(1+{}_0f_{24})^2 = (1+r_{02})^2 / (1+r_{04})^2$, which is less than 1 given the upward sloping yield curve.

(b) *The Risk Free Rate and the Market Risk Premium*

As the tracking portfolio approach (equation 2) makes clear, the critical ingredients in the determination of the required rate of return are the current risk free interest rate and the expected return on the market portfolio. The required return is, in theory, based on forward looking, expected returns. In practice, the approach often used is to apply equation (1) where the difference between the expected return on the market and the risk free rate, known as the market risk premium (MRP) is used as an input. Motivating this approach is the assumption that historical estimates of the MRP can be used as a proxy for the current expected value.

It is in this context that a second argument relating to the choice of the risk free rate emerges. Often, historical estimates of the MRP have been calculated as some historical average of the actual market return over some risk free rate. Often the risk free rate used is a 10 year government bond rate. The assertion often made is that if these estimates of the MRP are to be used in the CAPM, consistency requires use of the same maturity risk free rate.

There are a number of arguments which can be advanced against the strictures advocated by such a position.

(a) The MRP should be forward looking. Historical data provides some benchmark, but should not accepted uncritically.

(b) The method of estimation of historical MRP figures is subject to much debate. Arithmetic or geometric averages may be used (with significant effects on the result). An approach sometimes used is to compare contemporaneous 10 year bond yield to maturity with annual holding period returns on the market portfolio. This has no correspondence with the concept of the MRP in the CAPM which involves comparison of a risk free return and a market return for the same holding period.

(c) The MRP can be expected to vary over time.

(d) The historical MRP estimates are derived primarily from a period without dividend imputation and reflect equity returns without franking credits. The MRP estimate required now involves equity returns inclusive of the value of franking credits. While a plausible argument can be advanced those estimates will be equal in magnitude, there is no guarantee that this is the case.

A more significant argument however is based on noting that government securities markets have changed markedly over the past twenty years, and that historical MRP estimates are based largely on data prior to this time. Interest rates were significantly less volatile. In this context, a ten year bond might be interpreted as a zero beta asset, since monthly or annual holding period yields on the bond would have relatively little variability. However, in a market where interest rates have significant short term variability, holding period returns on a ten year bond will fluctuate, and some part of this variability will be systematic. Preliminary estimates I have made indicate a beta for 10 year government debt, assuming a monthly holding period return as is common in beta calculations, of as high as 0.35. This implies that the ten year bond can no longer be treated as a zero beta asset as required for calculation of the MRP. It would be inappropriate to apply an estimate of the MRP derived from comparison of market returns and those on a (then) zero beta asset, to the rate of return on an asset which is now a non zero beta asset.

(c) Corporate Debt Maturity / Re-pricing characteristics

Recommendation: In calculating the cost of debt, the maturity of the risk free rate used as a benchmark should be set equal to the regulatory horizon. The credit spread added to the risk free rate should reflect that prevailing in the market for issues of that maturity and the agreed appropriate level of credit rating for the regulated entity. Allowable cash flows should incorporate an allowance for cost of refinancing debt with a maturity equal to the regulatory horizon.

Analysis

The WACC involves an average of required return on equity and on debt. It should be noted that, in theory, the cost of debt figure used should be the expected return required by investors in debt securities. In practice, the yield to maturity is typically used, even though this figure is a yield calculation assuming no default, and thus exceeds the expected return when there is default risk.

It is possible to divide the yield to maturity (r_d) on a risky corporate debt instrument into components of :

$$r_d = r_f + (r_d^e - r_f) + (r_d^d - r_d^e) + (r_d - r_d^d)$$

where r_f is the risk free rate for an equivalent maturity, r_d^e is the expected (required) return on the debt, and r_d^d is the promised return which (given the default risk) generates an expected return of r_d^e. The three last components of the equation can be described as a (systematic) risk premium, a default spread, and a liquidity spread respectively. The risk premium reflects systematic risk of the debt, the default spread reflects the fact that promised repayments exceed expected payments when default is possible, and the liquidity spread represents compensation for differences in the depth of market (or other factors) involved when comparisons are made between individual corporate debt instruments and government risk free debt.

Elton et al (2001) suggest that, based on US data, much of the yield spread ($r_d - r_f$) for investment grade companies can be attributed to the risk premium and liquidity (and in their sample tax) factors. The default spread, they observe, is relatively small. This suggests that using yield to maturity (rather than the unobserved expected return) will not involve too great an upward bias in the estimate of the cost of debt. One consequence of a non zero risk premium (to be considered later) is that debt has a non zero beta.

In calculating the return by investors in corporate debt, a common approach is to add a premium to the yield on an equivalent maturity risk free security. Thus, it is necessary to make some judgement as to the appropriate maturity for corporate debt of the regulated entity. It is sometimes asserted that prudent financial management will involve the entity raising debt with a maturity close to the expected life of the asset. Sometimes this argument is based on transactions costs of rolling over shorter term debt. Sometimes the argument is based on interest rate risk considerations with the implicit assumption made that maturity and duration of the debt are equivalent. As is well known, the interest rate risk characteristics of a debt instrument need not be related to its maturity, or can be altered if so desired. Use of floating rate debt or use of interest rate swaps are two simple examples.

In practice, efficient interest risk management requires identifying the interest rate exposure faced by equity holders from both operating cash flows and borrowing activities. If it is desired to avoid interest rate exposure, it is necessary to structure the repricing period for debt so that exposure from this source is offset by exposure from operating activities.

Consider the case of a regulated utility which has expected cash flows determined by regulatory decisions made at five year intervals. Assume that demand for the service and thus actual cash flows are not affected by interest rate movements (except insofar as those movements affect the actual return on the market portfolio) over that five year period. (All variability in cash flows is assumed to reflect systematic risk related to market movements and idiosyncratic risk). Over that five year period, actual cash flows will be largely independent of interest rate changes (since the target cash flow has been set using a required rate of return fixed for the five year period). Cash flows will be reset by the regulator after five years to reflect interest rate movements. Thus, suppose an asset is purchased at the start of a five year regulatory period by an all-equity company. The interest rate exposure of the company can be estimated using duration, such that :

$$\Delta E = \Delta A = -D_A^*. A. \Delta r$$

where D_A^* is the duration of the asset (A)'s cash flows.

In the case under consideration, the duration of the asset is approximately 2.5 years. The reason is that the cash flows are independent of interest rates over the next five years and the cash flows resemble an annuity.

Suppose, now that the entity replaces some equity with debt (B), for example it adopts a Debt/Assets (B/A) ratio of 0.5. What duration for the debt is required to remove the interest rate exposure of the equity? Now

$$\Delta E = \Delta A - \Delta B = -D_A^*. A\Delta r - (-D_B^*)B\Delta r$$

For $\Delta E = 0$, $D_B^* = D_A^*$ (A/B).

If $D_A^* = 2.5$ and (B/A) = 0.5, the required duration of debt is 5 years.

It would thus seem appropriate to use a risk free rate with maturity equivalent to the regulatory horizon for calculating the cost of debt. A company issuing debt with a duration equal to the regulatory horizon will largely remove interest rate exposure faced by its equity holders.

The difficulty which arises in this context is that the risk free rate is used as a benchmark in calculating the company's cost of debt by adding to it a premium to reflect the spread paid by a private company with similar risk characteristics in raising debt funds. This spread however, can be expected to depend more on the maturity of the debt instrument rather than its duration, and increase with the maturity of debt.

For a company investing in a long term asset, which is expected to be held to the end of its economic life, there may be some attraction in issuing debt with a long maturity. This could reflect transaction costs of repeated debt issuance or desire to lock in a particular credit spread on debt for the life of the asset. Locking in the credit spread could be desired to protect against market wide movements in credit risk premia, or concerns about issuer specific credit risk. This can be done simultaneously with adopting a shorter duration, by use of floating rate debt or use of derivative instruments such as interest rate swaps.

Such considerations would suggest an argument favouring the application of a credit spread appropriate to a long maturity debt instrument, even where the duration of the debt is much shorter. However, the building block framework involves the recalculation of allowable cash flows at each five year reset date which take into account the market wide credit risk margin applying at that date. Thus, the argument for long maturity debt based on "locking in" a credit spread which is not subject to market wide movements is no longer applicable. Allowable cash flows adjust to hedge this source of risk. This leaves the possibility that the issuer specific component of the credit spread may change over time, as for example if the company experienced a credit rating adjustment. This is a risk (of both upside and downside movements) which regulators can leave the company to bear, by, for example, basing credit spreads on market based amounts for a specified credit rating. Alternatively, if the spread is based at each reset date on the current credit rating of the company, this source of risk is also removed. The former approach seems appropriate in order to provide appropriate incentives for regulated businesses to maintain some minimum credit rating and level of default risk.

Consequently, the argument for using a spread applicable for a longer term borrowing revolves around preference for long maturities to reduce issuance and rollover costs. If the regulatory authority provides allowance in the cash flow determination for such costs based on a maturity of debt equal to the regulatory period, this argument also disappears. The company is compensated for higher costs of shorter term debt issuance.

The Averaging Period for Calculation of the Risk Free Rate

Recommendation: There is some practical merit in taking an average of the risk free rate over a (relatively) short period of time (such as 10 -40 days) at the regulatory reset date. This is more relevant in calculating the cost of debt than for calculating the cost of equity.

Analysis

In theory, the CAPM involves use of the risk free rate "on the day" at which required returns are to be estimated. Given the inherent imprecision with which most of the relevant parameters in the WACC are estimated, there is little reason not to take an average risk free rate over a short period such as, for example, twenty days prior to the regulatory reset date. This may reduce some of the uncertainty associated with the reset arrangements, by reducing the impact of daily movements in market rates. Provided that the averaging period is well specified in advance, there is little risk of "gaming" behaviour by participants in periods when there have been significant trends in interest rates.

In calculating the cost of equity, the case for averaging is not particularly strong (but neither are the grounds for not doing so). In calculating the cost of debt, the arguments may be somewhat stronger. A regulated entity wishing to minimise interest rate risk will establish a debt structure (as outlined earlier) with a duration equal to the time till the next regulatory reset date. It may be impractical for many regulated entitities to arrange their debt portfolio such that all debts (or derivatives used in risk management) reprice on the reset date. A portfolio with an average duration equal to that required can be established, comprising debts with an appropriate range of repricing dates, but exposes the entity to some basis risk. Using an average risk free rate (over say a 10-40 day period) in the regulatory determination seems likely to reduce the basis risk faced by the entity.

The Beta of Debt and the Cost of Debt

Recommendation: A small non-zero value (in the range of 0.10 –0.20) for the debt beta is appropriate and reflects reality. However, the effect on the WACC of assuming *a higher debt beta than zero will generally be negligible because of the offsetting effect on the equity beta and the cost of equity. Consequently, there is likely to be little effect on the WACC if a debt beta different from zero (rather than equal to zero) is chosen.*

Analysis.

Debt which is default free can have a non-zero beta. Beta reflects the covariance between the holding period return on a particular asset and the market portfolio. The holding period commonly used as the time interval in estimating beta is one month. A 5 year default risk free, fixed coupon, government bond will have monthly holding period returns which vary as a result of changes in market interest rates. Since these changes will also have some effect on returns on risky assets, it can be expected that there is some covariance between the holding period returns. Some preliminary estimates I have made indicate a debt beta for five year government coupon bonds in the order of 0.2 over the period 1992-2000. The beta of debt will increase with the duration of the debt instrument. A floating rate bond which has interest rate resets each six months will have a very small beta (0.005 on my preliminary estimates) regardless of its maturity. A five year annuity style bond (with duration of between 2 - 2.5 years) could be expected to have a beta of around 0.1.

It is sometimes argued that the systematic risk of corporate debt arises from the possibility of default, and this being systematically related to returns on the market portfolio. While default probability may have some systematic component, this is not necessary for the beta of corporate debt to be non zero.

What is an appropriate estimate for the beta of debt of regulated entities? One complication arises from the fact that some part of corporate debt takes the form of bank loans which are non-traded and held till maturity by the lenders. This long term holding period could be expected to imply a lower beta. Also relevant is the repricing period of the debt, and the duration of the debt.

If it is assumed that regulated entities raise debt funds by the issue of 5 year fixed rate debt then, given the comments above, a debt beta in the range 0.10 – 0.20 might be appropriate.

One approach sometimes advocated for calculating a debt beta is to "back out" a beta from the CAPM. Given the expected return on an asset and the MRP the beta can be calculated as:

$$\beta = (r_a - r_f) / MRP$$

Unfortunately the implementation of this approach is generally flawed for the following reason. The CAPM provides an estimate of the required or expected return on an asset. Most attempts to adopt this method use a yield to maturity (ytm) on corporate debt which is a different concept, since it is a yield based on the assumption that promised payments eventuate. In that regard, this approach provide a very loose upper bound for the estimate of a debt beta. Taking a spread of (ytm-rf) for corporate bonds of 150 bp and a MRP of 6% would suggest an upper bound of 0.2 for a debt beta, with an actual value significantly below this.

In principle, backing out the beta of a corporate bond using the CAPM would involve use of the unknown systematic risk premium. Alternatively, estimating the debt beta from some other source would enable calculation of the risk premium and expected return on debt. The rationale for doing so would be (a) to provide a more correct leverage adjustment in calculating the required return on equity from the required return of the asset, and (b) using the expected return on debt, rather than the (higher) yield to maturity as the cost of debt.

Implications of a Non-Zero Debt Beta

The precise value of the debt beta has little effect on the estimated WACC. Consider for example the hypothetical case of a perfect capital market, zero tax, world. In this case, the WACC is invariant to leverage and the beta of the asset can be written as:

$$\beta_A = \beta_E\, E/V + \beta_D\, D/V$$

Since the asset beta is fixed, any change in the assumed value of the debt beta is offset by a change in the equity beta. When taxes exist, the offset will not be perfect, but it is of relatively small net impact.

Estimating Equity Betas

Recommendation: Use of comparator firms from the Australian market to estimate equity betas for regulated firms is desirable, but at this stage not reliable due to the small sample of relevant firms and limited span of historical data.

Analysis:

Standard practice for estimating an equity beta is based on estimating the equity beta for a portfolio of comparator firms. Those firms should be in a similar line of business, such that the systematic risk of the underlying assets is believed to be of similar magnitude. Ideally a large portfolio of such firms would be used to reduce the effects of idiosyncratic factors affecting the returns of individual firms over the estimation period. Ideally the comparison would involve firms whose stocks trade in the same capital market as the target firm, since this would provide a measure of systematic risk relative to the relevant market portfolio.

In practice, this is often not feasible, and betas are calculated for comparator firms operating in other countries and using the market portfolio of that country. It is then assumed that the systematic risk characteristics observed in that country are similar to those which would apply here. Although this approach, and assumptions involved, can be debated, there is no obvious preferable alternative, unless there is a significant portfolio of comparator stocks trading in the local market.

While there is a small group of comparator firms now trading in the Australian market, the size of that group does not seem sufficient to currently justify its use as the sole input for reliable beta estimation. It is however a relevant source of information about beta values which should not be ignored and could be incorporated into the overall sample of comparator firms, with a weighting which increases over time as more data becomes available.

Leverage Formulas

Recommendation: The leverage formula proposed by Monkhouse for use under dividend imputation is as suitable as any other available formula.

Analysis.

In calculating the equity beta of a firm using those of comparator firms, it is generally necessary to undertake a delevering and relevering process. By delevering the equity beta of a levered comparator firm, the asset beta (that of the underlying activity undertake by a 100% equity firm) is calculated. Relevering involves recalculation of the equity beta to reflect the leverage of the firm involved.

There are a number of leverage formulas available in the literature. There is no formula which is correct in all circumstances since assumptions must be made about such things as the future growth of the firm, debt policy of the firm, tax shield availability and usage. However, differences in relevered equity betas arising from the use of different formula are often immaterial.

The leverage formula derived by Monkhouse (1997) for the case of the imputation tax system is as suitable as any other available, and immediately applicable to the imputation tax system. For delevering equity betas for comparator companies from overseas companies with different, non-imputation tax systems, the Monkhouse formula needs to be adapted to ignore franking credits (by assuming that γ in the formula equals zero).

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