REVIEW OF SUBMISSIONS FROM FRONTIER ECONOMICS ON THE WACC FOR AURIZON NETWORK

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8 November 2017

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1. Introduction

Aurizon Network has recently submitted a DAU for the regulatory period from 1 July 2017 to 30 June 2021 (UT5 period), for the QCA's consideration. Consequent upon this, Frontier Economics has submitted three reports, relating to the risk-free rate, the MRP, and gamma. These reports contain some new arguments. Accordingly, this paper assesses these new arguments.

2. Risk-Free Rate

Frontier (2017a, section 2.3) argues that the goal of regulation is to replicate the pricing outcomes in a competitive market, which is unregulated, and therefore the risk-free rate must be that appropriate to otherwise identical but unregulated firms. In support of this, Frontier cites wording from a decision by the Federal Court (2017, para 537):

> "But the attribution of the relevant "efficiency" (i.e., in respect of financing costs) is to be gauged by the disciplines of a workably competitive market (i.e., an unregulated market)."

However, at para 534, the Court states:

> "Plainly enough, a workably efficient market is not a regulated market. But, viewing the efficient financing costs of a benchmark efficient entity as those that would be incurred in a workably competitive market does not mean that, for the purposes of construing and applying the allowed rate of return objective, the benchmark efficient entity must then be fixed with the character of an unregulated entity."

These two statements are contradictory; having (rightly) equated a workably competitive market with an unregulated one in para 537, the Court asserts otherwise in para 534. So, I do not think that the Federal Court has offered a clear view on this matter. The point here on which the Court is clear is that the benchmark efficient entity (BEE) must have the same risk as the service provider (which is regulated) but this BEE need not be regulated. However, since regulation is likely to affect risk, it would be difficult to find a BEE that is not regulated.[1]

[1] For a review of the theory and empirical evidence on the relationship between regulation and risk, see Lally (2016a, section 2.2).

The ACT (2016a, paras 913-914) is in a similarly difficult position on this matter. Like the Federal Court, the ACT states that the BEE must have similar risk to the service provider. It then argues that, since the purpose of regulation is to replicate the pricing outcomes of an efficient market, the BEE *must* be unregulated. As with the Federal Court, the ACT's conclusion faces the problem that regulation is likely to affect risk and therefore it would be very difficult to find an unregulated BEE with similar risk to the service provider.

The apparent problem here is that

(1) the BEE must have the same risk as the service provider, which strongly implies that the BEE must be both regulated and subject to the same regulatory regime as the service provider, and

(2) regulation should seek to replicate competitive market outcomes.

Prima facie, these two requirements are inconsistent. However, there is no necessary conflict. As argued in Lally (2013a, pp. 44-45), regulation should seek to replicate competitive market outcomes in the sense that unregulated firms in competitive markets charge prices that just cover efficient costs, including the cost of capital, and regulation should seek to do likewise. However, it does not follow that every detail about regulated firms and competitive firms 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 are likely to 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 is likely to affect 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. It seems that both the ACT and the Federal Court think that otherwise identical unregulated firms in a competitive market actually exist and therefore can provide the BEE. However, such firms do not exist and could not exist because regulated businesses are natural monopolies. Instead, the relevance of competitive market situations is that the prices charged by the service provider must also just cover efficient costs.

Frontier (2017a, section 2.4) notes that independent expert valuation reports use the ten-year risk-free rate even when valuing regulated businesses. This point repeats that raised in SFG (2014a, section 2), which was addressed in Lally (2015, section 2.1). Frontier does not respond to the arguments in Lally (2015).

Frontier (2017a, section 3) addresses the analysis in Lally (2004), which demonstrates that

(1) The appropriate risk-free rate used by a regulator is that matching the regulatory cycle even in the presence of cost and volume risks, and risks arising from asset valuation methodologies.

(2) These risks are therefore allowed for by adding a risk premium to the discount rate used to value cash flows, and therefore also to the cost of equity allowed by the regulator, not by altering the term for the risk-free rate.

Frontier's response is to claim that the risk premium can only deal with uncertainty whilst the risk-free rate must match the horizon of the cash flows, except if the value of the regulated assets at the end of the regulatory period is certain, in which case the appropriate risk-free rate matches the regulatory cycle. Frontier does not supply any analysis in support of their claim. Nevertheless, I examine this issue in more detail as follows. The test of any claims about the appropriate cost of capital to be used by a regulator are that they satisfy the fundamental regulatory requirement that the present value of the resulting revenues net of operating costs and taxes is equal to the initial investment (the NPV = 0 principle).

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 are no revenue risks, the allowed depreciation is 50% of the asset cost in each year (and hence there is no RAB risk), the regulator correctly sets revenues at each point, and there is no differential personal tax treatment across different sources of investment income.[2] 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 will set 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:

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

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:

$$V_0 = \frac{(.5B + BR_{01}) + .5B}{1+R_{01}} = B \tag{2}$$

So, the NPV = 0 principle ($V_0 = B$) is satisfied through the regulator using the prevailing one-year risk-free rate at each reset point. In this scenario, V_1 is certain. The conclusion here that the regulator should use a risk-free rate matching the regulatory term is accepted by Frontier. 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 is known at time 1, the revenues on the regulated assets arising one year later (and based upon the RAB at time 1) will still be certain at time 1. So, the appropriate discount rate on these revenues is still the one-year risk-free rate prevailing at that time, and therefore the regulator still uses the one-year risk-free rate at that point for setting revenues for the second year. So, equation (1) becomes

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

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[2] Apart from the assumption relating to RAB risk, which will be relaxed, these assumptions are adopted to simplify the presentation and relaxation of them does not alter the conclusion.

So, whilst the value of the regulatory assets at the end of the first regulatory period (V_1) becomes known at that time, it is uncertain at the beginning of that period (because Z is unknown at the beginning of the period), consistent with Frontier's scenario. Suppose now that Z is mean zero and uncorrelated with market returns. In this case, the appropriate discount rate on the time 1 payoffs will still be the one-year risk-free rate. Accordingly, the regulator will still use the one-year risk-free rate in setting the allowed cost of capital for the first year. The revenues from the regulated assets at time 1 would then be ($.5B + BR_{01}$), and the residual value at that point will be ($.5B + Z$) as shown in equation (3). So, the value now of the regulated assets would be as follows:

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

So, the NPV = 0 principle ($V_0 = B$) is still satisfied through the regulator using the prevailing one-year risk-free rate at each reset point, despite the fact that V_1 is now uncertain. This contradicts Frontier's claim that the two-year risk-free rate (matching the asset life) must be used by the regulator when V_1 is uncertain. Had the regulator used the two-year risk-free rate rather than the one-year rate, the effect would have depended upon the difference between the two rates. If the two-year rate exceeded the one-year rate, the allowed revenues would then have been larger than above, and therefore larger than those required to satisfy the NPV = 0 principle ($V_0 = B$). So, the allowed revenues would have been too high. Accordingly, use of the two-year risk-free rate by the regulator would have been incorrect.

This single scenario in which V_1 is uncertain is sufficient to rebut Frontier's claim. Nevertheless, in the interests of demonstrating that this scenario is not unique in warranting regulatory use of the risk-free rate matching the regulatory cycle, suppose now that Z embodies systematic risk. This has no effect upon equation (3) because the risk relating to Z is resolved over the first year. However, the appropriate discount rate on the payoffs on the regulatory assets at the end of the first year should now be the one-year risk-free rate augmented by a risk premium (p_{01}). This premium is therefore also added by the regulator to its allowed cost of capital in the first year. So, equation (4) becomes:

$$V_0 = \frac{(.5B + BR_{01} + Bp_{01}) + .5B + E(Z)}{1 + R_{01} + p_{01}} = \frac{B(1 + R_{01} + p_{01})}{1 + R_{01} + p_{01}} = B \qquad (5)$$

So, the NPV = 0 principle ($V_0 = B$) is still satisfied through the regulator using the prevailing one-year risk-free rate at each reset point, despite the fact that V_1 is again uncertain. This again contradicts Frontier's claim that the two-year risk-free rate must be used by the regulator when V_1 is uncertain.

In summary, it has been shown that the NPV = 0 principle is still satisfied by using the risk-free rate that matches the regulatory cycle even if there is ex-ante uncertainty about the value of the regulatory assets at the end of a regulatory cycle. However, Frontier's claim that the appropriate risk-free rate matches the horizon of the cash flows is true in some situations. For example, if a project delivers a certain cash flow in two years, then the value now of that cash flow is the cash flow discounted at the current two-year risk-free rate. Alternatively, if a project delivers an uncertain cash flow in two years and that uncertainty is not determined (at least in part) by an observable risk-free rate at some intervening point, then the value now of that cash flow is the expected cash flow discounted at the current two-year risk-free rate plus a premium for risk (this is the standard valuation scenario referred to by Frontier in para 98 of their report). However, if the uncertainty in the future cash flows is determined (at least in part) by an observable risk-free rate at some intervening point (as occurs with regulatory situations), a recursive valuation process must then be applied as shown above. So, the key issue is whether uncertainty in future cash flows is driven at least in part by an observable risk-free rate at some earlier point.

It should also be noted that, if Frontier's belief (that equations (1) and (2) are valid if V_1 is certain but that the appropriate risk-free rate becomes the two-year rate if V_1 is uncertain) were true, it would remain true even if the risk associated with V_1 were infinitesimally small, and therefore would violate a "smooth-pasting" requirement in asset pricing and regulation, i.e., very small changes in risk cannot give rise to substantial changes in valuation (due to arbitrage) and hence cannot give rise to substantial changes in the appropriate regulatory decision. Furthermore, the change favoured by Frontier when V_1 has any risk involves switching from the one to the two-year risk free rate, and this change would be substantial if the one and two year rates were quite different. All of this implies that Frontier's argument cannot be valid.

Frontier (2017a, para 102) asserts that, if it is correct to cut-off a series of long-run risky cash flows, that approach could be applied to any series of long-run risky cash flows. I presume Frontier's reference to cutting off means to initially value the year 2 revenues at time 1, followed by valuing the time 1 payoffs at time 0. This is a recursive process, but it is only warranted if the revenues arising at time 2 are determined at time 1 and the revenues arising at time 1 are determined at time 0. This is a feature of regulatory scenarios but not of risky cash flows in general. So, the recursive approach is not warranted for risky cash flows in general.

Frontier (2017a, para 98) also characterizes the risk premium in equation (5) as compensation for using the "wrong" risk-free rate. This is not correct. The risk premium compensates for systematic risk arising from the RAB adjustment (Z), and could be zero or even negative depending solely upon the nature of that risk, i.e., is Z correlated with market returns and, if so, is the correlation positive or negative. The sign and size of this premium is therefore unrelated to the difference between the one and two-year risk-free rates, and therefore could not compensate for that difference.

Frontier (2017a, section 3) asserts that various parties including the QCA (2014a, page 46) and Lally (2013a) accept that choosing the risk-free rate to match the regulatory cycle will satisfy the NPV = 0 principle only if the value of the regulatory assets at the end of the regulatory cycle is certain. However, Frontier's (2017a, section 3.3) quotation from the QCA is drawn from a section of the QCA's paper headed "Example" and sources of uncertainty (operating costs, taxes and demand risk) are assumed to be absent in this example in order to "simplify the example" (QCA, 2014a, footnote 40). Thus, the presentation of this example by the QCA does not imply that the QCA believes that certainty about the value of the regulatory assets at the end of the regulatory cycle is a necessary assumption. It is perfectly normal in illustrating the application of a mathematical proposition to invoke conditions that are not essential to the proof of the proposition. Furthermore, the QCA (2014a, page 47) explicitly states that certainty about the value of the regulatory assets at the end of the regulatory cycle is *not* a necessary assumption here, and Frontier cannot have failed to notice this because SFG (2014, section 3) refers to this statement by the QCA and SFG is Frontier under an earlier name. Furthermore, Frontier's (2017a, section 3.5) quotes from Lally (2013a) are also drawn from an example and therefore suffer from the same problem as the quotes drawn from the QCA. It would be remarkable if Lally (2013a) did support Frontier's position on this matter because Lally (2004) does not support it and Frontier devotes section 3 of its report to attempting to demonstrate that Lally (2004) is not correct.

Frontier (2017a, section 3.4) argues that the QCA (2014a, page 47) has misrepresented a submission from the QTC (2014a). In particular, the QTC (2014, pp. 3-4) argues that the proposition that the regulator must use a risk-free rate matching the regulatory cycle in order to satisfy the NPV = 0 principle assumes that the regulatory assets can be sold at the end of the regulatory period for an amount equal to the RAB. The QCA (2014a, page 47) summarises and critiques this argument. Frontier (2017a, section 3.4) claims that the QCA refers to the act of selling the assets but not also to the fact that the sale proceeds needed to match the RAB. Frontier (2017a, section 3.4) further claims that the QTC's point is concerned only with the value of the assets at the end of the regulatory cycle and not with whether they are sold. Neither of Frontier's claims is correct; the QTC refers to both sale and at RAB, and the QCA refers to both of these points in summarizing the QTC's point.

Frontier (2017a, section 4.1) argues that use of the four-year risk-free rate within the first term of the CAPM and the ten-year risk-free rate within the MRP would lead to an erroneous estimate of the cost of capital of a business with a beta of 1. The same argument was raised by The Brattle Group (2014, section IV) and addressed by Lally (2015, section 3.2). Frontier has not responded to that.

Frontier (2017a, section 4.3) refers to comments by the QCA (2014a, page 52), that the QCA had considered estimating the MRP using the five-year risk-free rate rather than the ten-year rate so as to achieve consistent use of a risk-free rate within the CAPM and concluded that doing so did not change the rounded MRP estimate. Frontier asserts that inconsistencies and approximations can be avoided by consistent use of the ten-year risk-free rate throughout the CAPM. However, as discussed in Lally (2015, page 8), this is inconsistent with the CAPM and also violates the NPV = 0 principle whenever this model is applied to a regulatory problem with a regulatory cycle of other than ten years (as is the case here). Frontier does not respond to this point. Frontier also asserts that, whilst the difference between the four and ten-year risk-free rates is small on average, it can be large at the time of a particular determination and provides evidence of a difference of up to 0.70% in recent times. However, amongst the four principal approaches to estimating the MRP that the QCA considers, Frontier's point is relevant only to the Cornell approach and this markedly dilutes Frontier's point.

Frontier (2017a, section 5.1) approvingly notes that the majority of Australian regulators use the ten-year risk-free rate. The same point was raised by SFG (2014a, section 5) and Lally (2015, page 9) addresses this issue. Frontier does not respond to this.

Frontier (2017a, section 5.2) approvingly cites various parties who believe that the proposition that the regulator must use a risk-free rate matching the regulatory cycle in order to satisfy the NPV = 0 principle assumes that the value of the regulatory assets at the end of the regulatory cycle is certain. This claim has been rebutted by the analysis above.

Frontier refers to a survey conducted by Incenta (2013), which appears to support use of the ten-year risk-free rate. This report is examined in Lally (2014, pp. 26-28), and the conclusion reached there is that the Incenta survey results do not suggest that the QCA should adopt the ten-year risk-free rate. Frontier has not responded to any of the points raised in Lally (2014, pp. 26-28).

3. Market Risk Premium

Frontier (2017b, section 2.4) refers back to evidence presented in Frontier (2016a), to the effect that the cost of equity has remained stable whilst the risk-free rate has declined since the GFC, and therefore the MRP must have risen. This evidence has been critiqued in Lally (2017, pp. 25-26). Frontier (2017b) does not respond to the points made there.

Frontier (2017b, section 3) argues that the Ibbotson estimator provides an estimate of the MRP that reflects average market conditions over the estimation period, that current market conditions differ from average historical conditions in that the risk-free rates are low, that the relationship between risk-free rates and the MRP "may" be negative, and accordingly there is a "strong" basis for concluding that the Ibbotson estimate of 6.5% is too low. However, Frontier's (reasonable) belief that the MRP "may" be negatively related to risk-free rates does not support its conclusion that there is a "strong" basis for concluding that the Ibbotson estimate of 6.5% is too low. Furthermore, there are a large set of other considerations that suggest that the Ibbotson estimate is currently too high. These include the growth of mutual funds, increased liquidity in the equities market, increased macroeconomic stability, and the internationalization of equity markets, all of which would have reduced the MRP, thereby generating a one-off boost to the value of equities, which in turn would have raised the Ibbotson estimate of the MRP above the initial MRP value and hence even more so over the current MRP value. In addition, the inflation-shock in the late 20th century would have raised the Ibbotson MRP estimate but not the true MRP value.

Frontier (2017b, section 4.3.1) argues that, even if unexpected inflation did raise the Ibbotson MRP estimate, it is only one of a variety of events (some of which will have raised the estimate and some to have lowered it), there are no reasonable grounds for singling out unexpected inflation, and the effects from all of these events will tend to average out in the historical period examined. However, as discussed in the previous paragraph, there are a set of events that would likely have significantly lowered the MRP during the period over which the estimate was based, and no clear contrary case is apparent. Although it is not possible to quantify any of these effects to an acceptable degree of precision, their existence reinforces the merits of using the Siegel estimator.

Frontier (2017b, section 4.3.2) argues that the basis of the Siegel methodology is the unusually low real yields on government bonds prior to 1990 (thereby inducing an upward impact on the Ibbotson estimator), the QCA's preferred period for generating the Ibbotson estimate is from 1958, and the real yields on Australian government bonds over this period are not unusually low (with negative rates in the 1970s offset by high rates in the 1980s). However, as noted by Lally

(2014, page 11), Australia's experience from 1883-2013 can be divided into a low inflation era (1883-1939), a high inflation era (1940-1990), and a second low inflation era (1991-2013) with average inflation rates of 0.9%, 6.4% and 2.5% respectively. The corresponding average real yields on ten-year government bonds were 3.5%, 0.7% and 3.5%. So, in the high inflation era, real yields on government bonds were markedly below that from the earlier period (highly suggestive of ten-year inflation forecasts having been too low in this high inflation era) and with little 'compensation' in the subsequent low inflation era (due to ten-year inflation forecasts being too high). The effect of this would have been to inflate the Ibbotson MRP estimate, to the extent that data from the period 1940-1990 is used in forming the Ibbotson estimate. Presumably, Frontier's response to this would be to say that, if the Ibbotson estimator is based upon data from 1958, any conclusions about government bond yields being unusually low would have to be based upon data on those bond yields from exactly the same period. I do not agree. The QCA's preference for estimating the Ibbotson estimator from 1958 arises from a concern only about data on equities, and data on inflation and government bond yields from a longer period can and should be used to form a conclusion as to whether real yields were unusual over any period. Since real yields on government bonds were unusual in the 1940-1990 period due to high inflation not being fully anticipated, the extent to which this point causes the Siegel estimate to be below the Ibbotson estimate depends mechanically upon what fraction of the 1940-1990 period is used in forming the Ibbotson estimate and what fraction this represents of the entire period used to form the Ibbotson estimate. For example, using the 1883-2013 data referred to by Lally (2014, page 11), had the Ibbotson estimate used data from 1883-2013, the Siegel estimate would have been the Ibbotson estimate subject to adding back the average ex-post real government bond yield over the same period and then deducting an estimate of the long-term expected real bond yield to yield a Siegel estimate of 5.5% as follows (see Lally, 2014, page 12), producing a difference between the Ibbotson and Siegel estimates of 1.2%:

$$M\hat{R}P = .067 + .024 - .036 = .055$$

By contrast, had the Ibbotson estimate been based upon data from 1940-2013, the Siegel estimate would have been reduced to 4.5% as follows, producing a difference between the Ibbotson and Siegel estimates of 2.0%:

$$M\hat{R}P = .065 + .016 - .036 = .045$$

These results are shown in Table 1 along with those using data from 1958-2013 and 1980-2013.

Table 1: Ibbotson (I) and Siegel (S) Estimates of the MRP

Data Period	I	S	I - S
1883-2013	.067	.055	.012
1940-2013	.065	.045	.020
1958-2013	.066	.057	.009
1980-2013	.064	.067	-0.003

So, regardless of which data is used to form the Ibbotson estimate (providing the commencement date is pre 1990), Siegel's argument is still valid but the effect of it (in terms of the differential between the Ibbotson and Siegel estimates) varies and tails away to zero as the commencement date for the period used to form the Ibbotson estimate approaches 1990.

Frontier (2017b, section 4.3.3) claims that the QCA estimates the average expected real bond yield from 1958 by using data on inflation-protected bonds from 1987 onwards, thereby extrapolating the latter average to the 30 preceding years, and argues that doing so was unreasonable in view of the volatility in the data. The same argument was raised by SFG (2014b, paras 77-79), and addressed in Lally (2015, pp. 26-27), i.e., SFG fail to note that the QCA (2014a, page 65) offers an additional justification for the estimate of 3.7%: it is similar to the average realised real return of 3.5% over a long period (1883-1939) during which inflation was low (averaging 0.9%). These two pieces of information support the QCA's conclusion that the average expected real risk-free rate over the period from 1958 (or any earlier period) was about 3.7%, and rebut SFG's claim that sufficient data is not available to implement the Siegel approach. Frontier (2017b) is aware of Lally (2015), because they cite it in an earlier report (Frontier, 2016), but does not respond to the arguments there.

Frontier (2017b, section 4.4) claims that the basis of the Siegel approach is that real government bond yields in 1990 would continue to remain high after 1990, this prediction has proved to be inaccurate, and this undercuts the merits of the Siegel approach. Again, this argument has been raised earlier by SFG (2014b, paras 80-83) and addressed in Lally (2015, pp. 28-30). Frontier (2017b) is aware of the latter paper because they cite it in an earlier report (Frontier, 2016a), but does not respond to the arguments there.

Frontier (2017b, section 5.2.2) addresses the QCA's practice in using the Cornell methodology of estimating the long-run expected growth rate in DPS by deducting some amount from the long-run expected growth rate in GDP, in recognition of the fact that the long-run expected growth rate in aggregate dividends to all equities must match that for GDP and some proportion of these aggregate dividends goes to shares that do not currently exist. In particular, Frontier argues that constraining the expected growth in DPS to that of expected GDP growth is only necessary in the very long-run (such as beyond 50 years), which is beyond the point at which there is any material effect on equity value from that change. This argument repeats that in SFG (2014c, section 3.3), and has been addressed in Lally (2015, page 22). Frontier (2017b) is aware of the latter paper because they cite it in an earlier report (Frontier, 2016a), but does not respond to the arguments there.

Frontier (2017b, section 5.2.2) argues that the QCA's practice in using the Cornell methodology of estimating the long-run expected growth rate in DPS by deducting some amount from the long-run expected growth rate in GDP is unwarranted because recent empirical evidence (post 1990) is inconsistent with this. This argument repeats that in SFG (2014c, section 3.3), and has been addressed in Lally (2015, page 22), i.e., the deduction is logically necessary (or else the earnings share of GDP either goes to zero or exceeds 100%), empirical analysis is therefore required merely to estimate the size of the deduction, the empirical evidence cited by Frontier has been for too short a period to provide a reliable estimate, it does not provide a reliable estimate for the long-run (because it shows EPS growing faster than GDP, which is not indefinitely sustainable), and longer term evidence reveals that EPS does grow slower than GDP. Frontier (2017b) is aware of the latter paper because they cite it in an earlier report (Frontier, 2016a), but does not respond to these arguments there or in their current paper.

Frontier (2017b, section 5.2.3) addresses the QCA's practice of using two discount rates in its Cornell methodology, one from the tenth year set equal to the long-run estimate and the other determined through the Cornell methodology. In particular, Frontier argues that the return adopted from the tenth year (11.8%) will never be realized, and provides an example in which the regulator always allows 9% over the first ten years. Clearly, in such a situation, shareholders will never be allowed 11.8% but this is merely an example manufactured by Frontier and therefore cannot prove that 11.8% is never attainable.

Frontier (2017b, section 5.2.3) also claims that the QCA could lower the allowed return arising from the Cornell approach with two discount rates, simply by choosing a high discount rate from the tenth year. However, the QCA (2014a, page 71) explains the derivation of this discount rate, Frontier (2017b, footnote 34) is clearly aware of this, and it contests the QCA's analysis later in this same section of its report. In particular, it focuses upon the risk-free rate of 5.8% from the tenth year, notes that the QCA obtains this from the post 1993 average, that it is currently 2.6%, and therefore a better estimator would be the "observed ten-year forward rate". However, the ten-year forward rate is not observable because there are no observed rates beyond ten years. So, presumably Frontier meant the current ten-year rate. This would be appropriate if interest rates were random walks without drift. However, they are mean reverting processes.[3] So, if the current rate is low, the best estimate of its future value would be higher and the longer into the future one predicts, the closer the predicted rate should be to the long-run rate around which the process oscillates. A reasonable estimate for this long-run rate is the historical average as far back as the process is considered to be stable, and a reasonable judgement for this point would be 1993 (at the commencement of the inflation-targeting regime by the Reserve Bank). All of this supports the QCA's approach, and therefore Frontier's suggestion that the QCA has chosen an unduly high value for the ten-year rate in ten years for the purpose of lowering the allowed cost of equity within the regulatory cycle is not justified.

[3] This property of interest rates is considered to be sufficiently uncontroversial in the academic literature that it underlies all modern theoretical modelling of interest rate movements (Vasicek, 1977; Cox et al, 1985; Hull and White, 1990). The intuition is thus: high (real) rates curtail demand for and increase supply of funds, thereby pulling rates down, whilst low rates incite demand for and reduce supply of funds, thereby pushing rates up.

Frontier (2017b, section 5.2.3) claims that the two-discount rate approach increases the volatility in the MRP estimates, and provides analysis in support of this claim. However, variation over time per se is not an undesirable feature of an estimator. The important point is whether this variation reflects the underlying situation and Frontier's approach (of using a single discount rate when there are good grounds to believe that the rate is currently low and therefore will not persist indefinitely) would be less likely to do so. To illustrate this point, suppose (purely in the interests of simplifying the analysis) that dividends are not expected to grow. Suppose the cost of equity for the market portfolio over the next ten years is currently low (10%) and is expected to revert back to the long-term average of 11.8% in ten years (due to the risk-free rate being currently low and expected to revert to its long-term average of 5.8% in ten years). The market value of equity will then be \$9.42 per \$1 of current dividends as follows:

$$P = \frac{\$1}{1.1} + ... + \frac{\$1}{(1.1)^{10}} + \frac{\frac{\$1}{1.118} + \frac{\$1}{(1.118)^2} + ...}{(1.1)^{10}} = \$9.42 \qquad (6)$$

If the two-discount rate approach is adopted for estimating the current ten-year cost of equity, along with an exogenous (and correct) estimate for the ten-year rate in ten years, the current ten-year rate will be correctly estimated at 10%. By contrast, using the single discount rate approach favoured by Frontier, this estimate (*k*) must satisfy the following equation:

$$\$9.42 = \frac{\$1}{1+k} + \frac{\$1}{(1+k)^2} + ... = \frac{\$1}{k} \qquad (7)$$

The solution is that *k* is equal to 10.6%, which is too high. Now suppose instead that the cost of equity for the market portfolio over the next ten years is currently high (14%) and is expected to revert back to the long-term average of 11.8% in ten years. Following equation (6), the market value of equity will then be \$7.50 per \$1 of current dividends. The two-discount rate approach will again correctly estimate the current ten-year cost of equity at 14% whilst, following equation (7), the single discount rate approach favoured by Frontier will estimate it at 13.3% (which is too low). So, consistent with Frontier's claim, its approach yields estimates of the current ten-year cost of equity with less volatility over time than the two-discount rate approach used by the QCA (10.8% and 13.3% versus 10% and 14%). However, in this example, the QCA's estimates would be correct and Frontier's would be incorrect. So, the lower volatility in Frontier's estimates is undesirable.

Frontier (2017b, section 6) notes that the Fernandez et al (2017, Table 2) survey reports a median MRP for Australia of 7.6% (the "raw estimate"), and Frontier raises this to 8.3% allegedly in accordance with the QCA's (2014a) adjustment for imputation credits using a gamma value of 0.47.[4] However, the QCA (2014a, page 66) does not assert that the MRP estimates from surveys should be adjusted to that degree; it instead states that it is unclear whether the survey responses do incorporate an allowance for imputation credits and therefore considers the range of possibilities. Furthermore, as argued in Lally (2017, page 18), the full adjustment for imputation credits would only be warranted if *none* of the survey respondents allowed for the imputation credits *and* all of their MRP estimates were based upon the Cornell or similar approach. By contrast, if all of the survey respondents did allow for the credits, no adjustment for the imputation credits would be warranted. Alternatively, if none of the survey respondents allowed for the credits, but all of their MRP estimates were based upon the Ibbotson, Siegel or Wright approaches, the appropriate adjustment for the credits would be closer to zero than to the QCA's upper bound because these MRP estimation methods use long-term historical data and only a portion of that data is drawn from the period in which imputation prevailed. Thus, if even a substantial minority of survey respondents did allow for credits in their estimates (say, at least 30%) and even a substantial minority of those who did not do so use historical data rather than the Cornell approach (say, at least 30%), the appropriate adjustment for the credits will be closer to zero than to the QCA's upper bound.[5] Thus, Frontier's addition of 0.7% to the Fernandez survey result is unwarranted.

[4] The QCA (2014a) uses its formula (21) to make the imputation adjustment but mistakenly reports the result of their calculation at 0.18% rather than 18% and also neglects to include the cash dividend yield in the calculation. Correcting for these two points, the imputation adjustment raises the MRP by 0.8% rather than the 0.18% (rounded to 0.2%) reported by the QCA (2014a, page 66). This correction was noted by the QCA (2014b, page 232).

[5] The same result would arise if a majority of survey respondents did allow for credits in their estimates, regardless of how the other respondents estimate the MRP.

Frontier (2017b, section 6) also claims that these survey respondents are using a risk-free rate materially above the prevailing government bond yield and therefore an MRP above 8.2% should be used if it is combined within the CAPM with the prevailing government bond yield. Fernandez et al (2017, Table 3) reports a median risk-free rate used by respondents of 3.1% whilst the average five and ten-year Australian government bond yields during the survey period (March 2017) were 2.29% and 2.81% respectively.[6] So, the median survey respondent is using a risk-free rate that is materially above the five-year Australian government bond yield. The claim that this warrants an increase to the MRP estimate has been raised previously by SFG (2014b, section 5) and addressed in Lally (2015, pp. 28-29). Frontier does not respond to those points.

Turning now to the median estimate of 7.6% from Fernandez et al (2017, Table 2), this is highly unusual in a number of ways. Firstly, as shown in Table 2 below, this figure is well in excess of any previous Fernandez survey-based estimate for Australia (5.1% to 6.0%).[7] Secondly, across the developed markets (Western Europe, North America, Japan, and Australasia) and over the period 2010-2017, this figure of 7.6% is exceeded only by some Fernandez results for Portugal, which (unlike Australia) suffered a very severe economic and financial crisis during this period (requiring bailouts by the IMF and the EU).[8] Thirdly, this figure of 7.6% exceeds all Fernandez results in this period for both Spain and Ireland, which both (unlike Australia) experienced very severe economic and financial crises during this period (requiring bailouts by the EU). Fourthly, whilst there was a general tendency for the 2017 survey results for each country to lie above the range of previous results for that country, the median excess across these markets is only 0.4% whilst the figure for Australia is 1.6% and is exceeded in this respect only by Switzerland. Finally, the sample size for Australia in 2017 (26) was only one third that of the previous year (87), it is the smallest sample size across all of these markets for the years 2015-2017 (sample sizes in earlier years are not reported), and this sample size is not satisfactorily large in any

[6] The Australian government bond yield data was drawn from Table F2 on the RBA's website (http://www.rba.gov.au/statistics/tables/#interest-rates).

[7] The results in Table 2 for earlier years are drawn from Fernandez et al (2016, Table 2), Fernandez et al (2015, Table 2), and Fernandez et al (2014, Table 2, Table 4). The surveys before 2011 report results for only individual types of respondents (academics, analysts and companies) and are therefore not included here.

[8] The set of developed markets could reasonably include Singapore and Hong Kong, but Fernandez does not report results for these places for most years.

absolute sense. Accordingly, the median Australian MRP estimate for 2017 of 7.6% may be a computational error, typo, the result of transcription errors, or a consequence of the much smaller and less representative sample. Thus, without further investigation, it should be viewed very skeptically. Frontier (2017b, section 2.2) notes that, like Australia, most markets experienced an increase in their average result from 2015 to 2017 and claims that the Australian results are therefore in line with results from other countries. However, there is no particular reason to use 2015 as a benchmark (rather than the range in previous years) and Australia's experience is highly unusual in its magnitude as demonstrated above.

Table 2: Fernandez Median MRP Survey Results

	2017	2016	2015	2014	2013	2012	2011
Australia	7.6	6.0	5.1	6.0	5.8	6.0	5.2
US	5.7	5.0	5.3	5.0	5.5	5.4	5.0
UK	6.2	5.0	5.0	5.0	5.0	5.0	5.0
Canada	6.4	5.2	6.0	5.0	5.3	5.5	5.0
NZ	5.9	6.0	6.0	5.5	5.8	6.0	6.0
Spain	6.8	6.0	5.5	6.0	5.5	5.5	5.5
Germany	5.9	5.0	5.1	5.0	5.0	5.0	5.0
Italy	6.7	5.5	5.2	5.5	5.5	5.5	5.0
France	6.7	5.5	5.5	5.9	6.0	6.0	6.0
Netherlands	6.2	5.0	6.0	5.0	5.8	5.5	5.0
Switzerland	7.5	5.0	5.0	5.0	5.5	5.3	5.5
Sweden	7.1	5.0	5.1	5.0	5.9	6.0	5.5
Austria	6.6	5.3	5.6	5.5	5.8	6.0	5.7
Belgium	6.6	5.5	5.4	5.5	6.0	6.0	6.1
Norway	6.3	5.0	5.2	5.0	6.0	5.5	6.0
Denmark	6.3	5.0	5.5	5.0	5.9	5.0	4.5
Japan	6.1	5.0	6.0	5.0	6.4	5.0	3.5
Finland	6.1	5.0	5.8	5.4	6.0	6.0	4.7
Ireland	6.8	5.8	5.2	6.3	7.0	6.1	5.1

Portugal	8.0	8.0	5.5	8.5	5.9	6.5	6.1

Frontier (2017b, Section 7) reports "effective MRP" estimates from four recent independent expert valuation reports, ranging from 6.9% to 8.0%. These effective MRPs are obtained by adding the MRP and risk-free rate used by each valuer, followed by deducting the (typically lower) contemporaneous ten-year risk-free rate. This involves attributing to the MRP the difference between the risk-free rate used by each valuer and the contemporaneous ten-year risk-free rate. As noted above, this argument has been raised previously by SFG (2014b, section 5), and critiqued in Lally (2015, pp. 28-29). Frontier does not respond to those points. Furthermore, across these four reports, the MRP estimates used by the valuers are 6.0% in three cases (Lonergan Edwards, 2016, page 46; Grant Samuel, 2016, page 6; KPMG, 2016, page 85) and 7.75% in the remaining case (Deloitte, 2016, page 39), which yields a median of 6.0%. Furthermore, in respect of Deloitte, they are the only one of the four valuers to use a contemporaneous ten year risk-free rate, which suggests that their MRP estimate of 7.75% incorporates a premium to reflect the unsuitability of the contemporaneous ten-year risk-free rate, and therefore their actual MRP estimate is less than 7.75%. All of this suggests that the QCA's MRP estimate of 6.5% is too high rather than too low. Furthermore, each of the three valuers who use a risk-free rate above the contemporaneous ten-year rate state that they do so because they believe that risk-free rates will rise in the future (Lonergan Edwards, 2016, pp. 46-47; Grant Samuel, 2016, page 10; KPMG, 2016, page 85), and these beliefs support the QCA's use of a two-discount rate approach in the DDM as described on pp. 16-17 above.

4. Gamma

Frontier (2017d, section 2.2) refers to a recent decision from the Federal Court (2017). This decision rejected the contention by the ACT that the reference to the "value of imputation credits" in the NER and the NGR meant the market value of the credits, and instead accepted the AER's contention that "value" must be interpreted in the context of the entire regulatory framework (ibid, paras 750-755). Frontier (2017d, section 2.3) argues that, within the regulatory framework, the role of theta is to reduce the allowed return on equity that would otherwise be paid to investors and therefore theta must represent the value of the credits relative to the value of the return on equity that the credits are replacing. In furtherance of this claim, Frontier (2017d, section 2.4) notes that the total expected rate of return to shareholders includes a component involving imputation credits, argues that the rest is a market rate that reflects the existence of phenomena such as personal taxes, and therefore that theta must also be a market rate to be consistent. However, this reasoning is fallacious. Letting S_m denote the market value of all equities and IC_m the imputation credits attached to dividends on all equities, the expected return on the market inclusive of the credits is equal to the expected return exclusive of the credits plus the imputation term as follows:

$$E(R_m^I) = E(R_m^X) + \theta \frac{E(IC_m)}{S_m} \quad (8)$$

The first component on the right-hand side $E(R_m^X)$ is a market rate, and so is the second component $\theta E(IC_m)/S_m$ because the denominator S_m is a market price. Accordingly, it is not necessary that theta (θ) be a market value just as it is not necessary that IC_m be a market value. Furthermore, IC_m is not a market value so Frontier's process of trying to deduce the definition of theta by invoking consistency arguments would suggest that theta *isn't* a market value rather than it is. More importantly, equation (8) is part of the Officer (1994) model, this model (like any other model that has been theoretically developed) arises from a set of assumptions and definitions coupled with the laws of algebra, and the definition of θ within that process is a weighted average over the utilisation rates of investors for imputation credits (as shown in Lally and van Zijl, 2003). This settles the matter and one cannot then substitute a different definition for this parameter θ. The same point was made in Lally (2017, pp. 10-11).

Frontier (2017d, section 2.5) also argues that the parameter θ in the regression model used in a dividend drop-off analysis represents this valuation for credits relative to the value of the return on equity that the credits are replacing. However, the regression equation in question as shown in Frontier (2014d, para 123) derives from the Officer (1994) model shown in Frontier (2017d, para 115), the parameter θ in the regression equation must then have the same definition as it does in the Officer model, and (as noted in the previous paragraph) the definition of θ within that model is a weighted average over the utilisation rates of investors for imputation credits.

Frontier (2017d, section 2.6) refers to the recent SAPN Decision by the ACT (2016), and in particular to the fact that the ACT (2016b, para 148) asserted that there are two alternative theoretical approaches to determining theta. The first of these is the "average investor perspective", of Monkhouse (1993) and Lally and van Zijl (2003), in which theta is the weighted average of investors' utilization rates for imputation credits (ACT, 2016, para 149). The second approach is the "marginal investor perspective", in which each investor has a demand function for each stock (units desired as a function of its market price), aggregating over investors generates the total demand curve for each asset, matching this to its supply produces the equilibrium price, this price corresponds to the valuation of a particular investor, and the residence of that investor (foreign or domestic) determines whether theta is 0 or 1 respectively (ACT, 2016, para 153). Frontier (2017d, section 2.6) argues that this distinction is tangential to the issue at hand. However, Frontier does not express a view on its validity and I do so here. In support of its claim that there are two such approaches, the ACT (2016, para 148) cites Ainsworth et al (2015), and Ainsworth et al (2015, Figure 3) do present an example of this kind (involving a marginal investor approach). However, the example contains a number of features (such as assuming that investors are indifferent to risk and that the market risk premium is determined outside the model) that preclude it serving as an alternative to the aggregation approach. Furthermore, neither the ACT (2016) nor Ainsworth et al (2015) cite any literature on equilibrium asset pricing models that is consistent with such claims about the determination of theta, nor am I aware of any. Furthermore I consider that these claims about the equilibrium setting process are incorrect. Within standard equilibrium asset pricing models (i.e., versions of the CAPM), the aggregate demand for any asset depends not only on the price of that asset (and hence its expected rate of return and its standard deviation) but the prices of all other assets (and hence their expected rates of return, standard deviations, and correlations between assets). In addition, within standard equilibrium asset pricing models (i.e., versions of the CAPM), investors choose portfolios in the Markowitz fashion, there is no place in such models for investors conducting valuations of assets, and therefore it is meaningless to refer to the investor valuation that matches the equilibrium price. Furthermore, even if there were asset pricing models that did determine theta in the way described here, such models would not correspond to the Officer (1994) model (which is a version of the CAPM), and therefore would have no relevance to the estimation of theta for the purposes of implementing the Officer model (which is used by all Australian regulators). In my own reports to Australian regulators, I refer only to the "average investor" approach because this is the approach embodied in the Officer (1994) model, and this is the model used by Australian regulators and most participants in its proceedings.

The ACT (2016, paras 154-155, 168, 174, 186, 193) goes on to consider some aspects and implications of this marginal investor approach. However, since such an approach (as described above) has no relevance to the Officer model used by all Australian regulators, and no relevance to any other model for pricing equities, these aspects and implications are devoid of interest. Nevertheless, the statements by the ACT (2016, paras 154-155) could be interpreted as claiming that the activities of tax arbitrageurs around ex-dividend days adversely affect the reliability of dividend drop-off estimates of theta. I agree with this (see Lally, 2013b, pp. 20-21).

Frontier (2017d, sections 2.4, 3.1, 3.2 and 3.3) critiques the views of the AER in this area. Since these alleged views of the AER have not to my knowledge been expressed by the QCA, I do not need to address these matters here.[9] Nevertheless, I will comment on Frontier's views here. Frontier (2017d, para 151) again asserts that theta is the valuation for the credits relative to the value of the return on equity that the credits are replacing. However, as argued earlier, the definition of theta arises in the course of developing the Officer (1994) model, and is the weighted average over investors' utilization rates for the credits. Frontier (2017d, para 153) also argues that theta reflects the impact of personal costs that relate only to the imputation credits, such as the administrative costs involved in redeeming them. However, as argued in Lally (2016b, page 13), the Officer (1994) model assumes that these costs do not exist. Furthermore, if they were acknowledged, they would have to be recognized through additional terms in the Officer model rather than merely through changing the definition of the utilization rate for credits for each investor and hence theta. Furthermore, if these additional costs were recognized in respect of imputation credits, they would also have to be recognized in respect of cash

[9] Frontier (2017d, para 140) claims that the QCA (2014a) has subscribed to one of these lines of argument but does not provide the page reference and I cannot see any such view expressed by the QCA (2014a).

dividends, and therefore further terms would have to be added to the model. Furthermore, the rationale for not allowing for such terms in the Officer (1994) model is clear; the effect would be inconsequential. Frontier does not address any of these points.

Frontier (2017d, section 3.4) notes that the QCA's definition of theta (as the weighted average over investors' utilization rates for the credits) invokes the work of Lally and van Zijl (2003), that this model assumes that national share markets are fully segmented, that foreign investors should be omitted from consideration, and that this approach conflicts with the empirical fact that foreign investors do exist and that they affect equilibrium prices. I agree with all of this, and have consistently expressed the same view previously (for example, see Lally, 2016b, pp. 18-19). However, Lally and van Zijl (2003) merely supply a derivation of the Officer (1994) model rather than a different model, and all regulators and most participants in this process use that Officer model (including Frontier). So, the points raised by Frontier are criticisms not only of the QCA's approach but those of all other Australian regulators and their own cost of equity estimates. This is a quite different issue to how one should interpret parameters within the Officer model.

Frontier (2017d, section 4.1) considers the implications of two possible definitions for theta (market value or the proportion of credits redeemed) for the appropriate estimation methodology. However, the appropriate definition of theta (the weighted average over investors' utilization rates for the credits) was not considered by Frontier, despite the fact that this is the QCA's view and Frontier is well aware of it as shown in Frontier (2017d, para 166).

Frontier (2017d, section 4.2) acknowledges that there are concerns about the ATO figures for the "credits distributed", but argues that since gamma is estimated (using ATO data) as the product of the credit distribution rate (credits distributed/credits created) and the credit utilization rate (credits utilized/credits distributed), concerns about the reliability of the "credits distributed" from the ATO data do not therefore affect the estimate of gamma, and therefore such ATO data is useful for estimating gamma. To address this argument, I note that the expected revenues allowed by the regulator include the cost of equity applied to the regulatory equity base B_E, company tax (*TAX*) net of the imputation credit effect, and other terms that do not involve gamma or theta as follows:

$$E(REV) = B_E\left[R_f + \left(E(R_m^X) + \theta\frac{E(IC_m)}{S_m} - R_f\right)\beta\right] + E(TAX)(1 - F\theta) + OTHER \qquad (9)$$

Frontier's argument has a number of shortcomings. Firstly, in addition to the estimate of gamma (the product of θ and the credit distribution rate F) being used to estimate the effective company tax payments appearing within the penultimate term in equation (9), the Officer model also requires an estimate of θ (the utilization rate) in order to estimate the MRP appearing earlier in equation (9). So, if gamma ($F\theta$) were estimated from the ATO data, the estimate of θ within the MRP would also have to use the ATO data because θ is part of gamma, and the unreliability of the ATO data in estimating the "credits distributed" (which Frontier now seems to accept) would then be problematic for the estimate of θ (because θ is "credits utilized" divided by "credits distributed") Secondly, Frontier's approach requires recourse to the same set of companies for estimating both the utilization and distribution rates (the two components of gamma), there is no necessity to do so, and good reason for not doing so (because one would not want to use unlisted firms for estimating the distribution rate F, which is firm-specific, whilst one would want to use all firms to estimate the utilization rate θ because it is a market-wide parameter). Thirdly, whilst the problems in the ATO data *may* be limited to the "credits distributed" (because the data offers two conflicting estimates of that quantity, from dividend data and franking account balance data), the credibility of the *entire* ATO database is damaged by both the conflicting estimates of the "credits distributed" and the inability of the ATO to identify the source of that conflict.

Frontier (2017d, section 4.3) repeats the points made in section 4.1, and these are addressed in the penultimate paragraph above.

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