MEMORANDUM

TO: Kenny Yap
Australian Energy Regulator

FROM: John Handley
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DATE: 18 January 2011

RE: Peer Review of Draft Report by Davis on the Cost of Equity

BACKGROUND

Pursuant to the National Gas Rules, the Australian Energy Regulator (AER) is currently undertaking a review of the gas access arrangements of APT Allgas and Envestra (the distributors) in Queensland and South Australia for the period 2011 to 2016. As part of this review, the AER determines the allowed revenues/tariffs that can be charged by the distributors over this period which in turn requires the AER to determine the appropriate return on capital for the period.

The AER is seeking expert advice from Professor Kevin Davis on a range of issues put forward by APT Allgas and Envestra in their access arrangement proposals[1] concerning the cost of equity. In this regard, the AER is also seeking a peer review of the draft report prepared by Davis[2] and in particular, a critical assessment of the analysis and opinions contained therein.

This memorandum sets out my comments on the Davis report.

[1] APT Allgas Energy Pty Limited (2010) and Envestra (2010).
[2] Davis (2011).

OVERALL CONCLUSION

I am in general agreement with the analysis, opinions and conclusions contained in the Davis report, except in regards to the following:

- conclusion (a)(iii) – the CAPM should be viewed in a conditional sense;

- conclusion g(i) – the theoretical relationship between the cost of equity and cost of debt cannot be readily derived from the Modigliani-Miller theorem; and

- the impact of differential borrowing and lending rates on the Capital Asset Pricing Model (CAPM).

These matters, in addition to a number of other comments that Davis may wish to consider in finalizing his report to the AER, are discussed below.

COMMENTS

The Key Issue

It is noted that much of the argument for a higher cost of equity by Envestra and its consultants, Competition Economists Group (CEG) and Professor Bruce Grundy largely stems from what may be called the "low-beta bias" of the Sharpe CAPM – i.e. that the Sharpe CAPM underestimates the cost of equity capital for low beta stocks such that the lower the beta, the greater the underestimation.[3]

The low-beta bias arose out of the results of two well known international empirical studies by Black, Jensen and Scholes (1972) and Fama and MacBeth (1973). Both studies find that the empirical security market line is flatter and has a higher intercept than is predicted by the

[3] A low beta stock is one having an equity beta (relative to the market portfolio) less than one.

Sharpe CAPM. This empirical finding is well illustrated by Figure 2 in Fama and French (2004) [4] who updated the evidence to the end of 2003.[5]

Whilst there is no dispute concerning the results reported by Black, Jensen and Scholes (1972), Fama and MacBeth (1973) and Fama and French (2004), it is important to note that there still remains considerable uncertainty as to how this empirical evidence should be interpreted – in other words, what do the empirical results, concerning past realized returns, imply about the validity of the Sharpe CAPM as a model for estimating future expected returns ?

For example, it has been suggested that the empirical results may reflect restrictions on riskless borrowing, consistent with the zero beta CAPM of Black (1972)[6], or may reflect the impact of barriers to international investment, consistent with the international CAPM of Black (1974)[7], or may simply reflect a specification error in the proxy for the market portfolio as suggested by Roll (1977).[8] Grundy (2010) also suggests that the empirical results may be explained by relaxing one or more of the theoretical assumptions underlying the Sharpe CAPM such as allowing for higher borrowing rates compared to lending rates or allowing for non-zero transactions costs or allowing for multi-period consumption/investment considerations.[9] In other words, there are a number of possible (and not necessarily mutually exclusive) explanations for the low-beta bias:

> *"The CAPM's empirical problems <u>may</u> reflect theoretical failings, the result of many simplifying assumptions. But they <u>may</u> also be caused by difficulties in implementing valid tests of the model".*[10] [emphasis added here].

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4 Fama and French (2004 p.33).

5 This is the same diagram reproduced in Grundy (2010 p.3).

6 Black (1972 p.454) suggests: *"Thus the empirical results reported by Black, Jensen and Scholes are consistent with a market equilibrium in which there are riskless lending opportunities as well as with an equilibrium in which there are no riskless borrowing or lending opportunities".*

7 Black (1974 p.344) suggests: *"the presence of taxes on international investment tends to make high [beta] assets have negative [alphas] and low [beta] assets have positive [alpha's]. This is the direction of deviations from the capital asset pricing model found in empirical studies".*

8 Roll (1977 p.131) states:*"For the Black, Jensen and Scholes data, for example, there was a mean variance efficient 'market' proxy that supported the Sharpe-Lintner model perfectly and that had a correlation of 0.895 with the market proxy actually employed."* . In other words, Roll shows that if Black, Jensen and Scholes (1972) used a slightly different proxy for the market then their econometric results would have be perfectly consistent with the Sharpe CAPM.

9 Grundy (2010 p.4-10).

10 Fama and French (2004 p.25).

So whilst a number of possible explanations have been proposed for the low-beta bias, it is important to keep in mind that there is at least one very influential explanation by Roll (1977) which seriously questions whether the low-beta bias even exists.[11]

Accordingly, CEG is incorrect to suggest that:

> *"The existence of bias in the AER implementation of the CAPM can reasonably be regarded as being universally accepted by those who have examined the empirical data. ... This is one of the few areas of consensus amongst finance experts".* [12]

One particularly important implication of the above discussion concerns how to correct for the low-beta bias if such a correction is deemed to be appropriate. Herein lay a difficulty. The fact that we don't have a clear explanation for the "problem" means we don't have any clear guidance on how to "solve" it. For example, should an alternative asset pricing model be used ? If so, then which one ?

Should the CAPM be Viewed in a Conditional Sense ?

Davis suggests:

> *"it is my opinion that … (iii) there is general agreement that the CAPM needs to be viewed in a conditional form – but that the precise determinants and size of that conditionality (and hence variations over time in beta, MRP etc) are not well agreed".*[13]

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[11] A similar sentiment is expressed by Roll and Ross (2004) in relation to the finding by Fama and French (1992) that the cross-sectional relationship between average returns and beta is virtually zero. In particular, Roll and Ross (2004) state: *"It is perplexing, then, that some authors relate the absence of a detectable cross-sectional slope for a particular market index proxy to a general condemnation of the SLB CAPM model"* (p.110) and further, *"As we have seen, though, the empirical findings are not by themselves sufficient cause for rejection of the theory. The cross-sectional OLS relation is very sensitive to the choice of an index and indices can be quite close to each other and to the mean-variance frontier and yet still produce significantly different cross-sectional slopes, positive, negative, or zero. The finding that a market index proxy does not explain cross-sectional returns is consistent with even a very close, but unobserved, true market index being efficient. ... Sampling error makes these problems all the more troublesome. Since estimates of the efficient frontier and of the index proxy's mean and variance are subject to serious sampling error, the proxy itself may have a true positive cross-sectional expected return-beta OLS relation that cannot be detected in the sample mean return-estimated beta relation."* (p.115-116).

[12] Competition Economists Group (2010 p.14).

[13] Davis (2011, p.17).

In my opinion, this view is not supported by earlier statements by Davis, such as:

> *"There have been a significant number of recent studies examining the CAPM and other asset pricing models published in recent years in leading academic journals. The following discussion provides a brief overview of approaches and implications, and illustrates what I interpret to be the lack of general agreement on the superiority of alternative asset pricing models to the CAPM. In conjunction with other studies, however, they do suggest that there are alternative factors which should be included in an unconditional CAPM reflecting either the conditional nature of the CAPM or the greater realism of the ICAPM. However, agreement on which additional factors are warranted has not been reached".* [14]

Whilst it is certainly true that there are many competing alternatives to the Sharpe CAPM to choose from including Black (1972), Merton (1973), Fama and French (1992), (1993), (1996), Jagannathan and Wang (1996) and Campbell and Vuolteenaho (2004) – each with its perceived advantages and disadvantages and importantly, each with its own set of estimation issues and challenges – there is no consensus that conditional models are superior to unconditional models. So whilst Davis may conclude that, in his opinion, conditionality is important (consistent with a statement later in his report)[15] in my view it is too strong to suggest that there is general agreement that the CAPM should be viewed in a conditional sense.

[14] Davis (2011 p.2).

[15] Specifically, *"… Third, the evidence is mixed on whether alternative models outperform the static CAPM, although recognition that the CAPM is conditional with parameters which can vary over time is important."* (Davis (2011 p.6)).

What Does The Modigliani-Miller Theorem Imply About the Relative Costs of Equity and Debt?

Grundy (2010) suggests that the Modigliani-Miller theorem can be used to derive a lower bound on a firm's equity risk premium relative to its debt risk premium and hence provide a consistency check between the observed cost of debt and the cost of equity derived from an asset pricing model. In particular, he suggests:

> *"If the firm has 60% debt financing and the asset pricing model does not imply an Equity Risk Premium at least 2.66 the observed Debt Risk Premium, then the asset pricing model is underestimating the true cost of equity for the firm."* [16]

Davis disagrees with Grundy's analysis and on the contrary, suggests that the theoretical relationship between the cost of equity and cost of debt cannot be readily derived from the Modigliani-Miller theorem:

> *"More importantly, this argument does not, of itself, provide any substantive information about the relationship between the debt premium and the cost of equity. The reason is straightforward. The MM relationship, when expressed in terms of rates of return on debt and equity, applies to the expected rates of return. The debt premium, and cost of debt commonly used in a WACC calculation, relate to a contractual (promised) rate of return on debt – which will generally exceed the expected return because of default risk … This simple example illustrates the fallacy in using arguments based on the behavior of the expected return on debt and equity as leverage changes to draw inferences about the relationship between the expected return on (equivalently, cost of) equity and the contractual interest rate on debt."* [17]

I have three difficulties with this view. First, Davis seems to be suggesting that the cost of debt used in the WACC is not the expected return on debt but rather is something else – the promised/contractual interest rate which will differ from the expected return (due to default risk). But the extent to which the current market price of a risky bond reflects the possibility of default and the current yield is based on the current price suggests to me that the observed

[16] Grundy (2010 p.18).
[17] Davis (2011, p.14-15).

yield and the expected return are one and the same. Second, in regards to his accompanying simple example, I can't see how the promised return on the debt could be 200% given that the expected return on the project is only 150% i.e. assuming the firm is 100% debt finance, I cannot imagine an investor accepting a promise of 200% on a project that is only expected to deliver 150%. Third and most importantly, notwithstanding Modigliani and Miller (1958) derived their irrelevance theorem under the assumption that debt was riskfree, this result has since been extended (under various assumptions) to the case of risky debt[18] by: (i) Stiglitz (1969) in a general equilibrium state preference framework; (ii) Rubinstein (1973) in a mean-variance framework; (iii) Merton (1974) in an option pricing framework; and (iv) Galai and Masulis (1976) in a combined CAPM/option pricing framework. In this regard, Merton (1974) shows that the cost of equity is an increasing, concave, unbounded function of the (market) debt-to-equity ratio of the firm and the cost of debt is an increasing, S-shaped, bounded function of the (market) debt-to-equity ratio of the firm, as illustrated in his figure 9 and reproduced below: [19]

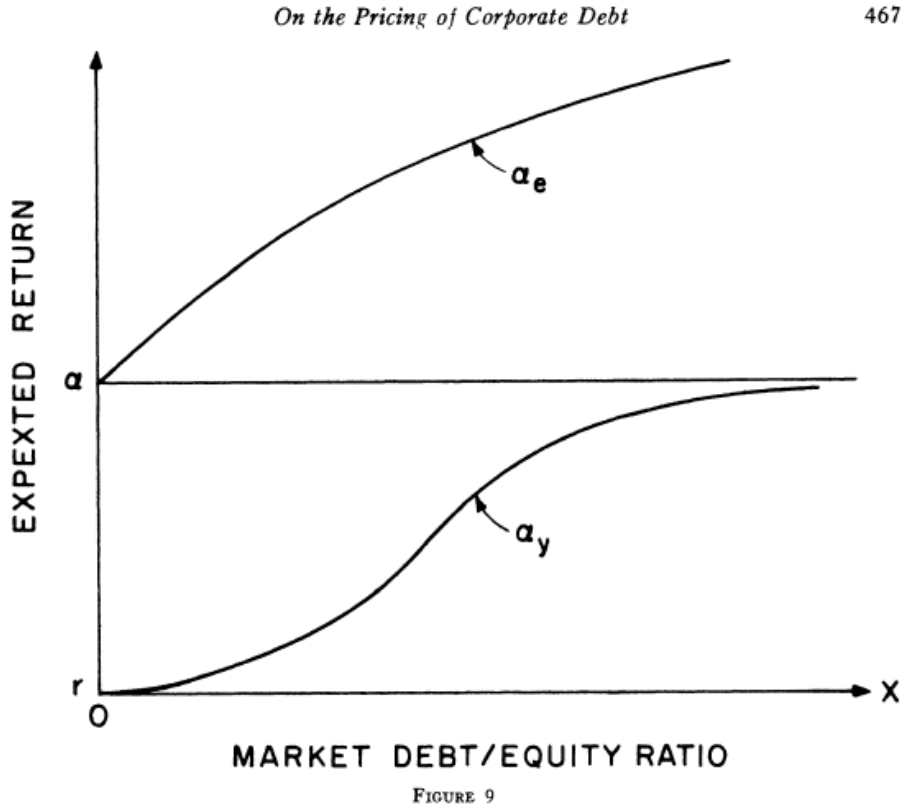


FIGURE 9

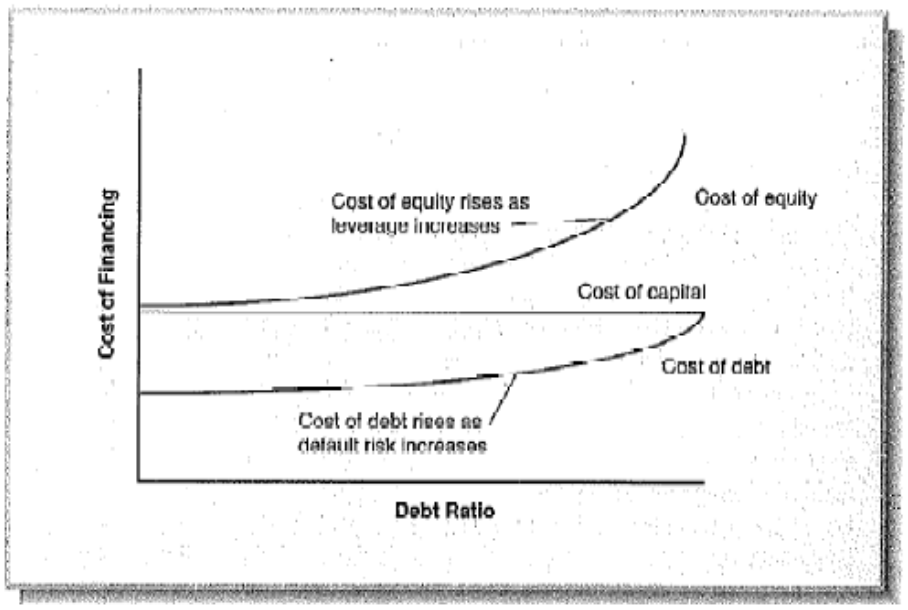
[18] Including as Davis (2011 p.14) correctly notes, assuming no taxes and no financial distress costs (i.e. although default can occur there are no costs to the firm if this occurs)..

[19] Merton (1974 p.467). The top line is the cost of equity, the bottom line is the cost of debt and the middle line is the firm's cost of capital which is constant in accordance with Modigliani and Miller's proposition II.

So, the question remains – is the Grundy analysis valid ?

There are three key steps to consider. The starting point is the claim that the cost of debt of a firm is an increasing, convex, bounded function of the (market) debt-to-value ratio of the firm, as illustrated by the figure taken from Grundy, which in turn was taken from Damodaran (2001) and is reproduced here for convenience[20]:

Figure 18.5 Cost of Capital in the Miller-Modigliani World



The above figure from Damodaran (2001) suggests that the cost of debt is a convex function of leverage, when measured by the (market) debt-to-value ratio of the firm whereas the previous figure from Merton (1974) suggests that the cost debt is neither a convex nor a concave function of leverage, when measured by the (market) debt-to-equity ratio of the firm. It is not clear from where Damodaran (2001) has sourced this diagram and so I have not been able to confirm the convexity of the relationship, but I note that a similar diagram appears in Copeland, Weston and Shastri (1995).[21]

Taking the convexity as given, the second step is Grundy's insightful observation that the above diagram leads to the following relationship between the equity risk premium $ERP(L)$ and the debt risk premium $DRP(L)$ of the firm:

[20] Grundy (2010, p.17). The top line is the cost of equity, the bottom line is the cost of debt and the middle line is the firm's cost of capital which is constant in accordance with Modigliani-Miller's proposition II.

[21] See Figure 15.9 in Copeland, Weston and Shastri (1995 p.588).

$$ERP(L) \geq \frac{1+L}{L} DRP(L) \quad (1)$$

where L is the (market) debt-to-value ratio. Substituting a leverage ratio of $L = 0.60$ into equation (1) gives:

$$ERP(0.60) \geq 2.66 DRP(0.60) \quad (2)$$

i.e. assuming a leverage ratio of 60%, the equity risk premium of the firm (at a 60% leverage) must be at least 2.66 times the debt risk premium of the firm (at a 60% leverage).

Taking the observed cost of debt and so the estimated debt risk premium as given, the third step is Grundy's conclusion that if the relevant asset pricing model (in this case, the Sharpe CAPM) does not result in an estimate of the equity risk premium at least 2.66 times the estimated debt risk premium in accordance with equation (2), then the asset pricing model is underestimating the true cost of equity for the firm.

As previously mentioned, Stiglitz (1969), Rubinstein (1973), Merton (1974) and Galai and Masulis (1976) have all shown that (under certain assumptions) the Modigliani-Miller theorem holds in the presence of risky debt. An implicit assumption common to all four papers, is that both the equity and debt securities in the firm are priced according to the same relevant asset pricing framework – i.e. a general equilibrium state preference framework in the case of Stiglitz (1969), a mean-variance framework in the case of Rubinstein (1973), an option pricing framework in the case of Merton (1974) or a combined CAPM/option pricing framework in the case of Galai and Masulis (1976). In other words, the validity of the Modigliani-Miller theorem in the presence of risky debt is based on the implicit assumption that equity and debt are priced in the (same) integrated market rather than being priced in (separate) segmented markets. In this case, not only is it possible to derive a lower bound on the firm's equity risk premium relative to its debt risk premium but rather one can derive an exact relationship between the firm's cost of debt and its cost of equity and accordingly an exact relationship between the firm's equity risk premium and its debt risk premium. This is precisely what is implied by the diagrams of Damodaran (2001) and Merton (1974) above.

For example, within the combined CAPM/option pricing framework of Galai and Masulis (1976) the link between the debt risk premium and the equity risk premium at any given leverage ratio is equal to:

$$\frac{\beta_d}{\beta_e} = \frac{N(-d_1)}{N(d_1)\frac{D}{E}} \tag{3}$$

where β_d is the debt beta of the firm, β_e is the equity beta of the firm, D/E is the (market) debt-to-equity ratio and $N(d_1), N(-d_1)$ have standard option theoretic interpretations consistent with a Black-Scholes framework.[22]

Certainly Grundy appears to make weaker assumptions in determining the lower bound in (2) compared to Stiglitz, Rubinstein, Merton or Galai and Masulis, but he has nonetheless assumed that the Modigliani-Miller theorem holds which in turn means that he has implicitly assumed, (like Stiglitz, Rubinstein, Merton and Galai and Masulis) that the equity and debt are priced in an integrated market rather than being priced in segmented markets. In other words there are joint hypothesis considerations in comparing the observed cost of debt to the estimated cost of equity. Specifically, if the bound in (2) does not hold such that the equity risk premium is less than 2.66 times the debt risk premium then this could imply either: (i) that the equity and debt are priced in an integrated market and the equity risk premium is too low; or (ii) that the equity and debt are priced in an integrated market and the debt risk premium is too high; or (iii) that the equity and debt are priced in segmented markets and so the Modigliani-Miller theorem cannot be used to infer that the equity is mispriced relative to the debt. Whilst Grundy suggests the first is the appropriate conclusion to be drawn, this shows that two feasible alternatives are available.

[22] See Galai and Masulis (1976 p.58) for further details.

What Impact Does Differential Borrowing and Lending Rates Have on the Sharpe CAPM ?

Grundy (2010) and CEG (2010) both advocate a strong preference for the zero-beta CAPM of Black (1972) – hereafter the Black CAPM – over the Sharpe CAPM. For example, Grundy (2011) states:

> *"The empirical evidence that the Black CAPM provides a better fit to the data than the Sharpe CAPM is clear. What then is the bias in the Sharpe CAPM?"*[23]

In a similar vein, CEG (2011) suggests:

> *"The Black CAPM is a more realistic theoretical model than the original CAPM developed by Sharpe and Lintner in that it does not assume that investors can borrow at the risk free rate (government bond rate). This gives rise to a CAPM formula where the return on a zero beta investment is higher than the risk free rate and, consequently, the sensitivity of required returns to beta is lower. This more realistic theoretical model is, unsurprisingly, much better supported by the data from equity markets."*[24]

Black (1972) examines how the Sharpe CAPM changes if there are restrictions on investors borrowing at the risk free rate. If it is assumed that there is no riskfree asset, then the equilibrium relationship between the expected return on an asset $E(r_i)$ and its beta β_i takes the same functional form as the Sharpe CAPM, but with the risk free rate, r_f replaced by the expected return on the 'zero-beta portfolio', $E(r_z)$.[25] According to Black (1972 p.452),

> *"Prohibition of borrowing and lending, then, shifts the intercept of the line relating $E(r_i)$ and β_i from r_f to $E(r_z)$. Since this is the effect that complete prohibition would have, it seems likely that partial restrictions on borrowing and lending, such as margin requirements, would also shift the intercept of the line, but less so."*

[23] Grundy (2010 p.16).
[24] Competition Economists Group (2010 p.18).
[25] As its name suggests, the beta of the zero-beta portfolio, with respect to the market portfolio M, is equal to zero.

Black (1972) also considers the case where investors can lend but not borrow at the risk free rate and shows that the same expected return-beta relationship holds with $r_f < E(r_z) < E(r_M)$ where $E(r_M)$ is the expected return on the market portfolio. In other words, if there are no restrictions on borrowing at the risk free rate then $r_f = E(r_z)$ otherwise the intercept of the expected return-beta line is shifted up to $E(r_Z)$ which results in a relationship that is flatter than otherwise suggested by the Sharpe CAPM.

So a critical component of the Black (1972) CAPM is the expected return on the zero-beta portfolio $E(r_Z)$. A number of comments concerning the estimation of this parameter is deferred to the next section.

Grundy (2010 p.13) uses four previous empirical studies, including Black, Jensen and Scholes (1972) to derive an estimate of the ratio of (i) the ex-post market risk premium relative to the ex-post zero beta portfolio to (ii) the ex-post market risk premium relative to the ex-post risk free rate, $\frac{r_M - r_Z}{r_M - r_f}$. This is then used to estimate the return on the zero-beta portfolio. Specifically, assuming the current risk free rate is 5.3%, Grundy suggests that the empirically based estimate of the cost of zero beta stock is 8.5% based on the average estimate of $\frac{r_M - r_Z}{r_M - r_f}$ and is 10.3% based on the most recent and lowest estimate implied from Da, Guo and Jagannathan (2009).[26] Note the substantial difference between the riskfree rate and the estimated return on the zero-beta portfolio – 320 basis points in relation to the average. This stands in sharp contrast to the view of Davis who suggests:

> *"With borrowing and lending opportunities available, the zero beta expected return will lie within the range given by those borrowing and lending rates. While it will be above the risk-free interest rate, it will not lie above the available borrowing rate."*[27]

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[26] Davis (2011 p.9) notes that he is only able to replicate the estimate of $\frac{r_M - r_Z}{r_M - r_f}$ in one of the four papers mentioned by Grundy. I note that the necessary data to replicate the estimate from the Black, Jensen and Scholes (1972) study can be found in Table 1 of Roll (1977 p.152).

[27] Davis (2011 p.8).

Further, based on a consideration of rates at which institutional investors can borrow from the Reserve Bank of Australia using repurchase agreements, Davis suggests that

> *" the margin between the interest rate on "risk free" borrowing opportunities for wholesale market participants and the government risk free rate is relatively low."* [28]

It is noted that when investors can lend but not borrow at the riskfree rate, Black (1972) says relatively very little about the expected return on the zero-beta portfolio – the only guidance is that it must fall between the riskfree rate and the expected return on the market portfolio. So Davis at first appears to be at odds with the Black CAPM in suggesting that the expected return on the zero-beta portfolio is bound above by the (higher) lending rate rather than being bounded above by the expected return on the market portfolio. However, support for the Davis view comes from Brennan (1971) who presents a version of the CAPM which is related to the Black CAPM but differs in one subtle yet important way. Specifically, Brennan (1971) examines how the Sharpe CAPM changes if investors can borrow and lend risk free but at different rates. In other words, the "restrictions" on riskfree borrowing considered by Brennan (1971) are not as severe as those considered by Black (1972). In this regard, Brennan (1971) concludes:

> *"Thus the only difference in the market equilibrium condition introduced by divergence of borrowing and lending rates is that the intercept of the capital market line is shifted. This intercept represents the expected rate of return on a security with a return which has zero covariance with the return on a value-weighted market portfolio of all securities and may be referred to as the market's equivalent risk-free rate. It is apparent from (14) that this market equivalent risk-free rate of interest is a weighted average of the individual investor's equivalent risk-free rates ... Thus the market equivalent risk-free rate is constrained to lie between the borrowing rate b and the lending rate l."*[29]

Also note that in the Brennan (1971) model, the expected return on the zero-beta portfolio is specified to be equal to a complex weighted average of the individual riskfree borrowing and

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[28] Davis (2011 p.8) estimates the difference to be in order of 5 basis points.

[29] Brennan (1971, p.1203-1204).

lending rates, across all investors in the market. So in this regard, Davis's comparison of the borrowing and lending rates of institutional investors is somewhat incomplete since it is the borrowing and lending rates of all investors in the market that would be required. Notwithstanding, the quote that Davis has sourced from Lewellen, Nagel and Shanken (2010 p.183) is particularly pertinent in this context i.e.

> *"(riskless) borrowing and lending rates just aren't sufficiently different, perhaps 1–2% annually, to justify the extremely high zero-beta estimates in many papers"*

Estimating the Cost of Capital Using The Black (1972) CAPM

In the Black CAPM, the expected return on the zero-beta stock is a shadow interest rate however, other the above mentioned bound, its value is unspecified by the model. [30]

This raises a particularly important issue for those who wish to estimate the cost of capital using the Black CAPM – how do you estimate the expected return on the zero-beta portfolio?

Three comments are offered in this regard.

First, in my opinion the CEG report gives a misleading impression that it is reasonably straightforward to operationalise the Black (1972) CAPM. On the contrary, this is far from being true. I am not aware of any generally accepted way to estimate the expected return on the zero beta portfolio and further there is much uncertainty surrounding how this should be done. The analysis of Grundy (2010 p.13) does not constitute a rigorous estimation of the expected return on the zero-beta portfolio for the purposes of estimating the cost of equity capital for APT Allgas and Envestra

Second, Roll (1977 p.134) shows that for any portfolio which lies on the positively sloped segment of the efficient set (of risky assets) there exists a unique zero beta portfolio. This means that the zero-beta asset and the return thereon is sample specific (in relation to the set of assets under consideration, the particular proxy for the market portfolio and the time

[30] Brennan (1992 p.290).

period under consideration). This therefore diminishes the efficacy of using previous empirical studies to estimate the expected return on the zero-beta portfolio.

Third, the Black CAPM has been around for a long time but I am not aware of it being used by practitioners. It is well understood that all cost of capital estimates are subject to error. So whilst it may be argued that the Black CAPM is more "realistic" than the Sharpe CAPM, the onus is on the proponents to show that this outweighs the benefits associated with using a riskfree rate which is largely observable.

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