REVIEW OF FURTHER WACC ISSUES

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CONTENTS

EXECUTIVE SUMMARY

This paper has examined a number of issues relating to the WACC of regulated businesses, and the principal conclusions are as follows.

Firstly, and in relation to the cost of debt, recent analysis strengthens the case for the Commission's continued use of the on-the-day regime. In particular, imperfections in the process by which businesses subject to the on-the-day regime hedge the risk-free rate component of their cost of debt (a regulatory window for averaging the risk-free rate that is shorter than firms require for hedging, and the use of the swap rate to hedge the government bond rate) have been shown to be inconsequential. This strengthens the case for regulatory use of the prevailing risk-free rate. In addition, although mismatches between the DRP allowed under the on-the-day regime and the trailing average DRP that is incurred by firms gives rise to violations of the NPV = 0 principle and bankruptcy risk, the mismatch also partly offsets likely MRP estimation errors. This strengthens the case for regulatory use of the prevailing DRP. In addition, violations of the NPV = 0 principle are much more severe with regulatory use of a trailing average regime than the on-the-day regime, for both the initial investment and subsequent capex (even with annual updating of the allowances). This also strengthens the case for regulatory use of the prevailing risk-free rate.

Secondly, although there are differences between Australia and New Zealand, the conclusions reached by me earlier in relation to the cost of debt for regulated businesses in Australia apply equally to New Zealand. In particular, the viability of regulated businesses hedging the risk-free rate component of the cost of debt (via interest rate swap contracts) depends upon the size of that swap market relative to the aggregate debt of the regulated sector, and this ratio *may* be lower in New Zealand than in Australia. However, even if this were true, the problem could be addressed by firms expanding the period over which the swap transactions were undertaken with little additional risk and any additional risk from doing so could be mitigated or even neutralised by the regulator widening the window over which it averaged the risk-free rate. In addition, there is a potentially significant point of difference in the regulatory processes in the two countries in the form of a Customised Price Path (CPP) in New Zealand, in which some regulated businesses can apply for a new price cap at the time of undertaking new investment, and the new WACC would also apply to the business's existing assets. This reduces the value from more frequent WACC or cost of debt resets. However, to date, there has been only one CPP application (by Orion). Thus, the option to apply for a CPP would seem to have only limited value in raising the frequency of WACC resets.

Thirdly, a variety of different regulatory regimes apply in New Zealand including a five-year revenue cap for Transpower (IPP), a five-year price cap applied to most electricity and gas distribution businesses (DPP), a CPP available to a business subject to a DPP, and Information Disclosure (ID) applied to Transpower, all electricity and gas distribution businesses, and airports, and involving reporting of the rate of return and the Commission's WACC estimate. As noted in the previous paragraph, the option to seek a CPP reduces the value from more frequent WACC or cost of debt resets, but only marginally. In addition, the argument for a trailing average risk-free rate being used by a regulator is moderately greater in the case of an ID regime relative to an IPP, DPP or CPP regime. This occurs because regulatory use of the trailing average risk-free rate reduces differences between the regulatory WACC and the business's actual rate of return, thereby reducing false signals of monopoly pricing. However, there are many other sources of false signals of monopoly pricing and a sensible regulatory reaction to this would be to consider differences between the rate of return and the regulatory WACC assessment over a protracted period. Accordingly, the superiority of a trailing average over the on-the-day regime for ID purposes is not a substantial point.

Fourthly, if a trailing average cost of debt regime is applied, it should be limited to the debt risk premium (DRP). In addition, it should be a seven-year trailing average (to match the average term for which firms borrow) with annual updating, the QTC's approach to dealing with capex should be adopted, a transitional scheme should be adopted that avoids the use of historical data, and this transitional scheme should also have the property that no large one-off gain or loss occurs to regulated businesses in general.

Fifthly, three possible modifications to the current on-the-day regime for the cost of debt should be considered. The first is to reset the DRP annually rather than five-yearly, which would significantly reduce the violations of the NPV = 0 principle in the case of capex but worsen them in the case of the initial investment. The second is to widen the window over which the risk-free rate is averaged by the Commission in recognition of the fact that firms may need to use the wider window to undertake interest rate swap contracts without exposing themselves to less favourable prices. The third is to widen the window over which both the risk-free rate and the DRP are averaged, in order to reduce volatility in output prices over time. These modifications would not add to the administrative costs of the regulatory process.

Sixthly, both annual resetting of the cost of debt and use of a trailing average reduce the incentive problems arising from CPPs. However, with the exception of capex that was provided for under the DPP but which takes place from the time of the CPP until the next reset under the DPP, a superior approach is to apply the new WACC to the CPP capex and the old WACC to the existing assets. The advantage of annual resetting and the use of a trailing average in reducing incentive problems here is then quite limited.

Seventhly, the Commission's use of the Term Credit Spread Differential (TCSD) is not inconsistent with regulatory use of a trailing average. A TCSD could be coupled with a trailing average but would suffer from the same disadvantage as it does when applied to the prevailing rate: it is a cost-based scheme that would incite firms to lengthen their borrowing term.

Eighthly, policy reversals incur administrative costs and may also inflict large one-off gains or losses on to regulated businesses. The administrative costs would be in addition to those incurred for the first policy change and the gains or losses to businesses from transitional processes could offset or aggravate those incurred in the first policy change. So, policy changes should not be undertaken lightly.

Ninthly, in relation to the Commission's treatment of inflation, neither its RAB indexation approach nor its price path adjustment violate the NPV = 0 principle. In addition the collective effect of these two adjustments is to preserve both the real output price paid by consumers and that received by the shareholders of the businesses. The only downside is to expose the businesses to some additional bankruptcy risk, but this would be slight. Finally, there appears to be a design error in dealing with inflation forecasting errors arising from opex.

Tenthly, in respect of the Commission's inflation adjustments that protect the real payoffs received by businesses and maintain the output price in real terms, CEG's preference for maintaining at least part of the payoffs in nominal terms because interest payments are fixed in nominal terms protects shareholders against a minor risk and ignores the preferences of customers for prices that are stable in real terms. In addition, CEG's recommendation to forecast inflation from the difference between the yields on nominal and inflation-indexed bonds suffers from the significant disadvantage that this difference in yields is affected by two additional factors, and therefore does not warrant substitution for the Reserve Bank's forecasts.

Eleventhly, in respect of recent submissions on the Commission's current asset beta adjustment of 0.10 for gas pipeline over electricity businesses, the empirical evidence presented in these submissions does not support a higher beta for the gas pipeline businesses of 0.10 or even half of it. Furthermore, whilst revenue weights rather than volume weights for customer types should be used in assessing whether gas pipeline businesses warrant a higher beta, and account should be taken of the income elasticities of demand for gas and electricity by both residential and commercial customers, the effect of doing so does not clearly support a higher beta for the gas pipeline businesses of 0.10 or even half of it. Since 0.10 is the minimum unit of measure for estimating asset betas, I do not favour a differential between gas pipeline and electricity businesses.

Finally, in respect of recent submissions from CEG and Frontier Economics in relation to the TAMRP, although I agree with some of the points raised in these submissions, I do not agree that the TAMRP estimate should be higher or that a different approach to estimating this parameter should be adopted. The most significant point of difference between me and both CEG and Frontier is that they favour exclusive or primary weight on the results from the DGM whilst I favour equal weighting over the results of five methodologies including the DGM. The result of equal weighting on these five methodologies will be an estimate of the TAMRP that is likely to have smaller estimation errors than that from exclusive or primary weight on the DGM. A policy of exclusive or primary weight on the DGM would only be applicable if this methodology was significantly superior to all alternatives, and I do not think that this is the case.

1. Introduction

This paper seeks to review a number of issues relating to the WACC of regulated businesses, comprising the merits of adopting a trailing average cost of debt, the implications of inflation risk, the Commission's existing asset beta differential of 0.10 for gas pipeline businesses over electricity businesses, and the appropriate estimate for the TAMRP.

2. The Use of a Trailing Average Cost of Debt

2.1 New Arguments

The Commerce Commission currently determines the allowed cost of debt for the regulatory period using risk-free rate and DRP data averaged over a single month close to the beginning of the regulatory period (the 'on-the-day' regime). By contrast, some submissions (Powerco, 2015; HoustonKemp, 2015a; Transpower, 2015; Frontier Economics, 2015; NZ Airports Association, 2015; Orion, 2015) favour a trailing average, in which the cost of debt is periodically reset in accordance with a long-term trailing average at each such point. As argued in these submissions, the use of a trailing average reduces the volatility in the price caps, better matches the allowed cost of debt to that incurred by an efficient business, and reduces the incentive problems arising from CPPs.

The pros and cons of a trailing average versus the on-the-day regime (for either the DRP or the entire cost of debt) have been examined in Lally (2014a; 2014b, section 2.4). As noted there, the use of a trailing average for the DRP reduces volatility in the price caps and using a trailing average for the entire cost of debt further reduces this volatility. However, unlike the submissions referred to in the previous paragraph, the effects are quantified and balanced against a wider set of considerations than those presented in these submissions. In respect of the claim that regulatory use of a trailing average leads to allowed costs that better match those incurred by an efficient firm, this is true only of the DRP component of the cost of debt (because regulated businesses can and should enter interest rate swap contracts to match the risk-free rate component of their cost of debt to that allowed under the on-the-day regime). Furthermore, the DRP mismatches are only important to the extent that they give rise to violations of the NPV = 0 principle or raise bankruptcy risk. As shown in Lally (2014a; 2014b), neither point is significant. In respect of the claim that a trailing average reduces the incentive problems arising from CPPs, this issue is examined in section 2.6 and it is argued there that the claim is correct but the effect is limited to the cost of debt whilst the incentive problems are driven by the entire WACC.

More recent information on the pros and cons of a trailing average versus the on-the-day regime appear in Lally (2015a; 2015b), and the following additional points are made there. Firstly, one argument in support of using the prevailing value for the risk-free rate component of the cost of debt rather than a trailing average is that regulated businesses can enter interest rate swap contracts to match their cost to that allowed by the regulator, thereby undercutting the claim that a trailing average better matches the allowed risk-free rate to the efficient costs of a regulated business. A counterargument raised in many submissions on this matter to the AER is that the volume of swaps required by regulated businesses in aggregate would at certain times (the usual regulatory window of one month shortly before the commencement of the regulatory cycle) raise demand by so much that the swap transactions could not be conducted at 'normal' prices (see Lally, 2014c, section 5; 2015a, section 9). However Lally (2015a, Appendix 2) demonstrates that use of a wider window of five months for transacting the swaps (corresponding to the longest period argued for in submissions for addressing the problem) does *no*t increase the risk of mismatch between the costs incurred by firms and those allowed by the regulator under the on-the-day regime. So, firms could have used a wider transaction window to deal with the concern without any adverse effect on mismatch risk. This strengthens the case for regulatory use of the prevailing risk-free rate.

A variant on the counterargument described in the previous paragraph is that interest rate swap contracts involve swap rates rather than government bond rates (treated as the risk-free rate by the Commission) and therefore the hedging process is imperfect (Frontier Economics, 2015, page 6). However, Frontier does not offer any empirical evidence on the matter. By contrast, Lally (2015a, Appendix 2) demonstrates using US data that the imperfection is very small.

Secondly, mismatches between the DRP incurred by a firm with staggered borrowing (which is clearly efficient) and the DRP allowed under the on-the-day regime are regarded as a drawback of the on-the-day regime, because they increase bankruptcy risk for regulated businesses and give rise to violations of the NPV = 0 principle. However, as argued in Lally (2015b, pp. 12-13), these DRP mismatches also have a desirable consequence: they are favourable to firms when the prevailing DRP is high relative to its ten-year trailing average, this occurs when economic conditions are unfavourable, and therefore when the true MRP is likely to be above its allowed value (which has always been 7% or close to it in the Commission's case). For example, in the US DRP series for 1953-2014 that is examined in Lally (2015b, pp. 11-13), the highest margins for the prevailing DRP over its ten-year trailing average occur in 2008-09 (3.54%), 1974-75 (1.85%), 2001-2002 (1.71%), 1970-71 (1.67%), and 1980-81 (1.18%); these periods correspond to the set of US recessions since 1970. Similarly, the DRP mismatches are most unfavourable to firms when the prevailing DRP is low relative to its ten-year trailing average, this occurs when economic conditions are favourable and therefore when the true MRP is likely to be below its allowed value. Thus, use of the prevailing DRP has the desirable effect of producing DRP mismatches that at least partly offset likely MRP estimation errors.[1] This strengthens the case for regulatory use of the prevailing DRP.

Thirdly, and in respect of investment incentives for a new regulatory business, the on-the-day regime is likely to produce violations of the NPV = 0 principle if the DRP prevailing at the time of the initial investment in the regulatory assets is unusually high or low. In this event, the initial regulatory allowance will be unusually high or low with subsequent allowances (at the reset points) expected to drift back towards the long-run level of the DRP. In addition, the initial borrowing cost will be unusually high or low (matching the allowance) with subsequent costs expected to drift back towards the long-run average DRP as the firm gradually shifts towards staggered borrowing. With ten-year debt, the firm would achieve the staggered profile most rapidly by undertaking 10% of the borrowing for a one year term, then roll it over for ten years, undertake a further 10% of the borrowing for a two year term, then roll it over for ten years, and so forth, so as to attain the desired staggering of debt in ten years' time. However, the expected drift back in the allowances will not match that in the costs incurred. Following Lally (2015b, section 2.2), the Appendix shows that with five yearly regulatory resetting the violation of the NPV = 0 principle would not exceed 0.4% of the value of the investment (with 95% probability). If the resetting is done annually rather than five yearly, the figure of 0.4% rises to 1.1% because the allowance is now expected to drift towards the long-run average more quickly and therefore diverge more from the incurred

[1] This argument does not imply that the Commission's MRP estimates should be more variable over time, because it is impossible to reliable estimate short-term variations in this parameter. So, use of an estimate that does not exhibit much variation is entirely reasonable, but one consequence is that values are likely to be too high at certain times and too low at other times, and these times match those in which the DRP mismatches are in the opposite direction.

cost. If a (ten-year) trailing average regulatory regime is used instead, the results are much worse at 1.9% with annual updating and 2.3% with five yearly resetting. These trailing average regime results are much worse than from the on-the-day regime because the initial regulatory allowance will differ from the initial cost incurred by the firm (at the prevailing rate) and by a significant margin in the extreme scenario considered (the 95th percentile).

In respect of subsequent investment (i.e., capex, which in general occurs part-way through a regulatory cycle), there is the additional complication that the allowed DRP is set at the beginning of the regulatory cycle whereas the borrowing cost does not commence for up to five years after that point (for a five year reset scenario and up to one year later with annual resetting), during which interval the prevailing borrowing rate could significantly change. Following Lally (2015b, section 2.2), the Appendix shows that, for the on-the-day regime with five yearly resetting, the violation of the NPV = 0 principle would not exceed 1.4% of the value of the investment (with 95% probability). With annual resetting of the allowed DRP, the figure falls to 0.8%. If the regulator instead uses a (ten-year) trailing average, the results are worse (as with the initial investment): 1.9% with annual resetting and 2.3% with five yearly resetting.

An alternative regulatory approach has been presented by the QTC (2014, section 4, section 7), involving application of the prevailing borrowing rate to capex with gradual transition in this rate towards the trailing average in accordance with how a firm might transition towards staggering of that borrowing.[2] The Appendix analyses this issue and finds that, with annual resetting of the allowed DRP, the violation of the NPV = 0 principle would not exceed 0.9% of the value of the investment (with 95% probability).

All of these results are shown in Table 1 below and details of these calculations appear in the Appendix. The results may not seem large (2.3% of asset value at most) but they correspond to significant shortfalls in the allowed cost of debt relative to that incurred within the first few years of the investment. For example, in respect of the worst case corresponding to a trailing average regime with five yearly resetting and the initial investment into regulatory assets, the allowed DRP for the first five years is 1.44% whilst that incurred starts at 3.2% and is

[2] If the firm uses ten year debt, it is presumed to borrow 10% of the amount for one year, at which point it is rolled over to ten-year debt, 10% of the amount for two years, at which point it is rolled over to ten-year debt, etc. Ten years is then required to fully stagger this debt, at which point its cost is the ten-year trailing average of the ten-year cost of debt.

expected to drift down only slowly. Table 1 reveals that, for both the initial investment and capex, a trailing average regime produces significantly inferior results to the on-the-day regime, for both annual and five yearly resetting. The QTC's modification to the trailing average regime is a hybrid model, and therefore unsurprisingly produces results that lie between these two extremes. Annual resetting also reduces violations of the NPV = 0 principle, except for the initial investment coupled with on-the-day regime. In addition, unlike the initial investment, subsequent investment is recurring and the NPV = 0 violations will tend to wash out over time providing they are random. However, firms control the timing of these additional investments and therefore could be expected to undertake them when it is advantageous to them, in which case the NPV = 0 violations will *not* wash out over time. So, the best regime is the on-the-day regime, with annual resetting for capex and five yearly resetting for the initial investment. This supports continued use of the on-the-day regime, with the merits of annual versus five yearly resetting depending upon whether capex or initial investment occurs. If a trailing average were adopted, annual resetting is desirable and the QTC's adjustment even more so.

Table 1: 95th Percentile Violations of the NPV = 0 Principle

Regime	Initial Investment	Capex
OTD with Annual Resetting	1.1%	0.8%
OTD with Five Year Resetting	0.4%	1.4%
TA with Annual Resetting	1.9%	1.9%
TA with Five Year Resetting	2.3%	2.3%
QTC with Annual Resetting		0.9%

In summary, the new arguments are threefold. Firstly, imperfections in the process by which businesses subject to the on-the-day regime hedge the risk-free rate component of their cost of debt (a regulatory window for averaging the risk-free rate that is shorter than firms require for hedging, and the use of the swap rate to hedge the government bond rate) have been shown to be inconsequential. This strengthens the case for regulatory use of the prevailing risk-free rate. Secondly, although mismatches between the DRP allowed under the on-the-day regime and the trailing average DRP that is incurred by firms gives rise to violations of the NPV = 0 principle and bankruptcy risk, the mismatch also partly offset likely MRP estimation errors. This strengthens the case for regulatory use of the prevailing DRP. Thirdly, violations of the NPV = 0 principle are much more severe with regulatory use of a trailing average regime than the on-the-day regime, for both the initial investment and subsequent capex (even with annual updating of the allowances). This also strengthens the case for regulatory use of the prevailing risk-free rate. So, in all three respects, the case for regulatory use of the on-the-day regime is strengthened.

2.2 New Zealand Specific Factors

The conclusions reached by Lally (2014a; 2014b; 2015a; 2015b) relate to Australia, and therefore might not be relevant to New Zealand for the following reasons. Firstly, the viability of regulated businesses hedging the risk-free rate component of the cost of debt (via interest rate swap contracts) depends upon the size of that swap market relative to the aggregate debt of the regulated sector, and this ratio *may* be lower in New Zealand than in Australia. However, even if this were true, the problem could be addressed by firms expanding the period over which the swap transactions were undertaken with little additional risk (as discussed earlier in section 2.1 and analysed in Lally, 2015a, Appendix 2). Furthermore, any additional risk from doing so could be mitigated or even neutralised by the regulator widening the window over which it averaged the risk-free rate. So, assuming (reasonably) that the ratio of the swap market size to the aggregate debt of the regulated sector is not dramatically lower in New Zealand than in Australia, this issue would not undercut the relevance of the conclusions reached in Lally (2014a; 2014b; 2015a; 2015b) to New Zealand.

Secondly, there are differences in the regulatory processes in the two countries. The only potentially significant point of difference is the presence of a Customised Price Path (CPP) in New Zealand, in which some regulated businesses can apply for a new price cap at the time of undertaking new investment, and the new WACC would also apply to the business's existing assets. This creates some incentive problems, to be discussed in section 2.6. It also reduces the value from more frequent WACC or cost of debt resets. However, to date, there has been only one CPP application (by Orion). Thus, the option to apply for a CPP would seem to have only limited value in raising the frequency of WACC resets. So the presence of this CPP option does not materially affect the conclusions reached in Lally (2014a; 2014b; 2015a; 2015b).

In summary, although there are differences between Australia and New Zealand, the conclusions reached by Lally (2014a; 2014b; 2015a; 2015b) in relation to the cost of debt for regulated businesses in Australia apply equally to New Zealand.

2.3 The Effect of Different Types of Regulation

A variety of different regulatory regimes apply in New Zealand. The first is an Individual Price Path (IPP) applying specifically to Transpower and involving a five year term and a revenue cap. The second is a Default Price Path (DPP), applied to most electricity and gas distribution businesses and involving a five-year price cap. The third is a CPP, available to a business subject to a DPP and is as described in the previous section. The last is Information Disclosure (ID), applied to Transpower, all electricity and gas distribution businesses, and airports, and involving reporting of the rate of return and the Commission's WACC estimate.

As noted in the previous section, the option to seek a CPP reduces the value from more frequent WACC or cost of debt resets, but only marginally. In relation to the merits of a trailing average and the on-the-day regime, the crucial distinction here is between price control (IPP, DPP or CPP) and disclosure (ID). Under price control, a business subject to the on-the-day regime has a very strong incentive to engage in interest rate swap contracts in order to match the risk-free rate component of its cost of debt to the regulatory allowance. Similarly, a business subject to a trailing average would have a strong incentive to not use swaps, and therefore again match the risk-free rate component of its cost of debt to the regulatory allowance. So, under price control, regulatory use of a trailing average risk-free rate does not better match the allowed risk-free rate to the efficient costs of a regulated business.

By contrast, under an ID regime, there is an advantage to a regulator using a trailing average. In particular, if a regulator uses a trailing average, the business would not have any incentive to use swaps and would simply choose between setting prices in accordance with its costs (leading to no variation between its rate of return and the regulatory WACC) or smoothing its prices (leading to small variation between its rate of return and the regulatory WACC, because trailing averages are already a form of smoothing). Alternatively, if the regulator uses the on-the-day regime, a business might then enter swaps and set its prices in accordance with its costs, in which case there would be no variation between its rate of return and its regulatory WACC (both reflecting an on-the-day approach). However, this leads to volatility in prices and a business might choose to smooth its prices. In this case, it would not enter the swaps, its cost of debt would be a trailing average and its prices would reflect some smoothing of this, i.e., two layers of smoothing would apply. However, with the regulatory WACC following the on-the-day regime, the differences between its rate of return and the regulatory WACC would be more substantial than when the regulator used a trailing average. These results are summarised in Table 2 below, where WACC is that estimated by the regulator. Any excess in the rate of return over the regulatory WACC is a signal of monopoly pricing, but the excess could be due to the business smoothing its prices. So, a false signal arises, false signals are undesirable, and they are worse if the regulator uses the on-the-day regime and the business smooths its prices over time. So, for this purpose, regulatory use of a trailing average is superior to the on-the-day regime. This conclusion is consistent with less detailed comments in NZ Airports (2015, pp. 17-18). However, there are many other sources of false signals of monopoly pricing and a sensible regulatory reaction to this would be to consider differences between the rate of return and the regulatory WACC assessment over a protracted period. Accordingly, the superiority of a trailing average over the on-the-day regime for ID purposes is not a substantial point.

Table 2: Information Disclosure Regime

Reg Policy	Firm Policy	Costs	Prices	ROR – WACC
OTD	Swaps + prices match costs	OTD	OTD	zero
OTD	No swaps + smooth prices	TA	TA smoothed	big diff
TA	No swaps + prices match costs	TA	TA	zero
TA	No swaps + smooth prices	TA	TA smoothed	small diff

In summary, the argument for a trailing average risk-free rate being used by a regulator is moderately greater in the case of an ID regime relative to an IPP, DPP or CPP regime.

2.4 Key Factors in Implementing a Trailing Average

If a trailing average regime is adopted, the following factors must be considered in implementing it. Firstly, it is necessary to decide whether to apply the trailing average to the entire cost of debt or only the DRP. As discussed in Lally (2014a, section 8), applying the trailing average to the entire cost of debt rather than just the DRP leads to lower variation over time in output prices but greater incentive problems with capex (NPV = 0 violations), the possible need for a (possibly imperfect) transitional regime for the risk-free rate component of the cost of debt, and an allowed cost of debt that is likely to be too high. In my view, the net effect favours application of the trailing average to only the DRP (if at all).

Secondly, it is necessary to determine the efficient behaviour of firms under the on-the-day regime. If this efficient behaviour is judged to involve the use of interest rate swap contracts to hedge the risk-free rate component of the cost of debt, which is my view, then a switch to a trailing average would require firms to change their behaviour (abandon the use of swap contracts, some of which would still be outstanding). Accordingly, there is a strong argument for a transitional regime for this component of the cost of debt, and the mechanics of this are discussed in Lally (2014c, section 2.1). In addition, if efficient behaviour is judged to involve staggered borrowing and no hedging of the resulting DRP risk (because such hedging is infeasible), as is my view, then there is a case for no transitional regime for the DRP component of the cost of debt. However, if the timing of such a regime switch has the effect of imposing a large one-off gain or loss on the regulated business, then a transitional regime should be adopted in order to mitigate this effect. Discussion of this matter appears in Lally (2014c, section 3; 2015a, section 8).

Thirdly, it is necessary to assess the quality of historical data when choosing between immediate adoption of a trailing average (which would require historical data) and a transitional regime that avoids the need for historical data. The data availability issue does not apply to the risk-free rate (which is available from the Reserve Bank for several decades) but it does apply to the DRP. In particular, there is no DRP index available at the present time in New Zealand, let alone one that is generally accepted and has a (say) ten year history. Thus, immediate adoption of a trailing average for the DRP would give rise to highly contentious debates about the appropriate values of the DRP over the requisite historical period. Even in Australia, where several DRP indexes are available and have been for many years, the issue is highly controversial because the different indexes yield quite different results at various points in the past. In particular, in early 2009, the estimates from the RBA, CBA Spectrum, and BFV indexes were 9.5%, 5.0% and 3.5% respectively (CEG, 2014a, Figure 1). This supports the use of a transitional regime that avoids the need for historical DRP data.

Fourthly, it is necessary to assess the pros and cons of the QTC's (2014) approach to dealing with capex. This approach involves application of the prevailing cost of debt to capex with gradual transition towards the trailing average. As discussed in section 2.1, this materially reduces the violations of the NPV = 0 principle. However, it adds to the complexity of the trailing average regime. I consider that the QTC's approach should be adopted if a trailing average is adopted.

Fifthly, it is necessary to determine how frequently the trailing average should be updated. As shown in Table 1, annual rather than five yearly updating reduces the violations of the NPV = 0 principle for both the initial investment and subsequent capex. This modification would not add to the administrative costs of the regulatory process because annual reassessment of WACC is required for ID purposes. Accordingly, I favour annual updating.

Sixthly, it is necessary to determine the period over which the trailing average will be conducted. The AER uses a ten-year trailing average to reflect the belief that regulated businesses use ten-year debt. In respect of New Zealand regulated business, the figure is about seven years (Lally, 2014b, page 14). Accordingly, the trailing average should be a seven-year one. Interestingly, many of the submissions to the Commission on these matters favour a ten-year cost of debt (Powerco, 2015, para 56; Houston Kemp, 2015, page 8; Frontier Economics, 2015, page 7) but none of these submissions present any persuasive empirical evidence on this matter. Houston Kemp (ibid) refers to the AER's use of a ten-year rate but fails to note that the AER's choice reflects the empirical situation in Australia and this seems to differ from that in New Zealand. In addition, Frontier Economics (ibid) refers to Transpower having a ten-year borrowing term but does not refer to any other firms.

In conclusion, if a trailing average regime is applied, it should be limited to the DRP. In addition, it should be a seven-year trailing average with annual updating, the QTC's approach to dealing with capex should be adopted, a transitional scheme should be adopted that avoids the use of historical data, and this transitional scheme should also have the property that no large one-off gain or loss occurs to regulated businesses in general.

2.5 Modifications to the Current Regime

An alternative to moving from the current (on-the-day) regime to a trailing average would be to modify the current regime so as to address any legitimate concerns about it. One such modification has already been discussed in section 2.1: resetting the DRP annually rather than five yearly, on order to reduce the incentive problems arising from setting the DRP allowance that will apply to capex commencing up to five years later. As shown in Table 1, doing so significantly reduces violations of the NPV = 0 principle in the case of capex but worsens them in the case of the initial investment. This modification would not add to the administrative costs of the regulatory process because annual reassessment of WACC is required for ID purposes. So, the merits of annual updating of the DRP rest on the relative importance of initial investment versus capex. The latter events are (collectively) more significant, and therefore favour annual updating.

A second possibility is to widen the window over which the risk-free rate is averaged by the Commission, in recognition of the fact that firms may need to use the wider window to undertake interest rate swap contracts without exposing themselves to less favourable prices.[3] This modification does not add to the administrative costs of the regulatory process.

A third possibility would be to widen the window over which both the risk-free rate and the DRP are averaged, in order to reduce volatility in output prices over time. This recommendation embraces the second one, but with a different rationale. Again, this modification does not add to the administrative costs of the regulatory process.

In summary, three possible modifications to the current regime should be considered. The first is to reset the DRP annually rather than five-yearly, which would significantly reduce the violations of the NPV = 0 principle in the case of capex but worsen them in the case of the initial investment. The second is to widen the window over which the risk-free rate is averaged by the Commission in recognition of the fact that firms may need to use the wider window to undertake interest rate swap contracts without exposing themselves to less favourable prices. The third is to widen the window over which both the risk-free rate and the DRP are averaged, in order to reduce volatility in output prices over time. These modifications would not add to the administrative costs of the regulatory process.

[3] The latter point is discussed in section 2.1.

2.6 Relevance to DPP/CPP Incentives

Lally (2015c) examines the incentive problems arising from firms applying for a CPP, leading to the WACC also being reset on their existing assets earlier than would otherwise have applied under a DPP. For example, if the WACC is reset at 9% under a DPP for a five year term, and three years later the WACC is 8%, and a regulated business contemplates applying for a CPP at this point, the business would be discouraged from doing so because the WACC on its existing assets would decline by 1% for the remaining two years of the regulatory cycle. Alternatively, if the WACC is currently 10% rather than 8%, then the regulated business would have an incentive to undertake the CPP purely in order to gain the allowed WACC uplift on its existing assets.

These incentive problems described here presume that the WACC is reset every five years. As noted in Lally (2015c, pp. 7-8), reducing the reset interval for the cost of debt from five years to one year reduces this incentive problem, because a shorter interval implies that the WACC change would typically be smaller, but only in respect of the cost of debt component of the WACC. The incentive problems arising from the cost of equity would be unaffected. Furthermore, the incentive problems can be directly addressed by applying the new WACC to the CPP capex whilst retaining the existing WACC for the existing assets.

Lally (2015c, pp. 8-9) also refers to the effect of the trailing average but there is some ambiguity in that brief discussion. Regardless of how the cost of debt incurred by the firm is determined, the incentive problems arise purely from the difference between the WACC allowed at the last reset and the WACC allowance that will be applied today in the event of a CPP. The cost of debt is part of this. If the allowed cost of debt is set in accordance with a trailing average, that trailing average was set at 6% at the last reset, and it is currently more or less than 6%, the incentive problem arises. Similarly, if the allowed cost of debt is set in accordance with the prevailing rate, the prevailing rate was 7% at the last reset, and it is more or less than 7% now, the incentive problem still arises. However, trailing averages do not in general shift as quickly over time. Thus, if the allowed cost of debt is set in accordance with a trailing average, the change since the last reset is likely to be smaller and therefore the incentive problems in question here would be less. So, regulatory use of a trailing average cost of debt reduces the incentive problems arising from CPPs. However, as with more frequent resetting of the cost of debt, a superior approach is to apply the new WACC to the CPP capex whilst retaining the existing WACC for the existing assets.

A further issue relates to incentives in respect of capex. As noted, Lally (2015c) argues that the best approach is to continue to apply the old WACC to the existing assets, so as to avoid the problems described above, and to apply the new WACC to the CPP capex, to provide the proper incentives for a business to undertake a CPP. However, a third class of assets exists, being the capex that was provided for under the DPP but which takes place from the time of the CPP until the next reset under the DPP. As described in Lally (2015c), the better WACC to be applied to this capex (old WACC or new WACC) is unclear, in which case whichever course of action is adopted comes with the risk of being suboptimal. However, if the difference between the old and new WACCs is smaller, the consequence of choosing the wrong course of action is less, and the difference will generally be smaller when the allowed cost of debt is set using a trailing average with annual resetting.

In summary, both annual resetting of the cost of debt and use of a trailing average reduce the incentive problems arising from CPPs. However, with the exception of capex that was provided for under the DPP but which takes place from the time of the CPP until the next reset under the DPP, a superior approach is to apply the new WACC to the CPP capex and the old WACC to the existing assets. The advantage of annual resetting and use of a trailing average in reducing incentive problems here is then quite limited.

2.7 Compatibility with the TCSD

In respect of the cost of debt, the Commission currently uses an on-the-day regime, in which the prevailing five-year cost of debt is allowed for firms whose average debt term does not exceed five years whilst firms with an average debt term in excess of five years receive a DRP premium (the Term Credit Spread Differential or TCSD) for each bond issue with a term beyond five years, in accordance with its additional term, plus the transactions cost of an interest rate swap contract to convert the risk free rate component of this bond to the five-year rate, less the reduction in the per annum debt issue costs resulting from this bond having a term exceeding five years. This raises the question of whether use of a trailing average in substitution for the Commission's current use of the prevailing rate would be compatible with the TCSD.

As argued in Lally (2014b, page 13), I do not support a TCSD in conjunction with the on-the-day regime because it is a cost-based scheme rather than an incentive-based scheme.

Incentive-based schemes grant the same allowance to all firms, and firms are free to behave differently if they wish (receiving the benefits or bearing the cost from doing so). Thus, if all firms receive a DRP allowance based upon five-year debt, some firms may prefer longer term debt because they consider that the reduction in refinancing risk more than compensates for the higher DRP whilst others may prefer shorter term debt because they consider that the reduction in refinancing risk does not compensate for the higher DRP. By contrast, the TCSD applies different rules in accordance with the firm's actual behaviour. In general, cost-based schemes pervert incentives, and this one is no exception. In particular, in the presence of the TCSD, if a firm chooses longer-term debt, it will receive a higher DRP allowance that matches the increased cost it will incur. Under such conditions, all firms could be expected to prefer longer-term debt because they would thereby reduce their refinancing risk and would not bear the increased DRP. The Commission may feel that it is desirable for firms to adopt longer-term debt. If so, it should grant a DRP allowance for debt of a longer term than five years, and grant it uniformly to all firms.

The same issue would arise if the allowed cost of debt were set in accordance with a trailing issue. In particular, one could apply a five-year trailing average to some firms and a longer average for part of the debt of the remaining firms. However, it would still be a cost-based scheme that would incite firms to lengthen their borrowing term. So, again, I would not support it and would favour application of the same trailing average to all firms.

In conclusion, the TCSD is not inconsistent with regulatory use of a trailing average. A TCSD could be coupled with a trailing average but would suffer from the same disadvantage as it does when applied to a prevailing rate: it is a cost-based scheme that would incite firms to lengthen their borrowing term.

2.8 Reversal Problems

If the Commission decides to adopt a trailing average, it might subsequently decide to reverse that decision, in which case there would be costs in doing so. Firstly, there are administrative costs in changing regimes, which would be enlarged by the use of a transitional process. These costs include the costs of seeking and addressing submissions on this matter, and the AER's experience in recently switching to a trailing average suggests that these are large. Secondly, in respect of the risk-free rate component of the cost of debt, the transitional process (if adopted) would arise because efficient firms would have to change behaviour and this requires a judgement about efficient behaviour prior to the regime reversal and an efficient response to the regime reversal. In so far as the answers to these questions are not fully clear, there would be a risk of large one-off gains or losses to efficiently operating businesses (at the expense of their customers). These problems would be aggravated if the reversal occurred before the transitional process for the initial change had been completed, in which case the efficient response to the reversal might be even less clear and therefore the risk of gains or losses to efficient businesses would be even greater. Thirdly, in respect of the DRP component of the cost of debt, if a transitional process were not adopted, large one-off gains or losses to regulated businesses could result (as discussed in Lally, 2014c; 2015a). Even if a transitional process were adopted, because historical DRP data were too contentious and perhaps also to avoid a large one-off gain or loss to the regulated businesses, application of a uniform transitional process over the regulated sector might still lead to some firms experiencing a large one-off gain and others a large one-off loss. These gains or losses to businesses from a regulatory reversal might offset or aggravate those from the initial regime change.

In summary, policy reversals incur administrative costs and may also inflict large one-off gains or losses on to regulated businesses. The administrative costs would be in addition to those incurred for the first policy change and the gains or losses to businesses from transitional processes could offset or aggravate those incurred in the first policy change. So, policy changes should not be undertaken lightly.

2.9 Review of Submissions

CEG (2016b, section 6.1) argues that any regulatory allowance for the cost of debt should match an efficient debt management strategy, and that the trailing average regime does so whilst the on-the-day regime does not. This is equivalent to arguing that a regime that gives rise to mismatches relative to an efficient debt management policy should be precluded. However, I think such mismatches are only one of a number of criteria that should be considered, as discussed in section 2.1. Furthermore, under the steady-state scenario assumed by CEG (in which the firm's debt level is stable and the desired degree of staggering has been achieved so that the DRP allowances under the trailing-average regime will match that incurred by a firm while those from the on-the-day regime will not), Lally (2014b, Appendix 1) shows that the mismatches from the on-the-day regime do not exceed 2.5% of the regulatory compensation for the cost of equity, which easily absorbs such effects. In addition to these steady-state mismatches, and assuming a debt term of ten years, mismatches will occur under either regulatory regime during the first ten years following new investment. Table 1 in section 2.1 examines violations of the NPV = 0 principle in this situation, and finds that the trailing average regime is worse in this respect to the on-the-day regime. Thus, even if the steady-state mismatches were considered to be the more important issue, the advantage of the trailing average regime over the on-the-day regime is slight.

CEG (2016b, section 6.2) favours use of a ten-year debt term for determining the allowed cost of debt, corresponding to the (efficient) use of bond markets by large regulated businesses (local and foreign). However, the behaviour of foreign businesses reflects features of their markets that are not applicable to New Zealand. Furthermore, even in respect of using only New Zealand regulated businesses that use bond markets, since most regulated New Zealand businesses are too small to access bond markets and therefore rely on shorter-term bank debt (as acknowledged by CEG, 2016b, para 179), the effect of CEG's proposal would be to apply the longer term (and generally higher) cost of debt to the smaller businesses, thereby generating an allowed cost of debt that was too high for the sector on average. Furthermore, in favouring this approach, CEG is departing from its guiding principle that the allowed cost of debt should reflect an efficient debt management strategy (CEG, 2016b, section 6.1) because recourse to bond markets is not efficient for smaller firms. Applying a uniform debt term to regulated businesses, corresponding to the value-weighted average term for which they borrow (of about 7 years: Commerce Commission, 2010, Table H4), produces a result that is at least correct for the sector on average. An alternative approach would be to invoke different debt terms for small and large firms, but this requires a (highly subjective) definition of "small". Applying the same term to all firms avoids this issue, and therefore is simpler, whilst the downside (of granting too large an allowance for small firms and too small an allowance for large firms) is small, and I therefore favour it.

CEG (2016b, section 6.3) favours a trailing average for the entire cost of debt and addresses arguments raised by Lally (2014b, section 2.4) in support of the on-the-day regime, as follows. Firstly, Lally (2014b, section 2.4) argues that a trailing average provides the wrong cost of debt for new entrants and capex, which can be addressed by applying the prevailing cost of debt to new debt arising from both capex and new entrants, and then gradually adjusting the rate towards the trailing average, but this significantly adds to the complexity of the regime, and therefore to the ease with which it can be understood. In response, CEG

(2016b, section 6.3.2) argues that the "complexity" could be dealt with in a "few lines of spread-sheeting". However, the issue is not *how* the calculations are performed but whether they can be readily understood. In my view they cannot be readily understood and this constitutes a significant downside to this approach. Thus, if a trailing average is adopted, one is faced with the unenviable choice between a cost of debt that provides the wrong signals for new entrants and capex (if the adjustment is not done) and complex adjustments that cannot be readily understood (if it is done). Amongst regulators who have adopted a trailing average, I am not aware of any who have undertaken these adjustments. Furthermore, amongst the four consumer groups that CEG (2016b, para 210) cites in support of a trailing average, two of them explicitly favour a "simple trailing average", and therefore presumably do not favour this "few lines of spread-sheeting".

Secondly, Lally (2014b, section 2.4) argues that regulatory use of a trailing average for the risk-free rate component of the cost of debt requires that the regulator determine the cost of debt that the benchmark unregulated firms would have faced, this requires knowledge of both the term for which they borrow and any interest rate swaps used to shorten the effective term of the risk-free rate component of the cost of debt, the latter cannot be observed, and determining the cost of debt purely in accordance with the term for which unregulated firms borrow would produce an excessive allowance to regulated firms. Similarly, if unregulated firms could choose between two possible opex levels, and chose the lower-cost level in order to optimally trade-off cost against reliability, a regulator might choose the higher cost level but if it did so on the basis that it was replicating the actions of benchmark firms the claim would be false. Equally, if unregulated firms chose the more expensive opex level but also entered into some kind of derivative contract that had the effect of essentially converting their choice to the less expensive opex level, a regulator could again not justify choosing the higher cost level (without the derivative contract) on the basis that it was replicating the actions of the unregulated firms. In response, CEG (2016b, section 6.3.2) argues that a simple trailing average does not involve the use of swap contracts. This response reveals a misunderstanding of the issue because the swaps referred to by Lally (2014b, section 2.4) are those that are used by the benchmark firm rather than the firm that is regulated in accordance with a trailing average. However, CEG (2016b, section 6.3.2) also argues that Lally provides no evidence that such use of swaps would reduce interest costs (net of the transaction costs of the swaps), and that a comparison of the historical average yields on five and ten-year bonds reveals that the use of swaps would not do so, which indicates that CEG does understand the point. In respect of the point that no evidence was provided on the question of whether such use of swaps reduces expected interest costs, it is true that I did not provide such evidence at that point, and is therefore rectified as follows.

To estimate the expected reduction in (the risk-free component of) interest costs, the natural data set to use would be New Zealand data over the longest available period (from March 1985), and this reveals that the average ten-year yield exceeds the contemporaneous two-year yield by only 0.06%.[4] This is less than the transactions costs of the swaps, and therefore suggests that swapping into a shorter term would not reduce expected costs as claimed by CEG. However, the relevant comparison is not between the contemporaneous ten and two year rates but the ten-year rate and the set of two-year rates that span the same ten-year period. Furthermore, over this period from March 1985, the two-year rate declined from 19% to 2%. At least part of this decline would have been anticipated and therefore the expected excess of the ten-year rate over the set of two-year rates covering the same period would have been greater than 0.06%. Consistent with this, the March 1985 ten-year rate exceeds the average over the set of two-year rates in March 1985, 1987, 1989, 1991 and 1993 by 3.1%. Repeating the process for the ten-year rates in April 1985, May 1985…..October 2005 along with the relevant two-year rates, and averaging, the result is 1.8%.[5]

Since the decline in the two-year rate from 19% to 2% is so extreme, it is not likely to have been fully anticipated, and therefore the figure of 1.8% is likely to be too high as an estimator of the expected difference between the ten and two year rates over the same span. A more suitable data set is that for the US, because the period is much longer for some terms to maturity (1953-2016) and the rates are similar at both ends. The average differential here (between three and ten-year yields) was 0.56%, which is well in excess of the transaction costs of the swaps.[6] So, the empirical evidence supports the claim that borrowing long-term and swapping into a shorter effective term would significantly lower expected interest costs net of the transaction costs of the swaps. Even corporate borrowers have expressed this view.

[4] Data from the Reserve Bank of New Zealand (http://www.rbnz.govt.nz/statistics/b2).

[5] From October 2013, some of the two-year data is missing and therefore my examination of the ten-year rates ceases in October 2005.

[6] Data from the constant maturity series for US Treasury bonds from the Federal Reserve Bank of St. Louis: GS2 and GS10 (https://research.stlouisfed.org/fred2/series/GS2).

For example, Contact (2016, page 8) refers approvingly to the expected cost benefit of shorter term debt and quantifies this as 0.10 - 0.15% per year of reduced tenor.[7] Furthermore, all corporate borrowers are concerned with refinancing risk and the general practice (where possible) is to deal with it by using long-term staggered borrowing so as to minimise the proportion of debt requiring refinancing within any year. Since the expected interest costs from swapping into a shorter term are significantly lower (net of the transaction costs of the swaps) as described above, it is highly likely that many borrowers would have done so in order to optimally trade off the lower expected costs (net of the transactions costs of the swaps) against the greater volatility in shorter term interest rates.

Thirdly, and consequent upon the point raised in the penultimate paragraph, Lally (2014b, section 2.4) argues that use of a trailing average risk-free rate with the bond term based on the observed borrowing terms of benchmark firms (rather than the average effective borrowing term) will yield higher average output prices than the on-the-day regime to the extent that the average debt term of the benchmark firms exceeds the five year regulatory term. In response, CEG (2016b, section 6.3.2) notes that Lally (2014b, section 6.7) reports the average differential between five and ten-year rates at only 0.08%, and deduction of the Commission's estimate for the transaction costs of the swaps (0.08%) would reduce this to zero, in which case the regulatory use of a trailing average ten-year risk-free rate would not produce higher prices than use of the on-the-day regime with a five-year risk-free rate. This differential of 0.08% (the average ten-year rate net of the contemporaneous five-year rate) is appropriate for the purposes examined in Lally (2014b, section 6.7), which involves an Ibbotson estimate of the TAMRP, but it is not appropriate for the purposes of estimating the expected differential between the ten-year rate and the pair of five-year rates over the same period (for reasons discussed in the previous paragraph). The latter differential (the ten-year rate less the average of the two five-year rates over the same period) averages 1.2% over the period from March 1985 to March 2011, when the last such calculation can be performed.[8] So, as argued in Lally (2014b, section 2.4), use of a trailing average risk-free rate with the bond term based on the observed borrowing terms of benchmark firms (rather than the average effective borrowing term) will yield higher average output prices than the on-the-day

[7] The submission is dated 5 February 2015 but constitutes a response to a Commission paper released in November 2015, and therefore presumably should have been dated 5 February 2016.

[8] Data from the Reserve Bank of New Zealand (http://www.rbnz.govt.nz/statistics/b2).

regime to the extent that the average debt term of the benchmark firms exceeds the five year regulatory term.

Fourthly, even if it were true that borrowing for ten years and swapping it into a shorter effective term (such as three years) did lower expected interest costs (net of the transaction costs of the swaps), CEG (2016b, section 6.3.2) raises the question of why Lally (2014a, section 2.4) does not simply advocate use of the shorter term in the event of a trailing average of the risk-free rate being adopted by a regulator. The answer to this question was provided by Lally (2014b, page 16): the swap contracts used by the benchmark unregulated firms to reduce their effective borrowing term are simply unobservable, and therefore the effective term used by the benchmark firms is unobservable.

Fifthly, CEG (2016b, section 6.3.2, 6.3.3) argues that a transitional process to a trailing average is not required for the DRP because efficiently operating businesses subject to the current (on-the-day) regime are already incurring the trailing average DRP. However, contrary arguments have been expressed in Lally (2014b, section 2.4): to obviate the need to collect historical data, and to minimise the one-off profits or losses to firms from the switch in regime. CEG fails to comment on these arguments.

Sixthly, CEG (2016b, section 6.3.2) argues that the on-the-day regime has induced businesses to engage in interest rate swap contracts at the beginning of each regulatory cycle, which exposes them to default risks on the contracts and also to high transaction costs due to the narrow regulatory determination window, and these problems can be eliminated with a trailing average regime. However, in respect of the narrow regulatory determination window, this is not a criticism of the on-the-day regime per se but merely a criticism of a narrow determination window, which is readily correctable. Furthermore, even if the window were not widened, Lally (2015a, Appendix 2) shows that regulated businesses would face very little additional risk from undertaking the swap transactions over a wider period around a one month determination window. Consistent with this, Transpower (2016, page 23) notes that some businesses (including themselves) have acted in this way. Furthermore, in respect of the default risk on the swap contracts, CEG provides no evidence in support of its claim and the available literature (including Litzenberger, 1992; Gupta and Subrahmanyam, 2000; Bomfim, 2002) concludes that the pricing of interest rate swaps is not sensitive to default risk even at times of market stress because of institutional features that protect against default and its consequences (including the posting of collateral and the practice of netting off the fixed and floating rate obligations). All of this suggests that default risk on interest rate swap contracts is not a concern.

Seventhly, Lally's (2014b, section 2.4) analysis of the merits of the on-the-day regime and a trailing average regime assumes that it is optimal for firms subject to the on-the-day regime to engage in interest rate swaps in order to hedge the risk-free rate component of the allowed cost of debt. In response, CEG (2016b, section 6.3.3) argues that it is only efficient to hedge 1/3 of the exposure and refers to CEG (2015a) in support of this claim. However, CEG's analysis has been critiqued in Lally (2015d, section 3.1) and CEG (2016b) has not responded to these points.

CEG (2016b, section 6.6.1) also argues that the Commission's estimate for the transaction costs of interest rate swaps (0.08%) is too low, cites Australian estimates from UBS (2015) of 0.10% and from Evans and Peck (2013) of 0.15%, and argues that these Australian figures would be a lower bound on the New Zealand figures.[9] I express no view on the Commission's figure of 0.08%, because I lack the expertise to do so, but CEG's reference to Australian estimates is neither complete nor representative. Lally (2015d, section 3.1) refers to a much wider set of estimates from 0.03% - 0.16%, with the most recent ones being 0.03% - 0.10%. So, the Commission's estimate of 0.08% is consistent with this rather than lower.

Transpower (2016, section 2) favours a trailing average cost of debt over the on-the-day regime, for the following reasons. Firstly, a firm that sought to match its debt costs to those allowed under the on-the-day regime would refinance their debt at the beginning of each regulatory cycle, this would expose them to significant refinancing risk, and this is avoided by use of the trailing average. However, even Transpower (2016, page 10) recognise that firms subject to the on-the-day regime do not act in this way but instead stagger their debt portfolios (including themselves). So, this argument is irrelevant.

Secondly, Transpower (2016, section 2) argues that a firm subject to the on-the-day regime and managing its debt efficiently (through staggered borrowing and the use of interest rate swap contracts to deal with the base rate component of the cost of debt) could not match its

[9] CEG refers to figures from UBS of 0.10% and 0.23% but only the first figure deals exclusively with interest rate swap costs.

DRP costs incurred to those allowed by the regulator, these mismatches would be substantial, they would discourage investment, they would induce reductions in the quality of service when the mismatches were adverse, and they could be avoided by the use of a trailing average regime. In support of the claim that substantial mismatches arise, Transpower (2016, Appendix E) uses the CDS rates of Australian banks over the five year period 2011-2016 as a proxy for Transpower's DRP over the same period, the CDS rate in August 2014 (when Transpower last had its cost of capital set) was 0.45% lower than the average rate over that five year period, and application of this to Transpower's debt level of $3.3b yields a cash flow shortfall of $15m. However, Transpower fails to relate this shortfall to the cushion that absorbs it (Transpower's cost of equity allowance). With a book equity value of $1.7b (Transpower's RAB of $5b less debt of $3.3b), and an allowed cost of equity of about 6% set in August 2009, the allowance for the cost of equity would be $102m, and the shortfall of $15m is therefore only 15% of it.[10] Furthermore, the example is extreme rather than typical because (by extraordinary chance) the determination window in August 2014 corresponds to the point with the lowest CDS values throughout the entire five-year period examined (Transpower, 2016, Appendix E). Furthermore, Transpower errs in comparing the DRP allowance at the determination point with the average value over a surrounding five-year period; the correct comparison is between the allowance at the determination point with the average cost incurred by the business over a five-year period and the latter is the average of the trailing averages rather than the average of the prevailing rates. Assuming a ten-year trailing average, about 50% of the data contributing to the ten-year trailing average would then precede the GFC commencing in 2008, and therefore produce an average over the 2011-16 period of the ten-year trailing average CDS that is lower than the 2011-16 average of the prevailing rates. The result would be that Transpower's figure of 0.45% would be lowered. So, even Transpower's choice of an extreme case, with an erroneous formula that probably exaggerates the result, produces a mismatch of only 15% of the cushion that is available to absorb it.

A more appropriate analysis is conducted by Lally (2014b, Appendix 1), under the same steady-state scenario assumed by Transpower, in which the firm is not undertaking any new investment and therefore the DRP allowances will match that incurred by a firm under the

[10] Transpower (2016, footnote 34) reports its RAB at $5b. In addition, the average five-year risk-free rate in August 2009 was 4.98%. Coupled with a TAMRP of 7%, an equity beta of 0.34, and the Commission's model for estimating the cost of equity, this yields a cost of equity of 5.82%.

trailing-average regime. This analysis invokes plausible DRP values for regulated businesses (rather than the CDS rates for Australian banks), considers a range of possible regulatory reset dates, and recognises that the DRP costs incurred by firms are the ten-year trailing averages, and it reveals that the mismatches from the on-the-day regime do not exceed 2.5% of the regulatory compensation for the cost of equity, which absorbs such effects. In addition to these steady-state mismatches, and assuming a debt term of ten years, mismatches will occur under either regulatory regime during the first ten years following new investment. Table 1 in section 2.1 examines violations of the NPV = 0 principle in this situation, and finds that the trailing average regime is worse in this respect to the on-the-day regime. Since the usual criterion for selecting investment projects is NPV, these NPV violations are a bigger distortion to investment decisions than the possibility of mismatches in a steady-state scenario (which are both small and will tend to offset over the long life of regulated assets).

Thirdly, Transpower (2016, section 2) argues that a trailing average leads to lower volatility in output prices than the on-the-day regime. This is correct, and empirically assessed in Lally (2014b, Appendix 2). Interestingly, Transpower (2016, page 16) attributes to me the belief that a trailing average does *not* lower price volatility. However, no citation is provided and the claim is false.

Fourthly, Transpower (2016, section 2) argues that the on-the-day regime induces regulated businesses to engage in interest rate swap contracts, thereby incurring costs that are passed on to consumers, whereas no such costs are incurred under a trailing average regime. This point is correct, but the size of these costs is very small (the Commission's allowance being 0.08%), and therefore the issue is not a significant factor in the choice between the on-the-day regime and a trailing average.

Fifthly, Transpower (2016, section 2) argues that a narrow determination window raises the cost of hedging the interest rate risk arising from the on-the-day regime. However, this is not a criticism of the on-the-day regime per se but merely a criticism of a narrow determination window, which is readily correctable. Furthermore, even if the window were not widened, Lally (2015a, Appendix 2) shows that regulated businesses would face very little additional risk from undertaking the swap transactions over a wider period around a one month determination window. Consistent with this, Transpower (2016, page 23) notes that some businesses (including themselves) have acted in this way.

Sixthly, Transpower (2016, section 2) does not agree with the claim by Lally (2014b) that the violations of the NPV = 0 principle resulting from use of the on-the-day regime are minimal. However, Transpower supplies no analysis in support of this claim and perversely finishes its treatment of this issue by citing Lally (2014b) in support of the claim that the violations are minimal.

Seventhly, Transpower (2016, section 3) considers that the claim that mismatches under the on-the-day regime tend to offset over time is not supported by fact or experience. Transpower is presumably referring to the DRP, since the issue of mismatches does not arise for the base rate component when firms undertake interest rate swap contracts. However, in accordance with the Law of Large Numbers, the average of the randomly generated results from any distribution will tend towards the expectation of the distribution as the sample size increases. Thus, smaller subsets (of the total sample) in which the average is significantly below the expectation will tend to be offset by subsets in which the average is above the expectation.[11] Applied to the present situation, this implies that mismatches under the on-the-day regime (which could be positive or negative) will tend to offset over time as the sample increases. The only assumption involved here is that the data are randomly generated from the underlying distribution. In the present case, the DRP is a mean-reverting process, i.e., if unusually low values occur, they are more likely to be followed by higher values and if unusually high values occur they are more likely to be followed by low values. This would strengthen the tendency under the Law of Large Numbers for mismatches to offset over time. In respect of the evidence for the DRP being mean reverting, casual inspection of the US series from 1953-2014 used in the Appendix strongly suggests that it is mean reverting and the model fitted to it shown as equation (7) in the Appendix confirms this. All of this constitutes the very fact and experience that Transpower claims does not support the proposition that the average mismatch under the on-the-day regime tends to zero as the period examined increases.

Transpower (2016, pp. 10-12, Appendix B) also favours use of the ten-year cost of debt, based on the average debt term for large regulated business in New Zealand (Vector,

[11] For example, 1000 tosses of a fair coin will almost certainly yield close to 50% heads whereas successive sets of ten tosses may yield many cases in which the proportion of heads is close to zero or close to ten. So, in successive sets of ten tosses, the cases in which the proportion of heads is well below 50% will tend to be balanced by other cases in which the proportion is well above 50%.

Powerco, Chorus and Transpower) By contrast, the Commerce Commission (2010, para H5.11) surveyed New Zealand businesses regulated under Part 4, and the value-weighted average result was about 7 years. Since the majority of Part 4 suppliers have debt terms of no more than 2.5 years (Commerce Commission, 2010, Table H4), this implies that smaller firms have short debt terms and larger firms have longer debt terms. CEG (2016b, para 179) supplies the explanation for this: smaller firms do not have access to bond markets because their debt needs do not reach the minimum size necessary to enter that market, and are therefore limited to bank debt which is shorter term. The Commission's (2010, para H5.14) response to this was the TCSD. However, for reasons discussed in Lally (2014b, page 13), I do not favour this approach. An alternative approach would be to invoke different debt terms for small and large firms, but this requires a (highly subjective) definition of "small". Applying the same term to all firms avoids this issue whilst the downside (of granting too large an allowance for small firms and too small an allowance for large firms) is small, and I therefore favour it.

Transpower (2016, section 3) also favours annual rather than five-yearly updating of the trailing average. For reasons discussed in section 2.1, I agree. In discussing the implementation process, Transpower argues that a mechanistic updating process is essential and that other regulators such as the AER agree. However the AER's (2015, Attachment 3, pp. 191-216) mechanistic process for estimating the cost of debt involves a simple average of two indexes produced by independent parties: Bloomberg and the RBA, extrapolated out to ten years if required in accordance with the method presented in Lally (2014d, section 7), and generating daily values for the RBA index by interpolating over the adjoining end of month values reported by the RBA. By contrast, in New Zealand, there are no counterparts to these two series. So, although I do not consider that this disadvantage from annual updating is fatal, Transpower's own belief that a mechanistic process is essential to use of annual updating would seem to make it fatal to them.

Transpower (2016, section 4) also favours a transitional process for the risk-free rate component of the cost of debt. For the first year, the allowance would be 10% of the prevailing one year rate, 10% of the prevailing two year rate, etc. In the second year, the only change would be to replace the one year rate used previously by the new prevailing one year rate, etc. So, letting $R_{ft,T}$ denote the allowed rate prevailing at time t for the period from t to T, these allowances would be as follows:

Year 1: $.1R_{f0,10} + .1R_{f0,1} + .1R_{f0,2} + ...+ R_{f0,8} + R_{f0,9}$

Year 2: $.1R_{f0,10} + .1R_{f1,11} + .1R_{f0,2} + ...+ R_{f0,8} + R_{f0,9}$

…….

Year 9: $.1R_{f0,10} + .1R_{f1,11} + .1R_{f2,12} + ...+ .1R_{f8,18} + .1R_{f0,9}$

Year 10: $.1R_{f0,10} + .1R_{f1,11} + .1R_{f2,12} + ...+ .1R_{f8,18} + .1R_{f9,19}$

Thus, after 10 years, a ten-year trailing average of the ten-year rate would be attained. This proposal matches that of CEG (2015b, section 6.4). As described in Lally (2014c, section 2.1), this allowance is premised upon businesses using interest rate swap contracts under the on-the-day regime, which would leave them with floating rate debt at the time of the regime change (the end of a regulatory cycle), and also reacting to a regime switch to a trailing average by entering into a series of swap contracts, to swap each of their prevailing floating-rate exposures into a fixed rate for the remainder of the borrowing. Thus, the debt with one year to maturity would be swapped into one-year fixed-rate debt, the debt with two years to maturity would be swapped into two-year fixed-rate debt, etc. The costs that a firm would incur over the next ten years would then be as shown in the equations above, and hence the justification for granting a matching allowance. Lally (2014c, section 2.1) also discusses alternative transitional arrangements. For reasons discussed in Lally (2015a, pp. 59-60), there is minimal difference between these competing transitional arrangements. Thus, if a trailing average for the entire cost of debt is adopted, I have no objection to Transpower's proposed transitional arrangements for the risk-free rate component of the cost of debt. However, as discussed in section 2.4, I do not favour a trailing average being applied to the risk-free rate component of the cost of debt.

In respect of possible transitional arrangements for the DRP component of the cost of debt, Transpower's (2016, section 4) views are unclear. By contrast, Transpower (2016, section 1) favours no transitional arrangements for the entire cost of debt, but this contradicts its clearly expressed preference for transitional arrangements for the risk-free rate component of the cost of debt as discussed in the previous paragraph.

PwC (2016, pp. 12-17) favours a trailing average for the entire cost of debt rather than the on-the-day regime because it reduces volatility in output prices and better matches the allowance to the incurred costs of an efficient business. However, in respect of the risk-free rate component of the cost of debt, firms can match their costs to the allowance by the use of interest rate swap contracts. In respect of the DRP component of the cost of debt, as discussed in Lally (2014b, Appendix 1), under the same steady-state scenario assumed by PwC in which the firm is not undertaking any new investment and therefore the DRP allowances will match that incurred by a firm under the trailing-average regime, the on-the-day regime does produce mismatches but they do not exceed 2.5% of the regulatory compensation for the cost of equity, which easily absorbs such effects. In addition to these steady-state mismatches, and assuming a debt term of ten years, mismatches will occur under either regulatory regime during the first ten years following new investment. Table 1 in section 2.1 examines violations of the NPV = 0 principle in this situation, and finds that the trailing average regime is worse in this respect to the on-the-day regime. Since the usual criterion for selecting investment projects is NPV, these NPV violations are a bigger distortion to investment decisions than the possibility of mismatches in a steady-state scenario (which are both small and will tend to offset over the long life of regulated assets). PwC does not comment on this analysis.

PwC (2016, page 14) also argues that the use of interest rate swap contracts to hedge the risk-free rate component of the cost of debt allowed under the on-the-day regime exposes businesses to opportunistic pricing by counterparties during the regulatory determination window. However, this is not a criticism of the on-the-day regime per se but merely a criticism of a narrow determination window, which is readily correctable. Furthermore, even if the window were not widened, Lally (2015a, Appendix 2) shows that regulated businesses would face very little additional risk from undertaking the swap transactions over a wider period around a one month determination window. Consistent with this, Transpower (2016, page 23) notes that some businesses (including themselves) have acted in this way.

PwC (2016, page 16) also argues that the Commission has not demonstrated why the risk-free rate or the DRP should be annually updated when other inputs are not, and therefore does not support annual updating. However, as shown in Table 1 in section 2.1, annual updating of the DRP when using a trailing average DRP allowance reduces the violations of the NPV = 0 principle, and is therefore desirable when using a trailing average DRP allowance.

PwC (2016, pp. 16-17) also favours a cost of debt allowance based upon a debt term equal to the average tenor of bonds issued by the service providers. As discussed in Lally (2014b, section 2.4), I agree.

Orion (2016) favours a trailing average for the entire cost of debt, for the same reasons as PwC (2016) as described above, and therefore my comments on this matter presented above also apply here.

Orion (2016) also favours a cost of debt allowance based upon a debt term of ten years, corresponding to the average tenor of bonds issued by the larger service providers. However, since the smaller providers typically have lower terms, this would involve applying a debt term to all providers that exceeded the average for them and therefore produce a cost of debt allowance that was excessive for the set of providers in aggregate. Accordingly, I disagree.

Aurora (2016, sections 4 and 5) favours a trailing average over the on-the-day regime for four reasons.[12] The first two of these are those given by PwC (2016) as described above, and therefore my comments on this matter presented above also apply here. The third argument is that the use of the on-the-day regime prompts regulated businesses to adopt inefficient and costly debt management strategies to mitigate the risk. This is presumably a reference to the transaction costs of the swap contracts that enable businesses to hedge the risk arising from the risk-free rate component of the cost of debt. This point is correct, but the size of these costs is very small (the Commission's allowance being 0.08%), and therefore the issue is not a significant factor in the choice between the on-the-day regime and a trailing average. The fourth argument is that a trailing average would substantially relieve the DPP/CPP WACC disparity. As discussed in Lally (2015c), this is true in principle but disparities arising from the cost of equity would remain. Thus, in so far as these latter disparities prompt policy changes to address the problem, adoption of a trailing average for the cost of debt would have no incremental value. Furthermore, as noted in Lally (2015c), there has only been one CPP application to date, which suggests that the DPP/CPP WACC disparity is not a major issue

[12] Aurora's paper is dated 5 February 2014, but it refers to papers that were prepared in 2015, including Lally (2015c) which was prepared in September 2015. Consequently I assume Aurora's paper should have been dated 5 February 2016.

and therefore that the favourable effect of a trailing average on it is not a significant point in favour of a trailing average.

Contact (2016, page 11) favours a regulatory cost of debt based on the regulatory cycle of five years, on the grounds that consumers should not have to pay for a firm's choice of a different term. I disagree. Regulatory compensation should reflect the efficient strategy of a firm and the efficient strategy is to borrow for longer than five years and swap the risk-free component into five-year debt. This leaves an efficiently operating firm with the DRP for a term longer than five years, for which regulatory compensation should be provided.

Contact (2016, page 12) does not hold a clear view on the merits of a trailing average versus the on-the-day regime, but in the event of a trailing average being adopted favours a transitional process to a trailing average on the grounds that immediate adoption of a trailing average would result in a windfall gain to suppliers at the expense of customers due to the decline in interest rates in recent years. In respect of the DRP, I agree with these comments as discussed in section 2.4. In respect of the risk-free rate component of the cost of debt, the on-the-day regime induces efficient businesses to enter interest rate swap contracts in order to hedge risk, these would not be required under a trailing average regime, and therefore leads to different arguments in support of a transitional process, as discussed in Lally (2014c, section 2.1).

In summary, I agree with some of the points raised in these submissions on the cost of debt but none of them warrants any change to the conclusions presented earlier.

3. RAB Indexation and Inflation Risk

3.1 RAB Indexation

At the beginning of a regulatory cycle, the Commission determines the expected revenues of a regulated business (and hence the output price) from the sum of opex, depreciation, taxes and cost of capital, net of expected revaluation gains on the RAB (using forecast CPI). However, at the end of the regulatory cycle, the RAB is updated using the actual CPI over the regulatory cycle. Vector (2014, para 6) argues that this exposes the businesses to inflation risk and that this also violates the NPV = 0 principle.

To assess this question, suppose regulated assets are purchased now for A_0, with a life of two years, the regulatory cycle is one year, prices are set at the beginning of each year and the resulting revenues are received at the end of each year. I start by assuming that revenues received at the end of a year are certain as of the beginning of the year, and therefore the only source of uncertainty is the actual CPI and therefore the actual revaluation of the RAB at year end. To simplify the presentation, I assume there is no opex, capex or taxes.[13]

The revenues received in one year comprise the cost of capital, at the appropriate rate k_{01} set now (time 0) and applied to the initial asset base A_0, plus depreciation, less expected revaluations at the forecast CPI rate $_{iF01}$ applied to the year-end asset value before depreciation (A_0):

$$REV_1 = A_0 k_{01} + DEP_1 - i_{F01} A_0 \tag{1}$$

The revenues received at the end of the second year will comprise the cost of capital, at the appropriate rate k_{12} set at time 1 and applied to the asset base at the beginning of year 2, plus depreciation (which equals the asset base at the beginning of year 2). In addition, the asset base at the beginning of year 2 is the initial asset base A_0 less depreciation and then adjusted for actual year 1 inflation i_{01}. So, the revenues for year 2 are

$$REV_2 = [A_0(1+i_{01}) - DEP_1]k_{12} + A_0(1+i_{01}) - DEP_1 \tag{2}$$

These revenues are discounted back to time 1 using an appropriate discount rate, which is k_{12}. So, their value at time 1 is the RAB at the beginning of the year as follows:

$$V_1 = \frac{[A_0(1+i_{01}) - DEP_1](1+k_{12})}{1+k_{12}} = A_0(1+i_{01}) - DEP_1 \tag{3}$$

At time 0, the revenues arising at time 1 shown in equation (1) plus V_1 shown in equation (3) are discounted back to time 0 using an appropriate discount rate, which is k_{01}. The result is as follows:

[13] Opex and capex will be recognized later. In addition, most features of the modelling here are simplifications of the actual situation but are sufficient to convey the essential points.

$$V_0 = \frac{E(REV_1) + E(V_1)}{1 + k_{01}} = \frac{A_0(1 + k_{01}) + A_0 E(i_{01} - i_{F01})}{1 + k_{01}}$$

It is plausible to suppose that the Commission uses an unbiased inflation forecast for setting the revenues for year 1, as shown in equation (1) above. Consequently, the last term in the numerator of the last equation is zero, and therefore

$$V_0 = \frac{A_0(1 + k_{01})}{1 + k_{01}} = A_0$$

So, the present value of the revenues equals the initial investment, and therefore the NPV = 0 principle is satisfied. Vector claims that the businesses are exposed to an inflation risk and therefore that the NPV = 0 principle is violated is false. However, the NPV = 0 principle is satisfied, as shown above. Crucial to the latter proof is that the appropriate discount rate is chosen, and therefore an estimate of beta that incorporates any systematic component of the nominal inflation risk. Ideally, this requires a beta estimate drawn from firms subject to the same regulatory regime. However, some degree of imperfection in the comparators used to estimate beta is inevitable and such imperfections are secondary to the substantial statistical imprecision in estimating them.

In respect of inflation risk, as shown in equations (1) and (2), inflation shocks in the first regulatory cycle do not affect nominal revenues in the first cycle but raise subsequent revenues in proportion to the inflation shock. However, in real terms, REV_1 is down and REV_2 is unchanged. Since revenues beyond the first cycle are dominant, this is the more important matter. So, essentially, prices are preserved in real terms and this protects customers from inflation risk. The same holds for the shareholders of the businesses. So, both parties are largely protected from inflation risk. However, this methodology exposes businesses to some bankruptcy risk when inflation is lower than forecast, because the interest payments to debt holders are fixed in nominal terms. Nevertheless, the Commission's inflation forecast errors are likely to be uncorrelated over time and therefore will tend to offset over time. Furthermore, inflation in New Zealand has low variability. So, the bankruptcy risk to businesses is slight.

To illustrate the situation here, suppose that A_0 = \$100, DEP_1 = \$2m, $k_{01} = k_{12}$ = .08, $i_{F01} = i_{01}$ = .02.[14] In this case, following equations (1) and (2), REV_1 = \$8m and REV_2 = \$108m. Now suppose that the actual CPI for the first year was 4% rather than 2%. In this case, REV_1 is unchanged but V_1 rises by 2% to \$102m, and therefore REV_2 rises by 2% to \$110.16m. However, in real terms, REV_1 is down by 2% and REV_2 is unchanged.

In summary, the Commission's RAB indexation does not violate the NPV = 0 principle and the inflation risk to both customers and shareholders in the businesses exists only in the current regulatory cycle. The only downside is to expose the businesses to some additional bankruptcy risk, but this would be slight.

3.2 RAB Indexation and Price Path Adjustments

I now recognise that revenues are not certain at year end because prices are set by starting with equations (1) and (2), dividing by expected output for each year, deflated using forecast inflation, and then adjusted at the time output is sold in accordance with actual inflation.[15] So, letting i_{F12} denote the forecast inflation rate for year 2 and i_{12} the actual inflation rate for that year, in substitution for equations (1) and (2), revenues for years 1 and 2 are instead:

$$REV_1 = \frac{\left[A_0 k_{01} + DEP_1 - i_{F01} A_0\right]}{1 + i_{F01}}(1 + i_{01}) \tag{4}$$

$$REV_2 = \frac{[A_0(1 + i_{01}) - DEP_1](1 + k_{12})}{1 + i_{F12}}(1 + i_{12}) \tag{5}$$

The expectations of these revenues at the beginning of each year are equal to the formulas in (1) and (2) and therefore the NPV = 0 principle still holds. In addition, prices are preserved in real terms for all periods rather than just those beyond the first regulatory cycle. So, both customers and the shareholders in the businesses are protected against inflation risks.

To illustrate this situation, suppose as before that A_0 = \$100m, DEP_1 = \$2m, $k_{01} = k_{12}$ = .08, $i_{F01} = i_{01}$ = .02. In addition, the actual and forecast inflation for year 2 is also 2%. In this

[14] The assumption of 2% depreciation in the first year is intended to reflect the normal situation, with year 2 embodying the remaining life of the asset.

[15] The actual adjustment process uses inflation lagged by two years (Commerce Commission, 2015, page 25) rather than that in the actual year. So, the representation in equations (4) and (5) is approximate but sufficient for the present purposes.

case, REV_1 = \$8m and REV_2 = \$108m as determined above. Now suppose that the actual CPI for the first year was 4% rather than 2%. In this case, REV_1 rises by 2% to \$8.16m in accordance with the price path adjustment in equation (4) and REV_2 rises by 2% to \$110.16m due to the impact of this inflation shock on the RAB as described in the previous section. So, inflation shocks in any regulatory cycle have a dual impact: on the price path for that regulatory cycle and also on the RAB at the end of the cycle, which affects prices in subsequent cycles. This preserves the real price paid by consumers in all periods and also preserves the real price received by businesses. As described in the previous section, there is a small additional bankruptcy risk to businesses.

In summary, RAB indexation in conjunction with the Commission's price path adjustment does not violate the NPV = 0 principle. In addition the collective effect of these two adjustments is to preserve both the real output price paid by consumers and that received by the businesses over all periods, and therefore insulate them from inflation risks. The only downside is to expose the businesses to some additional bankruptcy risk, but this would be slight.

3.3 Opex

I now recognise the presence of opex, and the impact of inflation forecasting errors here. Opex is both a component in the allowed revenues, based upon the Commission's forecast using a relevant inflation index, and a cost incurred by the businesses, based on the actual inflation rate. Furthermore, in the presence of opex, the present valuing is done over net cash flow (*NCF*) rather than revenues. Finally, the Commission's policy is to reimburse businesses for 2/3 of the forecast error, and therefore businesses bear only 1/3 of it. Applying these modifications to equations (4) and (5), and letting OP_t denote the opex base for year t to which inflation is applied, p_{F01} denote the forecast inflation in opex for year 1, and p_{01} the actual rate of inflation for year 1, and with matching notation for year 2, the results are as follows:

$$NCF_1 = \frac{\left[A_0 k_{01} + DEP_1 + OP_0(1+p_{F01}) - i_{F01}A_0\right]}{1+i_{F01}}(1+i_{01}) - OP_0(1+p_{01}) + .67OP_0(p_{01} - p_{F01})$$

$$NCF_2 = \frac{\left[\{A_0(1+i_{01}) - DEP_1\}(1+k_{12}) + OP_1(1+p_{F12})\right]}{1+i_{F12}}(1+i_{12}) - OP(1+p_{12}) + .67OP(p_{12} - p_{F12})$$

The expectations of these net cash flows at the beginning of each year are still equal to the formulas in (1) and (2) and therefore the NPV = 0 principle still holds. However, the opex compensation in the last term of the last two equations is unnecessary because the price path adjustment preserves revenues in real terms and this includes the opex component of revenues. The appropriate compensation in the last term (if granted) should be for the difference between actual opex inflation (which determines the opex cost incurred) and the CPI rate (which determines the compensation provided via prices).

To illustrate this point, suppose that the opex base for each year is 7.5% of the asset base at the beginning of the year, actual and forecast inflation is 2% for each year, and for both CPI and the opex inflation index.[16] In that case, NCF_1 = \$8m and NCF_2 = \$108m as determined previously. Now suppose that the actual CPI for the first year was 4% rather than 2%, and likewise for the opex inflation index. In this case, REV_1 rises by 3.2% to \$8.26m and REV_2 rises by 2% to \$110.16m due to the impact of this inflation shock on the RAB as described previously. So, the effect of the opex inflation forecast error is to raise NCF_1 by 1.2% more than before. This additional 1.2% occurs because the opex forecasting errors are compensated for twice, once formally in the last term of the last two equations above and again in the price path adjustment in each of those equations (which applies to the allowed prices and therefore to the opex component of the allowed prices). This would appear to be a design error. If i_{01} were substituted for p_{F01} in the last term in the penultimate equation, and similarly for the last equation, as suggested above, then REV_1 would rise only by 2% so as to maintain revenues in real terms.

In summary, the Commission's approach to opex is consistent with the NPV = 0 principle but inflation forecasting errors arising from opex raise prices by more than the inflation shock because inflation forecasting errors are compensated for twice. This would appear to be a design error.

3.4 Capex

In respect of capex that occurs during a regulatory cycle, the allowed prices at the beginning of the cycle reflect expected depreciation and cost of capital on that capex. In principle, this is like opex, but these capex elements are only a small proportion of capex, and therefore the

[16] The figure of 7.5% was based upon advice from the Commission.

issue is trivial. The more important issue is the capex itself, with the incurred capex added to the RAB at the end of the cycle less any depreciation already allowed for. In addition, 15% of any divergence between actual and forecast capex is borne by the firm through a revenue adjustment. So, leaving aside the small effect of depreciation and cost of capital on the capex incurred within a cycle, and letting CAP_1 denote the actual capex incurred in period 1 and $FCAP_1$ the forecast of it, the equations in the previous section are now as follows:

$$NCF_1 = \frac{\left[A_0 k_{01} + DEP_1 + OP_0(1+p_{F01}) - i_{F01}A_0\right]}{1+i_{F01}}(1+i_{01}) - OP_0(1+p_{01}) + .67OP_0(p_{01}-p_{F01})$$
$$- CAP_1 - .15(CAP_1 - FCAP_1)$$

$$NCF_2 = \frac{\left[\{A_0(1+i_{01}) - DEP_1 + CAP_1\}(1+k_{12}) + OP_1(1+p_{F12})\right]}{1+i_{F12}}(1+i_{12}) - OP(1+p_{12})$$
$$+ .67OP(p_{12}-p_{F12})$$

Since the 15% adjustment is mean zero, and the capex incurred in year 1 is offset by the increment to the RAB at year end, the NPV = 0 principle is still satisfied. In respect of inflation risk, 85% of any inflation shocks to capex in the first cycle feed through to higher prices in subsequent cycles. Aside from the 15% difference, this matches the RAB adjustment discussed in section 3.1.

In summary, the Commission's approach to capex is consistent with the NPV = 0 principle is preserved and inflation shocks to capex during a regulatory cycle largely affect businesses in the same way as discussed in section 3.1 in relation to the RAB.

3.5 Methodology Variations

The scenario examined in section 3.4 corresponds to that faced by most of the regulated businesses. Two exceptions exist. The first of these relates to Transpower and AIAL, for which no revaluations of the RAB are undertaken nor any price path adjustment. This is a special case of the analysis in section 3.1, in which the actual and forecast inflation terms are set to zero. Since it is a special case, it too will not violate the NPV = 0 principle. However, in the presence of inflation, real prices will decline over time. Furthermore, since inflation is unpredictable, the rate of this real decline in prices will also be unpredictable. This imposes inflation risk on to both consumers and the shareholders of these businesses.

The second exception relates to WIAL, for which there is no price path adjustment but there are revaluations of the RAB. This conforms to the analysis in section 3.1. As noted there, the NPV = 0 principle is satisfied and inflation shocks during a regulatory cycle have no impact on prices during the cycle but alter subsequent prices so as to preserve them in real terms.

3.6 Review of Submissions

CEG (2016c, section 2) notes that the Input Methodologies uses forecast inflation to determine RAB revaluations, and hence revenues, within each regulatory cycle and actual inflation during the cycle to adjust the RAB at the end of the cycle, that differences between these two inflation rates imparts risk to capital suppliers in nominal terms, and therefore favours dispensing with these inflation adjustments so that shareholders do not face such risks in nominal terms.[17] This ensures that the regulatory allowance for the cost of debt match the cost of debt incurred, which is set in nominal terms. In the event that shareholders prefer certainty over real outcomes, CEG (2016c, section 3) proposes a weighted average over the Commission's approach and that recommended by them, where the weights are the relative values of the two sources of capital.

CEG's point that the current regime protects the real outcomes despite the cost of debt being set in nominal terms is correct, but the only significance of this is the bankruptcy risk that it imposes on shareholders, and this is trivial. For example, consider the analysis and example in section 3.2. With expected inflation of 2%, the expected revenues for the first year are $8m. If actual inflation is instead zero, then actual revenues will be 2% less at $7.84m using equation (4) in that analysis. If leverage is 50% on the asset base of $100m, and the cost of debt is 6%, the interest payment to debtholders is $3m, and therefore the adverse effect of the inflation shock is to reduce the cash flows to shareholders from $5m to $4.84m, which is a 3.2% reduction. This is trivial.

[17] CEG does not refer to the price path adjustment in which actual prices within a cycle are adjusted in accordance with actual inflation. I presume this is a mere oversight, and that CEG meant to refer to it.

Furthermore, CEG's recommendations ignore the preferences of consumers, who could reasonably be presumed to favour prices that are stable in real rather than nominal terms, including across generations. This point favours the Commission's methodology over CEG's alternatives. Furthermore, CEG (2016b, pp. 73-74) are clearly not indifferent to the preferences of consumers because they deferentially refer to the preference of consumers for lower volatility in output prices and the fact that regulatory use of a trailing average cost of debt reduces such volatility. To illustrate the point about stability in prices in nominal or real terms, consider an asset with an indefinite life (hence no depreciation), no operating costs or taxes, a cost of capital of 8% nominal, and expected and actual inflation of 2%. Under the current methodology, the output price would grow at 2% per year in nominal terms, which would be constant in real terms. By contrast, under CEG's first proposal, the output price would remain fixed in nominal terms and therefore decline in real terms at 2% per year. After 25 years, the real price would have fallen by 40%. After 50 years, it would have fallen by 63%. So, the cost burden will fall more on the first generation of users of the asset than the second generation, and more on the second than the third, etc. Even within a generation of users, the cost burden is high relative to their income in the initial years, and this is disadvantageous because it leads to uneven consumption over time (initially low and then rising over time as the real price falls).

CEG (2016c, section 4) notes that the Commerce Commission's (2012, page 18) inflation forecast is the RBNZ's most recent forecasts coupled with linear transition over three years to the midpoint of the RBNZ's target range (2%), that the latter figure is higher than the "break-even inflation rate" (the yield on nominal less inflation indexed government bonds of the same maturity), and therefore that the Commission should forecast inflation from this "break-even" rate. However the difference between these bond yields is affected not simply by expected inflation but by an allowance for the inferior liquidity of the indexed bonds (which raises their yields) and an allowance for the inflation risk on the nominal bonds (which raises their yields). CEG (2016b, section 4.2.1) are certainly aware of the illiquidity issue and its impact on yields, because they raise it in the context of estimating the expected real yield on nominal bonds. Furthermore, since the illiquidity effect would raise the yield on the indexed bonds, it would cause CEG's "break-even" inflation forecast to be too low. Thus, CEG has raised the issue when they feel it buttresses their case but does not do so when it undercuts their case. Furthermore, since the allowance for inflation risk on the nominal bonds would raise the yield on these bonds, it would therefore cause CEG's "break-even" inflation forecast to be too high. The net effect of these two additional considerations is unclear and therefore CEG's "break-even" inflation forecast might be too low or too high. Thus, it is not a reliable estimator. Unsurprisingly, the Reserve Bank (2016, Table 2, Figure 1) uses a range of estimators and concludes from them that inflation will converge on its 2% midpoint over the next five years. This supports the Commission's approach.

In summary, and in respect of the Commission's inflation adjustments that protect the real payoffs received by businesses and maintain the output price in real terms, CEG's preference for maintaining at least part of the payoffs in nominal terms because interest payments are fixed in nominal terms protects shareholders against a minor risk and ignores the preferences of customers for prices that are stable in real terms. In addition, CEG's recommendation to forecast inflation from the difference between the yields on nominal and inflation-indexed bonds suffers from the significant disadvantage that this difference in yields is affected by two additional factors, and therefore does not warrant substitution for the Reserve Bank's forecasts.

4. The Asset Beta Adjustment for Gas Pipeline Businesses

The Commerce Commission (2010, paras H8.167-179) adds 0.10 to its estimate of the asset beta for electricity businesses to obtain its estimate for gas pipeline businesses. By contrast, Lally (2016a, section 2.1) argues that this margin is not warranted because the only apparently strong theoretical argument (the higher weight of commercial customers for gas pipeline businesses) reveals that the appropriate margin to reflect this would be close to zero. In response, the following contrary arguments have been raised.

Incenta (2016, Chapter 3) compares the asset betas of US gas pipeline businesses with those of a (suitably updated) collection of businesses used by the Commerce Commission to estimate the asset beta for New Zealand gas and electricity businesses (comprising firms involved in gas transmission, gas distribution, electricity transmission, electricity distribution, and integrated electricity operations). Incenta estimates the margin for the US gas pipelines over this broader set at 0.11-0.14, over the period 2005-2010, and argues that this supports a margin for New Zealand gas pipelines over electricity businesses. However, the New Zealand "gas pipelines" to which the Commerce Commission (2010, paras H8.167-179) refers comprise both transmission and distribution networks whereas the US "gas pipeline" businesses to which Incenta refers are only transmission businesses (Incenta, 2016, Tables 3.2-3.5), and this misunderstanding by Incenta undermines the value of their analysis. Furthermore, even if Incenta's set of US companies had (appropriately) included gas distribution as well as transmission businesses, it would be perverse to compare this set to a set of businesses that also included such companies; the appropriate comparison would be between one set of firms comprising only gas businesses and another set comprising only electricity businesses. Similarly, if one suspected that the height of men exceeded that of women, it would not be sensible to compare the height of a sample of men with that of a sample comprising both men and women. Incenta (2016, section 3.5) appears to defend its use of the Commission's set of firms because the Commission uses a sample of both gas and electricity businesses to estimate the asset beta for both sets of firms, but the Commission's pooling of firms is premised on there being no difference in the betas; once that premise is challenged, as Incenta does, the Commission's set of firms should not be one of the two sets examined by Incenta. Furthermore, Incenta's (2016, Table 3.5) analysis involves beta estimates for gas transmission businesses for only a five-year period and this is too short a period to draw reliable conclusions about the difference relative to the second set of firms. For example, Lally (2008, Table 3) shows significant variation in the differential beta estimates for US gas and electricity businesses across successive five year periods from the same supplier. For example, S&P estimates the beta differential (electricity – gas) at 0.07 for 1989-1993, -0.13 for 1994-1998, and 0.02 for 1999-2003.

Incenta (2016, section 4.3.1) argues that the volume weights used by Lally (2016a, section 2.1) to estimate the asset beta differential for gas and electricity businesses should be replaced by revenue weights, and doing so would lead to the conclusion that a margin of 0.10 for gas over electricity businesses was warranted. I agree that revenue weights are better than volume weights. However the analysis carried out by Lally (2016a, section 2.1) covers both transmission and distribution (for both the gas and electricity sectors), which is appropriate, whereas Incenta's revenue data is not of this type. In particular, Incenta's electricity data covers only distribution businesses and its gas data purportedly covers only transmission businesses. Furthermore, it is unlikely that the gas data provided by Incenta does deal with only transmission businesses because it refers to residential customers and such customers do not obtain gas from transmission pipelines. Furthermore, Incenta provides no source for its data and therefore the actual nature of this data cannot be checked. These errors undermine the value of Incenta's analysis. Nevertheless, the point that revenue weights should have been used is correct and the effect of doing so is discussed in the next section.

Incenta (2016, section 4.3.2) disputes the claim in Lally (2016a, footnote 1) that the contribution of the revenues from transporting gas to the methanex plants is a trivial proportion of the total revenues of the gas businesses, and can therefore be ignored, by noting that these methanex revenues constituted 15% of those for the Maui transmission system. However, the Maui transmission revenues are only part of those from the entire transmission system, and presumably less than 50% judging from the fact that the Maui transmission system comprises only about 20% of the pipeline kms (Ministry of Business, Innovation, and Employment, 2014, Figure D.19). Furthermore, the transmission network is only part of the entire gas network. Thus, Incenta's information supports rather than contradicts the claim in Lally (2016a, footnote 1) that the revenues from transporting gas to the methanex plants is a trivial proportion of the total revenues of the gas businesses.

Incenta (2016, section 4.3.2) disputes the suggestion in Lally (2008, page 62) that most of the methanex is exported and therefore this would reduce the beta from the revenues earned by the gas pipeline businesses from transporting gas to these plants. In particular, Incenta shows that the methanol price is correlated with New Zealand GDP. However, nothing in this analysis undercuts the claim in Lally that the beta from these revenues is *reduced* as a result of the revenues coming from foreign rather than local buyers. Furthermore, even if there were no such downward effect on beta, the revenues earned by the gas pipeline businesses from this source are still a trivial proportion of the total revenues, and this fact alone would warrant disregarding them in the analysis in Lally (2016a, section 2.1).

Incenta (2016, Appendix A) conducted a survey of three investment analysts in Australia regarding the appropriate beta for a gas transmission business relative to a gas or electricity distribution business, which resulted in all three favouring a higher beta. However, consistent with Incenta's earlier misunderstanding over the meaning of "gas pipelines", the wrong question has been asked; the question ought to have involved the beta of a gas business relative to an electricity business. In addition, Incenta discloses the beta differentials for only one of the three analysts, thereby reducing the effective sample size from three to one. Both sample sizes are well below an adequate size.

Incenta (2016, Appendix B) also reports some US information on the appropriate asset beta of gas transmission businesses relative to both gas and electricity distribution businesses. However, as with Appendix A, the wrong comparison has been examined.

HoustonKemp (hereafter HK, 2016, section 2) notes that Lally (2004, pp. 32-34) favoured a beta differential for gas over electricity businesses of 0.10 on the basis of differences in customer types and in the betas associated with those customer types, and that this margin was maintained in Lally (2008, pp. 62-64) but with the additional argument that growth options were more valuable for gas businesses, implying that the growth option argument was secondary, which contradicts the claim in Lally (2016a, section 2.1) that the growth options argument was the more important consideration in Lally (2008). I agree with this point, but it highlights errors in my earlier analysis rather than in Lally (2016a). In particular, in recommending a beta difference of 0.10 in Lally (2004, pp. 32-34) essentially on the basis of the difference in customer mix, I did not have the benefit of the analysis in Lally (2016a, section 2.1) on this issue. Had I undertaken such an analysis in Lally (2004), I would have concluded as I have in Lally (2016a, section 2.1) that the difference in customer mix did not warrant a beta difference. Similarly, in recommending a beta difference of 0.10 in Lally (2008, pp. 62-64) essentially on the basis of the difference in customer mix and the greater growth options for the gas businesses, I did not have the benefit of the analysis in Lally (2016a, section 2.1) on this issue. Had I undertaken such an analysis in Lally (2008), I would have concluded as I have in Lally (2016, section 2.1) that the difference in customer mix did not warrant a beta difference and therefore that the more important argument related to the growth options.

HK (2016, section 2) notes that Lally (2008, pp. 62-64) favoured a beta differential for gas over electricity businesses in part due to greater growth options for gas businesses, this occurred in anticipation of the gas businesses being subject to price or revenue controls, and this contradicts Lally's (2016a, section 2.1) argument that such controls undercut the beta impact of the growth options. However the second of these claims is not correct. The arguments described in Lally (2008, pp. 62-64) relate to estimating WACC for the purpose of assessing excess profits under the regime operating in 2008 rather than in anticipation of the price control regime that came into effect shortly afterwards: see Lally (2008, section 1). Thus there is no conflict between Lally (2008, pp. 62-64) arguing that the greater growth options for gas businesses warrant a higher beta than for electricity businesses and Lally

(2016a, section 2.1) arguing that they have low relevance under price control. Nevertheless, Lally (2008, section 12) does discuss the WACC suitable for the price control regime, and that section should have (but did not) note that the growth options argument for a beta differential no longer applied. However, even If I had dismissed the growth options issue there, I would presumably still have recommended a beta differential of 0.10 primarily on the basis of the different customer mix, just as I had in Lally (2004, pp. 32-34), because I did not in 2008 have the benefit of the analysis in Lally (2016a, section 2.1) on the small impact of this customer mix issue. In short, the error is in Lally (2008, section 12) rather than in Lally (2016a, section 2.1).

HK (2016, section 3) argues that the analysis in Lally (2016a, section 2.1) regarding the beta differential between gas and electricity businesses is in error because it used volume rather than revenue weights, it assumed that the betas for gas and electricity residential revenues were the same, and that the betas for gas and electricity commercial revenues were the same. In particular, HK (2016, Table 2) presents evidence on the income elasticities of demand by residential gas customers, commercial gas customers, commercial electricity customers, and residential electricity customers, and couple this with data on the proportion of revenues in the form of variable charges (HK, 2016, Table 4) to obtain the sensitivities of revenue from each of these customer groups to income (GDP) shocks, relative to residential consumers of electricity (HK, 2016, Table 5). HK recognise that the differences in these revenue sensitivities across the customer groups are upper bounds on the differences in the betas for the customer groups and that the actual difference in betas would be much less. HK (2016, Table 3) also presents evidence on the revenue weights for small customers, which they equate with residential customers. Applying this additional information to the analysis in Lally (2016a, section 2.1), HK (2016, Table 6) conclude that the betas for the different customer groups would have to differ by only about 17% of the difference in the revenue sensitivities in order to support a beta differential of at least 0.1 in favour of the gas over electricity businesses, and therefore that such a differential is highly plausible.

HK's analysis suffers from the following two shortcomings. Firstly, HK (2016, page 12 equations) assume that the entire residential use of gas is direct (residential purchases of gas) whereas most of it is instead indirect (residential use of electricity that is generated from gas). They also assume that all commercial use of gas is direct whereas some is indirect (commercial use of electricity that is generated from gas). So, if (as HK find) the income elasticity of residential demand for (directly purchased) gas differs from that for electricity, and the income elasticity of commercial demand for (directly purchased) gas differs from that for electricity, it would be necessary to recognise four classes of demand for gas: residential direct demand for gas, residential demand for electricity generated from gas (which has the same income elasticity of demand as that for residential demand for electricity from any source), commercial direct demand for gas, and commercial demand for electricity generated from gas (which has the same income elasticity of demand as that for commercial demand for electricity from any source), and then apply different betas to each of these four classes. Letting β_{ER} denote the beta for residential use of electricity, K denote the multiple to obtain the beta for commercial use of electricity, K_1 the further multiple to obtain the beta for commercial direct use of gas, and K_2 the multiple applied to β_{RE} to obtain the beta for residential direct use of gas, HK (2016, Table 5) suggests that K must lie between 1 and 0.98, K_1 must lie between 1 and 1.41, and K_2 must lie between 1 and 3.65. So, Lally (2016a, section 2.1) recognises only two types of customers across both the gas and electricity sectors: residential and commercial, HK (2016, section 3) recognises four types (residential and commercial for each of gas and electricity businesses, but the evidence presented by them actually points to two further types (residential indirect users of gas and commercial indirect users of gas).

HK's second error is to use the revenue weights for residential and commercial customers obtained from only gas distribution businesses and electricity distribution businesses rather than for the entire gas sector and the entire electricity sector. Since residential customers deal only with distribution businesses, the residential customer revenue weights used by HK are too high for the sector as a whole. This is reflected in HK (2016, Table 3) attributing 48% of sales by volume to residential (small) customers of distribution businesses whereas Lally (2016a, section 2.1) attributes only 32% of sales by volume to residential users (for the entire sector). In respect of gas, the corresponding figures are 21% and 7%. Having been unable to obtain information of the kind shown in HK (2016, Table 3) for the entire gas sector and the entire electricity sector, an alternative approach to addressing HK's point that revenue shares differ significantly from volume shares is to estimate the charges per unit delivered by distribution businesses to residential compared to commercial customers, and to assume that the commercial customers who receive delivery directly from transmission businesses face the same charge per unit as do commercial customers of distribution businesses. Since the higher charges by electricity distributors to residential customers transform a volume weight for these customers of 48% into a revenue weight of 63% (HK, 2016, Table 3), the charge per unit multiple for residential customers of electricity distributors relative to their commercial customers must be 2, i.e.,

$$w_{RD} = \frac{0.48(2)}{0.48(2)+0.52} = 0.63$$

Similarly, since the higher charges by gas distributors to residential rather than commercial customers transform a volume weight for residential customers of 21% into a revenue weight of 62% (HK, 2016, Table 3), the charge multiple for residential customers must be 6. So, in respect of the entire electricity sector, with 32% of volume delivered to residential users and 68% to commercial users (Lally, 2016a, section 2.1), the revenue weight for residential users of electricity would be 48% as follows:

$$w_{RE} = \frac{.32(2)}{.32(2)+.68} = .48$$

The revenue weight for commercial users of electricity is then the residue of 52%. Similarly, in respect of the gas sector, with 4% delivered to residential customers, 41% to electricity generators (with 32% of the resulting electricity generated used by residential customers and 68% by commercial customers), and 55% to other commercial customers (Lally, 2016a, section 2.1), the volume weights are then 4% for direct residential gas use, 13% for residential gas use via electricity, 28% for commercial gas use via electricity, and 55% for direct commercial gas use. With a charge multiple of 6 for residential customers, the revenue weight for residential direct use of gas users would be 13% as follows:

$$w_{RG} = \frac{.04(6)}{.04(6)+.13(6)+.28+.55} = .13$$

Similarly, the revenue weight for residential use of gas via electricity generation is 42%, that for commercial use of gas via electricity generation is 15%, and that for commercial direct use of gas is 30%. So, Lally (2016a, section 2.1) uses volume weights, HK (2016, section 3) uses revenue weights but only for the distribution businesses for each of the two sectors, and I have estimated the revenue weights for each sector. All of these results are shown in Table 3 below along with the betas applicable to each of them.

Table 3: Revenue Weights and Betas for Customer Types

	Weight	Beta
Electricity: Residential	0.48	β_{RE}
Commercial	0.52	$K\beta_{RE}$
Gas: Residential Direct	0.13	$K_2\beta_{RE}$
Residential Indirect	0.42	β_{RE}
Commercial Indirect	0.15	$K\beta_{RE}$
Commercial Direct	0.30	$KK_1\beta_{RE}$

Using this improved information, the Commission's estimate for the asset beta for the electricity businesses of 0.34 can then be expressed as a revenue-weighted average of the betas for residential and commercial customers, as follows:

$$0.34 = \beta_{RE}(0.48) + \beta_{RE}K(0.52) \tag{6}$$

The asset beta for the gas businesses would then be a revenue-weighted average of the betas for their four customer types, as follows:

$$\beta_G = \beta_{RE}K_2(0.13) + \beta_{RE}(0.42) + \beta_{RE}K(0.15) + \beta_{RE}KK_1(0.30) \tag{7}$$

By positing values for the parameters K, K_1 and K_2, equation (6) can be solved for β_{RE} and then equation (7) for β_G. For example, if $K = K_1 = K_2 = 1$, then $\beta_{RE} = 0.34$ and therefore $\beta_G = 0.34$. Alternatively, if K, K_1, and K_2 all lie midway between their base case values of 1 and their extreme values (in which betas are proportional to the income elasticity of demand adjusted by the proportion of revenues in the form of variable charges), then $K = 0.99$, $K_1 = 1.20$, and $K_2 = 2.32$, whereupon $\beta_{RE} = 0.34$ and therefore $\beta_G = 0.42$. So, the beta for the gas businesses would exceed that for the electricity businesses by 0.08 (0.42 versus 0.34), compared with an estimated difference of 0.03 in the earlier analysis by Lally (2016a, section 2.1). This would support retaining the beta differential of 0.10. Alternatively, if K, K_1 and K_2 all lie only 25% of the way from their base case values of 1 to their extreme values, then $K =$

1, K_1 = 1.10, and K_2 = 1.66, whereupon β_{RE} = 0.34 and therefore β_G = 0.38. So, the beta for the gas businesses would then exceed that for the electricity businesses by only 0.04 (0.38 versus 0.34), and this would *not* support the beta differential of 0.10.

The extent to which these parameters K, K_1 and K_2 lie between their base case values of 1 and their extreme values is denoted "theta" by HK. HK (2016, Table 6) shows that a value for "theta" of only 0.17 would be sufficient to produce a beta differential between gas and electricity businesses of 0.10. By contrast, in my analysis above, a value for "theta" of 0.62 would be required in order to achieve this result. This difference is due to the two errors in HK's analysis identified above. Nevertheless, in my analysis, a "theta" of 0.375 would be enough to yield a beta increment for the gas businesses of 0.06, which would support a differential of 0.10 when rounding to the nearest 0.10. So, notwithstanding HK's errors that lead them to significantly underestimate the "theta" value sufficient to warrant a beta differential between gas and electricity businesses of 0.10, it is still possible that 'theta" might be large enough to produce such a differential. So, the crucial issue here is the size of "theta", i.e., the extent to which differences in income elasticities of demand (adjusted for the proportion of revenues arising from variable charges) translate into differences in betas. Clearly, the relationship is positive, but less than proportional because other factors affect beta. Lally (2008, section 5.1) identifies the sensitivity of returns to real GDP shocks, inflation, changes in the long-term real risk-free rate, and market risk aversion as the crucial factors affecting beta, and HK's analysis relates to only the first of these sensitivities. Thus, even if the returns from gas businesses are much more sensitive to real GDP shocks than for electricity businesses (because the income elasticities of demand by their customers are much higher, adjusted for the proportion of revenues in the form of variable charges), this effect is diluted by these other three sensitivities, which are presumably similar for gas and electricity businesses. Furthermore, Lally (2008, section 5.1) identifies nine factors that could affect the sensitivity of returns to real GDP shocks, of which the first two (type of product and type of customer) relate to the income elasticity of demand and the third is the proportion of revenues in the form of variable charges. So, HK have dealt (comprehensively) with only the first three of nine factors affecting the sensitivity of returns to real GDP shocks, and this sensitivity is only one of the four types of sensitivities that underlie asset betas.

In respect of the factors that affect the sensitivity of returns to real GDP shocks that are not considered by HK, at least three may be significantly different for gas and electricity businesses: monopoly power, operating leverage, and the periods for which prices to customers and from suppliers are fixed. Without a similarly comprehensive analysis of these additional factors, HK's results in the last column of their Table 3 are not even indicative of the difference between gas and electricity businesses in their return sensitivities to GDP shocks, let alone betas. It might be suspected that the income elasticity of demand was the crucial factor in determining the sensitivity of returns to real GDP shocks, and therefore that the incremental effect of the other factors not considered by HK would not be substantial. However, HK's own data rebut this suspicion. To demonstrate this, suppose one thought that income elasticity of demand was the only factor relevant to beta. In this case, one would estimate the relative betas of the various customer groups using the income elasticity data in the first column of HK (2016, Table 5). So, K = 1.73, K_1 = 0.88 and K_2 = 4.67. In conjunction with equations (6) and (7), this implies that the beta of the gas businesses would be 0.43 and therefore 0.09 larger than that of the electricity businesses. If the proportion of revenues received in the form of variable charges were also recognised, the relevant data would then be that shown in the last column of HK (2016, Table 5).[18] So, K = 0.98, K_1 = 1.41 and K_2 = 3.65. In conjunction with equations (6) and (7), this implies that the beta of the gas businesses would be 0.50 and therefore 0.16 larger than the electricity businesses. Thus, the effect of allowing for the proportion of revenues received in the form of variable charges would be to boost the beta margin for gas over electricity businesses from 0.09 to 0.16. So, the effect of the variable charge proportion is almost as large as the effect of income elasticity of demand. Thus, the other factors affecting the sensitivity of returns to real GDP shocks (which are not considered by HK) could also be very substantial, and the effect could be in either direction.

Whilst the effect of this omission in HK's analysis could be in either direction, the effect of return sensitivities to shocks other than real GDP (which are also omitted from HK's analysis) would be to dilute the effect of return sensitivities to real GDP. To illustrate this point, suppose that market returns (R_m) would be 20% above or below expectation with equal probability, and such shocks could arise from changes in real GDP, the long-term real interest rate, inflation, and market risk aversion with equal likelihood. Furthermore, in respect of these same shocks, the returns from electricity businesses (R_E) are 5% above or below

[18] If the proportion of revenue in the form of variable charges is zero, real GDP shocks that raise demand for products would not increase a business's revenues and therefore the sensitivity of the business's returns to real GDP shocks would be zero.

expectation with equal probability for real GDP shocks and 8% above or below expectation with equal probability for the other three types of shocks. These results are shown in the first two columns of numbers in Table 4 below. Suppose also that the returns from gas businesses (R_G) are the same as for electricity businesses except that returns are 8% above or below expectation with equal probability for real GDP shocks, as shown in the last column of Table 4. So, the returns from gas businesses are much more sensitive to real GDP shocks. Using these possible returns, and recalling that beta is Cov(R, R_m)/Var(R_m), the beta for the electricity businesses would be 0.36 whilst that for the gas businesses would be 0.40. So, despite the sensitivity of gas business returns to real GDP shocks being 60% larger than for electricity businesses, their beta is only higher by 0.04 (11%). In HK's language, "theta" is only 0.11/0.60 = 0.18.

Table 4: Return Sensitivities for Electricity and Gas Businesses to Various Shocks

	R_m	R_E	R_G
Real GDP	.20	.05	.08
	-.20	-.05	-.08
Long-term Real Risk-Free Rate	.20	.08	.08
	-.20	-.08	-.08
Inflation	.20	.08	.08
	-.20	-.08	-.08
Market Risk Aversion	.20	.08	.08
	-.20	-.08	-.08

In summary, properly using the revenue data from HK, their estimates for the income elasticities of demand by the various customer types, and their estimates for the proportion of revenues in the form of variable charges, the extent to which beta differences would have to reflect differences in income elasticities of demand (adjusted by the proportion of revenues in the form of variable charges) in order to produce a beta differential between gas and electricity businesses of 0.10 is much greater than estimated in HK's analysis, and therefore HK's analysis is much less persuasive. Furthermore, because betas are affected by many factors in addition to the two considered by HK, it is impossible to reliably estimate the difference in the betas of gas and electricity businesses purely on the basis of the two factors considered by HK, and the effect of these two factors will be significantly diluted by other factors. HK's analysis is akin to attempting to estimate the height difference between two men based only on the height difference in their paternal grandfathers whilst ignoring all other relevant factors (the three other grandparents, diet, illnesses, etc). Thus, HK's analysis does not clearly support a beta margin for gas over electricity businesses of 0.10 (or even half of it).

NERA (2016, section 2) reviews European regulatory practice, finds that the average allowed asset beta for gas businesses exceeds that of electricity businesses, and that this is relevant to New Zealand. However, the most extensive evidence presented by NERA (2016, Table 2.2) reveals an average differential of only 0.04 and a median of zero. This does not support a differential of 0.10 for New Zealand.

NERA (2016, section 3) also reviews Australian regulatory practice, notes that the AER applies the same beta to both gas and electricity businesses, and that the AER mitigates stranding risk by providing for accelerated depreciation in the event of a significant fall in demand. NERA then argues that this mitigation measure is not available in New Zealand, and therefore supports a higher beta for gas relative to electricity businesses in New Zealand. However, NERA does not explain why stranding risk would be higher for gas nor does it attempt to quantify the beta impact of this alleged differential stranding risk. So, again, nothing here supports a differential of 0.10 for New Zealand.

CEG (2016a, section 2) argues that gas businesses have a smaller number of customers than electricity businesses and therefore, given a downward sloping average cost curve, are more exposed to a demand drop that induces stranding of the assets. Accordingly, they warrant a higher beta. However, the argument also presumes that the average cost curve of gas businesses is identical to that of electricity businesses, and CEG present no evidence on this matter. Furthermore, CEG does not present any evidence on the size of the effect.

CEG (2016a, section 3) argues that various technological developments pose a greater risk of stranding to gas businesses than electricity businesses. However such risks are not obviously systematic risks. Furthermore, CEG does not present any evidence on the size of the effect.

CEG (2016a, section 3) argues that the asset betas, credit ratings, and DRPs for a given credit rating, are higher for a range of foreign regulated gas businesses than electricity businesses. However, only the evidence on asset betas is directly relevant to the issue, and the differential is only 0.02 (CEG, 2016a, Table 3-3). So, even if the regulatory situations in these foreign markets were the same as in New Zealand, this evidence does not support a differential of 0.10 for New Zealand.

In summary, the new empirical evidence presented in these submissions does not support a higher beta for the gas pipeline businesses of 0.10 or even half of it. Furthermore, whilst revenue weights rather than volume weights for customer types should be used in assessing whether gas pipeline businesses warrant a higher beta, and account should be taken of the income elasticities of demand for gas and electricity by both residential and commercial customers, the effect of doing so does not clearly support a higher beta for the gas pipeline businesses of 0.10 or even half of it. Furthermore, in view of the uncertainty in estimating asset betas (Lally, 2008, Table 5, estimates the standard deviation on the estimate for US regulated utilities at 0.136), I do not consider that this parameter can be estimated to a higher degree of precision than 0.10. Accordingly, I do not favour a differential between gas pipeline and electricity businesses.

5. Review of Submissions on the TAMRP

CEG (2016b, section 4.1) notes that the Commission's TAMRP estimate of 7% is derived from Lally (2014b), and alleges that he introduced three new methods for estimating the TAMRP (Siegel version 1, Siegel version 2, and surveys), and that these produced the lowest estimates of the TAMRP. However, the claim that these methods were first used by me in 2014 is false. I have consistently used the results from surveys since first advising the Commission on this TAMRP issue in 2001 (Lally, 2001, section 5). In addition, I have consistently used results from Siegel version 1 in advising the Commission from 2003 (Lally, 2003, section 6.3), and my adoption of this approach in 2003 was motivated by the analysis in Lally and Marsden (2002). In addition, I have consistently used results from Siegel version 2 since 2013 (Lally, 2013a, section 5) and did so in response to arguments raised in submissions from experts commissioned by regulated businesses in Australia. Furthermore, at the time of doing so, this approach produced the highest results across the methods used

(Lally, 2013a, Table 3). Thus, CEG's suggestion that I have changed my views on this matter in 2014, and for the purpose of lowering the estimate of the TAMRP, is false.

CEG (2016b, section 4.1) argues that the methodology used in Lally (2015e) for estimating the TAMRP differs from that in Lally (2014e) in two respects, the effect of each is to reduce the estimate of the TAMRP, and these changes are not warranted. The first of these changes in methodology is the exclusion of imputation credits from the dividends. In particular, Lally (2014e, section 6.4) adopted CEG's (2014b) DGM estimate of the TAMRP, which involves adding the imputation credits to the dividends. By contrast, Lally (2015e, section 7.4) did not adopt CEG's DGM estimate of the TAMRP and defined the dividends within the DGM as the cash dividends only, consistent with the simplified version of the Brennan-Lally model that is used by the Commission. Within the latter model, dividends are defined to be only the cash component, imputation is therefore treated as a phenomenon that lowers the personal tax rate on dividends, and in particular lowers it to zero by assuming that all dividends receive imputation credits at the maximum rate and that all investors can fully use them. Coupled with the additional assumption that capital gains are tax free for all investors, the tax parameter on the dividend term within the TAMRP is zero and therefore that term disappears (see Lally, 1992, equation (2)). Thus, CEG's (2014b) inclusion of imputation credits within dividends in its application of the DGM for the purpose of estimating the TAMRP within the simplified Brennan-Lally version of the CAPM was wrong, and Lally's (2014b) acceptance of that estimate was therefore also wrong. Thus, rather than Lally (2015e) erring in failing to include these credits in the definition of dividends, thereby underestimating the TAMRP, it is Lally (2014b) and CEG (2014b) who err in including them, and the result was to overestimate the TAMRP estimate from the DGM in those papers. However, an examination of the TAMRP estimates in Lally (2014b, Table 5) reveals that the DGM estimate would not have changed the rounded median value (7.0%), which was used. The source of CEG's error may be the use of the Officer (1994) version of the CAPM by Australian regulators, and this model defines dividends to include imputation credits. Accordingly, applications of the DGM to estimate the MRP in the Officer model must include the credits within dividends, and both CEG and Lally have done so in the course of making submissions to Australian regulators or reviewing them. Thus, habit may have led to CEG (2014b) mistakenly including these credits within dividends when estimating the TAMRP for the simplified Brennan-Lally model, and Lally (2014b) then overlooking this error.

The second of these points is that Lally (2014b, section 6.5) uses the mean of the MRP responses across respondents whilst Lally (2015e, section 7.5) uses the median. The explanation for this subtle change in methodology is provided in Lally (ibid): use of the median mitigates the problem that some of the survey respondents may have offered frivolous responses or responses calculated to affect the result in a particular direction because they were aware of the use of the survey results by regulators. An example is the 25% response offered by at least one Australian respondent in 2013 (Fernandez et al, 2013, Table 2), thereby raising the mean Australian response from 5.7% to 6.8%. CEG offers no comment on this argument for using the median. A reasonable conclusion is that CEG does not disagree with this rationale for using the median. So, in summary, both changes in methodology in Lally (2015e) relative to Lally (2014b) are warranted and CEG provides no contrary argument in either case.

CEG (2016b, section 4.1) also argues that the recent fall in the risk-free rate should have raised the estimate of the TAMRP and therefore the fact that Lally's approach did not do so constitutes a deficiency in his approach. However, after correcting the DGM and Survey estimates in Lally (2014b, Table 5) for the issues raised in the previous two paragraphs above (to 6.2% and 7.1% respectively), two of the five estimators using New Zealand data rise by approximately 1% each (the DGM and Siegel version 2) and the median rises from 6.9% in 2014 to 7.1% in 2015 (Lally, 2015e, Table 4). It is the rounding process that leaves the estimate unchanged at 7.0%, and the merits or otherwise of rounding are a different issue (to be discussed in the next section). More importantly, CEG appears to hold the view that, if empirical results conflict with his prior views, the empirical results must be deficient. The appropriate and conventional view is instead to reconsider the prior view.

CEG (2016b, section 4.2.1) argues that Siegel version 1 should not be used and repeats a number of earlier arguments that have been addressed in Lally (2015e). Nevertheless, several new arguments are raised by them. Firstly, CEG argues that both the Ibbotson and Siegel version 1 are attempting to estimate the same thing (the average value for the TAMRP over time), one of these two approaches is better, and the better approach should be used rather than both of them. However, I consider that all five estimators considered in Lally (2015e) are attempting to estimate the *current* value of the TAMRP, all of them are imperfect, and therefore the results from all of them should be considered. The Ibbotson and Siegel version 1 approaches are also estimators of the average value for the TAMRP over time, but this is not inconsistent with them also being estimators for the current value of the TAMRP. By analogy, if the height of an individual is measured with considerable error and measurement errors are uncorrelated across individuals, the average height estimate across some sample of a population from which that individual is drawn is both a useful estimator of the height of any individual as well as being an (even better) estimate of the average height of that population.

Secondly, CEG (2016b, section 4.2.1) argues that, apart from Siegel version 1, there are other variations on the Ibbotson estimator and consistency would suggest that I should add them to my set of methodologies. By way of example, CEG suggests that results from the Ibbotson (and Siegel version 1) approaches be adjusted to reflect the higher liquidity of stocks at the present time. I agree that there are other variations on the Ibbotson estimator, Siegel version 2 is so, and I have included it amongst the approaches considered by me. However, I do not consider that other credible variants on the Ibbotson approach are available, and any adjustment for changes in liquidity over time would not be credible because there is too much uncertainty about the change in liquidity over time. Nevertheless, the higher liquidity of stocks at the present time implies that the TAMRP has fallen over time and therefore that the Ibbotson estimator is biased upwards. Furthermore, as will be discussed in the next section, there are a number of other issues of this type and they all point to the TAMRP having fallen over time, and therefore that the Ibbotson estimator is biased up relative to its current value. All of this strengthens the case for making an adjustment in the one situation in which it is possible to do so (Siegel version 1).

Thirdly, CEG (2016b, section 4.2.1) argues that application of the DGM requires various assumptions and therefore, consistent with using multiple variants on the Ibbotson methodology, I should use multiple DGM estimates. However the DGM variations that CEG is alluding to arise from uncertainties about parameter values within the DGM, such as the speed with which the short-run expected growth rates in DPS converge on the long-run rate. Such variations involve using the same formula and are therefore quite distinct from the variations on the Ibbotson approach, which involve different formulae. The DGM variations referred to are comparable to different methods for estimating the dividend yield on the market portfolio in the early years of the data used in the Ibbotson approach, when there may be considerable uncertainty about the correct value for this parameter.

Fourthly, and in relation to the question of whether investors underestimated inflation in the period used to determine the Ibbotson estimate (1931-2014), and therefore what the average expected real risk-free rate was during this period, Lally (2015e, section 7.3) estimates this at 3.5% *partly* on the basis of the average yield of 3.6% on New Zealand government inflation-protected bonds since their inception in 1996, and CEG (2016b, section 4.2.1) critiques use of this evidence because the latter period (20 years) represents only 25% of the entire period of concern (1931-2014). However, Lally's (2015e, section 7.3) estimate of 3.5% draws upon other sources of evidence precisely because these inflation-protected bonds have only been available since 1996, as explained in Lally and Marsden (2004, page 95). Thus, if one estimates a parameter in various ways because of limitations in each such approach, it is not a meaningful critique to merely recite a limitation in one source of evidence that has already been acknowledged.

Fifthly, and in relation to the same issue of using the average yield of 3.6% on New Zealand government inflation-protected bonds since their inception in 1996 to *assist* in estimating the average expected real-risk-free rate over the 1931-2014 period (on conventional government bonds), CEG (2016b, section 4.2.1) argues that these inflation-protected bonds have lower liquidity than conventional government bonds, this raises the real yield, and therefore use of such data on inflation-protected bonds would overestimate the expected real yield on conventional bonds. This is true. However, it is also true that the real yield on conventional bonds is uncertain (because inflation is uncertain), the same does not apply to inflation-protected bonds, and therefore use of the yield on the latter to estimate the expected real rate on conventional bonds is likely to underestimate the expected real yield on conventional bonds. Since the net effect of these forces is unclear, one cannot conclude that the use of real yields on inflation-protected bonds would impart a bias in the estimate of the average expected real-risk-free rate over the 1931-2014 period.

Sixthly, and in relation to the question of whether investors underestimated inflation over the period from 1931-2014, Lally (2014b, section 6.3) argues that this did occur by reference to the low real returns on conventional government bonds during this period. In response, CEG (2015c, Appendix D) cited a report by NERA (2013, pp. 21-22) that argues by reference to two US surveys of one-year ahead inflation expectations that there was no systematic tendency by US investors to underestimate or overestimate inflation (because the period up to 1980 in which inflation was underestimated was countered by the subsequent overestimation).

In response, Lally (2015e, page 15) argued that the risk-free rate data underlying the Siegel analysis in Lally (2014b, section 6.3) is for ten years, the relevant period for assessing inflation forecast errors is therefore ten years rather than the one year used in the two surveys, and an ability to (on average) accurately forecast inflation one year ahead would not be inconsistent with significant underestimation of inflation in ten-year forecasts, with Lally (2013a, section 2.12) providing an example of that type. In response, CEG (2016b, section 4.2.1) argues that the example does not demonstrate that this did occur and that, in the absence of any contrary information, the appropriate assumption is that investors did not err in their expectations. However, CEG's premise of no contrary information is false: there is contrary information on inflation expectations in the form of low real returns on conventional government bonds, as described in Lally (2014b, section 6.3; 2015, page 14). The evidence from NERA (2013, pp. 21-22) was intended to counter this evidence on low real returns on conventional government bonds, but the example in Lally (2013a, section 2.12) demonstrates that NERA's evidence is not relevant, thereby leaving unrebutted the evidence on low real returns.

Seventhly, CEG (2016b, section 4.2.1) argues that, since the Ibbotson estimate of the TAMRP measures returns over one year periods, forecast errors in estimating inflation over a ten-year period are irrelevant, the example in Lally (2013a, section 2.12) is therefore irrelevant, and therefore the evidence on inflation forecast errors in NERA (2013, pp. 21-22) is relevant. However, the period over which returns are measured in an Ibbotson estimate has no effect on the results; measuring returns over a month and then averaging would yield the same result as measuring them over a year and then averaging. The crucial issue is the term to maturity of the bonds used in the exercise and the yields on ten-year bonds are used. These ten-year yields reflect inflation expectations over a ten-year period. Accordingly, if expectations of ten-year inflation were on average too low over the period used to determine an Ibbotson estimate of the TAMRP, the estimate will be biased up.

Eighthly, in relation to the Fernandez et al (2015) survey cited by Lally (2015e, section 7.5), CEG (2016b, section 4.2.2) notes that the survey also asked respondents what risk-free rate they were using, that the rates were in excess of prevailing ten-year government bond rates (Fernandez et al, 2015, Table 8), and that Lally (2015e, section 7.5) neither mentions it nor makes any adjustment for this. This is true, but no adjustment is warranted for the following reasons. The typical respondent to the survey is likely to be using a risk-free rate and an

MRP estimate for valuing businesses with infinite-life cash flows and therefore would be interested in the prevailing term structure of risk-free rates for terms out to infinity.[19] Furthermore, typical practice amongst valuers is to use a single risk-free rate, which must then average over the term structure. Since the term structure was markedly upward sloping at the time of the survey (and still is), the average rate invoked by the valuers over the entire term structure would have to be in excess of the ten-year rate. For example, the prevailing 10, 20, and 30 year US Treasury Bond yields at the time of the survey (March-April 2015) were 2.0%, 2.4%, and 2.6% respectively.[20] Thus, the average risk-free rate used by US respondents at that time of 2.4% (Fernandez et al, 2015, Table 8) corresponds to the prevailing 20-year rate. Accordingly, the MRP estimate could be interpreted to be that for a 20-year term, and this raises the question of whether any adjustment is required to provide an estimate for a ten-year term. CEG (2016b, section 4.4) considers that an offsetting increase should be made to the TAMRP. Clearly, if a respondent's cost of equity at a given point in time were the same for all future terms (i.e., a flat term structure), then variations in risk-free rates over the term structure would imply perfectly offsetting variations in the MRP over the term structure, in line with CEG's recommendation. However, it is not plausible that the term structure for the MRP would be related to that of the risk-free rate in this way, because the MRP is an allowance for risk and the risk-free rate is the time value of money. Thus, the fact that the respondents in the Fernandez et al (2015) survey used risk-free rates in excess of prevailing ten-year rates does not warrant any adjustment to the MRP estimates provided by those respondents.

Ninthly, and again in relation to the Fernandez et al (2015) survey cited by Lally (2015e, section 7.5), CEG (2016b, section 4.2.2) argues that the survey question is insufficiently precise to ensure that respondents would answer it in the intended fashion. In support of this point, CEG also note four alternative definitions of the equity premium that are referred to by Fernandez et al (2015). The point of doing so is presumably to suggest that some respondents might have answered the survey question with one of these alternative definitions in mind. However the wording of the survey question corresponds to only one of these alternative definitions of the "equity premium", the precision with which Fernandez et

[19] Brotherson et al (2013) survey a range of practitioners in the US, where government bonds with maturities up to 30 years exist, and enquired into the risk free rates used for DCF purposes. The shortest maturity bonds used were ten-year bonds and many practitioners used 30-year bonds (ibid, Table 2).

[20] Data from the Federal Reserve Bank of St Louis constant-maturity series (https://research.stlouisfed.org/fred2).

al frame their question was clearly driven by their concerns over ambiguities in this area, and the alternative definitions were presented by them to illustrate the need for the very clarity exercised by them in framing their question. Thus, CEG's citing of these alternative definitions in support of their claim that the question is still ambiguous is perverse.

Tenthly, and in relation to CEG's (2015c, Appendix D) recommendations relating to alternative approaches to estimating the TAMRP, involving favouring exclusive use of the DGM, use of the DGM and Siegel version 2 if multiple estimators were to be used by the Commission, and the Ibbotson estimator over Siegel version 1 if at least one of them were to be used by the Commission, Lally (2015e, section 5) observes that the recommendations appear to be driven by the outcomes from these methods rather than their "inherent methods" (the phrase should have been "inherent merits"). In response, CEG (2016b, section 4.3) claims that their position on this issue has been consistent across time and jurisdictions, and cites a 2013 submission to the AER in which they also favoured exclusive use of the DGM for Australia. However, across the same five methods considered in Lally (2015e), the DGM would also have yielded the highest value in Australia in 2013 (Lally, 2013a, Table 3). Thus, CEG's favouring exclusive use of the DGM in both Australia in 2013 and New Zealand in 2015 does not demonstrate that they choose a method in accordance with its inherent merits rather than because it produces the highest outcome. By contrast, in a 2010 submission to the Commission, CEG (2010, section 2.4) argues that the Commission's estimate of the TAMRP is too low, but by reference to estimates of the volatility of equity returns and the debt risk premium on BBB relative to AAA bonds rather than by reference to the DGM. This represents a considerable difference in approach, and contradicts CEG's claim that their position on the best means of estimating the TAMRP has not changed over time.

Eleventhly, and again in relation to Lally's (2015e, section 4.3) suggestion that CEG's (2015c, Appendix D) recommendations relating to alternative approaches to estimating the TAMRP appear to be driven by the outcomes from these methods rather than their inherent merits, CEG (2016b, section 4.3) claims that they recommended a lower weight for survey results than the Ibbotson method despite survey results being higher, which contradicts my suggestion about their motivation. However, CEG's claim is not correct; they did not recommend a lower weight for survey results than the Ibbotson method, and instead recommended zero weight for both of them (CEG, 2015c, Appendix D). CEG's (2015c, Appendix D) recommendations in toto were for exclusive use of the DGM, use of the DGM and Siegel version 2 if multiple methods were to be used by the Commission, and use of the Ibbotson method rather than Siegel version 1 if at least one of them were to be used by the Commission. These recommendations imply that CEG ranks the DGM first, Siegel version 2 second, and Ibbotson over Siegel version 1. These rankings correspond to the relative values of the TAMRP estimates favoured by CEG (2015c, Table 20), leading to the (reasonable) suggestion in Lally (2015e, section 5) that CEG's recommendations were driven by the methods' outcomes rather than their inherent merits.

Twelvethly, and in relation to my claim that CEG's rankings described in the last paragraph would occur by chance with a probability of only 2.5%, CEG (2016b, section 4.3) argues that this calculation assumes that the methods have equal merit in which case all possible rankings would be equally valid. However, my calculation does not assume that all methods having equal merit and instead merely assumes that all methods have equal chance of being chosen for a particular ranking position. Since the probability of ranking the method with the highest result first (by chance), and ranking the method with the second highest result second (by chance), and ranking Ibbotson above Siegel version 1 when its outcome is higher (by chance), has a probability of only 2.5%, this strongly suggests that these (CEG) rankings are driven by their outcomes rather than inherent merit. Of course, it is possible that CEG genuinely believes that the DGM is the best method, and Siegel version 2 is the second best, and Ibbotson is better than Siegel version 1, but the perfect correspondence between CEG's rankings and their relative outcomes invites scepticism, and the calculation is merely a means of assisting in forming a conclusion here. Similarly, if five people (one per country) were asked to choose the best national soccer team, and each chooses their home country's team, one could reasonably suspect that the choices were driven by chauvinism. To assist in this matter, one might calculate the probability that the choices matched the home country by chance, which would be (.2)^5 = 0.00032, i.e., one chance in 3,125. In both cases, the calculation is merely a means of assessing whether the choices are likely to be chauvinistic or self-interested.

In summary, I agree with some of the points raised by CEG (2016b) but I do not agree that the TAMRP estimate should be higher or that a different approach to estimating this parameter should be adopted. The most significant point of difference between me and CEG is that they favour exclusive weight on the results from the DGM whilst I favour equal weighting over the results of five methodologies including the DGM. The result of equal weighting on these five methodologies will be an estimate of the TAMRP that is likely to have significantly smaller estimation errors than that from exclusive weight on the DGM. A policy of exclusive weight on the DGM would only be appropriate if this methodology was significantly superior to all alternatives, and I do not think that this is the case.

Frontier (2016, sections 2.1, 2.2, 2.3) argues that the TAMRP has significantly varied over time (based principally upon its belief about changes in market volatility) whilst the Commission's estimate has varied little over time, implying that the Commission's estimate has varied too little over time. However, this effectively involves estimating the TAMRP on the basis of one methodology (using market volatility) without even specifying the details of that methodology or its result. Furthermore, when choosing appropriate estimators of the TAMRP, Frontier does not include that methodology in its set of TAMRP estimators, thereby revealing how little confidence Frontier has in such an approach. Furthermore, even if one were very confident that the TAMRP had moved more over time than the Commission's estimate, this would not be sufficient to reject the Commission's approach; it would be also necessary to present a superior approach and this would require being able to quantify the change in the TAMRP over time more reliably than the Commission's approach. I share Frontier's view that the TAMRP has *probably* moved over time by more than the Commission's estimate (which is my own) but do not believe that this additional movement can be reliably estimated.

Frontier (2016, section 2.5.1) argues that the Commission's use of a set of equally-weighted estimators in which the majority of them cannot respond quickly to changing market conditions is undesirable because the resulting estimate of the TAMRP will not respond quickly to changing market conditions. However, Frontier includes surveys amongst this group that cannot respond quickly to changing market conditions, purely on the basis that they have moved slowly in recent years rather than because they are bound to do so, which is not the case. So, Frontier are essentially criticising an estimator (surveys) on the basis of its outcome rather than its inherent properties, which is simply self-interested. In respect of the issue of equally weighting estimators, Frontier subsequently provides more explicit comments on the use of time-varying weights over estimators, and these views are discussed below.

Frontier (2016, section 2.5.1) argues that a median across different TAMRP estimates is undesirable because the most reliable approach when the TAMRP is high (the DGM) exerts little effect on the median. This is less a complaint about the use of the median than a belief that the DGM warrants primary weight, this argument is explicitly raised later by Frontier (2016, section 2.6.4), and addressed below.

Frontier (2016, section 2.5.2) argues that there is no sound economic or regulatory rationale for the Commission's practice of rounding its estimate of the TAMRP to the nearest 0.5%. I do not agree. Rounding does add to the errors in estimating the TAMRP, but the increase is trivial when rounding to 0.50%. In the example examined by Lally (2012, section 5), rounding to 0.50% raised the mean squared error of the estimate by only 0.01%, from 0.87% to 0.88%. However, rounding saves regulators from the need (and hence the cost) to estimate the TAMRP to a very high degree of precision and this is desirable because high levels of precision in this area are spurious. For example, a claim that the TAMRP is 7.1% rather than 7.2% would be spurious precision. A consequence of rounding would be to discourage self-interested lobbying by regulated businesses or consumer groups over small variations in the TAMRP estimate. These advantages outweigh the disadvantage of a very small increase in the mean squared error. Accordingly, I favour rounding to at least 0.5%.

Frontier (2016, section 2.6.3) argues that the Siegel version 1 method should not be used, for a number of reasons as follows. Firstly, Frontier argues that it is just a variant of the Ibbotson estimator and therefore should not be used. It is true in that there is significant commonality in the data used in both estimators (both use the historical average returns on equity), but the same is true of Siegel version 2 which Frontier supports. Despite this significant commonality in data, they have each produced significantly different estimates of the TAMRP. There are only two completely distinct estimators: Ibbotson and the DGM. Thus, if one seeks a larger set of estimators, which is desirable in my view, the rest will have to be variants of one or both of the Ibbotson and DGM estimators.

Secondly, Frontier argues that Siegel (2011) has abandoned his earlier belief about unanticipated inflation in the late 20th century (that it reduced real yields on conventional government bonds, that this induced an overestimate of the MRP, and that this will not persist into the future), due to the post 1999 decline in real yields on inflation-protected government bonds, and that this undercuts the merits of Siegel version 1. However, Frontier is conflating two distinct issues: whether unanticipated inflation in the late 20th century temporarily boosted the Ibbotson estimate of the MRP, and the issue of the best MRP estimator. Nothing in Siegel (2011) contradicts Siegel's (1992, 1999) view that unanticipated inflation did occur. Frontier (2016, page 24) quotes from Siegel (2011, page 144), seemingly to the contrary, but Siegel here refers to his prediction in 2001 that real yields on Treasury inflation-protected securities (TIPS) would remain at 3-4% based on their then current yield rather than on a consideration of past real yields on conventional government bonds, because he believed the latter were biased down by unanticipated inflation. So, at this point, Siegel is merely explaining the rationale for his earlier forecast of the TIPS yield rather than renouncing his belief that unanticipated inflation occurred during the late 20th century. The more important issue here is instead how one responds to the inflation shock that did occur. Siegel's (1992, 1999) response to that shock was to argue for the estimator denoted Siegel version 2, and Siegel (2011) continues to estimate the MRP in this way. In 1999, this led him to an MRP estimate below that of Ibbotson. By 2011, this estimator produces an estimate above that of the Ibbotson estimator (Siegel, 2011, page 147), due to the significant post 1999 decline in the real yields on government bonds, and this is the change in Siegel's views to which Frontier refers. However, an alternative response to the inflation shock in the late 20th century is the estimator denoted Siegel version 1, as presented by Lally and Marsden (2004). In 1999, this estimator produced a lower MRP estimate than the Ibbotson estimator, and continues to do so because it does not use the current real yield on government bonds; it simply corrects the Ibbotson estimate for the upward impact of an unanticipated historical event. Thus, in referring to the change in Siegel's views about the MRP from 1999 to 2011, Frontier are simply referring to the uncontroversial change over that period in the MRP estimates from Siegel version 2, and nothing in this change in estimates undercuts the merits of Siegel version 1.

Thirdly, Frontier argues that there are many alternative explanations for the low real yields on conventional government bonds during the late 20th century observed by Siegel (1999). These include explanations offered by Siegel (2011, page 144) for the post 2007 drop in real yields: the aging of the population and the shock associated with the GFC. However, since these are possible explanations for events *after* 2007, neither could explain the negative real yields in the late 20th century that Siegel (1992, 1999) attributed to unanticipated inflation. The other explanations offered by Frontier are those offered by Siegel (1992, pp. 36-37): the legacy of fear from the Great Depression, interest rate controls from WWII till the 1980s, redistributive government policies after the Great Depression, and increased liquidity in the market for government bonds. However, none of these phenomena could explain the negative real returns that arose during the late 20th century, with Siegel (2011, Table 1) reporting an average of -3.9% on bonds for 1966-1981. So, at most, these additional factors could only have added to the outcome. Furthermore, amongst these additional explanations, the first two (like unanticipated inflation) were temporary and therefore reinforce the conclusion that low real yields on bonds in the late 20th century were temporary, leading to an upward but temporary effect on the estimated MRP, thereby justifying a downward adjustment to the Ibbotson estimate.

Fourthly, Frontier argues that many unanticipated events occurred in the past and therefore adjusting for only one of them (unanticipated inflation) is unwarranted. In support of this, Frontier points to increasing market integration raising the risk of systemic failures, which warrants an increased MRP, and therefore past returns would underestimate the future MRP. However, Frontier provides no evidence that integration has raised risk in individual markets. Furthermore, the MRP in each market is a reward for bearing volatility, the volatility on the world portfolio is less than that of the average market in isolation (due to imperfect correlation between markets), integration leads to investors holding portfolios that are more internationally diversified, and hence lower volatility, which would therefore warrant reduced MRPs. Accordingly, past returns would tend to overestimate rather than underestimate the future MRPs. Furthermore, as integration proceeded and thereby lowered MRPs, there would be a one-off upward impact on stock prices, thereby further raising the Ibbotson estimate of the MRP relative to the post-integration value. For example, suppose pre-integration that the risk-free rate is 4%, the MRP is 6%, and the expected growth rate in dividends is 5%. Using a constant growth rate model, this implies a price per $1 of dividends of $21 as follows:

$$P = \frac{\$1(1.05)}{(.04+.06)-.05} = \$21$$

If integration lowers the MRP from 6% to 4.5%, the price per $1 of current dividends rises to $30, which represents a capital gain of 43%. With 80 years of data used to determine the Ibbotson estimate of the MRP, this capital gain raises the Ibbotson estimate by 0.5% per year. Thus, pre-integration data would be biased upwards in estimating the new MRP by 1.5% per year exclusive of the price impact of the switch to integration, plus a further 0.5% due to the price impact, for a total of 2.0%. Thus the price impact would significantly add to the upward bias in the Ibbotson estimate resulting from market integration, and even Frontier (2016, pp. 19-20) recognises this perverse feature of the Ibbotson estimator. However it is not possible to quantify this integration effect to an acceptable degree of precision.

Frontier also argues that investors in the 1920s could not have anticipated the subsequent growth in asset values due to subsequent technological developments, implying that past returns would overestimate the MRP. However, although investors could not anticipate the specific technological developments that did occur, a series of dramatic technological developments had already occurred by the 1920s, including the mechanisation of many previously labour-intensive tasks, railways, steamships, electricity, and internal combustion engines. Thus, investors in the 1920s were well primed to expect further technological developments and therefore there are no good grounds to believe that they would have been surprised by the extent (as opposed to the specific details) of subsequent technological developments. Further examples of unexpected events, not mentioned by Frontier, are the growth of mutual funds, which reduced the costs of forming well diversified portfolios, increased macroeconomic stability, and increased liquidity in equity markets, all of which would have reduced MRPs. Again, it is not possible to quantify any of these effects to an acceptable degree of precision. Nevertheless, in all of these cases along with market integration and unanticipated inflation, past returns would have produced an upward bias in estimating the future MRP by the Ibbotson method, and no contrary case is apparent. Thus, the downward adjustment to the Ibbotson MRP embodied in Siegel version 1 to reflect unanticipated inflation is likely to understate the scale of the total adjustment required for all of these unanticipated events. This reinforces the case for Siegel version 1 (as the only case in which the effect can be reliably estimated) rather than undercuts it.

Fifthly, Frontier argues that the correction to the Ibbotson estimate to account for unanticipated inflation is overstated because it does not allow for the illiquidity premium in inflation-indexed bonds relative to conventional government bonds. This argument replicates that in CEG (2016b, section 4.2.1), as discussed in the previous section, and therefore requires no additional comment here.

Frontier (2016, section 2.6.5) argues that the surveys used by Lally (2014b, 2015e) are so unreliable that they should be given only very low weight, for a number of reasons. One such reason is that the survey results (from Fernandez et al, 2013, 2015) are significantly less variable over time than for other methods (such as the DGM), and this suggests that the survey respondents are "…using outdated information to inform their responses, are displaying inertia for other reasons, or have misinterpreted the questions being asked." However, it may be that respondents consider that the highly variable results from estimators such as the DGM are insufficiently reliable to warrant much weight, or weight them equally with a set of more stable estimates such as Ibbotson, and therefore do not change their estimates as much as those arising from the DGM. If so, their behaviour would not be irrational. Frontier's other reasons for rejecting the survey results comprise lack of clarity over the term for which respondents are providing an MRP estimate, whether the response relates to the MRP or the TAMRP, the sample size, and the lack of clarity over the expertise of the respondents. In these respects, I agree that the surveys are sub-optimal. However, it does not follow that they should be jettisoned. Such a judgement also requires an assessment of the merits of the alternatives. For example, in respect of the Ibbotson estimator using New Zealand data, the standard error of the estimate is about 2.6%, and therefore the 95% confidence interval on the estimate is about ±5.2%.[21] With a point estimate for the TAMRP of about 7% (Lally, 2015e, Table 4), this confidence interval is from about 2% to 12%, and this is disturbingly large. So, the Ibbotson estimator is also highly imperfect. In respect of the DGM, implementation of it requires judgements about the long-run expected growth rate in dividends per share and the speed with which estimates of the short-run growth rate in this parameter converges to the long-run rate, there is considerable uncertainty about the values for these parameters, and therefore considerable uncertainty about the DGM estimate for the TAMRP. In addition, as discussed in Lally (2013b, section 10), the DGM is prone to errors in the presence of short-term fluctuations in the market's earnings retention rate and also to long-term changes in the market's earnings retention rate. In addition, as discussed in Lally (2013b, section 4), the DGM is likely to be biased when assuming (as is generally done) that the cost of equity is the same for all future years. More generally, all estimators of the TAMRP are highly imperfect and it is not apparent that the imperfections in the survey estimate are more or less than the others. Accordingly, equal weight on these estimators is warranted.

[21] The estimate for the standard error follows Lally (2008, footnote 7) with 84 years of data (1931-2014) rather than 74 years.

Frontier (2016, section 2.6.4) argues that the DGM is most likely to reflect prevailing market conditions (because it is entirely forward-looking), that it has also produced plausible estimates of the MRP in Australia, and therefore should be given primary weight. However, the purpose of this exercise is to obtain the 'best' estimator of the TAMRP, and 'best' is usually defined as minimum mean squared error (Ferguson, 1967, page 11). Frontier's comments about the DGM imply a belief that it produces an unbiased estimator under all conditions, which is a desirable property. However, as discussed in Lally (2013b, section 4), the DGM is likely to be biased when assuming (as is generally done) that the cost of equity is the same for all future years. Furthermore, even if it were unbiased, as shown in Lally (2014b, section 5), this characteristic does not imply that the estimator warrants primary weight because many alternative estimators have low correlation with the DGM and low correlation would support significant weight on these alternatives even if they are biased. Frontier is presumably aware of this argument in Lally (2014b), because they cite this paper, but fail to address it.

Frontier (2016, section 2.6.2) also argues that weight should be given to both the Ibbotson and Siegel version 2 estimators, with the weights depending upon prevailing market conditions. At this point, Frontier provides only an example of these conditions, in the form of applying more weight to Siegel version 2 in the face of a "flight to quality" (increased risk aversion), presumably because it is more likely to be accurate under such circumstances. Subsequently, Frontier (2016, section 2.7) presents a detailed approach to implementing time-varying weights on different estimates of the TAMRP. This involves estimating the TAMRP using only current market data, estimating the TAMRP using only long-run historical averages, determining the value for an uncertainty index (using the prevailing volatility of equities, prevailing credit spreads, etc), choosing the midpoint of the two TAMRP estimates if the uncertainty index is within one standard deviation of its long-term average, and otherwise deviating from the TAMRP midpoint in accordance with the value of the uncertainty index. Applied to the five estimators used by the Commission, this would involve estimating the TAMRP using the DGM and the Ibbotson method, with no role for Siegel version 2, and weighting the DGM and Ibbotson methods in accordance with the value of the uncertainty index. However, this contradicts Frontier's view that the DGM warrants primary weight and that time-varying weights should apply to only the Ibbotson and Siegel version 2 estimators. Subsequently, in discussing the application of time-varying weights to both the Ibbotson and Siegel version 2 estimators, Frontier (2016, section 2.8) argues for more weight on Siegel version 2 if there is "extraneous evidence that the total return on equity required by investors is similar to the historical average" and less weight if there is "extraneous evidence that shows that risk premiums have increased relative to historical average levels." This approach also contradicts that in Frontier (2016, section 2.7) and it is not accompanied by any advice on how one would decide which of the two scenarios prevails. For the latter reason, it does not warrant further consideration.

Of these three contradictory approaches to changing weightings on estimators described in the last paragraph, the second is sufficiently detailed that it can at least be assessed on its own merits. It involves using only the DGM and the Ibbotson estimators, taking the midpoint of them in most cases (because most outcomes of any distribution will lie within one standard deviation), and (presumably) tilting towards the DGM in other cases (when the uncertainty index is unusually high or low).[22] In addition, the uncertainty index is likely to be low when the DGM is low and high when the DGM is high.[23] Furthermore, the index is likely to be markedly skewed to the right and therefore most of the situations in which the index value is materially beyond one standard deviation will be when the index value is very high and the incidence of this will be very low.[24] So, virtually all of the time (when the index value does not materially exceed one standard deviation), the result of this approach would be a simple average of the DGM and Ibbotson estimators, and this is likely to produce an inferior result (higher mean squared error) to that currently obtained by the Commission because three of the five estimators used by the Commission have been abandoned. Furthermore, on the rare contrary occasions (typically when the uncertainty index is materially above one standard deviation), the resulting TAMRP estimate will exceed that from a simple average of the two

[22] This is consistent with Frontier's (2016, Table 4) statement that the weight on the DGM should be raised when market conditions are unusual.

[23] For example, Frontier (2016, Figure 8) reveals that the highest and lowest values for the AER's DGM estimates for Australia were in December 2008 and June 2007 respectively. At these same points, the BBB credit spread against CGS for five-year bonds was close to its highest and lowest levels respectively, at 9.11% (compared to a highest value of 9.41%) and 1.04% (compared to a lowest value of 0.90%): see Table F3 on the Reserve Bank of Australia's website (http://www.rba.gov.au/statistics/tables/#interest-rates).

[24] For example, in respect of the BBB credit spread against CGS for five-year bonds, the average and standard deviation over the period for which the RBA reports the results (January 2005 to February 2016) is 2.48% and 1.43% respectively (see Table F3 on the RBA's website: http://www.rba.gov.au/statistics/tables/#interest-rates). So, outcomes beyond one standard deviation are those below 1.05% and above 3.91%. There are 19 months in which the outcome is below 1.05% but the extent of this is trivial (the lowest of these outcomes is only 0.15% below 1.05% and the average of these shortfalls is only 0.10%). By contrast, there are 8 months in which the outcome is above 3.91%, and these exceed 3.91% by 2.85% on average. Furthermore, these 8 cases represent only 6% of all outcomes.

estimators used. Assuming (reasonably) that both the DGM and Ibbotson estimates are unbiased (across states in aggregate), and therefore that a simple average of them would also be unbiased (across states in aggregate), varying from this simple average only when the outcome would exceed the simple average will impart an upward bias to the TAMRP estimate, and this is undesirable. So, the deviation from the simple average is undesirable and the simple average (of the DGM and Ibbotson estimators) is inferior to the Commission's use of five equally-weighted estimators. Accordingly, Frontier's proposed approach to estimating the TAMRP would be inferior to that used by the Commission.

In summary, I agree with some of the points raised by CEG and Frontier but I do not agree that the TAMRP estimate should be higher or that a different approach to estimating this parameter should be adopted. The most significant point of difference between me and both CEG and Frontier is that they favour exclusive or primary weight on the results from the DGM whilst I favour equal weighting over the results of five methodologies including the DGM. The result of equal weighting on these five methodologies will be an estimate of the TAMRP that is likely to have smaller estimation errors than that from exclusive or primary weight on the DGM. A policy of exclusive or primary weight on the DGM would only be applicable if this methodology was significantly superior to all alternatives, and I do not think that this is the case.

6. Conclusions

This paper has examined a number of issues relating to the WACC of regulated businesses, and the principal conclusions are as follows.

Firstly, and in relation to the cost of debt, recent analysis strengthens the case for the Commission's continued use of the on-the-day regime. In particular, imperfections in the process by which businesses subject to the on-the-day regime hedge the risk-free rate component of their cost of debt (a regulatory window for averaging the risk-free rate that is shorter than firms require for hedging, and the use of the swap rate to hedge the government bond rate) have been shown to be inconsequential. This strengthens the case for regulatory use of the prevailing risk-free rate. In addition, although mismatches between the DRP allowed under the on-the-day regime and the trailing average DRP that is incurred by firms gives rise to violations of the NPV = 0 principle and bankruptcy risk, the mismatch also partly offsets likely MRP estimation errors. This strengthens the case for regulatory use of the prevailing DRP. In addition, violations of the NPV = 0 principle are much more severe with regulatory use of a trailing average regime than the on-the-day regime, for both the initial investment and subsequent capex (even with annual updating of the allowances). This also strengthens the case for regulatory use of the prevailing risk-free rate.

Secondly, although there are differences between Australia and New Zealand, the conclusions reached by me earlier in relation to the cost of debt for regulated businesses in Australia apply equally to New Zealand. In particular, the viability of regulated businesses hedging the risk-free rate component of the cost of debt (via interest rate swap contracts) depends upon the size of that swap market relative to the aggregate debt of the regulated sector, and this ratio *may* be lower in New Zealand than in Australia. However, even if this were true, the problem could be addressed by firms expanding the period over which the swap transactions were undertaken with little additional risk and any additional risk from doing so could be mitigated or even neutralised by the regulator widening the window over which it averaged the risk-free rate. In addition, there is a potentially significant point of difference in the regulatory processes in the two countries in the form of a Customised Price Path (CPP) in New Zealand, in which some regulated businesses can apply for a new price cap at the time of undertaking new investment, and the new WACC would also apply to the business's existing assets. This reduces the value from more frequent WACC or cost of debt resets. However, to date, there has been only one CPP application (by Orion). Thus, the option to apply for a CPP would seem to have only limited value in raising the frequency of WACC resets.

Thirdly, a variety of different regulatory regimes apply in New Zealand including a five-year revenue cap for Transpower (IPP), a five-year price cap applied to most electricity and gas distribution businesses (DPP), a CPP available to a business subject to a DPP, and Information Disclosure (ID) applied to Transpower, all electricity and gas distribution businesses, and airports, and involving reporting of the rate of return and the Commission's WACC estimate. As noted in the previous paragraph, the option to seek a CPP reduces the value from more frequent WACC or cost of debt resets, but only marginally. In addition, the argument for a trailing average risk-free rate being used by a regulator is moderately greater in the case of an ID regime relative to an IPP, DPP or CPP regime. This occurs because regulatory use of the trailing average risk-free rate reduces differences between the regulatory WACC and the business's actual rate of return, thereby reducing false signals of monopoly pricing. However, there are many other sources of false signals of monopoly pricing and a sensible regulatory reaction to this would be to consider differences between the rate of return and the regulatory WACC assessment over a protracted period. Accordingly, the superiority of a trailing average over the on-the-day regime for ID purposes is not a substantial point.

Fourthly, if a trailing average cost of debt regime is applied, it should be limited to the debt risk premium (DRP). In addition, it should be a seven-year trailing average (to match the average term for which firms borrow) with annual updating, the QTC's approach to dealing with capex should be adopted, a transitional scheme should be adopted that avoids the use of historical data, and this transitional scheme should also have the property that no large one-off gain or loss occurs to regulated businesses in general.

Fifthly, three possible modifications to the current on-the-day regime for the cost of debt should be considered. The first is to reset the DRP annually rather than five-yearly, which would significantly reduce the violations of the NPV = 0 principle in the case of capex but worsen them in the case of the initial investment. The second is to widen the window over which the risk-free rate is averaged by the Commission in recognition of the fact that firms may need to use the wider window to undertake interest rate swap contracts without exposing themselves to less favourable prices. The third is to widen the window over which both the risk-free rate and the DRP are averaged, in order to reduce volatility in output prices over time. These modifications would not add to the administrative costs of the regulatory process.

Sixthly, both annual resetting of the cost of debt and use of a trailing average reduce the incentive problems arising from CPPs. However, with the exception of capex that was provided for under the DPP but which takes place from the time of the CPP until the next reset under the DPP, a superior approach is to apply the new WACC to the CPP capex and the old WACC to the existing assets. The advantage of annual resetting and the use of a trailing average in reducing incentive problems here is then quite limited.

Seventhly, the Commission's use of the Term Credit Spread Differential (TCSD) is not inconsistent with regulatory use of a trailing average. A TCSD could be coupled with a trailing average but would suffer from the same disadvantage as it does when applied to the prevailing rate: it is a cost-based scheme that would incite firms to lengthen their borrowing term.

Eighthly, policy reversals incur administrative costs and may also inflict large one-off gains or losses on to regulated businesses. The administrative costs would be in addition to those incurred for the first policy change and the gains or losses to businesses from transitional processes could offset or aggravate those incurred in the first policy change. So, policy changes should not be undertaken lightly.

Ninthly, in relation to the Commission's treatment of inflation, neither its RAB indexation approach nor its price path adjustment violate the NPV = 0 principle. In addition the collective effect of these two adjustments is to preserve both the real output price paid by consumers and that received by the shareholders of the businesses. The only downside is to expose the businesses to some additional bankruptcy risk, but this would be slight. Finally, there appears to be a design error in dealing with inflation forecasting errors arising from opex.

Tenthly, in respect of the Commission's inflation adjustments that protect the real payoffs received by businesses and maintain the output price in real terms, CEG's preference for maintaining at least part of the payoffs in nominal terms because interest payments are fixed in nominal terms protects shareholders against a minor risk and ignores the preferences of customers for prices that are stable in real terms. In addition, CEG's recommendation to forecast inflation from the difference between the yields on nominal and inflation-indexed bonds suffers from the significant disadvantage that this difference in yields is affected by two additional factors, and therefore does not warrant substitution for the Reserve Bank's forecasts.

Eleventhly, in respect of recent submissions on the Commission's current asset beta adjustment of 0.10 for gas pipeline over electricity businesses, the empirical evidence presented in these submissions does not support a higher beta for the gas pipeline businesses of 0.10 or even half of it. Furthermore, whilst revenue weights rather than volume weights for customer types should be used in assessing whether gas pipeline businesses warrant a higher beta, and account should be taken of the income elasticities of demand for gas and electricity by both residential and commercial customers, the effect of doing so does not clearly support a higher beta for the gas pipeline businesses of 0.10 or even half of it. Since 0.10 is the minimum unit of measure for estimating asset betas, I do not favour a differential between gas pipeline and electricity businesses.

Finally, in respect of recent submissions from CEG and Frontier Economics in relation to the TAMRP, although I agree with some of the points raised in these submissions, I do not agree that the TAMRP estimate should be higher or that a different approach to estimating this parameter should be adopted. The most significant point of difference between me and both CEG and Frontier is that they favour exclusive or primary weight on the results from the DGM whilst I favour equal weighting over the results of five methodologies including the DGM. The result of equal weighting on these five methodologies will be an estimate of the TAMRP that is likely to have smaller estimation errors than that from exclusive or primary weight on the DGM. A policy of exclusive or primary weight on the DGM would only be applicable if this methodology was significantly superior to all alternatives, and I do not think that this is the case.

APPENDIX: Violations of the NPV = 0 Principle

This Appendix provides the details underlying the results presented in Table 1. The methodology follows Lally (2015b, section 2.2).

1: Initial investment and the on-the-day regime with five-yearly resetting. The potential for a violation of the NPV = 0 principle is greatest when the prevailing DRP is most extreme, because this will maximise the expected drift back towards the long-run DRP. So, using the monthly US DRP data from 1953-2014 described in Lally (2015b, section 2.2), the 95th percentile of the DRP values is 3.20%, corresponding to Dec 1974. Lally (ibid) also uses the following mean-reverting model of the DRP to estimate the expected DRP for subsequent months (estimated from the data):

$$DRP_1 = DRP_0 + .0235(.0192 - DRP_0) \tag{8}$$

This model produces an expected DRP in five years of 2.2%. The same model is used to produce expected DRPs at intervals of one year and therefore the expected borrowing costs for a firm shifting towards staggered ten-year borrowing. For example, the expected DRP in one year is 2.88%. So, assuming the same DRP for all terms to maturity, the firm would pay 3.2% during the first year for its debt (10% with a one year term, 10% with a two year term, etc) and, upon rolling over the one-year debt into ten-year debt at the end of the first year, would have an expected DRP for the second year of 3.17% as follows:

$$DRP = .1(.0288) + .9(.032) = .0317$$

So, assuming leverage of 40%, a corporate tax rate of 28%, a discount rate of 6%, and letting V_0 denote the current asset value, the present value now of the expected deviations between the allowed and incurred costs of debt would be 0.4% of the current asset value as follows:[25]

$$NPV_0 = .4V_0(1-.28)\left[\frac{(.032-.032)}{1.06} + .\frac{(.032-.0317)}{(1.06)^2} + ...\right] = -.004V_0$$

[25] The summations are continued until the additional terms are inconsequential, which occurs by year 15. In respect of the discount rate, a natural choice is the cost of debt. Furthermore, with a DRP of 3.2%, the risk-free rate is likely to be low, implying a total cost of debt of about 6%.

2: Initial investment and the on-the-day regime with annual resetting. The DRPs incurred by the firm will be the same as above, as will the initial DRP allowance of 3.2%. However, this allowance will be reset in one year to the prevailing DRP, which is expected to be 2.88% in accordance with equation (8), and progressively declines towards the long-run average. So, the present value now of the expected deviations between the allowed and incurred costs of debt would be 1.1% of the current asset value as follows:

$$NPV_0 = .4V_0(1-.28)\left[\frac{(.032-.032)}{1.06} + .\frac{(.0288-.0317)}{(1.06)^2} + ...\right] = -.011V_0$$

3: Initial investment and a trailing average regime with five yearly resetting. As before, the potential for a violation of the NPV = 0 principle is greatest when the current DRP is extreme. So, as before, the current situation involves a DRP of 3.2%, corresponding to Dec 1974 in the US data and therefore a contemporaneous ten-year trailing average of 1.44% in that data. So, the initial allowance would be 1.44% and would be maintained at this level for five years, upon which it would become the new ten-year trailing average (based on the five years of actual US data leading up to Dec 1974 and the five years of new data). Since expectations are formed at the time the investment is made, the five years of new data is the time series of expected DRP values commencing with the figure of 3.2%, and these are generated from the mean-reverting model shown in equation (8) above. The result is a ten-year trailing average of 2.24%, which would constitute the allowed DRP for the next five years. The DRPs incurred by the firm are the same as before. So, the present value now of the expected deviations between the allowed and incurred costs of debt would be 2.3% of the current asset value as follows:

$$NPV_0 = .4V_0(1-.28)\left[\frac{(.0144-.032)}{1.06} + .\frac{(.0144-.0317)}{(1.06)^2} + ...\right] = -.023V_0$$

4: Initial investment and a trailing average regime with annual resetting. This case differs from case 3 only in that the allowance is reset annually, starting with the same 1.44%. With each passing year, one year of data drops out of the US data leading up to Dec 1974 and one more year of future data is added, drawn from equation (8). So, starting with a ten-year trailing average of 1.44%, this trailing average rises to 1.68% one year later, and continues rising. The DRPs incurred by the firm are as before. So, the present value now of the expected deviations between the allowed and incurred costs of debt would be 1.9% of the current asset value as follows:

$$NPV_0 = .4V_0(1-.28)\left[\frac{(.0144-.032)}{1.06}+.\frac{(.0168-.0317)}{(1.06)^2}+....\right] = -.019V_0$$

5: Capex and a trailing average regime with five yearly resetting. This differs from case 3 only in that borrowing commences up to five years after the DRP is last reset. The divergence between the DRP allowed and that incurred now arises from two phenomena: capex occurring within a regulatory cycle (and therefore experiencing an initial DRP cost equal to that prevailing at the time of the capex whilst the initial regulatory allowance would be the DRP prevailing at the beginning of the cycle), and expected mismatches between the DRP allowed and that paid over the residual life of the debt. Initial differences will be most pronounced for capex near the end of a regulatory cycle, but such differences will be quickly mitigated at the end of the regulatory cycle, whilst initial differences will be least pronounced for capex shortly after the beginning of the cycle but persist for longer (until the end of that cycle). This suggests that the greatest problems will be for capex undertaken about half-way through a cycle. So, the capex is assumed to occur 2.5 years into the cycle. Since a trailing average is being used, the greatest problems will also tend to occur when the current DRP is extreme. So, the DRP at the time of the capex is assumed to be 3.2% as before (corresponding to Dec 1974 in the US data), and therefore the DRP allowed at the beginning of the cycle is the ten-year trailing average in the US data 2.5 years prior to Dec 1974 (June 1972), of 1.22%. This is reset five years later, being 2.5 years after the capex is undertaken, at the contemporaneous ten-year trailing average of 1.95% (using 7.5 years of actual data up to Dec 1974 plus 2.5 years of future data with expected outcomes determined from equation (8)). The next reset is five years later, being 7.5 years after the capex is undertaken, at the contemporaneous ten-year trailing average of 2.25% (using 2.5 years of actual data up to Dec 1974 plus 7.5 years of future data with expected outcomes determined from equation (8)). The DRPs incurred by the firm are as before. So, the present value now of the expected deviations between the allowed and incurred costs of debt would be 2.3% of the current asset value as follows:

$$NPV_0 = .4V_0(1-.28)\left[\frac{(.0122-.032)}{1.06} + .\frac{(.0122-.0317)}{(1.06)^2} + ...\right] = -.023V_0$$

<u>6: Capex and a trailing average regime with annual resetting.</u> This differs from case 5 only in that the resetting is annual, and therefore borrowing commences up to one year after the DRP is last reset. So, consistent with case 5, the capex is assumed to occur 0.5 years into the cycle. Since a trailing average is being used, the greatest problems will also tend to occur when the DRP is extreme. So, the DRP at the time of the capex is assumed to be 3.2% as before (corresponding to Dec 1974 in the US data), and therefore the DRP allowed at the beginning of the cycle is the ten-year trailing average in the US data 0.5 years prior to Dec 1974 (June 1974), of 1.35%. This is reset one year later, being 0.5 years after the capex is undertaken, at the contemporaneous ten-year trailing average of 1.56% (using 9.5 years of actual data up to Dec 1974 plus 0.5 years of future data with expected outcomes determined from equation (8)). The next reset is one year later, being 1.5 years after the capex is undertaken, at the contemporaneous ten-year trailing average of 1.79% (using 8.5 years of data up to Dec 1974 plus 1.5 years of future data with expected outcomes determined from equation (8)). The DRPs incurred by the firm are as before. So, the present value now of the expected deviations between the allowed and incurred costs of debt would be 1.9% of the current asset value as follows:

$$NPV_0 = .4V_0(1-.28)\left[\frac{(.0135-.032)}{1.06} + .\frac{(.0156-.0317)}{(1.06)^2} + ...\right] = -.019V_0$$

<u>7: Capex and the on-the-day regime with five yearly resetting.</u> As with case 5, capex is assumed to occur 2.5 years after the last reset. However, since the on-the-day regime is being used rather than a trailing average, the potential for a violation of the NPV = 0 principle is greatest when the DRP at the time of the capex differs most from that at the time of the last reset. Using the US data, the 95^{th} percentile of the entire distribution of [DRP – DRP (2.5 yrs prior)] is 1.38%, of which there are four such cases with an average DRP of 3.03% and an average DRP 2.5 years earlier of 1.65%. So, for the 95^{th} percentile, the current DRP is approximately 3.0% and that 2.5 years earlier is approximately 1.6%. Invoking the mean-reversion model for the DRP shown in equation (8), and starting with a mid-cycle DRP of

3.0%, the expected DRP after 2.5 years (the cycle end) is 2.45%, and that expected five years later is 2.05%. So, under the on-the-day regulatory regime, the firm would receive a DRP allowance of 1.6% for the remaining 2.5 years of the first cycle followed by an expected allowance of 2.45% for the next five years, and 2.05% for the next five years. The DRPs incurred by the firm now reflect an initial borrowing cost of 3.0%, which is expected to decline in accordance with the transition to staggered borrowing and the expected reduction in the prevailing DRP in accordance with equation (8). So, in one year, the prevailing DRP is expected to be 2.73% and therefore the firm's expected borrowing cost is 2.97%. So, the present value now of the expected deviations between the allowed and incurred costs of debt would be 1.4% of the current asset value as follows:

$$NPV_0 = .4V_0(1-.28)\left[\frac{(.016-.030)}{1.06}+.\frac{(.016-.0297)}{(1.06)^2}+....\right]=-.014V_0$$

8: Capex and the on-the-day regime with annual resetting. As with case 6, capex is assumed to occur 0.5 years after the last reset. However, as with case 7, since the on-the-day regime is being used rather than a trailing average, the potential for a violation of the NPV = 0 principle is greatest when the DRP at the time of the capex differs most from that at the time of the last reset. Using the US data, the 95th percentile of the entire distribution of [DRP – DRP (0.5 yrs prior)] is 0.8%, of which there is only one case. So, the next four closest cases are also considered (with differences of 0.78% and 0.77%). Across these five cases, the average DRP is 2.66% and that six months earlier is 1.88%. So, for the 95th percentile, the current DRP is approximately 2.7% and that 0.5 years earlier is approximately 1.9%. Invoking the mean-reversion model for the DRP shown in equation (8), and starting with a mid-cycle DRP of 2.7%, the expected DRP after 0.5 years (the cycle end) is 2.60%, that expected one year later (at the next reset) is 2.43%, etc. So, under the on-the-day regulatory regime, the firm would receive a DRP allowance of 1.9% for half of the first year after the capex and an expected allowance of 2.60% for the other six months, averaging 2.25%. For the second year following the capex, the expected allowance is the average of 2.60% and 2.43%, which is 2.51%, etc. The DRPs incurred by the firm now reflect an initial borrowing cost of 2.7%, which is expected to decline in accordance with the transition to staggered borrowing and the expected reduction in the prevailing DRP in accordance with equation (8). So, in one year, the prevailing DRP is expected to be 2.51% and therefore the firm's expected borrowing cost is 2.68%. So, the present value now of the expected deviations between the allowed and incurred costs of debt would be 0.8% of the current asset value as follows:

$$NPV_0 = .4V_0(1-.28)\left[\frac{(.0225-.027)}{1.06}+.\frac{(.0251-.0268)}{(1.06)^2}+....\right] = -.008V_0$$

9: Capex and the QTC regime with annual resetting. As with case 8, capex is assumed to occur 0.5 years after the last reset. Also, as with case 8, since the allowance commences with the prevailing rate rather than a trailing average, the potential for a violation of the NPV = 0 principle is greatest when the DRP at the time of the capex differs most from that at the time of the last reset. So, as with case 8, the 95th percentile involves a current DRP of 2.7% and a DRP of 1.9% 0.5 years earlier. So, as with case 8, the expected DRP after 0.5 years (the cycle end) is 2.60%, that expected one year later (at the next reset) is 2.43%, etc. So, under the QTC's regime, the firm would receive DRP allowances on the capex as follows:

Last reset (0.5 years ago): 1.90%

Next reset (0.5 years after the capex): .9(1.90%) + .1(2.60%) = 1.97%

Next reset (1.5 years after the capex): .8(1.90%) + .1(2.60%) + .1(2.43%) = 2.02%

So, the firm would receive a DRP allowance of 1.9% for half of the first year after the capex and an expected allowance of 1.97% for the other six months, averaging 1.94%. For the second year following the capex, the expected allowance is the average of 1.97% and 2.02%, which is 2.00%, etc. The DRPs incurred by the firm are as in case 8. So, the present value now of the expected deviations between the allowed and incurred costs of debt would be 0.9% of the current asset value as follows:

$$NPV_0 = .4V_0(1-.28)\left[\frac{(.0194-.027)}{1.06}+.\frac{(.0200-.0268)}{(1.06)^2}+....\right] = -.009V_0$$

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