REVIEW OF ARGUMENTS ON THE TERM OF THE RISK FREE RATE

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EXECUTIVE SUMMARY

This paper has addressed a number of issues raised with me by the ERAWA, and my views are as follows.

Firstly, I concur with the analysis by the ERAWA subject only to some relatively minor points.

Secondly, I do not agree with any of the points raised by GGT in their most recent submission. Most of these points simply involve misunderstanding arguments that lead to the conclusion that the regulator must use a risk-free rate with a term matching the regulatory cycle in order to satisfy the Present Value Principle.

Thirdly, I do not agree with any of the new points raised by SFG. In particular, I do not agree that regulatory use of a risk-free rate whose term matches the regulatory cycle requires absolute certainty about the value of the regulatory assets at the end of the regulatory cycle. In addition, I do not consider that the Incenta survey warrants the conclusion that regulators should use the ten-year risk-free rate so as to achieve consistency with the practice of valuation professionals.

1. Introduction

The ERAWA is currently assessing regulatory proposals for a five-year access arrangement from Goldfields Gas Transmission (GGT) and Dampier Bunbury Pipeline (DBP), relating to the Goldfields Gas Pipeline (GGP) and the Dampier Bunbury Natural Gas Pipeline (DBNGP) respectively. In respect of the term of the risk-free rate, the ERAWA favours that matching the regulatory cycle (ERAWA, 2013, Appendix 2; 2015, pp. 216-220). By contrast, both GGT and DBP favour the ten-year rate. Accordingly, this paper seeks to examine the views of these three parties on this question.

2. Review of ERAWA Arguments

I concur with the arguments in the ERAWA (2013, Appendix 2; 2015, pp. 219-220) subject to the following (minor) matters. Firstly, the ERAWA (2013, Appendix 2, paras 25-26) correctly rebuts DBP's claim that there is no two-year rate in Lally (2007). However, I do not understand para 27, it does not add anything to the previous two paras, and there is no rate denoted R_{02} in Lally (2007): the two-year rates referred to in Lally (2007) are the spot rate and the yield to maturity.

Secondly, the ERAWA (2013, Appendix 2, para 29) claims that Lally (2007) does not deal with refinancing risk and does not do so until Lally (2010). This is not quite correct. Lally (2007) addresses the issue of "recontracting risk", and this phrase is synonymous with "refinancing risk". However, Lally (2007) only deals with one manifestation of this risk: an increase in the DRP that is not compensated for through the regulatory allowance. The possibility of debt finance not being available at any rate is not considered in Lally (2007) but it is generally understood to be a significant aspect of refinancing risk.

Thirdly, the ERAWA (2013, Appendix 2, para 32) refers to the "debt premium" when the reference should instead be to the "equity premium".

Fourthly, the ERAWA (2013, Appendix 2, para 36) refers to an argument from the DBP (2013, para 5.45), that regulation should seek to set prices that would prevail in a competitive market, that the regulatory term is irrelevant to this, and therefore choosing the allowed risk-free rate to match the regulatory term is unwarranted. In response, the ERAWA argues that "the present value principle requires that the risk-free rate needs to match the term that would apply in an effectively competitive market for the period." I do not agree with the ERAWA's argument: once the regulatory term is chosen, the term for the allowed risk-free rate must match it, and this *might* differ from the risk-free rate term that underlies prices in a competitive market. In addition, I do not agree with the DBP's argument. As noted in Lally (2013a, pp. 44-45), "..the belief that regulation should seek to replicate competitive market outcomes is only true in the sense that unregulated firms in competitive markets charge prices that just cover costs, including the cost of capital, and regulation should seek to do likewise. Merely because both types of firms are subject to prices that just cover their costs, it does not follow that every detail about them is or should be identical. Nor is it possible for every detail to be identical because regulated firms are by definition regulated, in recognition of circumstances that differ from those of unregulated firms in competitive markets, and there are a variety of regulatory models. For example, one might regulate prices or revenues, and one might reset these at high or low frequency, and one might allow some costs to be passed-through. All of these regulatory choices affect the cost of capital of a regulated firm. So, having made the choice and therefore determined the cost of capital of the regulated firm, the cost of capital allowed by the regulator must compensate for it rather than match the cost of capital of an otherwise identical unregulated firm in a competitive market. Expressly alternatively, the cost of capital reflects risk, regulation affects the risk of regulated firms, and therefore the cost of capital for a regulated business may differ from the that of an otherwise identical unregulated firm in a competitive market."

Fifthly, the ERAWA (2013, Appendix 2, paras 49-52) refers to an argument from GGT (2013, section 6.2.3) concerning analysis by Davis (2012). I agree with the ERAWA's comments, with the exception of uncritically quoting GGT on the question of Davis failing to analyse the case in which the firm borrows for a term equal to the life of the assets and the regulator sets the output price for the same period. Davis (2012, footnote 9) does examine this case, and GGT (2013, page 33) acknowledges it. The examination is not formal, presumably because Davis considers it to be impossible for a firm to borrow for that term, but Davis still makes the important point that the firm will be exposed to interest rate risk when the regulatory cycle matches the life of the assets but the firm cannot borrow for that term.

Sixthly, the ERAWA (2013, Appendix 2, para 67) suggests that I have changed my view on the question of consistency over the risk-free rate within the CAPM. However, rather than cite me on this question, the ERAWA cites Incenta (2013), who in turn cite a report by Lally (2013b, page 6). Two points are made in the latter paper. Firstly, in respect of a five year regulatory period, the Present Value principle requires a cost of equity with a five-year risk-free rate and a risk premium defined over the same five-year period. Secondly, the Sharpe-Lintner CAPM is consistent with the Present Value principle so long as the parameter values are defined over the regulatory period and based upon conditions prevailing at the start of that period, which (in principle) implies use of a five-year risk-free rate throughout the model. Incenta appears to have interpreted this as a recommendation for consistent use of the risk-free rate within the CAPM. This interpretation is not correct, and therefore does not indicate that I have changed my view on this matter.

My consistently expressed views are as follows. The CAPM, by definition, contains only one risk-free rate but the term of that rate is not defined within the model. As argued in Lally (2010, section 2.2), there is a wide range of reasonable choices for this term including five years. So, if five years were chosen, the CAPM would be consistent with the Present Value Principle for a five-year regulatory situation. However, if one judged that the unspecified period to which the CAPM relates is ten years rather than five years, the CAPM and the Present Value Principle in a five-year regulatory setting would not be compatible. Alternatively, faced with a range of options over the period to which the CAPM applies, one might choose the ten-year term because the MRP must be estimated, one commonly adopted method uses historical averaging of market returns net of contemporaneous risk-free rates, this requires a very long time series of risk-free rates, and the only market rates on Australian government bonds for which a very long time series is available are ten-year ones. Thus, for reasons of data limitations alone, the term over which the CAPM is defined might be ten years. Accordingly, if the model were ‘properly’ applied, it could not be applied to a five-year regulatory situation. However, in the absence of any suitable alternative, the CAPM would have to be adapted in some way so as to provide an estimate of the cost of equity in a five-year regulatory situation.

One possible adaptation would be to use the ten-year risk-free rate throughout the CAPM. However, as risk goes to zero, the correct cost of equity for a five-year regulatory cycle goes to the five-year risk-free rate (Lally, 2004). So, if the CAPM were used to estimate the cost of equity, the risk-free rate constituting the first term within the CAPM must be the five-year rate, i.e., it must match the regulatory period. Furthermore the ten-year risk-free rate typically exceeds the five-year rate. So, if the ten-year risk-free rate were used throughout the CAPM, the resulting estimate of the cost of equity would be too high in the usual regulatory situation in which the equity beta is estimated to be less than 1.

A second possible course of action would be to use the five-year risk-free rate throughout the CAPM. However, as noted above, a long time series of five-year risk-free rates is not available in Australia and therefore would have to be estimated in order to estimate the MRP through historical averaging, and this would aggravate the usual difficulties in estimating the MRP (statistical imprecision and possible bias). Furthermore, a regulator faced with various regulatory situations (three and five year cycles for example) would then require a set of MRP estimates at each point in time (for three and five year situations), which would be incompatible with the CAPM (because the model allows only one MRP). Furthermore, most methods for estimating the MRP use the same data relating to the market portfolio regardless of the future term for which the MRP is sought. Consequently, in varying the risk-free rate used to estimate the MRP over different future periods, it is implicitly assumed that the expected rate of return on the market portfolio (k_m) is the same for all future periods, i.e., there is no term structure for k_m. This is particularly clear when estimating the MRP for T years via the DGM, in which k_m is estimated out to infinity and the risk-free rate for T years is then deducted. However, just as there is a term structure in the risk-free rate (due to expectations about future rates and risk premia), so too is there a term structure in k_m (but due only to expectations about future rates). Consequently, estimating the five-year MRP by estimating k_m out to infinity followed by deducting the prevailing five-year risk-free rate will be biased and a better estimate may arise by deducting the ten-year risk-free rate because it better matches the term to which the k_m estimate relates. The Appendix provides further detail on this matter.

A third possible course of action would be to use the same MRP estimate in all situations (based on the ten-year risk-free rate) and vary only the first term in the CAPM according to the regulatory situation. This too would be incompatible with the CAPM, but would at least limit the modification of the model to the first term within it. Of these three options, the last two have been widely used. I have expressed a (mild) preference for the third option over the second (Lally, 2010, pp. 21-24). Nothing in this mild preference is inconsistent with the comments appearing in Lally (2013b, page 6).

Seventhly, the ERAWA (2013, Appendix 2, para 38) refers to the question of whether the MRP estimate must use the same risk-free rate as that used in the first term of the CAPM (which is the five-year rate), and at this point in time the ERAWA did not use the same risk-free rate. However, more recently, the ERAWA (2015, paras 1038-1040) favours use of the same risk-free rate term (five years) so as to ensure consistency within the CAPM. My views on this matter have been outlined in the last three paragraphs. In respect of the need for a long-term series of five-year risk-free rates in order to estimate the MRP by historical averaging methods, the ERAWA (2015, para 1229) does so by averaging over the time series of three-month and ten-year rates reported in Brailsford et al (2008). However, the term structure of risk-free rates is concave (otherwise the rate would implausibly go to infinity for perpetual bonds) and therefore such a process would underestimate the five-year rate (and therefore overestimate the MRP) even if the three-month data were accurate. Furthermore, Brailsford et al (2008, section 3.2.3) notes that there is no market data on three-month government securities prior to 1959 and the data used in the earlier period (1883-1958, constituting over 50% of the data) is instead deposit rates at trading banks. This illustrates the point made above, that attempts to estimate the five-year MRP using historical data suffer from serious data limitations that aggravate the usual difficulties in estimating the MRP from historical data. Conventional estimates of the five-year from the DGM are also problematic, as explained above. So, for pragmatic reasons, I favour estimating the MRP using the ten-year risk-free rate. Furthermore the impact on the MRP estimate from this choice of historical risk-free rates is small. In particular, the average values for the three-month and ten-year risk-free rates in Brailsford et al (2012, Appendix) are 5.31% and 5.65% respectively, implying an average value for the estimated five-year rate of 5.48%. So, the average difference between the five and ten-year rates is only 0.17%, which would give rise to the same difference between the MRP estimates using these two different risk-free rates. This is not a substantial difference.

Eighthly, the ERAWA (2013, Appendix 2, para 70) argues that "…the use of the MRP in the CAPM suggests that the return on equity will err on the generous side as it is based on a weighted average of assets which have greater uncertainty attached to their future value than has the regulated asset base." In short, the ERAWA is arguing that the CAPM will necessarily overestimate the cost of equity of a low-risk asset. This is not correct. The presence of the beta coefficient in the CAPM ensures that the cost of equity of an asset with low (systematic) risk will have a lower cost of equity than the market portfolio.

3. Review of New Arguments from GGT

GGT (2014, section 7.6) is concerned with risk-free rate of return used by regulators, but does not repeat any of the arguments on this matter previously raised by GGT (2013, section 6). Thus, all of the GGT (2014, section 7.6) material is new and is therefore considered as follows.

GGT (2014, section 7.6.1) argues that the "Present value principle will be satisfied for any rate of return, providing the rate of return used in discounting cash flows for reference tariff calculation is the same as the rate of return used in determining the return included in total revenue….In particular, the present value principle does not require that the term to maturity of a proxy for the risk free rate …be equal to the length of the access arrangement period." This claim is false, and can be rebutted by considering the simplest possible regulatory scenario, in which fixed assets are purchased now, all financing is equity, a revenue or price cap is set now that yields revenues only in one year, there are no operating costs or corporate taxes, the regulatory assets purchased now have a life of one year, there is no risk relating to revenues, and there is no differential personal tax treatment across different sources of investment income.[1] In this case, since the revenues are received in one year and are risk free, their value now must be equal to the revenues (*REV*) discounting at the *current* one year risk free rate (R_{f01}), as follows:

$$V = \frac{REV}{1 + R_{f01}} \tag{1}$$

Furthermore, under the simplifying assumptions adopted here, the revenue received will be equal to that allowed by the regulator and this in turn will be the sum of the asset cost (*B*) plus an allowed rate of return (*R*) on that asset cost:

$$V = \frac{B(1 + R)}{1 + R_{f01}} \tag{2}$$

The Present Value Principle implies that this value *V* should equal the purchase price of the fixed assets (*B*), i.e., $V = B$. Substitution of this into equation (2) implies that the rate of return allowed by the regulator (*R*) must be equal to the current one-year risk-free rate (R_{f01}). This analysis is a simplified version of that in Schmalensee (1989) and Lally (2004). GGT claims

[1] Relaxing any of these assumptions does not alter the conclusion, but it does complicate the proof, hence the simplification.

that the Present Value Principle ($V = B$) would be satisfied by *any* choice for the allowed rate of return and the discount rate, providing that they are the same. This is false. One cannot arbitrarily choose the discount rate; the discount rate in this case must be the current one-year risk-free rate, because the cash flows arise in one year and they are certain. Arbitrage would rule out any other discount rate. Given this unique discount rate, the rate allowed by the regulator (R) must then match it, in order to satisfy the Present Value Principle.

GGT (2014, section 7.6.2) claims that Lally (2007) is concerned with the term to maturity of the debt issued by the regulated firm rather than the term to maturity of the risk-free rate that is allowed by the regulator. This claim is false; Lally (2007) is concerned with both issues. To quote from Lally (2007, Abstract): "If the regulator seeks to ensure that the present value of the future cash flows to equity holders equals their initial investment then the only choice of term for the risk free rate that can achieve this is that matching the regulatory cycle, but it also requires that the firm match its debt duration to the regulatory cycle." The same wording appears in the Conclusions and is preceded by the following words: "This paper examines the appropriate term of the risk free rate to be used by a regulator in price control situations, and in the presence of debt." Clearly, GGT have not carefully read this paper.

GGT (2014, section 7.6.2) also claims that Lally (2010) is concerned with the term to maturity of the debt issued by the regulated firm rather than the term to maturity of the risk-free rate that is allowed by the regulator, and makes the even stronger claim that Lally (2010) "…makes no reference to the term to maturity of the proxy for the risk-free asset." This claim can be rebutted by merely quoting the title of Lally (2010): "The Appropriate Term for the Risk Free Rate and the Debt Margin." GGT's failure to appreciate this point cannot be attributed to a less than careful reading of the title of the paper because GGT record the title of the paper in GGT (2014, footnote 21). Even more remarkably, GGT (2014, page 75) acknowledges that Lally (2010) is concerned with the term to maturity of the risk-free rate that is allowed by the regulator by stating that "The present value principle, Associate Professor Lally concludes, is satisfied when the risk-free rate and the debt margin are chosen to match the regulatory cycle."

GGT (2014, section 7.6.2) argues that, rather than choosing the allowed rate of return in order to satisfy the Present Value Principle, the regulator should choose the allowed rate of return to "provide the regulated firm with a return sufficient to efficiently finance the investments it must make in assets used to provide regulated services." However, the Present Value Principle is simply an operationalisation of this criterion specified by GGT. There is no conflict here.

GGT (2014, section 7.6.2) attributes to Lally (2010) the claim that the regulated firm is free to choose the allowed rate of return. However, no such claim is made by Lally (2010) nor would it be sensible. The allowed rate of return is chosen by the regulator, not the regulated business.

GGT (2014, section 7.6.2) argues that, in setting the allowed rate of return, the regulator must rely upon an asset pricing model and the parameters in such models reflect "investor behaviour." In addition, GGT attributes to Lally (2010) the claim that the regulator is free to choose the allowed rate of return, and implies that this allows the regulator to "arbitrarily" choose the parameter values in these asset pricing models. The last claim is false and GGT are manufacturing an inconsistency where none exists. It is an administrative fact that the regulator chooses the allowed rate of return and therefore has the power to choose. Naturally, some choices are better than others. The choice should satisfy the Present Value Principle, which implies that the appropriate choice for the risk-free rate is the market rate for a term matching the regulatory period, but the principle does not dictate how the risk premium should be determined; the latter requires an asset pricing model, and such models do reflect investor behaviour.

GGT (2014, section 7.6.2) argues that the risk-free rate is a market rate rather than a parameter that "regulators are free to choose when setting allowed rates of return". However, again, there is no conflict here. The risk-free rate is a market rate, with different rates for different terms to maturity. In choosing an allowed rate of return, part of the allowed rate is the risk-free rate and therefore the regulator must choose one such rate from the set of market rates. Whatever choice is made will be a market rate. For example, if the market risk-free rates for one, five and ten years are 4%, 5% and 5.5% respectively, and the regulator chooses the five-year rate of 5%, it has chosen a market rate. GGT appears to believe that there is only one risk-free rate at any given point in time rather than there being a rate for each possible term to maturity.

GGT (2014, section 7.6.3) examines the analysis in Davis (2003), which leads to the conclusion that the risk-free rate chosen by the regulator should be that whose term matches the regulatory cycle. GGT argues that the risk-free rate is a market rate rather than a parameter chosen by a regulator. This is the same point addressed in the previous paragraph.

GGT (2014, section 7.6.3) also argues that the rate of return allowed by a regulator must incorporate an "investor view of the risk-free rate" rather than a "regulator view". This seems to be expressing the same point described in the previous paragraph, and therefore the same response applies, as described in the penultimate paragraph; at any point in time, there is a set of risk-free rates, all of which are market rates, and the regulator must choose from this set. Any regulatory choice is then a market rate.

GGT (2014, section 7.6.3) claims that, in Davis's (2012) analysis, the regulator chooses a debt term for the purposes of setting the output price and does not choose a term for the risk-free rate in doing so. This claim is false. Davis (2012, pp. 7-8) lays out the possible courses of action open to the regulator. In respect of the possibility of the regulator setting prices annually, Davis specifies the regulatory allowance for the cost of debt in the first year to be $r_{01} + s_{01}$, and that for the second year to be $r_{12} + s_{12}$, where r_{01} is defined as the one-year risk-free rate prevailing at the beginning of the first year, s_{01} is the one-year DRP prevailing at the beginning of the first year, etc. Thus, in accordance with this regulatory policy, the regulator sets output prices annually using the prevailing one-year risk-free rate and the prevailing one-year DRP. Furthermore, even if Davis had merely said that the regulator sets output prices annually using the one-year cost of debt, it would be obvious that this meant setting output prices using the one-year risk-free rate plus the one-year DRP because these are the two components of the one-year cost of debt. Clearly, GGT has not carefully read Davis's paper.

GGT (2014, section 7.6.3) also claims that, in Davis's (2011) analysis, the regulator chooses a debt term for the purposes of setting the output price and does not choose a term for the risk-free rate in doing so.[2] This claim is false. Davis (2011, pp. 3-4) lays out the possible courses of action open to the regulator. In respect of the possibility of the regulator setting prices annually, Davis specifies the regulatory allowance for the cost of debt in the first year to be r_{01}, and that for the second year to be r_{12}, where r_{01} is defined as the one-year risk-free rate prevailing at the beginning of the first year, r_{12} is the one-year risk-free rate prevailing at the beginning of the second year.[3] Thus, in accordance with this regulatory policy, the regulator

[2] This claim, and the claim described in the previous paragraph, occurs in both of the last two paragraphs of section 7.6.3 of GGT's paper.

[3] Davis implicitly assumes that the DRP is zero.

sets output prices annually using the prevailing one-year risk-free rate. Clearly, GGT has not carefully read Davis's paper.

4. Review of New Arguments from DBP and SFG

DBP (2014, pp. 14-18) merely summarises arguments in SFG (2014) and I therefore focus upon the latter paper.

SFG (2014, page 3) argues that the Present Value Principle (equivalently expressed as the NPV = 0 Principle) says no more than that the discount rate should be correct. This is false. Equations (1) and (2) contain the correct discount rate, but are only preliminary to the Present Value Principle. The principle states that the rate allowed by the regulator (R) must be chosen to ensure that the present value of the future cash flows (V) is equal to the cost of the investment (B), and this implies that the term of the risk-free rate chosen by the regulator matches the regulatory term.

SFG (2014, section 2) argues that the Present Value Principle is only valid if the value of the regulatory assets at the end of the regulatory cycle are known with certainty. However, certainty on this matter is not a necessary assumption, as demonstrated in Lally (2004) and referred to by the ERAWA (2015, paras 1022-1026). Nevertheless, SFG raises the new argument that, once certainty in the asset value at the end of the regulatory period no longer exists, the standard valuation practice is now appropriate in which

(a) the appropriate discount rate for each year's cash flow embodies the spot risk-free rate for that year, and
(b) this is equivalent to using a single risk-free rate whose term matches the life of the regulatory assets, and therefore
(c) the regulator should use the same rate in setting the allowed revenues.

However the standard valuation practice to which SFG refers is applicable when resetting of revenues in accordance with prevailing interest rates does *not* apply. The regulatory situation is quite different. Furthermore, SFG fails to demonstrate that their approach would satisfy the Present Value Principle.

Nevertheless, one might reasonably wonder about the implications of uncertainty about the value of regulatory assets at the end of the regulatory cycle. To examine this issue, I commence with a very simple regulatory scenario, in which fixed assets are purchased now at cost *B*, their life is two years, all financing is equity, a revenue or price cap is set now that yields revenues in one year and is reset at that point to yield revenues one year later, there are no operating costs or corporate taxes, there is no risk relating to revenues, the allowed depreciation is 50% of the asset cost in each year, the regulator correctly sets revenues at each point, and there is no differential personal tax treatment across different sources of investment income.[4] The current one-year risk-free rate is denoted R_{01} and that in one year is denoted R_{12}. In this case, in one year's time, the regulator sets revenues to be received one year later that are certain. Accordingly, they should be discounted at the prevailing one-year risk-free rate (R_{12}) and therefore the regulator should use the same rate in setting these revenues. The revenues are then $.5B(1 + R_{12})$ and the value of these revenues at the time the revenues are set is as follows:

$$V_1 = \frac{.5B(1+R_{12})}{1+R_{12}} = .5B \qquad (3)$$

Similarly, the regulator sets revenues now (to be received in one year) equal to $(.5B + BR_{01})$ and the value now of these revenues plus V_1 is as follows:

$$V_0 = \frac{(.5B + BR_{01}) + .5B}{1+R_{01}} = B \qquad (4)$$

So, the Present Value Principle is satisfied through the regulator using the prevailing one-year risk-free rate at each reset point. In this scenario, V_1 is certain. I now consider some circumstances that would lead to uncertainty about V_1. One possibility is considered in Lally (2004), arising from changing the RAB at time 1 to match the replacement cost of the assets. This change is denoted *Z*. Since this change will become known at time 1, the payoff on the regulated assets one year later will still be certain at time 1, the appropriate discount rate is therefore still the one-year risk-free rate, and therefore the regulator should still use the one-year risk-free rate at that point for setting revenues for the second year. So, equation (3) becomes

$$V_1 = \frac{(.5B + Z)(1+R_{12})}{1+R_{12}} = .5B + Z$$

[4] Relaxing any of these assumptions does not alter the conclusion, but it does complicate the proof, hence the simplification.

So, the regulatory asset value at the end of the first regulatory period (V_1) is now currently uncertain, because Z is currently unknown, consistent with SFG's scenario. Accordingly, one might suspect that the appropriate rate allowed now by the regulator for setting the first year's revenues might change, and it is therefore denoted k_{01}. The revenues from the regulated assets at time 1 would then be ($.5B + Bk_{01}$) and the residual value at that point will be ($.5B + Z$). To focus upon the critical issue, suppose that Z is mean zero and uncorrelated with market returns. In this case, the appropriate discount rate on the time 1 payoffs is still the one-year risk-free rate and therefore the value now of the regulated assets would be as follows:

$$V_0 = \frac{(.5B + Bk_{01}) + .5B + E(Z)}{1 + R_{01}} = \frac{B(1 + k_{01})}{1 + R_{01}} \qquad (5)$$

Thus, to satisfy the Present Value Principle ($V_0 = B$), the rate allowed by the regulator (k_{01}) must still be equal to the prevailing one-year risk-free rate (R_{01}). So, despite the fact that V_1 is uncertain, regulatory use of the one-year risk-free rate at each reset point still yields a value for the regulated assets equal to the initial investment B, i.e., the Present Value Principle is still satisfied. This contradicts SFG's claims. Of course, only one possible scenario in which V_1 is uncertain has been examined above. However, SFG (2014, para 38) claims that regulatory use of the risk-free rate matching the regulatory cycle (one year in this case) would be invalid if V_1 is uncertain "for whatever reason". So, merely with one counter example, SFG's proposition has been rebutted. Nevertheless, in the interests of demonstrating that the scenario examined above is not unique in warranting regulatory use of the risk-free rate matching the regulatory cycle, suppose that Z embodies systematic risk. In this case, the appropriate discount rate on the payoffs on the regulatory assets at the end of the first year should be the one-year risk-free rate augmented by a risk premium (p_{01}). Equation (5) then becomes:

$$V_0 = \frac{(.5B + Bk_{01}) + .5B + E(Z)}{1 + R_{01} + p_{01}} = \frac{B(1 + k_{01})}{1 + R_{01} + p_{01}}$$

Thus, to satisfy the Present Value Principle ($V_0 = B$), the rate allowed by the regulator (k_{01}) must be equal to $R_{01} + p_{01}$, i.e., the one-year risk-free rate plus a premium to compensate for the systematic risk arising from Z. So, yet again, the appropriate risk-free rate is still the rate whose term matches the regulatory cycle.

SFG (2014, section 3) argues that standard commercial practice is to use the ten-year risk-free rate in valuing businesses, including those subject to five-year regulatory cycles, and therefore the ERAWA should do likewise. The ERAWA's (2015, page 219) response is to argue that the two exercises (price setting for five years and valuation) are fundamentally different and therefore that there is no inconsistency. I think this is a very good point when the valuation is conducted on an unregulated business, as argued in Lally (2013a, pp. 23-26), but less so when it is conducted on a regulated business and SFG refers to a report by Incenta (2013) that is concerned with this situation. My views on the Incenta report appear in Lally (2014, pp. 26-28), as follows:

"Incenta posed four questions to these analysts (14 investment analysts), of which the first two are as follows:

(a) what risk free rate term is used in valuing a regulated businesses subject to five-year regulatory cycle
(b) is a different rate applied to an unregulated business

Incenta claims that all interviewees used the ten-year rate in valuing a regulated business, and that they would all apply the same rate to an unregulated business but use a different beta (ibid, pp. 27-29). Incenta therefore concluded that regulators should use the ten-year rate so as to achieve consistency with the practice of valuation professionals (ibid, page 43).

I do not agree with the conclusion drawn by Incenta for the following reasons. Firstly, since Incenta refers to regulatory debates over the choice of the five or ten year rate, these regulatory rates are the prevailing rates (those at the commencement of the regulatory cycle), and Incenta recommends regulatory use of the ten-year rate, it follows that Incenta is recommending regulatory use of the *prevailing* ten-year rate. However, the rates used by these interviewees averaged 5% (Incenta, 2013, Table 2) whilst the prevailing ten-year rates averaged 3.2%.[5] Thus, most of the interviewees were not using the prevailing ten-year rate; in fact only one of the interviewees (who used a rate of 3.5%) could have been using the prevailing ten-year rate. Furthermore, one of the interviewees (Mr Edwards of Lonergan Edwards) stated that the term structure was significantly upward sloping and therefore a rate in excess of the prevailing ten-

[5] The dates of the interviews are not given but the report is dated June 2013 and I therefore examine the ten-year rates over the preceding year (June 2012-May 2013). The monthly averages range from 2.86% to 3.5% over this period and average 3.2% over the full year (data from the table F2 on the Reserve Bank website: www.rba.gov.au).

year rate was warranted for valuing the infinite-life cash flows of these businesses (ibid, page 45). Since most of the other interviewees stressed the long-term nature of the cash flows and the need for a matching discount rate (ibid, pp. 45-46), Mr Edwards's explanation may also characterise some or all of these other interviewees. Other interviewees described their risk free rate as being "through the cycle" (ibid, pp. 45-46) and therefore may be using a ten-year rate averaged over some historical period. Thus, despite Incenta recommending the use of the prevailing ten-year rate on the basis that it accords with market practice, their survey of market practice does not support their recommendation.

Secondly, even if the interviewees were using the prevailing ten-year rate for valuation purposes, it would not follow that they favoured use of the same rate by a regulator for setting output prices. If regulators set output prices correctly (so that the present value of future cash flows matched the contemporaneous RAV), regulated businesses were not expected to over or under perform the opex assumptions used by regulators, regulatory policy was not expected to change without appropriate compensation, and these businesses did not have any growth options, the valuation of a regulated businesses at any point in time would simply be the contemporaneous RAV.[6] Thus the value of a regulated business would be its RAV subject to correction for these additional issues. For example, if a regulated business was expected to have lower opex than that reflected in the prices allowed by the regulator, the value of the business would be its RAV plus the present value of this lower opex. Thus, when the analysts refer to using a ten-year risk free rate in the discounting process, they may be referring to the discounting for these additional issues. If so, this discount rate would have no relevance to the appropriate regulatory reset rate because the latter is reflected in the RAV component, i.e., in the WACC allowed by the regulator and applied to the RAV. Alternatively, if analysts are not acting in this way and are present valuing all cash flows (including those reflected in the RAV), then the use of the ten-year risk free rate within the discount rate would represent some sort of average over the rate that is relevant to the RAV (the five-year rate) and the rate that is relevant to the additional cash flows, and this average rate does not indicate the appropriate rate for the RAV component.

[6] To be precise, the value would be the present value of the cash flows over the remainder of the current regulatory cycle plus the present value of the RAV at the end of the cycle.

Thirdly, even if Incenta had asked these analysts the much better question of what was the appropriate risk free rate for a regulator to use in setting output prices and these analysts had clearly stated that this was the (prevailing) ten-year rate, Incenta ought to have enquired into the basis for this response. For example an analyst might have supplied a proof that use of the ten-year rate would satisfy the NPV = 0 principle. However Incenta hasn't asked either of these questions and this undercuts the value of their interviews. The value of interviewing these analysts lies not merely in asking what they do but why. If their practices seem to be wrong, and they cannot supply a plausible explanation for them, it would not be sensible for a regulator to match their behaviour.

Fourthly, a number of the responses from these interviewees undercuts the presumption that their views are authoritative. In particular, two of the interviewees claim to use the ten-year rate because it is "standard market practice" whilst a third one states that it is the "policy of the company" (Incenta, 2013, Appendix A). Such comments suggest that the analyst either has no opinion on the matter or holds a different view to the one presented. In addition, all of the interviewees claim that the appropriate risk-free rate for valuing regulated businesses (with five year cycles) is the same as that for unregulated businesses. Since regulated businesses subject to five-yearly price resets are similar to a very long-term bond with its coupon reset every five years, the belief on the part of all of these analysts that the appropriate risk-free rate for valuing regulated businesses (with five year cycles) is the same as that for unregulated businesses implies a belief that fixed rate bonds should be valued in the same way as floating rate bonds. This implicit failure to appreciate the difference between fixed-rate and floating-rate bonds undercuts the credibility of the interviewees."

SFG (2015, para 79) argues that setting the allowed risk-free rate to match the regulatory cycle leads to lower allowed returns to investors, and this logically implies that prices should be reset daily, which is "nonsensical", and therefore supports the use of a ten-year risk-free rate. My views on this issue appear in Lally (2013a, pp. 43-44): "However there are numerous reasons why regulatory terms are not set at very low levels. One is that the regulatory term determines the period for which regulated businesses retain the benefits from efficiency gains, and therefore determines the sharing of efficiency gains between producers and consumers. Another is that very short regulatory terms, coupled with output prices being set in accordance with prevailing short-term risk free rates, leads to greater volatility in output prices. Thus there is a trade-off between lower expected prices and higher volatility from reducing the regulatory term. The same trade-off is faced by borrowers in choosing interest rates that are reset frequently (floating rates) and rates fixed for some longer term; floating rates are on average lower (because the term structure is typically upward sloping) but involve greater volatility; some borrowers favour the floating rates and others the longer-term rates."

SFG (2014, section 5) critiques the inconsistency arising from the ERAWA's use of the five-year risk-free rate in the first term of the CAPM and the ten-year risk-free rate within the MRP estimate. However the ERAWA (2015, paras 1038-1040) now uses the same (five-year) risk-free rate in both places. My views on the merits of this matter are expressed in section 2 above. In summary, in seeking to apply the CAPM to a five-year regulatory situation, there are sound pragmatic reasons for estimating the MRP relative to the ten-year risk-free rate and coupling this with a five-year risk-free rate within the first term of the CAPM. Furthermore, whilst consistent use of the five-year risk-free rate within the model would appear to be conceptually compatible with the model, a conceptual incompatibility would still arise if the regulator were also faced with a (say) three year regulatory situation, leading to consistent use of the three-year risk-free rate within the model for the purposes of addressing that regulatory situation, and therefore to simultaneously using two different versions of the CAPM.

5. Conclusions

This paper has addressed a number of issues raised by the ERAWA and the conclusions are as follows.

Firstly, I concur with the analysis by the ERAWA subject only to some relatively minor points.

Secondly, I do not agree with any of the points raised by GGT in their most recent submission. Most of these points simply involve misunderstanding arguments that lead to the conclusion that the regulator must use a risk-free rate with a term matching the regulatory cycle in order to satisfy the Present Value Principle.

Thirdly, I do not agree with any of the new points raised by SFG. In particular, I do not agree that regulatory use of a risk-free rate whose term matches the regulatory cycle requires absolute certainty about the value of the regulatory assets at the end of the regulatory cycle. In addition, I do not consider that the Incenta survey warrants the conclusion that regulators should use the ten-year risk-free rate so as to achieve consistency with the practice of valuation professionals.

APPENDIX: Estimating the MRP from the Dividend Growth Model

This Appendix examines biases arising from estimating the MRP from the Dividend Growth Model (DGM). A conventional estimate of the MRP for *T* years from the DGM involves estimating the market cost of equity out to infinity followed by deducting the *T* year risk-free rate. So, the conventional estimate of the MRP over the next five years from the DGM involves estimating the market cost of equity out to infinity followed by deducting the five-year risk-free rate. This inconsistency in terms is likely to bias the estimate of the MRP and using the risk-free rate for the longest possible term is likely to minimise the bias.

To illustrate this point, suppose that the spot rates for the market cost of equity (k_m) grow linearly from 10.2% for one year out to 12% for ten years, and are 12% thereafter. This term structure is upward sloping for the first ten years because expected short-term rates are expected to rise. For example, the current k_m spot rate for the first five-years of 11% and that for the first ten years of 12% implies an expected five-year spot rate in five years of 13%. I further assume a constant growth rate in expected dividends per share (DPS) of 4%. Per \$1 of current DPS, the value now of the market portfolio is then 13.21 as follows:

$$V_0 = \frac{1.04}{1.102} + \frac{(1.04)^2}{(1.104)^2} + \ldots\ldots + \frac{(1.04)^{10} + \left[\frac{(1.04)^{11}}{.12 - .04}\right]}{(1.12)^{10}} = 13.21$$

This value can also be expressed as follows:

$$13.21 = \frac{1.04}{1.102} + \frac{(1.04)^2}{(1.104)^2} + \ldots\ldots + \frac{(1.04)^5}{(1.11)^5} + \frac{E(V_5)}{(1.11)^5}$$

and therefore $E(V_5) = 15.25$. So, the expected rate of return on the market portfolio over the next five years is the solution to the following equation, which is 10.94%.

$$13.21 = \frac{1.04}{1+k} + \frac{(1.04)^2}{(1+k)^2} + \ldots\ldots + \frac{(1.04)^5}{(1+k)^5} + \frac{E(V_5)}{(1+k)^5}$$

By the same process, the expected rate of return on the market portfolio over the next ten years is 11.75%. These two rates are conceptually identical to the yield-to-maturity on bonds. Now suppose that the current five and ten-year risk-free rates (yields to maturity) are 4.97% and 6.0% respectively. The spread in the last two rates (1.03%) is greater than that for the expected rate of return on the market portfolio for the two periods (0.81%) by 0.22% because the term structure for the risk-free rate embodies a liquidity premium as well as expectations about future rates, and an estimate for this liquidity premium is the average difference between the five and ten year rates over the longest period for which the data is available (0.22%, from January 1972 to October 2015).[7]

Thus, the MRP for the next five years is the expected rate of return on the market portfolio over that period (10.94%) less the five-year risk-free rate (4.97%), which is MRP_5 = 5.97%. By contrast, the conventional estimate of the MRP for the next five years using the DGM would be the estimate of k_m out to infinity less the five-year risk-free rate, and the former would be the solution to the following equation:

$$13.21 = \frac{1.04}{1+k_m} + \frac{(1.04)^2}{(1+k_m)^2} + ... = \frac{1.04}{k_m - .04}$$

The solution is 11.87%, and therefore the MRP estimate would be $M\hat{R}P_5$ = 11.87% - 4.97% = 6.90%. By contrast, the MRP estimate using the ten-year risk-free rate would be $M\hat{R}P_{10}$ = 11.87% - 6.0% = 5.87%. Since the actual MRP over the next five years is 5.97%, a conventional DGM estimate using the ten-year risk-free rate produces a far superior estimate than that using the five-year risk-free rate. These results are summarised in the first row of Table 1.

Table 1 also shows results from a set of other scenarios, including downward sloping term structures for k_m spot rates. In respect of the case shown in the last row of Table 1, k_m linearly declines from 13.8% for one year out to 12% for ten years, and 12% thereafter. Following the same process used above, this implies expected rates of return on the market portfolio over the next five and ten years of 13.06% and 12.23% respectively. The difference is 0.83%.

[7] The data is from Table F2 on the website of the RBA (www.rba.gov.au).

Accordingly, with a ten-year risk-free rate of 6%, an appropriate value for the five-year risk-free rate is 6.61% with the spread of 0.61% reflecting downward expectations of 0.83% partly offset by a liquidity premium of 0.22%. In addition, the DGM estimate for k_m out to infinity is 12.12%. The MRP over the next five years would then be MRP_5 = 13.06% - 6.61% = 6.45%, whilst the estimate from the DGM using the five-year risk-free rate would be $M\hat{R}P_5$ = 12.12% - 6.61% = 5.51%, and the estimate using the ten-year risk-free rate would be $M\hat{R}P_{10}$ = 12.12% - 6.0% = 6.12%. Across all four cases in Table 1, in estimating the MRP for the next five years, the DGM estimate using the ten-year risk-free rate is always a better estimate than that using the five-year rate.

Table 1: Estimates of the MRP for Five Years

k_m Spot Rates	k_{m5}	k_{m10}	R_{f5}	R_{f10}	MRP_5	$M\hat{R}P_5$	$M\hat{R}P_{10}$
10.2%.................12%	10.94%	11.75%	4.97%	6.0%	5.97%	6.90%	5.87%
11.1%.................12%	11.48%	11.87%	5.39%	6.0%	6.09%	6.55%	5.94%
12.9%.................12%	12.53%	12.12%	6.19%	6.0%	6.72%	5.87%	6.06%
13.8%.................12%	13.36%	12.23%	6.61%	6.0%	6.45%	5.51%	6.12%

In summary, conventional estimates of the MRP for some finite term from the DGM involve estimating the market cost of equity out to infinity followed by deducting the risk-free rate for that finite term. The inconsistency in these two terms implies that the resulting estimate of the MRP is biased and the bias is reduced by matching to the maximum possible extent the term of the risk-free rate to the term for which the market cost of equity is estimated, which implies use of the ten-year risk-free rate. Doing so yields an estimate for the market risk premium over the next five years that is markedly superior to that arising from deducting the five-year risk-free rate from the estimated market cost of equity out to infinity.

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