Report prepared for the

Australian Energy Regulator

Further Comments on the Sharpe CAPM

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1. INTRODUCTION

Pursuant to the National Electricity Rules, the Australian Energy Regulator (AER) is currently undertaking a review of the weighted average cost of capital (WACC) parameters to be adopted in determinations for electricity transmission and distribution network service providers. As part of the process, the AER released an Explanatory Statement[1] in December 2008 setting out its draft position, and in relation to which a number of interested parties have since made submissions. The AER has now sought further advice including a critique of the substantive issues raised in:

- the Joint Industry Association's (JIA) submission on the use of the Sharpe CAPM.[2]

- the JIA's submission on the use of stock market data to estimate the market risk premium (MRP).[3]

- the report submitted by Competition Economists Group (CEG) entitled: "Estimating the NER equity beta based on stock market data – a response to the AER draft decision". [4]

The advice should include, but not be limited to, a response to:

- did the AER 'fundamentally misconstrue' your original advice on the empirical tests of the Sharpe CAPM, as stated by the JIA ?

- did the AER incorrectly interpret the meaning of the statistical significance in CEG's original report i.e. 'the correct interpretation is that there is no basis for rejecting the null hypothesis that equity beta is only a weak or non-existent factor affecting equity returns', as stated by the JIA ?

This report should be read in conjunction with my earlier report to the AER on the Sharpe CAPM.[5]

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1 Australian Energy Regulator (2008b).
2 Network Industry Submission (2009 p.120-123) and referred to here as the JIA Submission.
3 Network Industry Submission (2009 p.87-88).
4 Competition Economists Group (2009) and referred to here as the CEG Report.

2. IS THE SHARPE CAPM VALID ?

The Key Issue

The key issue raised in (this part of) the JIA Submission and in the CEG Report concerns the validity of the Sharpe CAPM as an appropriate model for estimating expected equity returns.

The AER has concluded that the Sharpe CAPM is an appropriate model:

> *"Read together, the above statements suggest that the JIA consider that there is a conflict between the regulatory requirement to use the Sharpe CAPM and the requirement to set a forward looking rate of return commensurate with prevailing conditions in the market for funds and the risk involved in providing regulated services … the AER does not consider the JIA or CEG have provided persuasive evidence that there is a conflict with the use of the Sharpe CAPM and the other requirements of the NER."*[6]

Both the JIA and CEG strongly disagree, arguing that:

> *"While the CAPM is the most widely used method for determining the cost of equity, it must be recognised that the application of CAPM is subject to significant limitations … Empirical testing, as both cited and undertaken by CEG, shows that an equity beta estimate of 1.0 provides a more accurate estimate of the cost of equity than an equity beta solely derived from regression of market data."*[7]

and

> *"The key implication is that the AER should have regard to the uncontested empirical fact that equity beta's measured from stock market data do not*

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5 Handley (2008).
6 Australian Energy Regulator (2009 p.242-243).
7 Network Industry Submission (2009 p.120).

provide a good indication of the actual returns required by equity investors. This maybe because the Sharpe CAPM formula is imperfect or it may be because equity beta's derived from stock market data are poor proxies for the true equity beta. Ultimately, it doesn't matter why estimating equity betas in this fashion 'does not work'. What matters is the fact that it does not work."[8]

Analysis and Discussion

This is the same issue originally raised by the JIA, and accompanied by a report by CEG,[9] in response to the Issues paper.[10] In my earlier report on this issue, I concluded that:

"in my opinion, it would be premature to jettison the CAPM as the benchmark in setting rates of return. However, if one adopts the view that the Sharpe CAPM is flawed then the appropriate response is to choose a new model."[11]

Nothing in the (more recent) JIA Submission or CEG Report causes me to change my view, for reasons set out below.

The JIA/CEG argument is primarily an empirical one[12] relying, in particular, on the results of the two well known international empirical studies, Black, Jensen and Scholes (1972) and Fama and MacBeth (1973), in addition to the results of a CEG study using Australian data. There is no dispute concerning the results reported 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 Sharpe CAPM.[13] There is, however, uncertainty as to how this empirical evidence should be

8 Competition Economists Group (2009 p.3).
9 Competition Economists Group (2008).
10 Australian Energy Regulator (2008a).
11 Handley (2008 p.6).
12 For example, CEG (2009 p.10) state: *"Notwithstanding the fundamentally empirical nature of our conclusions, we did provide a discussion of the possible theoretical explanation for the empirical facts."*
13 For example, as Roll (1977 p.142) explains: *"Black Jensen and Scholes rejected the Sharpe-Lintner theory as a result of the following 'test': First, a 'market' portfolio was chosen and sample betas were calculated via a procedure designed carefully to remove measurement error. Then, the cross-sectional mean return/beta linearity relation was estimated in the form* $r_j - r_F = \hat{\gamma}_0 + \hat{\gamma}_1 \beta_j + \hat{\varepsilon}_j$ *where* $\hat{\varepsilon}_j$

interpreted i.e. what do the empirical results imply about the validity of the Sharpe CAPM as a model for estimating expected returns. There are a number of possible (and not necessarily mutually exclusive) explanations for the results. As Fama and French (2004, p.25) neatly summarise:

> *"The CAPM's empirical problems may reflect theoretical failings, the result of many simplifying assumptions. But they may also be caused by difficulties in implementing valid tests of the model".*

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)[14]. It has also been suggested that the empirical results may reflect the impact of barriers to international investment, consistent with the international CAPM of Black (1974)[15]. In a very influential paper, Roll (1977) follows a different path and argues that the choice between alternative forms of the CAPM is extremely sensitive to the choice of the proxy for the market portfolio (for a given set of assets) and accordingly:

> *"In summarizing all these empirical exercises about the Sharpe-Lintner theory, one is obliged to conclude that not a single paper contains a valid test of the theory. In fact, as Fama (1976, ch.9) has recently concluded, there has been no unambiguous test of the theory in the published literature … Therefore, for the Black, Jensen, Scholes paper taken in isolation from Jensen's addition, no hypothesis whatever was tested unambiguously".*[16]

The JIA/CEG are unconcerned about the fact that we don't have a clear explanation for the empirical results:

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is the estimated residual. The basic results were that $\hat{\gamma}_0$ *exceeded zero, that* $\hat{\gamma}_1$ *was less than* $r_m - r_F$ *and that* $\hat{\gamma}_0$ *was highly variable from one-sub-period to another."*

[14] 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".*

[15] 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".*

[16] Roll (1977 p.147-148).

> *"Whichever explanation is correct the fact remains that the returns predicted by the Sharpe CAPM do not reliably predict the true cost of equity well and a flatter version of the security market line is required."*[17]

In other words (and notwithstanding Roll's caution concerning empirical tests of the CAPM), the JIA/CEG suggest the model should be adjusted to fit the empirical results and in particular the beta should be set equal to one. But in my view this is tantamount to choosing a different model – in effect the JIA/CEG suggest the AER use an "empirical CAPM" to estimate equity returns. To be clear, the solution proposed by JIA/CEG is not the Sharpe CAPM.

Contrary to the view of the JIA/CEG, the fact that we don't have a clear explanation for the empirical results is of critical importance. In short, if there was a problem with the model (and again, the analysis of Roll suggests that this is not necessarily the case) then we would need to know exactly what that problem was before we could consider making any adjustments to the model's output. Further and as mentioned in my previous report, in this case, the most appropriate way to proceed would be to completely replace the Sharpe CAPM with an appropriate alternative asset pricing model. Simply making an ad hoc adjustment to the CAPM determined rate of return as suggested by CEG (albeit to tie it back to their empirical results) would by definition be arbitrary and therefore could not be justified. Unless one knows first, whether there is a problem and second, what is the source of the problem then one cannot possibly come up with an appropriate "solution".

[17] Network Industry Submission (2009 p.122).

3. DID THE AER "FUNDAMENTALLY MISCONSTRUE" MY PREVIOUS ADVICE ?

The JIA/CEG have suggested that the AER has misinterpreted my original advice on the empirical tests of the Sharpe CAPM. For example, CEG state:

> *"The draft decision does not appear to understand that this discussion from Handley is simply pointing out that one reason why stock market betas are unreliable predictors of investors required returns is that they are unreliable estimates of the true equity beta (measured relative to all assets including housing, land, human capital etc). That is, assuming beta can be measured relative to the return on the stock market only involves specification error in the measured 'market' portfolio."*[18]

and further:

> *"This is the 'specification error' in the above quote from Handley. It is also a specification error that would apply to the AER's proposed estimates of beta. Rather than providing a basis for not having regard to the empirical results we report, the Handley/Roll discussion provides another theoretical reason for scepticism about the AER's method.*[19]

Based on the discussion in section 2 above, I do not believe that the AER has misconstrued my advice. Rather, it appears that CEG has inadvertently interpreted my comments regarding Roll's critique in a narrow light – in particular, CEG have focused on the misspecification in betas (and returns) that would arise from using a stock market based proxy for the "market portfolio" instead of the universe of all assets. But the true market portfolio is unobservable and that is why, in practice, the standard approach is to use a suitable stock index. Further, Roll's concern about misspecification error is not limited to the problem of not being able to identify the universe of all assets – and which leads to his well known conclusion that *"the theory is not testable unless all individual assets are included in the sample"* (p.130) – but rather also arises with

[18] Competition Economists Group (2009 p.4).
[19] Competition Economists Group (2009 p.13).

respect to choosing an appropriate proxy for the 'market' from a given set of assets – such as a set of stocks.[20]

For clarity, in my opinion, there is no problem with using an appropriate stock index, such as the All Ordinaries Accumulation Index, as the proxy for the market portfolio for the purposes of estimating returns.

4. DID THE AER INCORRECTLY INTERPRET THE MEANING OF THE STATISTICAL SIGNIFICANCE IN CEG'S ORIGINAL REPORT ?

The JIA/CEG have suggested that the AER has erred in interpreting the results of CEG's empirical study. In its explanatory Statement, the AER states:

> *"Furthermore, CEG finds that there does not appear to be any significant relation between equity beta and equity returns in the Australian market. Accordingly, the AER considers that little, if any, useful information can be obtained from the shape of the slope (which was not found to be statistically significant)."*[21]

In response, CEG suggest:

> "*This statement suggests a profound lack of understanding of statistical concepts. CEG's finding was that there was little relationship between the empirically estimated equity beta and equity returns in the Australian market. That is, the slope coefficient was insignificantly different from zero. The AER appears to interpret this as evidence that our results are themselves statistically insignificant."*[22]

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20 See section 2.3 in Roll (1977).
21 Australian Energy Regulator (2008 p.245).
22 Competition Economists Group (2009 p.17).

In my view, I do not believe there is an inconsistency between CEG's interpretation of the results of its empirical study and the AER's interpretation of those results, in general.[23] In other words, CEG suggests its empirical study shows there is no statistical relationship between returns and beta and, in my opinion, this is how the AER has interpreted CEG's conclusion. There is, however, a difference of opinion concerning the implication of the study for estimating returns. As discussed above, CEG proposes that since the slope coefficient is insignificantly different from zero (i.e. the security market line is essentially horizontal) then the beta of one is appropriate (for all stocks). But as discussed in my previous report (and as appearing as a quote in the Explanatory Statement immediately following the above AER quote), there is an implicit inconsistency in CEG arguing on the one hand that beta and therefore the Sharpe CAPM is irrelevant, but then seeking to use the empirical results of a regression of (portfolio) returns against (portfolio) betas as the basis for estimating equity returns. As Fama and French (2004) state, *"If betas do not suffice to explain expected returns, the market portfolio is not efficient and the CAPM is dead in its tracks"* (p.36) – in other words, if beta is deemed irrelevant, then any analysis of returns based on beta is also irrelevant.

[23] It is noted that the AER has expressed some concerns about specific features of the study such as the issue of value verses equally weighted portfolios.

5. OTHER ISSUES

There are two other statements appearing in the CEG Report which require a brief comment.

(i) *"In our view, this is precisely what the AER draft decision does in relation to the NER equity beta. The draft decision makes a critical assumption about the definition of the equity beta. This assumption is that the NER equity beta can be accurately proxied by estimating the historical covariance between the return on a publicly listed equity with the historical average return on the listed equity market. For short hand, we refer to this as equity betas estimated from stock exchange data. The draft decision does not seek to test whether this assumption is reasonable and does not appear to give any weight to the evidence we provide that it is not."*[24]

CEG present this view in the context of arguing that in theory betas should be measured relative to the universe of all assets and therefore, measuring betas relative to a stock index will result in flawed beta estimates and accordingly flawed estimates of equity returns.

Whilst CEG is correct in its observation that the theoretical market strictly consists of the universe of all assets, this observation has no practical substance. It is well known that many assets that should ideally be included cannot be so, either because they cannot reasonably be observed or reasonably be measured. For this very reason, the standard practice in applying the CAPM is to use an appropriate stock index as the proxy for the market portfolio and therefore as the basis for determining betas.[25]

(ii) "CEG relied on the studies by Black Jensen and Scholes (1972) and Fama and Macbeth (1973) in our report (and other studies like them including our own which employed the same methodology using Australian data). The AER

[24] Competition Economists Group (2009 p.1).

[25] It is noted that extensions for including other asset classes along the lines of Stambaugh (1982) are possible.

appears to suggest that the work of Roll (1977) implies a criticism of the empirical results of Black Jensen and Scholes (1972) and Fama and Macbeth (1973) that gives the AER cause to give less weight to these studies' empirical results. Quite the opposite is the case."[26]

Consistent with the AER's suggestion, Roll (1977) is very clear in his criticism of the Black, Jensen and Scholes (1972) and Fama and Macbeth (1973) studies.[27]

6. USE OF STOCK MARKET DATA TO ESTIMATE THE MRP

In its Explanatory Statement, the AER suggests:

> *"the use of historical equity returns will bias upwards the return on the CAPM market portfolio, which includes all assets in the economy and is not limited to equities. This means that the above estimates for any period are more likely to overstate, than understate, a forward looking MRP".*[28]

The JIA disagrees with this argument. For example they state:

> *"Further, the implication that the MRP is biased upwards due to excluded asset classes is not supported by any empirical evidence or literature. The JIA has supplied a literature reference which can find no evidence of any such bias. Consequently, on evidence presented to date, the AER cannot reasonably assert an upwards bias in the historical MRP on this point."*[29]

In my view, without specifically knowing or quantifying the excluded assets, it is difficult to say ex-ante what impact their inclusion would have on estimates of the expected market risk premium.

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26 Competition Economists Group (2009 p.13).
27 See for example section 2.2 and 2.3 of Roll (1977).
28 Australian Energy Regulator (2009 p.179).
29 Network Industry Submission (2009 p.88).

REFERENCES

Australian Energy Regulator, 2008a, Review of the Weighted Average Cost of Capital (WACC) Parameters for Electricity Transmission and Distribution: Issues Paper, Commonwealth of Australia, Canberra, August.

Australian Energy Regulator, 2008bb, Explanatory Statement – Electricity Transmission and Distribution Network Service Providers: Review of the Weighted Average Cost of Capital (WACC) Parameters, Commonwealth of Australia, Canberra, December.

Black, F., 1972, Capital Market Equilibrium with Restricted Borrowing, Journal of Business, 45, 444-454.

Black, F., 1974, International Capital Market Equilibrium with Investment Barriers, Journal of Financial Economics, 1, 337-352

Black, F., M.C. Jensen and M. Scholes, 1972, The Capital Asset Pricing Model: Some Empirical Tests, in M.C. Jensen (ed), Studies in the Theory of Capital Markets, Praeger, NY.

Competition Economists Group, (2008), Estimation of, and correction for, biases inherent in the Sharpe CAPM formula, Report for the Energy Networks Assocaition, Grid Australia and APIA, 15 September.

Competition Economists Group, 2009, Estimating the NER equity beta based on stock market data – a response to the AER draft decision, A report for the JIA, January.

Fama, E.F. and K.R. French, 2004, The Capital Asset Pricing Model: Theory and Evidence, Journal of Economic Perspectives, 18, 25-46.

Fama, E.F. and J.D. MacBeth, 1973, Risk, Return and Equilibrium, Journal of Political Economy, 81, 607-636.

Handley, J.C., 2008, Comments on the CEG Reports: "Estimation of, and correction for, biases inherent in the Sharpe CAPM formula" and "An analysis of implied market cost of equity for Australian regulated utilities", Report prepared for the Australian Energy Regulator, 20 November.

Network Industry Submission, 2009, AER Proposed Determination – Review of the Weighted Average Cost of Capital (WACC) Parameters for Electricity Transmission and Distribution, February.

Roll, R., 1977, A Critique of the Asset Pricing Theory's Tests Part I: On Past and Potential Testability of the Theory, Journal of Financial Economics, 4, 129-176.

Stambaugh, R.F., 1982, On the Exclusion of Assets from Tests of the Two-Parameter Model – A Sensitivity Analysis, Journal of Financial Economics, 10, 237-268.