COMPETITION ECONOMISTS GROUP

Review of the use of the 75th WACC percentile

A REPORT FOR ORION

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COMPETITION ECONOMISTS GROUP

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Executive summary

1. This report has been prepared by CEG on behalf of Orion. Its subject is the weighted average cost of capital (WACC) percentile that should be used under the cost of capital input methodologies (IMs). At present, the 75th percentile is applied but, in a recent decision,[1] the High Court expressed some reservations about the appropriateness of this level.

2. We have identified a number of factors that suggest that it is necessary and appropriate for the regulatory WACC to be set above the mid-point estimate. However, more time and analysis is required to ascertain the magnitude of the required increment. The appropriate time and place to undertake such an assessment is during a full review of the IM.

The Commission must consider two sources of asymmetry

3. The socially optimal regulatory WACC to use as an input into the Commerce Commission's (Commission's) financial model – and, in turn, in regulated prices – is comprised of three separate components:

   - the best estimate of the "true WACC" that investors require in order to be willing to invest in the relevant industry (in this case electricity distribution) – call this the "mid-point WACC" or "$WACC^{Median}$"; *plus*
   - the best estimate of the expected cost of asymmetric cash-flow risks not compensated elsewhere in the financial model – call this "α", which is expressed as a percentage of the regulatory asset base (RAB); *plus*
   - the optimal increment to investor compensation to reflect any asymmetry in the social costs of under versus over compensating investors (i.e., setting $WACC^{Median}$ + α above or below its true value due to error) – call this "β".

4. If these three values could be observed, then setting the socially optimal regulatory WACC would be a simple matter of adding them up, i.e., "$WACC^{Median}$ + α + β". Of course, it is not so straightforward as that, because:

   - the $WACC^{Median}$ cannot be observed – it must be estimated using analytical models such as the capital asset pricing model (CAPM) and doing so is a complex and time consuming process; and
   - similarly, arriving at robust values for α and β is a complex and time consuming undertaking.

[1] *Wellington International Airport Ltd & Ors v Commerce Commission* [2013] NZHC, [11 December 2013], §1448-1487.

5. In its IM determination, the Commission stated that it was adopting the 75th percentile based on considerations relevant solely to the value of β. However, it did not seek to quantify the selection of a particular percentile. That absence of empirical evidence on the value of β was criticised by the High Court, which has prompted the Commission to launch a narrow review of the 75th percentile focussing predominantly on the value of β.

6. For the reasons we set out subsequently, it is not appropriate to review the use of the 75th percentile without taking into account the interdependencies with other parts of the IM and the broader regulatory framework. But there is a further problem. The Commission's Process Update paper makes it quite clear that it is focussing primarily on β. There is no mention of the concept or value of α.

7. This is problematic because, if the Commission was to conclude (wrongly in our view) that the best estimate of β was zero and, on that basis, remove the 75th percentile, investors would receive no compensation for either β *or α*. It would, in effect, be assuming that the value of α was also zero, when it clearly is not. Businesses face a number of negative cash flow asymmetries that are not compensated for elsewhere in the Commission's financial model.

8. One needs look no further than Orion for a clear example. It suffered significant losses from lower than forecast revenues as a result of the Christchurch earthquakes. No explicit compensation was provided for this risk in Orion's prior price threshold and the Commission did not allow it to recover those losses after the fact. Moreover, it justified that decision in part on the fact that:[2]

> *"The practical effect of using the 75th percentile WACC (determined under the IMs) is to provide a buffer against the financial impact of catastrophic events."*

9. In other words, the Commission was prepared to invoke the 75th percentile increment as a justification for Orion bearing asymmetric cash-flow risks of the kind that α compensates. In doing so, it acknowledged (quite rightly) that α has a positive value. As we explain further below, that increment must cover the risks arising not only from earthquakes, but for other factors such as asset stranding and the costs of financial distress – none of which are compensated for elsewhere. It follows that the Commission cannot now assess the appropriateness of the 75th percentile without assessing both β and α.

10. Our preliminary assessment suggests that negative cash-flow asymmetries alone may more than justify the 72 basis point (bp) increment provided by the 75th percentile. In other words, even if the Commission was to conclude that no asymmetry in social consequences existed (i.e., that β was zero – an unlikely

[2] Commerce Commission, *Setting the customised price-quality path for Orion New Zealand Limited, Final reasons paper*, 29 November 2013, §C5.2.

scenario in our opinion), that would not be sufficient cause to reduce the WACC percentile to the mid-point.

11. To act in this way, given a positive value for α, would be to deliberately set the IM WACC below the level that is required to adequately compensate investors. To avoid such a scenario, the Commission must therefore allow itself more time to properly investigate both sources of potential asymmetry. The currently proposed timeframe is inadequate for this purpose.

The task is complex and requires much more time

12. The best estimate of both α and β requires a complex and holistic analysis of almost every aspect of the regulatory framework. This includes aspects that are not currently fully defined. For example:

    - the best estimate of β depends, in part, on how the Commission will respond to evidence of under/over investment when setting forecast capital expenditure in future regulatory periods; and
    - the best estimate of α depends, in part, on how the Commission will respond to future natural disasters and its willingness to allow accelerated depreciation – including in response to asset stranding risks.

13. Until the Commission has engaged on these, and other wide ranging regulatory design issues, it is not possible to robustly approach the estimation of α or β. A full review of the IMs is the appropriate time at which to consider these matters. Such a forum would provide interested parties and the Commission alike with much more time to collect and consider the required information.

14. It will also enable the important interactions within the WACC IM to be taken into account. In particular, it is our view that the IM assumed credit rating may need to be downgraded from BBB+ if the 75th percentile was removed from the regulatory WACC. Indeed, the 75th percentile cannot be reviewed without concurrently assessing all of the other cost of debt calculations.

15. To determine empirically the value of β – upon which the Commission has explicitly invited submitters to provide empirical evidence – would require an unprecedented analysis of social costs and benefits. Properly carrying out this task would require input from a wide range of experts – from actuaries to researchers on alternative energy technologies.

16. Put simply, 21 working days is a very challenging timeframe over which to prepare such wide-ranging, multi-faceted quantitative analysis. In our opinion, it would also be difficult to arrive at robust estimates of α and β prior to November. A proper assessment is likely to require more time and, as noted above, is best undertaken as part of a full IM review.

17. In the meantime, it should not be open to the Commission to cite a shortage of quantitative evidence on β to support the 75th percentile as a reason for no longer using it. In addition to ignoring the value of α (which we preliminarily estimate as being strongly positive) and being an extremely challenging threshold to meet in the timeframe, there is the more fundamental point that it would inappropriately shift the onus of proof. The relevant question should be:

    - "Is there any reason why we *should* reduce the WACC point estimate from the 75th percentile?" (i.e., the change *will not* happen unless there is strong evidence furnished to support it); and not
    - "Is there any reason why we *should not* reduce the WACC point estimate from the 75th percentile? (i.e., there change *will* happen unless there is strong evidence provided to oppose it)."

18. Being required to provide evidence to support a change is quite a different threshold to simply relying on an absence of reasons "not to do something". The latter is a less stringent standard that, if relied upon frequently by the Commission, would undermine the certainty that Part 4 was intended to create. If businesses were being regularly told by the Commission that it intended to change a prior decision unless provided it with evidence to show why it should not, their incentives to invest and innovate would diminish rapidly.

Comparative Benchmarking

19. Before turning to our best estimates of the values of α and β, it is first instructive to consider how the Commission's WACC compares with those set by its fellow regulators. Indeed, all regulatory agencies must consider the problem of where to set the WACC and whether it should reflect any perceived asymmetry in social consequences (or cash-flows). To that end, in a separate report for Wellington Electricity, we have compared:[3]

    - the Commission's allowed premium above New Zealand Government bond rates for EDBs; relative to
    - the allowed premium above government bond rates for similar businesses in Australia, the UK and the USA.

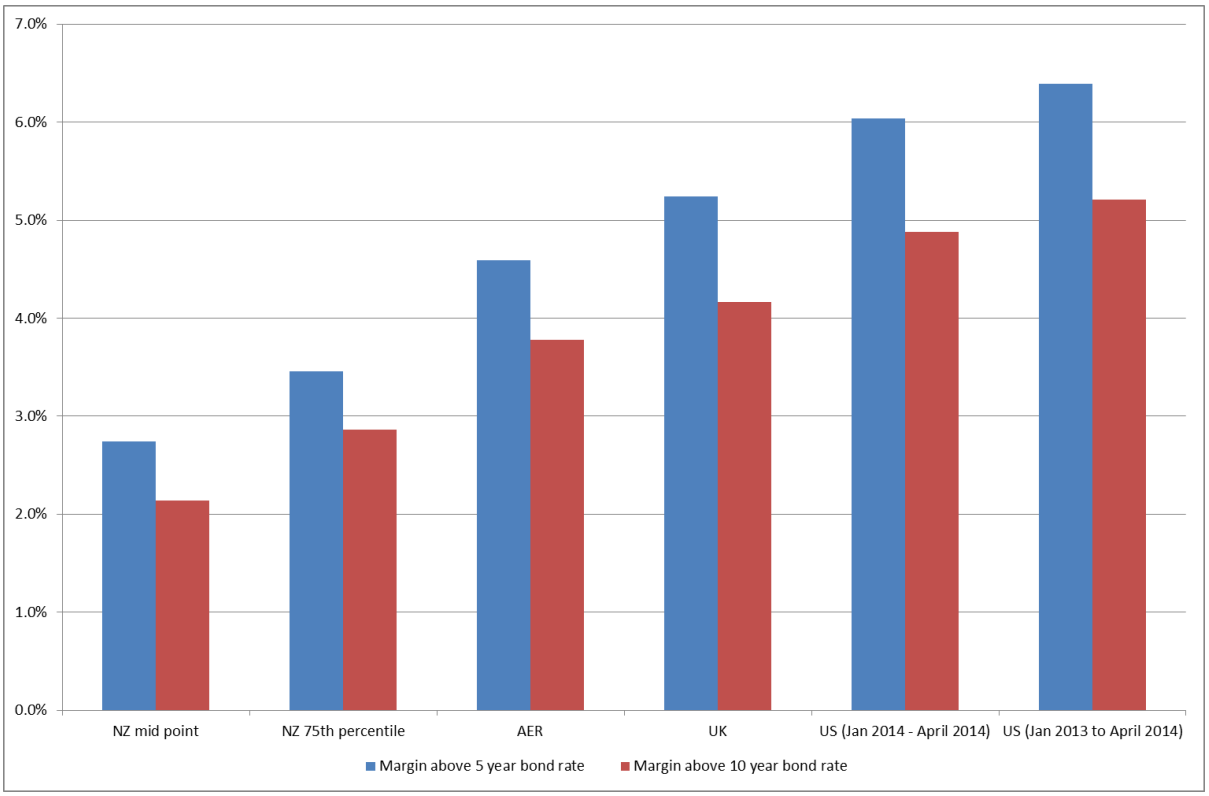
20. The premium above the government bond rate allowed in these other countries can be presumed to reflect, at least in part, the relevant jurisdictional regulator's view on the perceived magnitude of cash flow ("α") and social cost ("β") asymmetry. It is consequently relevant to consider how the risk premium (i.e., the margin above the Government bond rate) provided by the Commission – in part through its

[3] CEG, *International precedent relevant to the 75th percentile, A Report for Wellington Electricity,* May 2014.

application of the 75th percentile – compares with premia provided by these overseas regulators.

21. Figure 1 below – reproduced from our report for Wellington Electricity – shows that the premium allowed by the Commission is well below those allowed by other regulators. The premium provided by the Commission relative to 5-year bonds is between 110bp and 290bp lower than those provided overseas. If the Commission was to drop the 75th percentile increment and simply adopt the mid-point WACC, this range would increase to between 180 and 360bp, i.e., foreign risk premiums would be between 1.7 to 2.4 times as large as that allowed by the Commission.

Figure 1: International WACC premia allowed by regulators



Source: Regulatory decisions, Bloomberg, SNL and CEG analysis. Reproduced from CEG, International precedent relevant to the 75th percentile, May 2014, Figure 1, p.4.

22. This suggests that regulators in these countries believe that investors require a higher increment above the Government bond rate than the Commission is currently providing – even with the application of the 75th percentile. This also indicates that the 75th percentile may not be sufficient to compensate for asymmetries in cash flows ("α") and social costs ("β"). At the very least, it suggests that the 75th percentile is unlikely to be too high and the Commission has no basis to reduce it at present.

23. These conclusions are reinforced by the analysis that we have undertaken of the values of α and β in the time available. That analysis strongly suggests that there is a negative asymmetry of social consequences from under- versus over-estimating $WACC^{Median} + \alpha$, i.e., that β is positive. In addition, our quantitative analysis of cash-flow asymmetries indicates that, even if β was zero (which seems unlikely), the appropriate WACC percentile cannot be the mid-point, because α is positive – and potentially very significantly so.

Our best estimate of "α" in the time available

24. In the limited time that has been provided we have reviewed the following sources of asymmetry in cash-flows (i.e., α). Our best estimate is that these factors alone more than justify the current 72bp ("75th percentile") increment to the WACC. These sources of negative asymmetry include:

- The real possibility that distribution infrastructure will be stranded by the emergency of new technologies before the costs of those investments have been fully recovered – the potential for this to occur in the next 10 to 20 years is a real concern for investors (let alone the longer run).
  - No quantification attempted in the time frame available.
- The existence of low frequency but high impact events (such as earthquakes, tsunamis, etc.) that are not currently compensated for in businesses' price paths, and from which, on the basis of Orion's experience, they cannot recover lost revenues in a customised price path.
  - Orion's own costs in relation to the Christchurch earthquake justify a 60bp increment to the median WACC in perpetuity. This represents more than 83% of the 72bp increment currently provided by the 75th percentile under the DPP.
- The cash-flow risks from the potential costs of financial distress – the prospects of which may increase due to the other factors described above, e.g., a natural disaster may prompt customers to install battery and solar solutions, leading to asset stranding and a heightened financial distress.
  - In the report in **Appendix B**, CEG Academic Consultant Professor Bruce Grundy has estimated that, based on the empirical literature, compensating for this cost requires between 40 to 71bp to be added to the WACC in perpetuity (with the upper end of that range being a utility specific estimate). This represents between 56% and 98% of the 72bp increment currently provided by the 75th percentile.
- The fact that higher than expected demand can be expected to increase profits by less than lower than expected demand reduces them due to the asymmetric responses of costs to demand.

  - Our preliminary modelling suggests that the expected cost of this is between 6bp and 23bp. This represents between 8%-32% of the 72bp increment currently provided by the 75th percentile under the DPP.
- All other sources of potential asymmetry. For example, this list does not include the risk of future regulatory or government stranding of investments, e.g., through nationalisation of assets.

25. Our analysis consequently suggests that α is positive and, potentially, a very significant number. This is consistent with observations from workably competitive markets, in which firms typically employ "hurdle rates" for new investment well in excess of the WACC. These higher hurdle rates may, in part, be a reflection of the fact that a project must pay off above the true WACC in the normal (or median) state of affairs in order to compensate for the fact that asymmetric risks to cash-flows cause the mean expected return to be lower than this.[4]

26. To the extent that distributors face such asymmetric risks to cash flows (which our analysis suggests that they do) the same logic suggests that the Commission should adopt a regulatory WACC that is above its best estimate of the true WACC. It follows that, unless β is an even larger negative number, the appropriate WACC percentile *cannot be the* mid-*point*. As we explain below, that seems highly unlikely. Rather, there is good reason to think that β is also materially positive.

Our best estimate of "β" in the time available

27. We have also considered evidence relevant to determining the value of β. This evidence – although largely qualitative in nature – suggests that the social costs of erroneously setting the WACC "too low" (underestimating $WACC^{Median} + \alpha$) are likely to be higher than the costs of setting it too high by an equivalent increment. Relevant factors include:

- Distributors subject to incentive regulation will have a much more powerful incentive to reduce expenditure if the WACC is set too low than *vice versa*:
  - If the WACC is set above $WACC^{Median} + \alpha$, before investors overspend relative to forecasts, they must weigh the benefit of an investment that delivers above WACC in the following periods against the cost of foregoing a return on that overspending during the current period, i.e., it is not "all upside".[5]
  - In contrast, if the WACC is set below $WACC^{Median} + \alpha$, there is a clear incentive to underspend relative to forecasts, i.e., investors do not bear the

4 Such asymmetries may be difficult to model explicitly in cash-flows on a project-by-project basis, making it more efficient to apply a hurdle rate to *all* investments to, in part, account for such risks.

5 We estimate that the regulatory WACC would have to be several percentage points too high to precipitate such a response.

cost of an investment that delivers below WACC in the next period and they receive the upside from being paid "as if" they invested in the current period.

- A lack of investment can and does result in very costly reductions in the quality of service (QoS) customers receive. Given the high value that customers place on reliability, only a small improvement in QoS is needed before it is in their interest for the WACC to be above the mid-point.
- Reductions in QoS are not the only source of costs from setting the WACC below $WACC^{Median} + \alpha$. Distributors will also have an incentive to adopt an inefficient labour capital mix – the effect of which will be to raise costs and prices paid by customers even if QoS does not fall.

28. Although all of these factors suggest that β is positive we have not, in the time available, been able to estimate it empirically from a fully specified loss function (and fully specified distribution of the value of "$WACC^{Median} + \alpha$"). As noted earlier, such an assessment is best undertaken as part of a full IM review, when all relevant interdependences can be taken into account.

1 Introduction

29. This report has been prepared by CEG on behalf of Orion New Zealand Limited (Orion). Its subject is the weighted average cost of capital (WACC) percentile that should be used under the cost of capital input methodologies (IMs). In its Process Update paper,[6] the Commerce Commission (Commission) has invited submissions providing evidence regarding the WACC percentile. At present, the 75th percentile is applied but, in a recent decision,[7] the High Court expressed some reservations about the appropriateness of this level, which has prompted a review.

1.1 Background

30. The Commission's cost of capital IM was developed over 18 months (from June 2009 to December 2010) developing its cost of capital IM including, amongst other things, the WACC percentile. After this lengthy consultation process, the Commission concluded in its final Reasons Paper that it was appropriate to adopt the 75th percentile for default/customised price-quality regulation. It explained that the reason for adopting this point estimate was its belief that:[8]

> *"...considers the social costs associated with underestimation of the cost of capital in a regulatory setting involving constraining pricing to end users (as opposed to information disclosure applications and situations involving competition among suppliers), are likely to outweigh the short-term costs of overestimation (i.e., if the cost of capital is set too low, the incentives for suppliers to undertake efficient investments will be reduced, which would be inconsistent with the long-term benefit of consumers).*
>
> *That is, the Commission is acknowledging that where there is potentially a trade-off between dynamic efficiency (i.e., incentives to invest) and static allocative efficiency (i.e., higher short-term pricing), the Commission will always favour outcomes that promote dynamic efficiency. The reason is that dynamic efficiency promotes investment over time and ensures the longer term supply of the service, which thereby promotes the long-term benefit of consumers (consistent with outcomes in workably competitive markets)."*

6 Commerce Commission, *Further work on the cost of capital input methodologies, Process update and invitation to provide evidence on the WACC percentile*, 31 March 2014, p.2 (hereafter: "Process Update paper").

7 *Wellington International Airport Ltd & Ors v Commerce Commission* [2013] NZHC, [11 December 2013], §1448-1487.

8 Commerce Commission, *Input Methodologies (electricity distribution and gas pipeline services) Reasons paper*, 22 December 2010, §H1.31.

31. That reasoning was interrogated by the High Court, which questioned whether empirical evidence and theoretical results justified the use of the 75th percentile.[9] However, the Court ultimately concluded that, although it had some doubt about the Commission's position, there was no evidence to suggest that applying a mid-point WACC estimate would lead to a materially better IM. Nevertheless, the Court's comments have prompted the Commission to undertake a review of this single aspect of the WACC IM, with a view to settling the matter by November.

32. If this review continues as per the Commission's proposed timetable and if this led to a change in the WACC percentile, this would not immediately affect Orion. It will continue to set its prices by reference to the WACC defined in its customised price path (CPP) until such time as it reverts back to the default price path (DPP) or applies for a new CPP.

33. Nonetheless, Orion has asked CEG to provide an independent view of both the Commission's proposed process and timeline, and our view on the percentile itself. Specifically, Orion has asked us to consider whether it is appropriate to review the WACC percentile in isolation from other parameters and whether there is sufficient time to undertake a robust review by November. It has also asked us to see what qualitative and quantitative evidence there is to inform the determination of the appropriate WACC percentile.

1.2 Structure of this report

34. The short consultation period has restricted the analysis that we have been able to undertake. In the 21 working days provided it has not been possible to prepare the wide-ranging quantitative analysis of social costs and benefits referred to by both the Commission and the Court. For that reason, we have sought throughout this report to set out an analytical framework by which the Commission could review the WACC percentile if sufficient time was provided.

35. For certain aspects of that framework it is possible to undertake some preliminary quantitative analysis and we present those results throughout. However, empirical application of other aspects of the framework required more information – including clarification from the Commission about its own future regulatory policies – than could be acquired and assessed in the limited time provided. Our discussion of these matters is consequently largely qualitative in nature. With that qualification in mind, the remainder of this report is structured as follows:

    - **section two** sets out some general observations about the Commission's consultation process and timeline for completing the additional work on the appropriate WACC percentile:

9 *Wellington International Airport Ltd & Ors v Commerce Commission* [2013] NZHC, [11 December 2013], §1448-1487.

  - we highlight a number of factors that suggest that the appropriate WACC percentile is best addressed as part of the broader review of the cost of capital IM in 2018;
  - we explain why undertaking a narrow review of this one matter in the meantime will compromise the certainty that the IM framework was intended to deliver;
  - we set out why a period of 21 working days is a very challenging timeframe over which to assess the social costs of under- versus over-estimating the WACC, i.e., to quantify a "loss function"; and
  - we explain that in the absence of robust evidence to support another WACC point estimate, good regulatory practice suggests that the 75th percentile should be retained.

- **section three** sets out an analytical framework by which the Commission could review the WACC percentile if more time was provided – the two principal factors that would need to be considered being:
  - any asymmetries in the distributions of cash-flows around elements of the pricing model which mean that, even if the mid-point WACC is equal to the "true WACC" a businesses' expected revenues will not equal its expected costs; and
  - any asymmetries in the distributions of social costs and benefits of under- versus over-estimating the WACC which mean that under- or over-estimating the true "WACC+α" gives rise to greater costs, on average, than errors in the opposite direction.
- **section four** presents the qualitative and quantitative evidence of cash-flow asymmetries that we have managed to compile in the time available – the chief sources of asymmetry are:
  - the cash-flow risks from the potential costs of financial distress;
  - the fact that higher than expected demand increases profits by less than low demand reduces them due to the asymmetric change in costs;
  - the existence of low frequency but high impact events (such as earthquakes, tsunamis, etc.) that are not currently compensated for in businesses' price paths, and from which they cannot recover lost revenues in a customised price path; and
  - the real possibility that distribution infrastructure will be stranded by the emergency of new technologies before the costs of those investments have been fully recovered - the potential for this to occur in the next 10 to 20 years is a real concern for investors (let alone the longer run).
- **section five** presents the (largely qualitative) material that suggests that the social costs of setting the WACC "too high" are likely less than the social costs of

setting the WACC "too low" by an equivalent increment. This reflects the fact that:

- distributors subject to incentive regulation will have a much more powerful incentive to reduce expenditure (i.e., under-invest) if the WACC is set too low than *vice versa*;
- a lack of investment can and does result in very costly reductions in the quality of service (QoS) customers receive. Given the high value that customers place on reliability, only a small improvement in QoS is needed before it is in their interest for the WACC to be above the mid-point.
- If the WACC is set too low distributors may also have an incentive to adopt an inefficient labour capital mix – the effect of which will be to raise costs and prices paid by customers even if QoS does not fall; and
- regulators in Australia, the UK and the US are cognisant of the above factors and provide risk premia that are significantly higher than the premium currently provided by the Commission in its IM WACC – even accounting for the use of the 75th percentile;

- **Appendix A** sets out the key assumptions that we have made in the Monte Carlo simulations we undertake in section 4.1; and
- **Appendix B** contains a report by CEG Academic Consultant Bruce Grundy that examines the cash-flow risks from the potential costs of financial distress.

36. In short, the analysis that we have undertaken demonstrates that the appropriate WACC percentile cannot be the mid-point due to various asymmetries in cash-flows. However, to determine empirically a "bottom up" point estimate would have required an analysis of social costs and benefits that we could not undertake in the time provided.

37. In our opinion, the appropriate time and place to assess the WACC percentile is during a full review of the cost of capital IM. Such a forum would provide interested parties and the Commission alike with much more time to collect and consider the required information on social costs and benefits. It will also enable the important interactions with the other CAPM parameters to be taken into account.

2 Policy considerations

38. In this section we set out some general observations about the Commission's consultation process. We highlight a number of factors that suggest that the appropriate WACC percentile is best addressed as part of the broader review of the cost of capital IM in 2018 and explain why undertaking a narrow review of this one matter in the meantime will compromise the certainty that the IM framework was intended to deliver.

39. We also set out why a period of 21 working days is a very challenging timeframe over which to robustly estimate both α and β – particularly, the latter, which requires quantifying a "loss function" – something that, to our knowledge, has not previously been attempted. We also explain that in the absence of robust evidence to support another WACC point estimate good regulatory practice suggests that the 75th percentile should be retained.

2.1 Narrow reopening of IMs

40. The Commission's rationale for undertaking a narrow review of the WACC percentile appears to be that, unless this particular aspect of the IM is resolved in the near term, it will create unacceptable levels of uncertainty. We do not refute that, if the WACC percentile is not reviewed prior to 2018 (the date before which the IMs must be reviewed), the commentary of the High Court would cause investors to ponder whether the 75th percentile will continue to be used beyond that point. However, that seems to us to be an insufficient justification for the proposed approach.

41. It must be remembered that uncertainty surrounds a great many of the aspects of the cost of capital IM that will be applied when it is next reviewed. For example, investors will doubtless have observed that regulators in the United Kingdom and Australia have moved away from setting "on the day" estimates of the cost of debt and towards a long-term moving average. There is, consequently, significant uncertainty surrounding the design of this aspect of the Commission's approach when the IMs are next reviewed.

42. Similarly, investors will be cognisant of the fact that there is evidence to the effect that the Commission's capital asset pricing model (CAPM) framework underestimates the return on low beta stocks, such as electricity networks and implicitly overstates the value of distributed franking credits. These matters will doubtless be raised again in any IM review, and there is therefore necessarily some uncertainty surrounding these aspects of the Commission's approach also.

43. Moreover, investors in long-lived assets will know that new, unanticipated information may come to light that may affect the expected level of return. For

example, subsequent to the publication of the IM an expert report from leading economists might show that, on the basis of compelling new data, the equity beta should be lowered (or raised) by 0.2. These proverbial "unknown unknowns" provide yet another source of uncertainty for investors.

44. Even if it was possible to adequately address the matter of the appropriate WACC percentile before November (which, in our opinion, remains an open question), it is unrealistic to think that investors will then know with certitude what lies beyond the next IM review. In our opinion, the best way for a regulator to deal with these sources of uncertainty when they emerge is not to launch a narrow review to try and clarify the matter – especially over a heavily truncated timeframe.

45. Such an approach would be likely to undermine the very certainty that the IMs were intended to create. Investors would inevitably – and quite rightly – ask: if the Commission is prepared to re-evaluate the WACC percentile now, then what confidence can I have in all of the parameters around which there is some uncertainty? For example, why should investors believe that the IM equity beta is immune from a similar narrow review if a report of the type mentioned above was released at some point in the future? The same goes for all aspects of the WACC. The interdependence between the parameters exacerbates this problem, since changing one parameter has flow-on effects for others – including the IM credit rating, as we explain in section 2.3.

46. More generally, the best estimate of both α and β requires a complex and holistic analysis of almost every aspect of the regulatory framework. This includes aspects that are not currently fully defined. For example:

- the best estimate of β depends, in part, on how the Commission will respond to evidence of under/over investment when setting forecast capital expenditure in future regulatory periods; and
- the best estimate of α depends, in part, on how the Commission will respond to future natural disasters and its willingness to allow accelerated depreciation – including in response to asset stranding risks.

47. Until the Commission has engaged on these, and other wide ranging regulatory design issues, it is not possible to robustly approach the estimation of α or β. For all of those reasons, the appropriate WACC percentile is not something that can be satisfactorily addressed separately to the other aspects of the IM. This suggests that the best policy response to the High Court's observations is to state that they will be taken into account at the next IM review, when all of the other relevant parameters can be considered in conjunction.

48. In any event, as a practical matter, there may simply not be enough time before November to complete the further work that would be required to address these matters robustly. The Commission has provided businesses with 21 working days to provide evidence regarding the appropriate WACC percentile. Perhaps the

condensed nature of the consultation window reflects a belief on the Commission's part that the evidence it has requested is relatively straightforward to procure. If so, in our view, that belief is most likely misplaced.

49. The consultation timeframe *does* provide sufficient time to provide evidence – both qualitative and quantitative – that the mid-point is not the appropriate percentile. We present this material in sections 3.1 and 4. However, the time allowed has *not* been sufficient for us to prepare robust quantitative estimates of α and β – particularly the latter. Although we have been able to make some qualitative observations in section 5, producing quantitative estimates of the "loss function" would require more time and data.[10]

50. In the meantime, it should not be open to the Commission to cite a shortage of quantitative evidence in support of the 75th percentile as a reason for no longer using it (assuming that such evidence is not provided by other parties). Aside from being an extremely challenging threshold to meet in the timeframe, there is the more fundamental point that it inappropriately shifts the onus of proof. In short, before departing from the 75th percentile, the Commission should first point to persuasive evidence that shows that another point estimate would be superior.

2.2 Burden of proof

51. Good regulatory practice requires a regulator to weigh all of the evidence and arguments objectively, and to provide a clear explanation of the relevant factors that led to it reaching its decision. It is also vital that businesses can then rely on that precedent, and have confidence that it will not be departed from unless the right process is followed and compelling reasons are provided to support a change. In this particular instance, the relevant question should be:

    - "Is there any reason why we *should* reduce the WACC point estimate from the 75th percentile?" (i.e., the change *will not* happen unless there is strong evidence furnished to support it); and not
    - "Is there any reason why we *should not* reduce the WACC point estimate from the 75th percentile? (i.e., the change *will* happen unless there is strong evidence provided to oppose it)."

52. Being required to provide evidence to support a change is quite a different threshold to simply relying on an absence of reasons "not to do something". The latter is a less stringent standard that, if relied upon frequently by the Commission, would undermine the certainty that Part 4 was intended to create. If businesses were being regularly told by the Commission that it intended to change a prior decision unless provided with evidence to show why it should not, their incentives to invest and innovate would diminish rapidly.

[10] Indeed, to the best of our knowledge, not such quantification has ever been attempted.

53. This is made all the more likely by the fact that, in almost every regulatory determination, there is some scope for judgement by the regulator as to the most appropriate outcome. This is no more apparent than in the determination of the regulatory cost of capital, where the "true WACC" cannot be observed and analytical models must be employed. Given the uncertainties that always surround parameter estimates, placing the onus on businesses to provide reasons for a Commission not to depart from a past decision could lead to considerable uncertainty.

54. It is consequently vital that businesses can rely on the Commission's past decisions, and know that they will not be departed from without good reason. Commissioner Pat Duignan expressed this concept very clearly at the September 2012 conference on the re-benchmarking of the unbundled copper local loop (UCLL) service. When invited to re-consider the manner in which the Commission had undertaken an aspect of its previous benchmarking exercise (the specification of a "US dummy" variable), he remarked:[11]

> *"Okay, well, that's one possibility but what's the detail as to why we wouldn't follow what the Commission did? I do stress, you know, there was a lot of consideration by our predecessors. We don't depart from what they did lightly, so what is the argument for not following it?"*

55. Just as in the UCLL benchmarking exercise, there was a great deal of consideration of the appropriate WACC point estimate through the IM determination process. As the High Court acknowledged, there was strong support for the application of the 75th percentile – including from the Commission and its experts.[12] To be sure, the basis for that support was questioned by the Court, which is what has prompted the Commission (rightly or wrongly) to re-examine the rationale for the 75th percentile. However, in our opinion, there should be no presumption in favour of change.

56. Rather, there should be rebuttable presumption that the status quo will be maintained unless another approach can be persuasively shown to be materially better. In particular, before the Commission contemplated, say, applying a mid-point WACC, it should point to detailed evidence as to why that would better meet the requirements of the purpose statement and why its past decision was no longer appropriate. This is also the threshold that was applied by the High Court, which concluded that it had not been met at that time:[13]

> *"The onus is on MEUG to persuade us that applying a mid-point WACC estimate would lead to a materially better IM. While MEUG's in-principle arguments cast significant doubt on the Commission's position, it did not*

[11] Commerce Commission, *UCLL Benchmarking Review Conference Transcript,* 19 September 2012, p.99.

[12] *Wellington International Airport Ltd & Ors v Commerce Commission* [2013] NZHC, [11 December 2013], §1470.

[13] *Wellington International Airport Ltd & Ors v Commerce Commission* [2013] NZHC, [11 December 2013], §1483.

present any positive evidence of the type we refer to above, for example an inter-sectorial analysis, in support of its proposal. We are therefore unable to be satisfied that the IM amended as MEUG proposes would be materially better in meeting the purpose of Part 4 and/or the purpose in s 52R."

57. In our opinion, it should not be open for the Commission simply to say there is no strong evidence to oppose a proposed change – be it a lower point estimate or a higher point estimate. That would involve departing from a past decision without a sound basis and constitute poor regulatory practice.

58. This serves to reinforce the conclusion that the appropriate time and place to assess the WACC percentile is during the full IM review. That forum will provide interested parties and the Commission alike with more time to collect and consider the necessary information on social costs and benefits. It will also enable the important interactions with the other CAPM parameters to be taken into account. One of the most relevant relationships to consider is that between the WACC percentile and the IM credit rating, as we explain below.

59. For all of these reasons, we would urge the Commission to acknowledge that the WACC percentile cannot be satisfactorily addressed separately to the other aspects of the IM. Undertaking a narrow review of this one matter in the meantime will compromise the certainty that the IM framework was intended to deliver.

2.3 Credit rating

60. To show that that one CAPM parameter cannot be satisfactorily addressed in isolation one need only consider the IM credit rating. If the Commission undertook a narrow review of one parameter that reduced the WACC, this would reduce cash-flows significantly. In this regard it is important to note that the cash-flows from equity investors provide the financial buffer that debt providers rely on to avoid default.

61. In the last DPP decision the midpoint cost of equity allowance was 8.14%. The midpoint adjustment to the WACC added 1.29% (0.72%/(1-leverage)) to the equity buffer – so that the effective equity buffer was 9.43% of RAB per annum. Removing the 75th percentile WACC will reduce the equity buffer by 14% - worsening all credit metrics of concern to debt investors commensurately.

62. To the extent that the IMs are presently internally consistent, then the current IM credit rating, and associated cost of debt estimate, is consistent with the existence of an equity buffer that includes the 75th percentile WACC uplift of 0.72%. It follows that removing the 0.72% equity buffer will mean that the IM credit rating (and associated cost of debt) should fall (rise) if the IMs are to be kept internally consistent.

63. This illustrates the fact that efforts to resolve uncertainty in relation to one aspect of the IM can have the unintended consequence of creating error and uncertainty in relation to others. This suggests that, at a minimum, any review of the 75th percentile should be held concurrently with a review of the IM credit rating in particular and all aspects of the cost of debt calculations in general.

64. However, as we explained above, the best policy response is for the Commission simply to note the High Court's comments and resolve to take them into consideration in the context of a full review of the IM. In our opinion, any doubt that investors face in the meantime over the likely future WACC percentile will be far less than the enduring uncertainty that would be created if the Commission presses ahead with a narrow, heavily truncated review that does not account for all of the relevant interdependencies.

3 Analytical framework

65. In this section we set out an analytical framework by which the Commission could review the WACC percentile. There are two principal factors that would need to be analysed before the Commission could conclude that the mid-point WACC is the optimal WACC to use in its financial model. They are the following:

    - any asymmetries in the distribution of cash-flows around elements of the model such that, even if the mid-point WACC is equal to the "true WACC" a business's expected revenues will not equal its expected costs ("**cash-flow asymmetry**"); and
    - any asymmetries in the distribution of social costs and benefits of under-versus over-estimating the WACC which mean that under- or over-estimating the "true WACC" gives rise to greater costs, on average, than errors in the opposite direction ("**social consequences asymmetry**").

66. Unless these sources of asymmetry are immaterial (or cancel each other out[14]), the mid-point WACC is inappropriate. In the remainder of this section we describe in qualitative terms the framework for assessing these potential sources of asymmetry. We then attempt to apply that framework in sections 4 and 5 but, as noted above, that application is substantially restricted by the brief consultation timeframe.

3.1 Cash-flow asymmetry

67. The financial model that the Commission uses to determine the prices that businesses may charge requires a large number of assumptions to be made about the costs and revenues that businesses will incur and receive in the current regulatory period and beyond. For example, explicit assumptions must be made about the level of demand for electricity distribution services and the operating costs that will be incurred meeting that demand. The latter is the core determinant of the required revenue (the "numerator") and the former determines the price (the "denominator").

68. However, the Commission's financial model also makes other implicit assumptions about businesses' future ability to recover its expected costs through the regulatory

[14] In principle, positive asymmetry in one factor could offset negative asymmetry in the other. For example, imagine that it is more likely that profits will be below than above the forecast level generated by the Commission's financial model. This means that the actuarially expected level of profits will be less than the forecast profit level generated by the model. However, using the median WACC in that model may still be appropriate if it is the case that the social consequences of under compensating investors are smaller than the social consequences of over compensating investors. That is, even though using the median WACC delivers returns that that, on average, are expected to be lower than the median WACC, this is optimal because the cost of undercompensating investors is smaller than the costs of overcompensating them.

framework. For example, it assumes that the businesses will be able to recover the costs of investments through the regulated price path over timeframes that extend out in perpetuity (for the lives of existing assets and those of replacement assets required to keep the network functioning). It also assumes that the adverse effects on businesses' revenues from natural disasters such as earthquakes can be diversified away.

69. If the effect on businesses' cash-flows from variations in these explicit and implicit forecasts/assumptions are *asymmetric* then this can justify departing from the mid-point of the WACC range.

3.1.1 The potential problem with using median forecasts/estimates

70. If there are asymmetries in the distributions of cash-flows around elements of the Commission's financial model this means that, if median forecasts/estimates are used to set regulatory prices, a business' expected revenues *will not equal its expected costs*. This would be the case even if there was complete certainty about the level of the "true WACC" (which there is not, in practice) and that return was used to determine the price path. A simple example is where:

- there are only two possible future states of the world – State 1 and State 2;
- the probability of each state of the world is also known with certainty – 90% probability is assigned to State 1 and 10% probability is assigned to State 2;
- the price that recovers costs is known with certainty in both states of world: P1 = $1 and P2 = $5; and
- the demand for the service in State 2 is half that in State 1.

71. If there are full pass through provisions (i.e., if customers are required to pay all of the costs that a business incurs during a regulatory period) then prices will simply adjust in the relevant state of the world and no further compensation is required to address asymmetric cash-flows. However, if the regulatory regime sets a single price in advance that does not subsequently change depending on which state of the world transpires, then:

- 90% of the time the price that recovers costs is **$1**,); and
- 10% of the time then the price that recovers costs is **$5**.

72. The median price that recovers costs is, therefore, $1. However, this is below the mean expected price, i.e., the probability weighted costs divided by the probability weighted sales. This price is **$1.21** –calculated as expected revenues if prices recover costs in both states of the world (0.9*$1*2+0.1*$5*1) divided by expected volumes (0.9*2+0.1*1).

73. In other words, if median forecasts are used to determine the prices that the business in the above example may charge, its expected revenues will not equal its expected costs *even if the true WACC is used to set those prices*. One means of addressing that problem is to set the regulatory WACC *above* the median level, i.e., an amount "α" above the mid-point. There are a number of potential sources of cash-flow asymmetry that may justify such an adjustment.

3.1.2 Potential sources of cash-flow asymmetry

74. State 2 in the above example could be thought of as one in which a natural disaster occurs (such as an earthquake), leading to a substantial reduction in volumes (which Orion experienced). However, asymmetry of this kind does not only arise due to the existence of discrete events such as natural disasters. Another source of such asymmetry exists where marginal cost is increasing with demand served, i.e., where the additional costs incurred serving unexpectedly high demand are higher than the costs avoided serving unexpectedly low demand.

75. In this case, even if the distribution of demand is perfectly symmetrical and the firm's cost function is known with certainty, modelling prices on the assumption that demand will be equal to the median (which is also the expected) level will not result in prices that are expected to recover costs. The reason is that the distribution of costs is asymmetric due to an asymmetric response to variation in demand. High demand can be expected to increase profits less than low demand reduces profits because costs increase more with higher demand than they fall with lower demand:

    - if volumes are less than forecast this is unlikely to lead to widespread "decommissioning" of assets given the sunk nature of the investments, i.e., the same number of assets will need to be maintained and operating and capital expenditure may remain much the same as forecast; but
    - if volumes are greater than forecast, this may give rise to additional operating expenses and, potentially, a need to commission new investments in order to meet that higher than expected demand, i.e., operating and capital expenditure may increase relative to the levels forecast.

76. Another source of asymmetry in expected cash-flows is the expected costs of financial distress. It is well understood in the finance literature that the benefit of gearing to the firm comes in large part through the tax shield that this provides.[15] However, if this was the only effect of leverage then all firms would be much more highly geared. It is recognised that there must be a "downside" from leverage such that, at the margin, the benefit and cost of additional leverage are the same. The "catch-all phrase" for this downside in the economics literature is the "costs of financial distress" (CFD). These costs come in the many forms, including:

[15] The benefits of which the Commission's financial model captures and delivers to customers in the form of lower prices.

- being forced to raise capital at disadvantageous rates in the future;
- having to sell assets at "fire-sale" prices;
- distortions to operational decisions that result from operating in financial distress; and
- ultimately, the direct costs of litigation between stakeholders triggered by insolvency/bankruptcy.

77. Leverage raises the expected CFD because it reduces the equity buffer in a firm and, in turn, increases the probability of future financial distress. In a separate report prepared on behalf of Orion contained in **Appendix B**,[16] CEG Academic Consultant Professor Bruce Grundy has reviewed the literature on the CFD and is able to provide a reasonably tight bound for the expected CFD – including utility specific estimates. We summarise his findings in section 4.4.

78. Another source of asymmetry is the potential for distribution infrastructure to be stranded by the emergency of new technologies before the costs of those investments have been fully recovered. As noted above, the Commission's financial model implicitly assumes this form of asset standing is not possible. Important to this consideration is the fact that current regulatory policy is to backload asset recovery to the end of an asset's life (on average around 45 years). Also relevant is the fact that the regulatory asset base (RAB) is made up of interdependent assets with overlapping lives that are only of value if other assets are kept in place.[17]

79. Because assets' lives overlap, there will never be a point in time when all assets are fully depreciated and investors can "walk away" from the industry with a zero RAB. In effect, there is no exit strategy for investors – the service needs to be supplied in perpetuity. If the service ceases to be supplied at some point in the future that time will be associated with a positive RAB and some degree of asset stranding. This may not be expected to occur in the next 5-10 years. However, the potential for this to occur in the next 10 to 20 years is a real and growing possibility facing investors (let alone the longer run).

80. Finally, there is the potential for these various factors to interact, with compounding effects upon a business' cash-flows. For example, a future natural disaster may mean that customers have no grid access for long periods causing the distributor to lose revenue. Customers may also find installing solar and battery solutions attractive if this reduces the period in which they do not have electricity. Any subsequent attempt to raise prices to recover higher post disaster expenditure may

16 Professor Bruce Grundy, *The Costs of Financial Distress and Allowed Revenues for Regulated Firms*, 28 April 2014 – contained in **Appendix B.**

17 For example, if one electricity pole needs to be replaced, it will only remain useful over its remaining life if the poles connecting it to the substation are also replaced in the future when they reach the end of their lives. Similarly, all the poles between the substation and the customer are only of use if the substation is maintained and replaced into the future.

make substitution to "off grid" supply even more attractive. A firm may therefore quickly find itself in a "death spiral", trying to recover its costs from an ever shrinking pool of customers. In addition to the expected costs associated with these factors individually, these may also trigger costs associated with financial distress.

3.1.3 Hurdle rates

81. The analysis set out in the previous sections is also consistent with observations from workably competitive markets, in which firms are typically seen to employ "hurdle rates" for new investment well in excess of the WACC.[18]

82. These hurdle rates may, in part, be a reflection of the fact that a project must pay off above the true WACC in the normal (or median) state of affairs in order to compensate for the fact that asymmetric risks to cash-flows (the factors described in previous sections) cause the mean expected return to be lower than this. Because such asymmetries may be difficult to model explicitly in cash-flows on a project-by-project basis, this makes it more efficient to apply a hurdle rate in excess of the median WACC to *all* investments to account for such risks.

83. To the extent that distributors face such asymmetric risks to cash flows (which our analysis in the previous section suggests that they do) the same logic suggests that the Commission should adopt a regulatory WACC that is above its best estimate of the true WACC. In other words, just as firms in competitive markets may apply hurdle rates to, in part, account for asymmetric cash-flow risks, so too should the Commission make an allowance for such risks in its choice of WACC percentile.[19]

3.1.4 Implications

84. The implication of the above analysis is that, if the objective is to enable firms to earn an expected return equal to the median WACC, asymmetries in cash-flows will prevent that goal from being achieved if that mid-point WACC is used in the Commission's financial model. If the factors described above have negative asymmetric consequences for businesses' cash-flows then what is needed is a WACC point estimate that is *above the median* or, in mathematical terms:

$$E(WACC) = WACC^{Median} \rightarrow WACC^{Financial\ model} = WACC^{Median} + \boldsymbol{\alpha}$$

Where: the term "**α**" represents the compensation required to cover asymmetric risks to the business' cash-flows.

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18 For example, *see*: Poterba, J. and L. Summers, 1995, *A CEO survey of US companies' time horizons and hurdle rates*, Sloan Management Review, 43-53 available at http://sloanreview.mit.edu/article/a-ceo-survey-of-us-companies-time-horizons-and-hurdle-rates/..

19 This is based on the assumption that those risks are not compensated for elsewhere in the Commission's financial model which, as we explain in section 4, they currently are not.

85. That is, in order for the *expected* WACC to equal the median WACC it is necessary for the *regulatory* WACC (i.e., the WACC used in the Commission's financial model) be set *above* the median WACC, in expectation of these negative cash flow risks (represented by α).

86. In section 4 we present the qualitative and quantitative evidence of cash-flow asymmetries that we have managed to compile in the limited time that has been provided. This includes a preliminary estimate of the contribution to **α** from some of the potential sources described above. Although that analysis is preliminary in nature, it clearly suggests that **α** is material and positive.

3.2 Social consequences asymmetry

87. Assuming that cash-flow asymmetry has been appropriately dealt with (i.e., α has been estimated as accurately as possible) then we will still have residual uncertainty. This is because the true value of $WACC^{Median} + \alpha$ may be more or less than the estimated value of $WACC^{Median} + \alpha$. This uncertainty arises because, as we noted above, the true median WACC cannot be observed, and because of the uncertainty that will also surround the value of α.

88. The question consequently becomes whether it is better to err on the side of over-compensating investors (setting the WACC greater than $WACC^{Median} + \alpha$) than it is to err on the side of undercompensating investors (setting the WACC less than $WACC^{Median} + \alpha$). In the following sections, we describe, in conceptual terms, how a "loss function" could be used to determine whether there is any such asymmetry in social consequences. We then set out the many complexities that would be involved in estimating such a loss function empirically.

3.2.1 Conceptualising a loss function

89. A social loss function can be conceptualised that defines how the costs of regulatory error depend on:

- whether the true "$WACC^{Median} + \alpha$" has been over or under estimated; and
- by how much the true "$WACC^{Median} + \alpha$" has been over or under estimated.

90. A loss function so described can then be combined with an estimate of the distribution of the true "$WACC^{Median} + \alpha$" around the "mid-point" estimate of $WACC^{Median} + \alpha$. These two inputs (a loss function and a distribution for the true "$WACC^{Median} + \alpha$") can be used to determine the optimal return to include in the Commission's financial model. This process can be illustrated with a simple example. First, imagine that:

- we know that the "true" value of $WACC^{Median} + \alpha$ is either 10% or 12%, each of which has a 50% probability of being the correct estimate. That is, there is no

"continuous distribution" of possible answers – there are just two possibilities, one of which must be right;

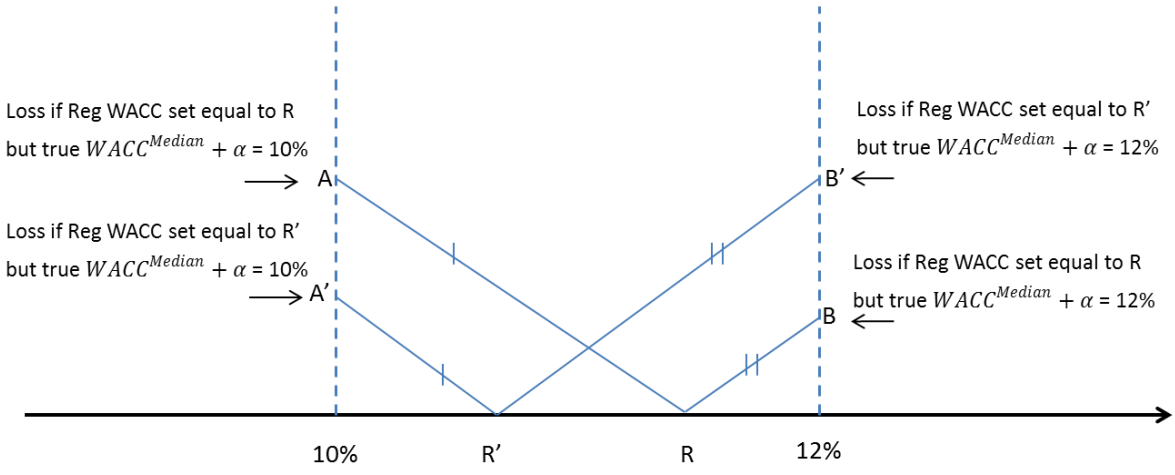
- there is a linear loss function such that:
  - the social losses from undercompensating investors increase at a constant rate as the amount of under compensation grows; and
  - the social losses from overcompensating investors increase at a constant rate as the amount of overcompensation increases; and
- both linear functions have the same slope.

91. Under these assumptions, any estimate within the range 10% to 12% gives rise to an expected social cost that is equal to any other estimate within the range. However, any estimate outside this range is socially inferior to an estimate within this range. This can be seen in Figure 2 below. If the regulatory WACC is set equal to R then the expected loss from underestimation is given by:

- the 50% (being the probability that 12% is the true value of $WACC^{Median} + \alpha$); multiplied by
- the vertical distance from the horizontal axis to the point B.

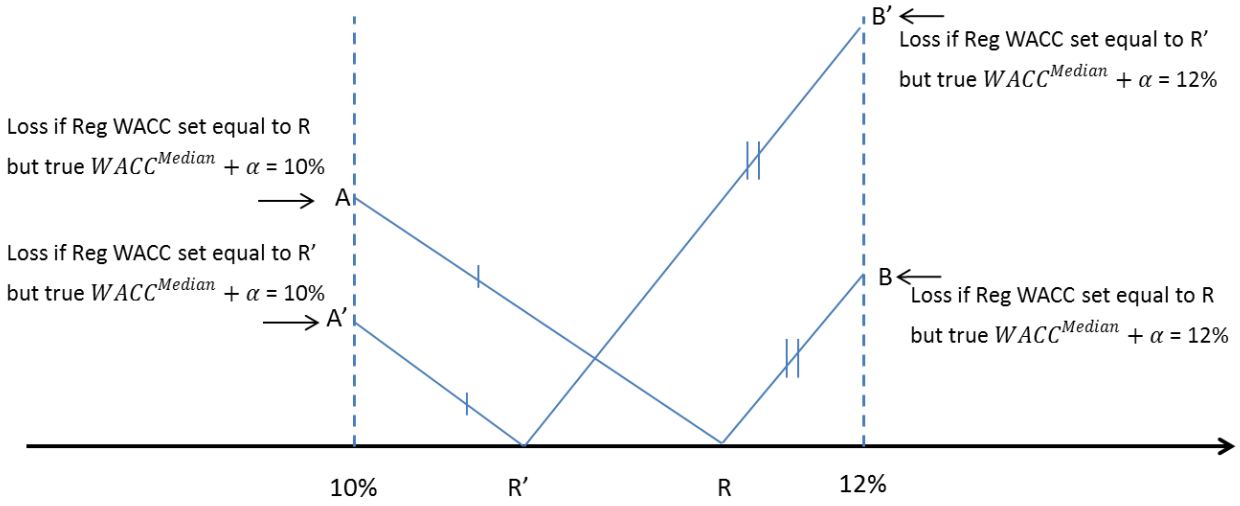
92. Similarly, the expected loss from overestimation is given by 50% of the vertical distance from the horizontal axis to the point A. The sum of these costs is simply ½ of the sum of the two vertical distances (to A and B). It can be seen that changing R to R' (or indeed to any other point between 10% and 12%) will not alter the sum of the expected losses. This is because the increase from B to B' is perfectly offset by the reduction from A to A'.

Figure 2: Optimal choice of regulatory WACC: binary distribution and equal linear loss functions



93. Now let us vary the above assumptions to allow for a different sloped loss function. Specifically, let the slope of the loss function with respect to under-compensation be twice the slope of the loss function with respect to over-compensation.

Figure 3: Optimal choice of regulatory WACC: binary distribution and different linear loss functions



94. In this scenario, changing the regulatory WACC from R to R' clearly increases the expected social loss because the increase from B to B' is twice as large as the reduction from A to A'. This is because the slope of the loss function associated with underestimation is double that of the loss function associated with overestimation, i.e., under-compensation gives rise to double the social costs as an equivalent amount of over-compensation.

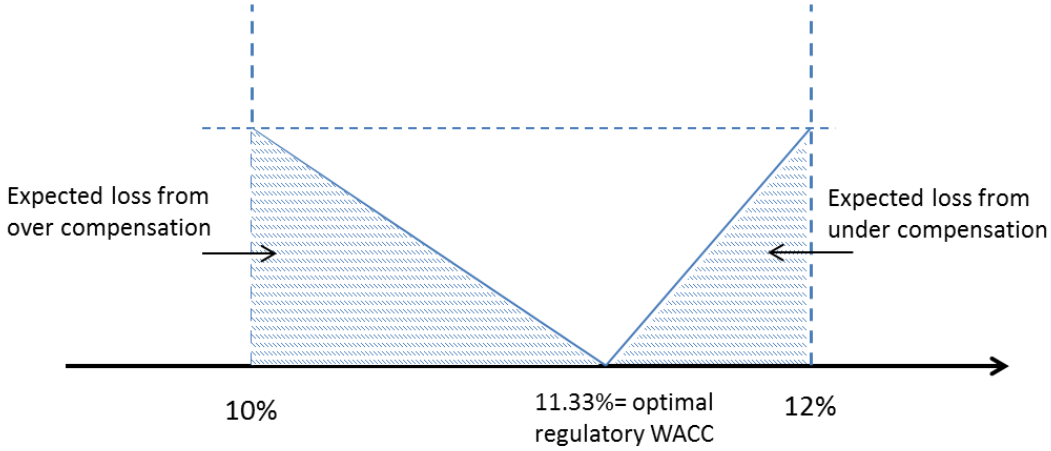
95. The optimal solution is consequently to set the regulatory WACC equal to 12%. This is because the higher slope corresponding to underestimation means that it is better to increase the regulatory WACC at least up to the point at which the probability of underestimation falls below the probability of overestimation (which, in this binary distribution, only occurs at values of R equal to 12% or higher).

96. If we instead assume that the true $WACC^{Median} + \alpha$ is uniformly distributed between 10% and 12% (i.e., if there is an equal probability that it could be any value in this range), then the optimal WACC to use in the financial model will fall somewhere between these points. This is because the optimal WACC used in the financial model is now the value of R that minimises the area under the loss curves that falls within the bounds of the (uniform) distribution (10% to 12%). That is, because each point in this distribution has an equal probability, the expected loss is simply the sum of the (equally weighted) losses within the distribution.

97. If the slope of the loss function from underestimation is double that of the loss function from overestimation then the optimal point will clearly be to the right of

the midpoint of the distribution (11%) but will no longer be at the extreme right hand side of the distribution (12%). It can be shown that the optimal regulatory WACC in this scenario is 11.33% (or the 67th percentile compared to the mid-point value of 11% for $WACC^{Median} + \alpha$). This is where the area under the loss functions is minimised as illustrated in the below figure.[20]

Figure 4: Optimal choice of regulatory WACC: uniform distribution and different linear loss functions



98. Of course, this discussion is highly stylised. The manner in which the optimally modelled WACC actually deviates from the best estimate of $WACC^{Median} + \alpha$ will depend on a number of factors that are themselves very difficult to estimate. It may be that the answer is not amenable to the simple mathematical specification provided in the above examples. For example:

    - non constant slopes, or even discontinuities, may exist in the way losses from over/under compensation vary as the distance of the modelled WACC from the true $WACC^{Median} + \alpha$ varies; and
    - the distribution around the best estimate of $WACC^{Median} + \alpha$ may not be uniform or even symmetric (it may be affected by uncertainty in a number of different parameters, not all of which will be independent).

99. There is therefore a considerable difference between conceiving of such a function at this level of principle and arriving at a robust *empirical estimate* of the relationship between the social costs of over- versus under-estimating the WACC. Yet it is this

[20] At the optimal regulatory WACC, the height of each triangle is the same. This reflects the fact that the marginal change in the area of each triangle associated with a marginal change in the base of each triangle (i.e., the regulatory WACC) is equal to half the height of the triangle. Thus, in order for the losses from over and under compensation to be equal *at the margin* the height of each triangle must be equal. (This does not mean that the absolute value of each triangle must be the same at the optimal WACC).

type of empirical evidence that the Commission has requested submitters to provide. Specifically, the Commission has invited submissions providing:[21]

> *"[E]mpirical or analytical evidence regarding the appropriate WACC percentile. For example, the Court referred to the possibility of using a 'loss function' approach, which would estimate the relative harm done by over-estimating and under-estimating the WACC, to determine the appropriate percentile."*

100. We are not aware of any regulator that has sought to quantify the social costs of over- versus under-estimating the WACC in this manner. Doing so would require a complex analysis that would be highly controversial. The Commission has provided businesses with only 21 working days to furnish it with this evidence. This would seem to indicate that it believes that the evidence it has requested is relatively straightforward to procure. If so, in our view, that belief is most likely misplaced.

101. In our opinion, more time would be needed to prepare robust quantitative estimates of the net social costs associated with under- versus over-estimating the WACC. To see why, it is instructive to consider the steps that would be involved in arriving at such estimates. As we explain below, each of these steps is very data intensive and would require a plethora of assumptions. We have consequently not been able to undertake them in the limited time available.

3.2.2 Estimating a loss function – effect on prices and consumption

102. The first – and easiest – step involved in estimating a loss function would be estimating the effect of over- or under-estimating the true WACC on the *prices* that final consumers pay for electricity and the attendant costs and benefits. If prices are above or below the levels implied by the true WACC, then this can potentially give rise to inefficient distortions to consumption decisions; for example:

- if prices are insufficient to allow full cost recovery (i.e., below the true WACC), there may be consumers who are willing to pay a higher price for additional output that would cover the true cost of that extra supply, but whose demand goes unmet because firms will not actually receive that true cost; and
- if prices allow for more than full cost recovery (i.e., above the true WACC), there will be consumers who would be willing to pay a price that allowed firms to cover their true cost of supply, but whose demand goes unmet because they are not prepared to pay the higher price that firms are allowed to charge.

103. In order to accurately quantify the effect on distribution prices, a great deal of information would be needed about the structure of prices charged to different customer groups by the various businesses. This is because distribution businesses

[21] Process Update Paper, pp.5-6.

invariably differentiate their prices by customer type, as well as typically levying both a fixed fee and a variable usage component.[22] This makes it difficult to model the impact of increases/decreases above/below the true WACC on prices.

104. In particular, one cannot simply assume that a distribution business will respond to an X% increase above the true WACC by increasing all of its prices by Y% (or vice versa). Rather, it may respond by increasing the prices to some of its customers by more than Y%, while the prices charged to other customers may increase by less than Y% or remain unchanged. Those increases may also fall on fixed components, variable tariffs or some combination of both, and the incidence may vary significantly from business to business depending on their pricing approaches.

105. Moreover, because the incidence of any price changes may fall on different customer groups multiple elasticity estimates would be needed to model the impact of those price changes on consumption. Empirical estimates of the price elasticity of demand for electricity vary materially depending upon whether it is the responsiveness of demand by residential, commercial or industrial customers that is being considered.[23] They also differ depending upon whether it is the short-run or long-run that is being considered – the latter being the more relevant in this case.

106. This all serves to increase the complexity of the exercise. In short, ascertaining the social costs of distortions to consumption arising from prices being above or below the level implied by the true WACC would be a very intricate exercise, if it is done properly. However, it is likely to be significantly easier than the next step involved in the estimation of any loss function – which would be quantifying the impacts upon the *level of investment* of over- versus under-estimating the true WACC.

3.2.3 Estimating a loss function – effect on investment and service quality

107. Of most importance to consumers are the potential impacts that setting the WACC above or below the "true level" have on distributors' incentives to innovate and invest – including in the quality and reliability of service that they provide. The potential costs and benefits arising from these investment decisions can be expected to exceed by a considerable magnitude any impacts flowing from distortions to consumption. In broad terms, the potential impacts on investment levels are the following:

    - if the WACC is set above the true WACC then businesses may have an increased incentive to undertake investments that entail greater marginal costs than the

[22] For a more comprehensive description of distribution companies' pricing methodologies, *see:* Castalia, *Review of Electricity Distribution Businesses' 2013 Pricing Methodologies, Report to the Electricity Authority*, November 2013, p.28.

[23] *See for example:* NERA Economic Consulting, *Cost Benefit Analysis of Smart Metering and Direct Load Control Work Stream 4: Consumer Impacts Phase 1 Report, Report for the Ministerial Council on Energy Smart Meter Working Group*, September 2007, p.19.

marginal benefits that they deliver in terms of improved quality of service, e.g., reduced incidence/duration of outages, etc.; and

- if the WACC is set below the true WACC then businesses may have an increased incentive to forsake or delay investments that would deliver marginal benefits in terms of improved quality of service (e.g., reduced incidence/duration of outages) that exceed the relevant marginal costs.

108. In our opinion, one cannot simply assume that if the WACC is set above the true WACC there will be rampant over-investment or, conversely, that there will be no investment whatsoever if it is set too low (i.e., that there will be an "investment cliff"). The extent to which the level of investment can be expected to change in response to a change in the regulatory WACC (what one might term the "elasticity of investment") will be effected by many factors, including (but not limited to):

- incentives built into the 5 year regulatory reset that raise the costs of investing more than forecast, including:
  - the fact that, if the WACC is set below the true WACC, any underspending relative to forecasts is "all upside", i.e., investors do not bear the cost of an investment that delivers below WACC in the next period and they receive the upside from being paid "as if" they invested in the current period; and
  - the fact that, if the WACC is set above the true WACC, the benefit to the firm of any over-spending above forecasts in terms of returns above the true WACC in the following periods must be weighed against the cost of foregoing a return on that overspending during the current period, i.e., it is not "all upside".
- mechanisms within the regulatory arrangements that may serve to protect against over-investment, e.g., the requirement for distributors to produce Asset Management Plans and the implicit threat that over-investment might be removed (i.e., "optimised") from the RAB;
- the effect of the quality of service standards – including the extent to which businesses' 5-year SAIDI and SAIFI averages can deteriorate without breaching the relevant standards, i.e., the scope – if any – for negative movements within the quality path "dead-bands";
- the extent to which opportunities exist for firms to reduce investment in ways that may not lead to quality breaches or significant reductions in volumes, but which may materially reduce reliability relative to what it would otherwise have been, e.g., not building in as much redundancy/safety margin; and
- the extent to which firms can feasibly substitute capital expenditure for operating expenditure, depending upon whether the true WACC has been over-estimated (which would incentivise firms to substitute opex for capex) or under-estimated (which would incentivise firms to substitute capex for opex).

109. All of these matters will have a bearing on the way in which investors respond to the WACC being set above or below the true WACC. However, the magnitude of the combined effect of these factors is far from clear *a priori* and would require a considerable degree of careful examination before the "elasticity of investment" could be approximated. Once the relationship between the level of the WACC and the level of investment had been estimated, the next step would be to assess the social costs and benefits of the increase or reduction in investment.

110. These would lie principally in the effect that any increase or reduction in investment brought about by over- or under-estimating the true WACC has on the quality of service (QoS) that customers receive and the cost of delivering that level (to the extent that an inefficient mix of operating and capital expenditure is promoted). This would require a substantial body of information about the value that customers place on additional QoS. Intuitively, the marginal benefit that customers derive from, say, an additional $10m in investment should depend to a material extent upon the *existing level of reliability*:

- if the existing QoS is very low (i.e., outages are frequent and long-lasting), then an additional $10m in investment may materially reduce the probability of outages which, given the high value of lost load (VoLL) – tens or hundreds of thousands of dollars per MWh – may deliver benefits that exceed $10m; but
- if the existing QoS is very high (i.e., if a network was at an "N-3" standard), then an additional $10m in investment may have a trivial effect on the probability of outages and, even accounting for the high VoLL, may consequently deliver benefits that are less than the $10m cost of the investment.

111. The welfare effects of equal and opposite quantities of under- and over-investment therefore depend upon businesses' existing price/QoS trade-off. At present, that trade-off will be defined by the SAIDI and SAIFI standards set out in the DPP as well as any circumstances in which customers have agreed to pay for even higher reliability. Those groups of customers who are paying more for higher QoS may be particularly susceptible to under-investment if the WACC is reduced, i.e., businesses may simply choose to stop investing in that higher reliability.

112. The fact that businesses may respond to changes in the WACC by over- or under-investing in ways that affect particular categories of customers (e.g., residential vs. industrial or urban vs. rural) further complicates the derivation of a loss function. These customers may be paying different prices, place different values on reliability and may therefore incur greater costs from under-investment (and derive greater benefits from over-investment). Moreover, the mix may well differ substantially from business to business.

113. In other words, although the high value that customers place on reliability might well suggest (as most have been long assumed) that the costs of under-investment will generally outweigh the costs of over-investment, establishing that empirically through a loss-function would be no small task. It would require a great deal of

information about price structures, demand response, price/quality trade-offs and existing constraints on over- and under-investment.

114. We have not been able to undertake this multi-faceted analysis in the 21 working days that the Commission has provided for submissions. Instead, in section 5 we present primarily qualitative material that suggests that the social costs of setting the WACC "too high" may outweigh the costs of setting the WACC "too low" by an equivalent increment.

4 Estimating cash flow asymmetry

115. In this section we present the qualitative and quantitative evidence of cash-flow asymmetries that we have managed to compile in the limited time that has been provided. Recall that the chief sources of cash flow asymmetry are:

- the fact that higher than expected demand increases profits by less than low demand reduces them due to the asymmetric change in costs, i.e., the distribution of expected costs is asymmetric due to an asymmetric response to variation in demand;
- the existence of low frequency but high impact events (such as earthquakes, tsunamis, storms, flooding, etc.) that are not currently compensated for in businesses' price paths, and from which they cannot recover lost revenues in a customised price path;
- the real possibility that distribution infrastructure will be stranded by the emergency of new technologies before the costs of those investments have been fully recovered - the potential for this to occur in the next 10 to 20 years is a real concern for investors (let alone the longer run); and
- the cash-flow risks from the potential costs of insolvency – the prospects of which may increase due to the other factors described above, e.g., a natural disaster may prompt customers to install battery and solar solutions, leading to asset stranding and a heightened risk of bankruptcy.

116. In what follows, we consider the potential magnitude of the increment above the median WACC ("**α**") that is required to compensate for these factors. Absent such an up-lift, a business' expected revenues will not equal its expected costs.

4.1 Cost asymmetries

117. In this section we model the potential impact of asymmetric changes in costs due to variations from demand forecasts. We show that if low demand delivers smaller cost savings than high demand causes cost increases, then the distribution of profits is asymmetrically distributed around the midpoint (median) return. Specifically, the mean return that a business actually expects to earn in a regulatory period is less than the regulatory WACC used in the Commission's financial model.

118. Our analysis is based largely upon data collected from the Commission's 2010-2015 default price-quality path (DPP) reset process. We provide an overview of our modelling and the results in the following sections. In short, we estimate that this asymmetry will reduce the actually expected return by between 6bp and 23bp. Given that the Commission's 75th percentile uplift is current 72bp this range accounts for between 8%-32% of that increment.

4.1.1 Overview of modelling

119. We begin with a "base case" financial model where modelled revenues (given assumed sales of energy and connections) are set equal to modelled costs (which are also a function of assumed growth in energy and connections). In the base case, the return actually earned on the opening RAB is equal to the assumed cost of capital, which is an input into the model. In other words, if the future turned out exactly as assumed in the financial model, then investors' returns would be exactly equal to the regulatory WACC.

120. However, this is simply the base case. Investors may earn more or less than this depending on the sales and expenditures that actually occur over the regulatory period. How much more or less depends on a range of factors that might cause sales and expenditures to vary from forecast levels. However, in our modelling we focus on just one source of variation: variation in demand from forecast levels and the extent to which this causes revenues and expenditures to differ from forecast levels.

121. Our modelling – and the Commission's – suggests that the elasticity of operating expenditure to variation in sales (of energy and connections) is less than one. That is, operating expenditure increases less than proportionally with increases in sales. For example, a 10% increase in sales may therefore only result in a 5% increase in operating expenditure. The same is also assumed to be the case for capital expenditure.

122. By contrast, real revenues grow proportionally under a regulatory regime that sets constant real prices. Consequently, as sales increases, so too do profits (because revenues rise faster than sales). Clearly, the opposite is also true – revenues fall faster than costs in the face of lower than forecast revenues.

123. Consequently, variation in demand gives rise to a distribution of returns that investors can actually expect to achieve. If revenues and costs respond symmetrically to variability in demand then this distribution will be symmetric. For example:

- a 10% increase in sales increases revenues by 10%; and
- a 10% reduction in sales reduces revenues by 10%.

124. However, expenditures are less likely to respond symmetrically to variation in sales. There are at least two reasons to believe that operating expenditure will not, in relative terms, fall as fast when demand is falling as it rises when demand is rising. The first is the fact that, once a business has invested in a distribution asset, the costs of doing so cannot usually be recovered be redeploying the asset or selling it on a second hand market. Those costs are, for all intents and purposes, sunk.

125. This means that the business has very little choice but to continue maintaining that asset, regardless of the level of demand. Consequently, falling demand will tend to

give rise to excess capacity relative to forecast rather than the "decommissioning" or redeployment of assets which one would expect to see in workably competitive markets characterised by more mobile assets. In short, around the same number of assets will need to be maintained even if sales volumes are lower than expected.

126. The second reason is that labour market dynamics typically require that firms, not employees, take on volume risk. That is, consistent with the findings of the economic literature,[24] workers are generally reluctant to agree to accept lower wages (or to risk being laid off) in response to volume risks. These risks consequently tend to fall on investors rather than workers.[25]

127. The two factors described above imply that unexpectedly high demand (energy sales and connections) will tend to raise profits by less than unexpectedly low demand causes profits to fall. This is because the cost increases that are incurred when demand is stronger than expected are larger than costs that are avoided when demand is weaker than forecast. In other words, profits respond asymmetrically to variations in demand.

128. For the purpose of this memorandum we model three relationships between operating expenditure and variability in sales (energy and connections).

    a. A symmetric scenario in which variances between forecast and actual volumes (positive or negative) have the same magnitude of effect on operating expenditures whether the variation is positive or negative.

    b. A scenario in which variances between forecast and actual volumes alter operating expenditures only if sales exceed forecasts. In this scenario, lower than expected volumes deliver no savings relative to forecast operating expenditure.[26]

    c. A "lower bound" scenario in which variances between forecast and actual volumes have a symmetric impact on operating expenditures up to the point at which volumes are falling in absolute terms – at which point any lower sales volumes deliver zero cost savings.

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[24] For example, Janet Yellen, the current Chair US Federal Reserve, surveyed the literature on Efficiency Wage Models of Unemployment in Vol. 74, No. 2, May, 1984 Papers and Proceedings of the Ninety-Sixth Annual Meeting of the American Economic *Association*. See also her 1990 publication with Nobel laureate George Akerlof: Akerlof and Yellen (1990), "The Fair Wage-Effort Hypothesis and Unemployment," *Quarterly Journal of Economics*, 105 (2), (May 1990), p255-283.

[25] A firm that nonetheless attempts to insulate its investors from volume risk by lowering wages/laying off workers when volumes are low will gain a reputation for such conduct. This reputation will make it harder to attract workers in the future when volumes are higher and may cause the highest productivity workers to leave. It may also lead to disgruntlement and lower productivity of workers who are retained. (Of course, it is also the case that it may not be possible to lower wages for contractual reasons and, similarly, legal requirements may mean a process of laying off workers may take time to put in place.)

[26] There may of course be other reasons for why actual expenditures may be lower than forecast expenditures, such as lower than expected increases in input prices.

129. We have tested the expected (mean) rate of return that a business can expect to earn under each of these scenarios if its price path is derived using the Commission's financial model. In all of the scenarios, if sales are equal to forecast, then the mean return is equal to 8.77% - the WACC in the Commission's financial model.

130. However, where costs respond asymmetrically to positive and negative variations in sales (scenarios (b) and (c) above) the average return actually earned is lower than WACC used to generate the price path in the Commission's financial model. We test the impact on firms' returns of this asymmetry by performing 10,000 Monte Carlo simulations, in each of which a sales figure is randomly selected by the model that could be above or below the forecast.

131. The exercise might therefore be thought of as modelling 10,000 hypothetical regulatory periods in which a firm is placed on a DPP and may earn a return above or below the regulatory WACC, depending of the levels of sales that actually transpire. Note that in order to perform this analysis we have had to make certain assumptions about the elasticity of operating costs. These are set out in detail in Appendix A. The results of our Monte Carlo simulations are set out below.

4.1.2 Modelling results

132. Table 1 shows that, in the scenarios in which costs respond *asymmetrically* to positive and negative variations in sales (scenarios (b) and (c) above), the average return that the business earns over the 10,000 hypothetical regulatory periods is lower than the regulatory WACC used to generate the price path (8.77%).

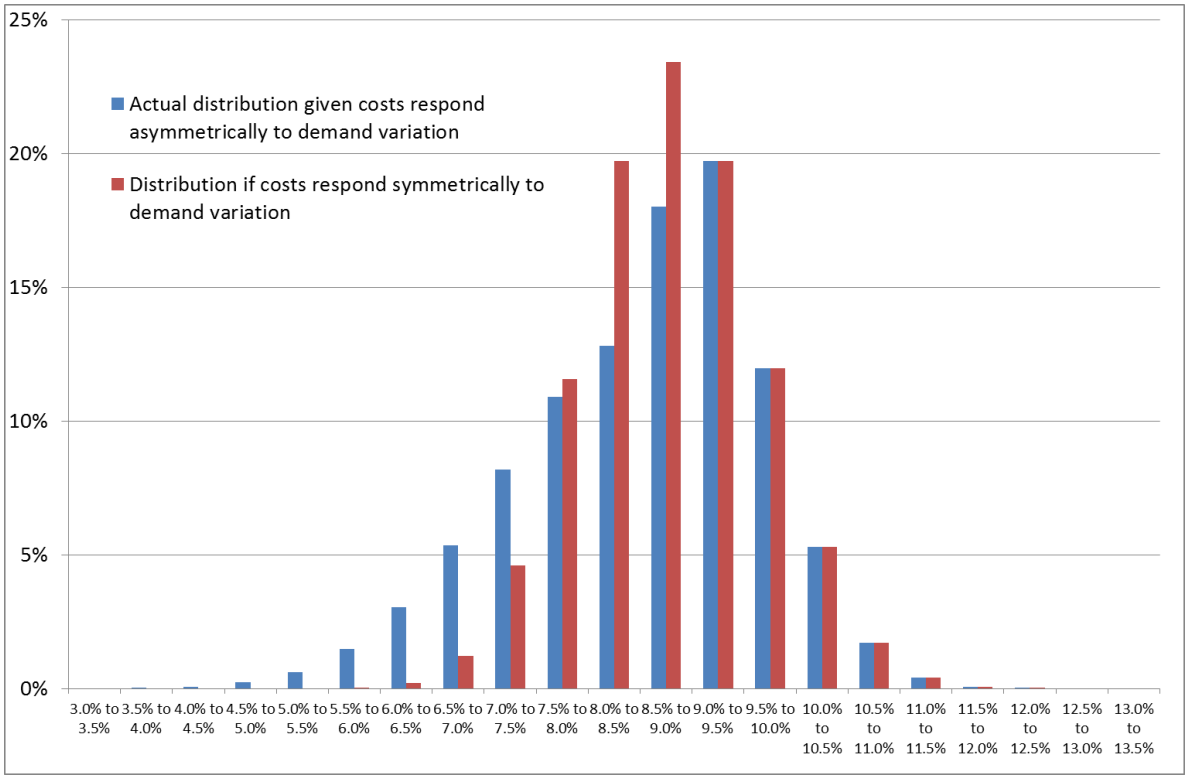
Table 1: Mean expected returns when regulatory WACC = 8.77%

Scenario	Mean return	8.77% less mean return	Scenario	Mean return
Scenario	Capex elasticity=0.5		Capex elasticity=1.0	
(a) Symmetry in costs associated with positive and negative variations in sales from forecast	8.77%	-	8.77%	-
(b) No cost savings associated with negative variations in sales from forecast	8.60%	0.17%	8.54%	0.23%
(c) Cost savings from negative variations in sales from forecast only up to the point at which sales fall in absolute terms	8.71%	0.06%	8.67%	0.10%

133. The results underpinning the 8.60% figure in the second column and the second last row of Table 1 shows that, in the scenarios in which costs respond asymmetrically to positive and negative variations in sales (scenarios (b) and (c) above), the average return that the business earns over the 10,000 hypothetical regulatory periods is lower than the regulatory WACC used to generate the price path (8.77%).

134. The distribution underpinning the 8.60% mean return in Table 1 is shown graphically in Figure 5 below. The blue distribution is the distribution that results from the asymmetric relationship between costs and sales. The red distribution is a symmetric distribution that *would* exist if the relationship between costs and sales was symmetric.

Figure 5: Distribution associated with 8.60% mean expected return



135. On the basis of the results set out in Table 1, we estimate that the modelled asymmetry in the relationship between expenditures and sales reduce the return that a business can actually expect to receive during a regulatory period by between 6bp (scenario (c) with capex elasticity = 0.5) and 23bp (scenario (b) with capex elasticity = 1.0). Given that the Commission's 75th percentile uplift currently amounts to 72bp above the midpoint (50th percentile), this range accounts for between 8% and 32% of that increment.

4.1.3 Implications

136. The asymmetry in cash flows arising from variations in forecast volumes is sufficient to justify an increment above the median WACC. As we just noted, our preliminary modelling suggests that the asymmetry in the relationship between expenditures and sales will reduce the actually expected return by between 6bp and 23bp or by 8%-32% of the current 75th percentile increment. Unless there are other,

off-setting positive asymmetries (which is unlikely), this source of asymmetry alone means that it is *not appropriate* to use the 50th percentile. Something higher is needed.

4.2 Natural disasters

137. Cash flow asymmetries may also arise due to natural disasters such as earthquakes that, although infrequent, have wide-ranging impacts on distributors' costs and revenues. The potential for these "low probability but high impact (LP/HI)" events to occur means that the demand for services within a regulatory period is more likely to be lower than the median forecast, and conversely for the costs associated with providing services. Put simply, disasters such as earthquakes, floods, storms and tsunamis cause costs to go up and revenues to go down.

4.2.1 Treatment within the regulatory regime

138. Whether the existence of LP/HI events justifies a further increment above the median WACC depends to a large extent upon how the regulatory regime manages the financial consequences of such events. If the regulations allow a business to recover all of the additional costs it incurs and the revenues that it loses when a LP/HI strikes (e.g., through "full pass through" provisions or a wider industry levy), then no further compensation would be required to address the asymmetric cash-flows.

139. Similarly, if businesses' are able to fully insure against every conceivable LP/HI event – either by taking out insurance policy with an external provider or by self-insuring (i.e., setting aside funds) – and those costs can be included in their revenue allowances, then the asymmetry again disappears. However, neither of these conditions applies in this particular instance, based on Orion's experience following the Canterbury earthquakes.

140. The Commission was willing to allow Orion to recoup the additional expenditures that it incurred prior to its CPP coming into effect. It also allowed Orion a higher expenditure allowance and reduced volume forecast, moving forward. However, it did not allow Orion to incorporate all of the additional expenditure that it had included in its proposal[27] and, crucially, it was prevented from clawing back the revenue that it had lost due to its volumes being lower than expected (prior to the CPP taking effect).

141. In addition, Orion did not have insurance to cover the unexpected reduction in its revenues, and it had not received an explicit allowance in its prices under the thresholds regime. Nonetheless, Orion was left to bear that cost. Moreover, the

[27] This was said to be "too much too soon", *see:* Commerce Commission, *Setting the customised price-quality path for Orion New Zealand Limited, Final reasons paper*, 29 November 2013, p.4.

Commission made it clear in its decision that that no compensation would be provided – either ex-ante or ex-post – for lower-than-forecast revenues due to future catastrophic events.[28]

142. In other words, the Commission appears to be stating that, even if it was possible to procure insurance from external providers to cover these volume risks or to feasibly self-insure, the attendant costs would not be recoverable in regulated prices. The reason that the Commission provided in its reasons paper for eschewing from providing such compensation was that "investor diversification minimises the impact of demand risk".[29] In our opinion, that is not the case.

4.2.2 Diversification does not address these costs

143. If the Commission does not provide some form of *ex-ante* or *ex-post* compensation to compensate investors for the costs of LP/HI events, then diversification will not make investors whole. The error that the Commission appears to have made in its assessment of Orion's CPP is to assume that, when a LP/HI such as an earthquake strikes, the losses to one business – in this case Orion – are off-set by gains to others – in this case, other distributors located in other parts of New Zealand.

144. In other words, although an investor in Orion will suffer a loss from the reduced demand for electricity in Christchurch, if she is "well diversified" she will own stakes in other distributors in other locations not affected by the earthquake, and benefit from higher demand in those areas. So long as these gains and losses offset one another, there is no need to provide the investor with any compensation for the lower demand in the area hit by the catastrophe.

145. The Commission sought to support this point in its final decision on Orion's application by observing trends across all of New Zealand's electricity distributors. It concluded that there was not much change in either connection numbers or annual energy entering the networks. It also stated that any increase in volatility was "not unusual compared to that observed before the earthquakes (i.e., between 2005 and 2010)".[30] It consequently concluded that:[31]

    - *"Based on our analysis of the number of connections, we are unable to conclude whether the demand reduction was symmetric (i.e., the drop in the number of connections fell for Orion but increased by a similar amount for*

[28] Commerce Commission, *Setting the customised price-quality path for Orion New Zealand Limited, Final reasons paper*, 29 November 2013, p.136.

[29] *Ibid.*

[30] Commerce Commission, *Setting the customised price-quality path for Orion New Zealand Limited, Final reasons paper*, 29 November 2013, §B95.

[31] Commerce Commission, *Setting the customised price-quality path for Orion New Zealand Limited, Final reasons paper*, 29 November 2013, §B83.

other NZ distributors) or asymmetric, i.e., connections lost on Orion's network did not move to other distributors' networks); and

- *We are also unable to conclude whether the demand reduction measured as the volume of energy entering the network was symmetric (ie, the drop in energy volumes fell for Orion but increased by a similar amount for other NZ distributors) or asymmetric, i.e., lost energy volumes on Orion's network did not move to other distributors' networks."* [internal footnote omitted]

146. In our opinion, the fact that the Commission could not isolate the effect of the Christchurch earthquakes on nationwide connection numbers and energy throughput from other factors does not mean there was "perfect displacement" of demand (i.e., a symmetric national response). In order for lower than forecast demand in an area affected by a disaster to lead to an equivalent increase in demand in other locations throughout New Zealand an implausible series of events would need to take place. Specifically, it would require:

- every person paying a connection fee to the local distributor to immediately move to another part of New Zealand;
- for every one of those persons to build themselves a new premises and start paying connection and usage fees to the distribution company in that area; for every one of those persons to consume the same volume of electricity that they would have in the absence of the LP/HI event; and
- for the new distribution company to incur zero costs in connecting the new customers and then serving them with energy.

147. In our opinion, none of these assumptions are reasonable. Consequently, they constitute a critical flaw in the Commission's "perfect displacement theory". The more plausible explanation is that there was *not* an equal and offsetting increase in demand in other locations following the earthquake and the Commission was simply *unable to quantify that reduction*. In our opinion, it is safe to assume that LP/HI events such as the Christchurch earthquakes may have the following impacts upon demand:

- people may move (at least initially) to live in more dense accommodation (e.g., stay with friends/family, live in smaller spaces);
- electricity consumption per person would fall (you use the same amount of electricity to heat a room if two people are sleeping in it rather than one);
- people may suffer financial hardship after the event and may be more cost conscious, consequently reducing their demand;
- the number of active connections in New Zealand would be likely to fall; and
- any displaced demand (for connections or energy) to other distribution areas would be associated with positive incremental costs for the new distributor.

148. In terms of the last point, even if 100% of demand/connections could be perfectly displaced following a LP/HI event (which is not possible), the costs to the other distributors of meeting the higher demand/connections will be much higher than the costs the affected local distributor would have faced without the event. This is because it had its infrastructure in place already serving those customers, whereas the other businesses would need to build it. Consequently, the lost profit to the affected local business from lower demand will be much higher than the gain in profits to other distributors.

149. The Commission is therefore incorrect to suggest that the ability of investors to diversify obviates the need to provide either ex-ante or ex-post compensation for lower-than-forecast revenues arising from catastrophic events. If compensation for these costs is not provided, then the adverse consequences for the businesses within an investor's portfolio that are hit by LP/HI events will not be offset by benefits accruing to other businesses in the portfolio that are unaffected.[32]

150. The Commission's refusal to provide any allowance for lower-than-forecast revenues arising from LP/HI events consequently represents an asymmetric risk to cash-flows that cannot be addressed through diversification. However, although the expected costs of lost revenue arising from such events are likely to be material (as evidenced by Orion's experience), arriving at robust quantitative estimate of those costs is likely to be very difficult.

4.2.3 Quantifying the expected costs

151. In order to estimate the expected costs of LP/HI one must have a good understanding of both the likelihood of such events occurring and the potential cost consequences if they do. That understanding is likely to be very difficult to obtain in practice, given the intrinsic uncertainty that surrounds these events. For example, there will be a substantial degree of uncertainty surrounding:

- the types of event that might occur, e.g., although earthquakes are a common occurrence in New Zealand, the two major Canterbury earthquakes occurred on previously unknown fault lines and few would have predicted their severity.
- the likelihood of those different types of events taking place in any given year, e.g., whether storms, tsunamis, earthquakes, floods, etc., will occur once every 10 years, 25 years, 50 years, 100 years and so on; and
- the potential impacts that these events may have on the affected businesses' revenue, e.g., few would have predicted the scale of the damage done by the Canterbury earthquakes and the extent of customer disruption.

[32] Note that the ability of investors to diversity beyond New Zealand distributors – e.g., across different sectors, asset classes and countries – does not detract from this fundamental point.

152. These uncertainties surrounding the calculation of expected costs caused Green and Houston (2012) to conclude that it may be best to allow businesses to recover the costs of such events from their customers as and when they happen, rather than to provide a speculative allowance in the DPP.[33] We are inclined to agree. However, if the Commission is disinclined to compensate businesses ex-post (which it appears to be), then they must be estimated ex ante.[34]

153. We have not attempted to do so in the time provided, given the complexities involved. However, it is possible to make some observations about the impact of the recent Canterbury earthquakes on Orion and the implications for its returns. The Commission estimated the present value of Orion's lower than forecast revenues at $59.4m.[35] This sum, which Orion was unable to recover, represents 6.9% of Orion's 2013 closing RAB[36] ($59.4m ÷ $864.65m).

154. Assuming that the appropriate discount rate is equal to the current DPP WACC of 8.77% (vanilla)[37] then, in order for Orion to be fully compensated for the $59.4m in lower than forecast revenues, it would need to earn an additional 60 basis points above the median WACC in perpetuity (i.e., $59.4m ÷ $864.65m x 8.77%). This accounts for more than 83% of the increment currently provided by the 75th percentile under the DPP (which is 72 basis points).

155. Of course, it must be acknowledged that this increment largely reflects the fact that Orion has just experienced an earthquake. The increment that would be needed to compensate businesses for the expected future cost of the next earthquake, storm, flood and so on, may be quite different and would need to reflect the probabilities of those events occurring throughout New Zealand. However, we have neither sufficient time nor data to arrive at a reliable estimate of the expected impact of LP/HI events on distributors' cash-flows.

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33 Green & Houston, *The Treatment of Self-Insurance, A Report for Orion New Zealand Ltd*, 25 January 2012, p.16.

34 We also note that there are problems with the Commission being able to deliver on a promise of ex post compensation if this causes customers to seek alternatives to grid based electric energy – as discussed further in section 4.3 below.

35 The Commission's calculation took into account lower than forecast 2013 actual revenues, used the projection of Orion's 2010 DPP price path and used the DPP cost of debt to calculate the 2014 present value. *See:* Commerce Commission, *Setting the customised price-quality path for Orion New Zealand Limited, Final reasons paper*, 29 November 2013, footnote 329.

36 Orion New Zealand Limited, Information for disclosure for the year ended 31 March 2013, Electricity distribution information disclosure determination 2012, Approved 14 August 2013, p.7. Note that Orion's 2014 regulatory asset value was not available at the time this report was published.

37 Commerce Commission, *Determination of the Cost of Capital for Services Regulated under Part 4 of the Commerce Act 1986, Pursuant to Decisions 709, 710, 711, 712 and 713, Decision Number 718*, 3 March 2011, §2.

4.2.4 Implications

156. The apparent unwillingness of the Commission to provide explicit compensation to businesses for LP/HI events represents yet another reason that, even if the median WACC is equal to the true WACC, expected revenues will not cover expected costs. As we explained above, the potential for investors to diversify does not make these costs go away. The existence of those costs is consequently sufficient to justify a further increment above the median WACC.

157. As we explained above, the modelling that would be required to estimate the magnitude of that increment is highly complex, and we have not attempted it in the time available. However, in our opinion, that increment is likely to be material and would need to be added to the 6bp and 23bp margin applicable to asymmetries in forecast volumes described in section 4.1 above.

4.3 Asset stranding

158. One typically associates the prospect of asset stranding with regulated industries such as telecommunications, where the emergence of competing technologies such as fibre and wireless constrain the price that can be charged for legacy copper networks. This well-understood possibility can be dealt with by adopting front-loaded recovery profiles.[38] In other words, the businesses can be allowed to recover a greater proportion of the initial investment cost in the early years of an assets life – in part to insulate them from the possibility that they might be unable to charge high prices in later years as competing technologies emerge.

159. Until recently, one did not necessarily associate stranding risks with electricity distribution. Rightly or wrongly, electricity lines have historically been viewed as more durable assets that are unlikely to be replaced by competing technologies in the foreseeable future. However, that impression does not reflect the current reality. There is now a growing recognition that distributors face a very real prospect asset stranding and that is not reflected in the Commission's regulatory model.

4.3.1 Current regulatory practice

160. The Commission's pricing model backloads the recovery of the costs of distribution assets to the end of their lives – around 45 years, on average. The various assets that comprise the RAB all have overlapping lives and are only of use if other assets are also kept in place. For example, if one electricity pole needs to be replaced, it will

[38] A common approach is to set the allowed rate of return on and of capital based on a "tilted annuity", whereby the level of recovery falls by a certain percentage (e.g., 5%) each year, but delivers the same present value of compensation overall as if straight line depreciation (a "zero tilt") had been applied. *See:* Hird & Young, *Application of Annuity Depreciation in the Presence of Competing Technologies II, A Report for Telecom New Zealand*, 29 March 2006.

only continue to be useful over its remaining life if the other poles connecting it to the substation are also replaced in the future when they reach the end of their lives.

161. The RAB might therefore be thought of as a single asset that is constantly having bits and pieces added or replaced. Because of these interdependencies and overlapping asset lives, there will never come a time when all assets are fully depreciated and investors can "walk away" from the industry with a zero RAB, having recovered all of their investments. They will always have some "skin in the game". The RAB might consequently be conceptualised as a "perpetual asset".

162. It follows that if the service ceased to be supplied at some point in the future, that time would necessarily be associated with a positive RAB and some degree of asset stranding – unless a radically accelerated depreciation profile was put in place. Moreover, it is becoming clear that this scenario may transpire relatively quickly. Although it may not occur in the next 5-10 years there is a widespread view that it could happen in the next 10 to 20 years.

4.3.2 Growing recognition of stranding risk

163. In recent years, there have been vast improvements in the economics of solar power. McKinsey report that the price of solar-PV modules dropped from more than $4 per Wp[39] in 2008 to just under $1 per Wp in 2012. This is corroborated by the US Department of Energy in a report entitled "*Revolution Now*" in which it is estimated that there was a 75% reduction in solar PV costs in the four years since 2008.[40]

> *"…today we are in the midst of a generational shift to solar energy. Falling costs for solar power mean that the infinite power of the sun is increasingly within reach for the average American homeowner or business. This shift has come about because of a dramatic retreat in the price of solar PV modules – a trend that has accelerated over the past 5 years. Today, solar PV is rapidly approaching cost parity with traditional electrical generation from gas, coal and oil in many parts of the world, including parts of the U.S."*

164. McKinsey estimate that global installed capacity increased from 4.5 GW in 2005 to more than 65 GW by 2012.[41] Sanford Bernstein highlights the same trend in a recent report that received widespread media coverage.[42] Figure 6 below illustrates.[43]

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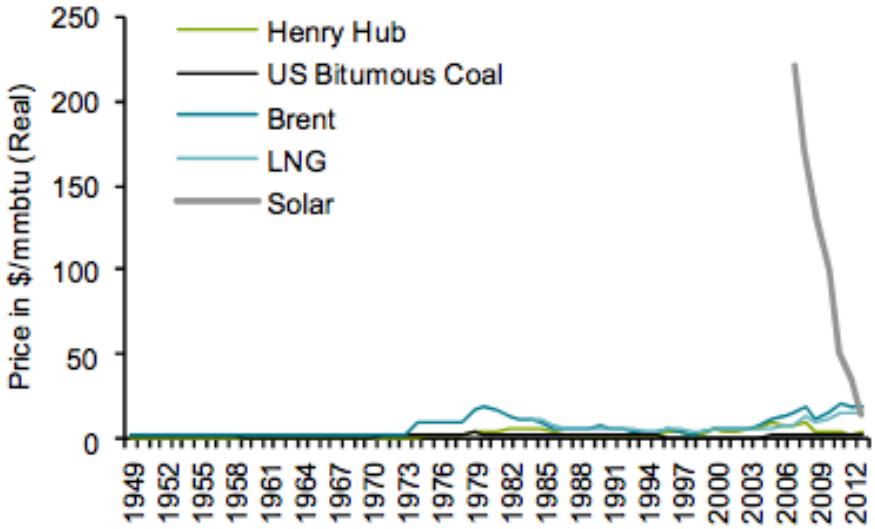
39 The output of a solar generator operating under standard conditions is defined as its peak output, which is measured in watts or kilowatts and expressed as either watt peak (Wp) or kWp, respectively.

40 US Department of Energy, *Revolution Now, The Future Arrives for Four Clean Energy Technologies*, September 2013, pp.4-5.

41 McKinsey and Company, *Solar power: Darkest before dawn,* May 2012, p.3.

42 Bernstein Research, *Bernstein Energy and Power Blast: Equal and Opposite…If Solar Wins, Who Loses,* April 4, 2014.

Figure 6 Prices per Energy Type



Source: Energy Information Administration, World Bank, Sanford Bernstein analysis.

165. These rapid developments in what is now a hundred billion dollar industry worldwide have potentially enormous ramifications for electricity distribution businesses. Although solar has only a small share of the energy market now, over the next decade and beyond the rapidly improving economics of solar cells may lead to it having a much greater, and rapidly escalating share of delivered energy. McKinsey conclude that distributed rooftop generation is likely to be the dominant source of solar demand in OECD countries.[44]

166. As far back as 2008, Ault et al, in a report for Ofgem, also posited a scenario in which, over the longer-term, the improved economics of alternative energy sources would cause groups within communities to work together to deliver even wider ranging off-grid solutions. In 2008, the authors suggested that it is conceivable that:[45]

> *"Within the domestic sector there could be widespread deployment of micro CHP and renewable micro generation. As a result of government strategy, public bodies (schools, hospitals, council offices) may have developed CHP, storage and renewable energy sources that reduce these organisations reliance on their grid connection and centralised energy*

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43 The comparison is Figure 6 is on an MMBTU basis. MMBTU is the standard unit of measure for liquid fuels, often referred to as one million British thermal units.

44 *Ibid,* p.8.

45 Ault et al (2008), *Electricity Network Scenarios for Great Britain in 2050*, *Final Report for Ofgem's LENS Project,* November 2008, p.63.

resource. Industrial consumers could be similar but may have larger generation sources serving multiple factories – Power Parks. In certain settings these institutions will be central players in community energy solutions, possibly trading within a local micro-grid. Many companies would service consumer demands for a variety of self-generation technologies and products."

167. Presently, despite the growth in solar and wind energy, their intermittent nature means that it is difficult for customers to be completely self-sufficient on these forms of energy, i.e., it is difficult to go completely "off grid". However, as solar prices continue to drop, the concept of installing PV cells and keeping a separate, back-up source of generation such as a diesel generator – or even a community-owned energy source of the type described above – becomes increasingly attractive.

168. Moreover, this intermittency problem may be overcome by improvements in storage technology. It was recently reported that Professor Michael Aziz, at Harvard University, is developing a flow-battery with funding from the US Advanced Research Projects Agency over the next three years that promises to cut the cost of energy storage by two-thirds below the latest vanadium batteries used in Japan.[46]

169. There is currently very significant investment in battery storage solutions focussed on electric vehicles. The US Department of Energy estimates that that cost of these batteries has halved in the last four years. It is likely that the development of knowledge in this area will lead to significant advances in electric energy storage solutions for households.

170. This is more than a theoretical proposition. On 30 April 2014, SunPower – a company now valued at more than $US4 billion – announced that it would soon add storage to its solar offerings in Australia in a pilot program that it hoped would evolve into the introduction of home energy management systems.[47] CEO, Tom Werner, said that this may lead to small-scale solar farms that are delivered close to the source of demand, i.e., precisely the type of community-based generation source foreshadowed by Ault et al in 2008. Mr Werner commented that:[48]

"A building owner, where they are residential or commercial, will go from having no control of their energy bill to total control of their energy bill"

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46 Evans-Pritchard A., "Global solar dominance in sight as science trumps fossil fuels" *in The Telegraph*, 9 April 2014.

47 *See:* http://reneweconomy.com.au/2014/interview-sunpower-ceo-tom-werner-on-solar-storage-revolution-15057; and http://reneweconomy.com.au/2014/sunpower-says-australia-could-be-global-leader-in-local-generation-62351.

48 *See:* http://reneweconomy.com.au/2014/interview-sunpower-ceo-tom-werner-on-solar-storage-revolution-15057.

171. Cheap solar plus cheap storage would have large implications for network businesses. For example, Sanford Bernstein has predicted that it may not be long before home energy storage is cheap enough to lure households away from the grid en masse across the world.[49] It has foreshadowed that grid companies will lose customers to these alternative technologies in the relatively near term and then face the prospect of a "death spiral". This spiral occurs because:[50]

- as customers go off grid (or reduce their demand), distributors must attempt to recover broadly the same pool of fixed costs from a dwindling customer base;
- this then causes prices to rise, making it more likely that more of those remaining customers will also switch; and
- this leads to further price rises and more switching, and so on and so on.

172. Even if that "tipping point" where customers start disconnecting from (or substantially reducing their use of) the grid has not yet arrived it may be unavoidable. If solar and battery costs continue to fall relative to "poles and wires", then that tipping point will one day come and, because distribution assets have overlapping lives and must constantly be replaced in order for other assets to retain their value, when it does, this will cause assets to be stranded.

173. It must be noted that stranding of this kind does not require households to actually install battery storage etc. and disconnect from the grid. Rather, all that is required is that they would do so if distributors attempted to recover their full RAB in prices. If this is the case then distributors will rationally charge less than is necessary to recover their full RAB – because this avoids or delays the "death spiral" described above. This will likely be efficient given that many of the distributors' assets at any given time are likely to be sunk.

174. However, notwithstanding that the assets are still being used and generating some revenue, this scenario still involves a partial stranding of the RAB. An investor in today's RAB will be cognisant of this future risk, and require compensation for it before he or she invests.

175. The tipping point described above might also be brought forward by the types of events described in section 4.2. Imagine that a natural disaster such as an earthquake hits a local distribution area. Suppose also that the effect of the earthquake is to:

- leave some households without grid power for an extended time; and
- cause the distributor to suffer significant costs, which are subsequently recovered from customers in that location through higher prices.

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49 Bernstein Research, *Bernstein Energy and Power Blast: Equal and Opposite…If Solar Wins, Who Loses,* April 4, 2014.

50 *Ibid.*

176. Customers who have no grid access for extended periods may find installing solar and battery solutions attractive if this reduces the period in which they do not have electricity. Moreover, any attempt to raise prices will make substitution to "off grid" supply more attractive. Both forces having the effect of pushing the distributor closer to, or over, the tipping point and into the predicament described above.

4.3.3 Implications

177. The continued emergence of solar and storage solutions as a genuine alternative to "poles and wires" gives rise to a material stranding risk. This may not be expected to occur in the next 5-10 years (although it may). However, the potential for this to occur in the next 10 to 20 years is a real and growing possibility facing investors (let alone in the longer run). The overlapping lives and interdependence of distribution assets means that, if it does happen, distributors will have unrecovered costs that they will struggle to recoup from a smaller customer base.[51]

178. The best estimate of the expected cost of stranding from this source requires projections of technological advances into the future which we, and the Commission staff, do not have the expertise to make – at least not without external expert advice and greater than 21 days to research the issue. The, expected cost of technological stranding also depends on the depreciation path used in the meantime by the Commission. The faster the Commission depreciates the RAB (so that it is shrinking rather than growing) the smaller is the exposure of investors to future stranding. Of course, this means increasing prices to end users in the short to medium term.

179. Even with inputs from the relevant experts and with a known future depreciation profile, there would still be a wide error range around this estimate. However, we can conclude that the best estimate of the cost of stranding is not zero. Assuming a zero stranding risk is an extreme assumption – one that no investor in any technology would rationally adopt.

4.4 Costs of insolvency

180. Another critically important source of asymmetry in expected cash-flows is the expected costs of financial distress. It is well understood in the finance literature that the benefit of gearing to the firm comes in large part through the tax shield that this provides.[52] However, if this was the only effect of leverage then all firms would be much more highly geared. It is recognised that there must be a transaction cost "downside" from leverage such that, at the margin, the transaction cost "upside"

[51] Or even a larger customer base, if those customers have lower cost alternatives.

[52] The benefits of which the Commission's financial model captures and delivers to customers in the form of lower prices.

associated with lower corporate taxes is equal to the transaction cost "downside". That is, the marginal costs and benefits of leverage are equal. The "catch-all phrase" for this downside in the economic literature is the "costs of financial distress" (CFD). These costs come in many forms, including:

- being forced to raise capital at disadvantageous rates in the future;
- having to sell assets at "fire-sale" prices;
- distortions to operational decisions that result from operating in financial distress; and,
- ultimately, the direct costs of litigation between stakeholders triggered by insolvency/bankruptcy.

181. Leverage raises the expected CFD because it reduces the equity buffer in a firm and, in turn, increases the probability of future financial distress. In a separate report prepared on behalf of Orion that is contained in **Appendix B**,[53] CEG Academic Consultant Professor Bruce Grundy has reviewed the literature on the CFD and is able to provide a reasonably tight bound for the expected CFD – including utility specific estimates.

182. Specifically, by relying on empirical estimates of the CFD in the finance literature, Professor Grundy estimates a range for the actuarially expected CFD of between 5% and 8.8% of firm value – with the upper end of that range being a utility specific estimate. At a median WACC of 8.05%, compensating for this cost requires between 40 to 71bp to be added to the regulatory WACC in perpetuity. This represents between 56% and 98% of the 72bp increment currently provided by the 75th percentile under the DPP.

183. Failure to compensate for the CFD amounts to essentially assuming that EDBs get only upside from using debt (in the form of lower tax costs) without compensating for the negative transaction costs that are the flipside of debt finance (and which are the reasons businesses are not geared at closer to 100%)..

53 Professor Bruce Grundy, *The Costs of Financial Distress and Allowed Revenues for Regulated Firms*, 28 April 2014 – see **Appendix B**.

5 Estimating asymmetry in social consequences

184. In this section we set out material that suggests that the expected social costs of setting the WACC "too high" is less than the costs of setting the WACC "too low" by an equivalent margin. Although this material is, by necessity, largely qualitative in nature, the available indications are that the expected costs of under-investment (i.e., cost x probability) exceed the costs of over-investment. If so, this would warrant yet another increment on the median WACC, i.e., in addition to the margin required for cash-flow asymmetries ("α").

5.1 Sources of asymmetry in social consequences

185. There are two potential sources of asymmetry in the consequences for regulatory error. These are that:

- investors may respond more aggressively to under-compensation than to over-compensation. That is, If the regulatory WACC is set 50bp above $WACC^{Median}$ + α then any consequent over-investment (i.e., relative to the optimal level) may be smaller than the under-investment that would result from a regulatory WACC that was set 50bp below above $WACC^{Median}$ + α; and/or
- the net social loss of under-investment may be greater than the net social loss of the same amount of over-investment.

186. We consider these in turn below.

5.1.1 Asymmetry in investment response

187. There are strong theoretical grounds on which to conclude that, in a light handed incentive regulation framework, investors will respond asymmetrically to regulatory error in setting the WACC. This is because, under incentive regulation there are pre-existing incentives that reward lower than forecast capital expenditure and penalise higher than forecast capital expenditure. Superimposing regulatory error on this framework will,:

- **if the error involves over-compensation**, run into a countervailing force in the form of penalising investment in excess of forecast; and
- **if the error involves under-compensation**: face no countervailing force but rather, simply reinforce incentives to spend less than forecast.

188. Indeed, the magnitude of the countervailing force under incentive regulation is sufficiently large that the regulatory WACC would need to be set several percentage

points above the true WACC before distributors would have a net incentive to spend in excess of forecast capital expenditure. This can be illustrated using a straightforward example.

189. Consider a distributor deciding whether to invest $1m more than is efficient and which has been allowed in forecast capital expenditure. If the regulatory WACC is above the true $WACC^{Median} + \alpha$, then, from the time at which the expenditure enters their RAB, the distributor will benefit by earning a higher return than is justified by the true risk of the investment. However, in the meantime:

- the distributor will suffer a loss in the form of foregone return on the $1m investment while it waits for it to enter the RAB and impact upon prices; and
- when the investment does enters the RAB at the beginning of the next period, it will do so at a depreciated value, i.e., the RAB will increase by less than $1m.

190. It is relatively easy to see that the level of over-compensation would have to be materially more than 1% (i.e., one percentage point) in order for a distributor to have an incentive to over-invest. Consider the situation in which:

- the distributor must wait five years before the capital expenditure in question enters the RAB;
- the expenditure enters at a level that reflects 5 years of depreciation;[54]
- the asset in question has a life of 45 years; and
- the true WACC is 8%, but the regulatory WACC is 9% (for simplicity, the value of α is assumed to be zero in this example).

191. In this case, the $1m of hypothetical overspending only enters the RAB at a depreciated value of $0.89m ($1m-5/45*$1m). Moreover, this only occurs after 5 years, and so the present value to the distributor is only $0.60m (=$0.89/(1.08)5). That is, the distributor, in present value terms, only receives 60% of the initial $1m investment in its RAB. The distributor then needs to "make up" this 40% loss in the value of the asset via earning a higher WACC over its remaining life which, in this example, is 40 years (45-5).

192. However, because the asset will depreciate over its life, this will leave a smaller and smaller amount on which the distributor will be earning any increment above its true WACC. When this is taken into account, the increment above the true WACC that would be required to entice this investment would need to be greater than 6%.[55]

54 This can be thought of as the expenditure occurring in the first year of a regulatory period or there being a capital expenditure incentive mechanism that ensure that overspending in subsequent years is penalised equally as heavily as overspending in the first year of a regulatory period

55 This is a spreadsheet calculation, but the order of magnitude can be seen by simply taking the ratio of the $1m original investment and the $0.6m PV of the value that enters the RAB (1.0/0.6 = 1.67). Multiplying this by the 8% true WACC gives 13.4% - which is the return that would be required on the

That is, a distributor with a true WACC of 8% would need the regulatory WACC to be set at more than 14% in order to be enticed to over-invest in this scenario.

193. Moreover, this assumes that the distributor is confident that it will actually earn the higher regulatory WACC over the remaining life of its investment. In reality, the distributor may be concerned that this will not happen for a number of reasons including, for example:

- it may consider that overinvesting now will raise the probability that a future regulator will deem that expenditure inefficient and exclude it from the RAB;
- it may raise the perceived probability that a future regulator will set lower capital expenditure forecasts in future periods, e.g., to reflect a perception of overcapacity; and
- even if it believes that over-investing now will have no impact on future regulatory decisions, it may still be concerned about the ability to recover its RAB given the threat of alternative technologies, discussed in section 4.3.[56]

194. We note that the above example assumes a 5 year delay until the asset enters the RAB. However, the ultimate result is not dependent on this assumption. Even if the delay until the asset entered the RAB was just 2 years, following the same logic and calculations, a distributor would require an increment above the median WACC to be more than 2.4% before it would have an incentive to over-invest. Again, this calculation assumes that overinvestment does not lead to any change in future regulatory action (including reduced future capex allowances) or any heightened risk of future commercial stranding.

195. By contrast, a distributor faced with a regulatory WACC that is too low will have no such countervailing incentive to avoid under-investing. Rather, the only countervailing force will be a heightened prospect of penalties if under-investment leads to breaches of quality of service standards. As discussed below, such penalties are a blunt instrument to prevent under-investment, in part because it is difficult to design quality of service penalties but also because reductions in quality of service are not the only way that the costs of under-investing manifest themselves.

196. For example, distributors can respond to the WACC being set too low by inefficiently substituting operating expenditure for capital expenditure, i.e., spending money on operating expenditure when it would be cheaper to invest in new capital. The effect of this substitution would be to raise overall costs without

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$60m PV that enters the RAB if the asset lasted forever (i.e., was never depreciated). The actual return required is higher still to reflect the fact that the asset actually depreciates over time – reducing the benefit of a high regulatory WACC.

56 That is, an EDB may be concerned that 'padding' its RAB now will expose it to heightened commercial (as opposed to regulatory) stranding risks in the medium to long term.

necessarily leading to quality of service reductions (or at least a sufficient reduction to trigger penalties).

5.1.2 Asymmetric net social costs from the same amount of under/over investment

197. Even if the probability of under-investment occurring if the WACC is too low is the same as the probability of over-investment occurring if the WACC is too high by an equivalent margin (which is not the case, as we explained above), there may still be an asymmetry of social costs. This can arise if the net social cost of $X of under-investment exceeds the net cost of $X of over-investment – where over/under investment is defined relative to an optimal level.

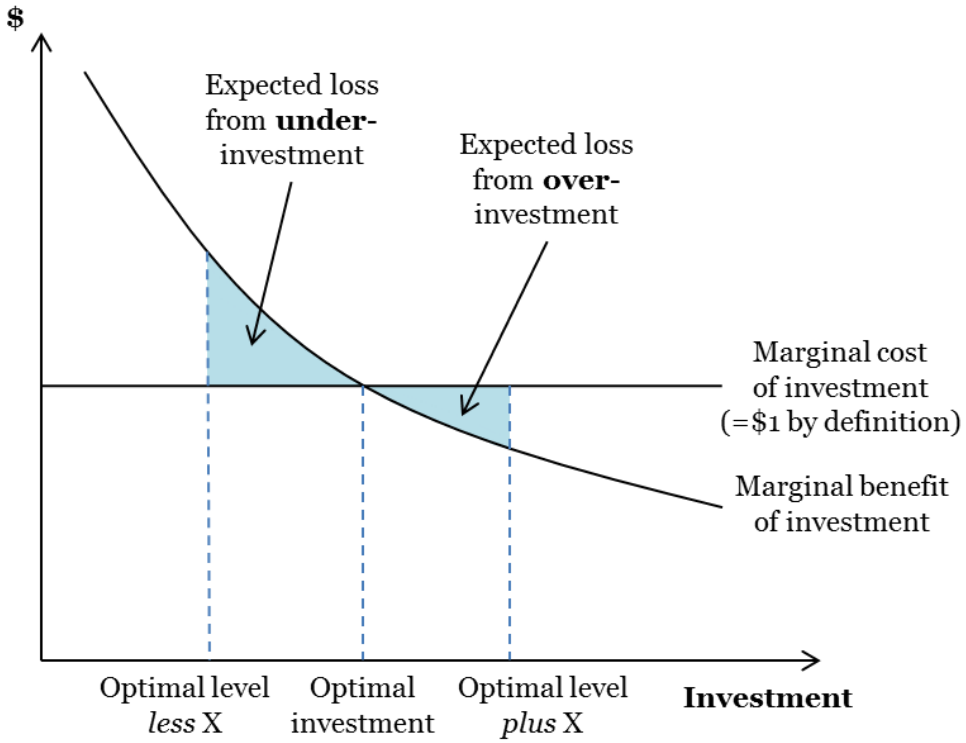
198. In these circumstances, even if under- and over-investment are equally likely, the *expected* net social cost of the former (i.e., probability of under-investment multiplied by the net social cost) will outweigh the expected cost of the latter. In technical terms, this asymmetry can be expected to arise if the slope of the marginal benefit curve is becoming less and less negative[57] the higher the level of investment. For example, as we explained earlier:

- if the existing QoS is very low (i.e., outages are frequent and long-lasting), then an additional $X in investment may materially reduce the probability of outages which, given the high value of lost load (VoLL) – tens or hundreds of thousands of dollars per MWh – may deliver marginal benefits that exceed $X; but
- if the existing QoS is very high (i.e., if a network was at an "N-3" standard), then an additional $Xm in investment may have a trivial effect on the probability of outages and, even accounting for the high VoLL, may consequently deliver benefits that are less than the $X cost of the investment.

199. This is illustrated in Figure 7 below. The unit cost of investment is set constant and equal to $1 by definition (i.e., the unit cost of $1 of investment is $1). The theoretically optimal level of investment is where the marginal benefit of investment is equal to the marginal cost, i.e., where the last $1 of investment delivered exactly $1 in benefits. If the marginal benefit curve is becoming "less negative" as the level of investment increases, then the expected loss from being $X to the left of this optimal investment level will be greater than the expected costs of being $X to the right of that optimal level.

57 This occurs when the marginal benefit of investment curve has a negative slope (with respect to investment), but the second derivative is positive.

Figure 7: Asymmetric costs of identical over/under investment



200. If the marginal benefit curve resembles that depicted in Figure 7 above, it follows that, even if the probabilities of under- and over-investment were the same (which is unlikely to be the case, for the reasons set out above), the *expected* social cost of under-investment would still be higher, i.e., β would be greater than zero, warranting an increment above the mid-point. However, confirming empirically the precise shape of the marginal benefit curve would be a complex exercise that would depend upon a number of factors.

201. For example, as we mentioned earlier, different groups of customers may place varying valuations on service quality and consequently derive quite different marginal benefits from incremental investments. Moreover, the shape of the curve will depend upon the investment options that are feasibly open to a distributor to deliver quality of service improvements and/or operating costs savings. This suite of options will be influenced by many factors, including requirements to prepare Asset Management Plans.

202. Finally, we note that if businesses are supplying less than optimal QoS for reasons unrelated to the WACC (e.g., customer growth in demand for QoS has outstripped supply or the regulator's willingness to include required capex in allowances) then asymmetric social consequences will exist even if the marginal benefit curve has a constant slope (or is convex). This is because, if the starting point is too little investment (rather than optimal investment) then an $X reduction in investment will exacerbate this situation, but an $X increase in investment will alleviate it.

5.2 Under-investment can and does reduce service quality

203. In the previous section we explained that if the WACC is set below the true $WACC^{Median} + \alpha$ there is a clear incentive to underspend relative to forecasts, but that there is not as strong an incentive to over-invest if it is set above this level. This under-investment may manifest itself in businesses forsaking or delaying investments that would deliver marginal benefits in terms of improved quality of service that exceed the relevant marginal investment costs. Alternatively, underinvestment may manifest social costs in the form of higher costs as operating expenditure is substituted inefficiently for capital expenditure.

5.2.1 Potential sources of under-investments

204. As we explained in section 3.2.3, if the WACC is set below the true $WACC^{Median} + \alpha$ this will not mean that there will be no investment whatsoever, i.e., there will not be an "investment cliff". Indeed, regulatory mechanisms such as requirements to produce Asset Management Plans and the SAIDI and SAIFI-based quality standards are likely to preclude an "investment strike". However, there are other avenues available to distributors to cut back on spending that would not be easily observable, for example:

    - businesses might take actions that would not be immediately apparent to most customers or the regulator, such as:
        - neglecting to replace ageing assets in a timely fashion, increasing the probability of failure;
        - allowing utilisation of existing assets to increase to levels that heighten the probability of failure before investing in new capacity;
        - choosing to invest in inefficiently small scale projects to alleviate capacity constraints; and/or
        - choosing to respond to constraints with inefficient operating cost solutions rather than capital expenditure solutions; and
    - firms may also reduce investment in ways that may not lead to quality breaches or significant reductions in volumes in the ordinary course of business, but which may have large ramifications in the event of, say, a disaster, e.g., not building in as much redundancy/safety margin.

205. It may take some time before degradation of the physical infrastructure or insufficient investment in new capacity arising from the former to translate into poorer reliability, i.e., in deteriorating SAIDI and SAIFI measures and in quality path breaches. Similarly, under-investment in redundancy, earthquake proofing and so on may have an immaterial impact upon SAIDI and SAIFI most of the time – and again, not result in quality path breaches – but give rise to substantial costs when adverse events occur and the reliability is not there.

206. In other words, it is conceivable that businesses may have some flexibility under the current regulatory regime to reduce investment in ways that reduce reliability, but which do not translate into quality path breaches – at least not immediately, and perhaps not even in the long-term. Investments in "earthquake proofing" are an example of the latter – deferring or cancelling such investments may have no material effect on SAIDI and SAIFI until a disaster strikes. The extremely high value that customers place on having a reliable supply of electricity means that the potential costs of these forms of under-investment are likely to be very high.

5.2.2 The cost of unserved energy

207. The current Electricity Industry Participation Code contains a default value of unserved energy of NZ$20,000/MWh.[58] However, as Frontier (2014) note,[59] more recent studies suggest that this is likely to be a significant underestimate. More recent Australian estimates place the value of lost load (VoLL) in the range of A$40,000 to 100,000/MWh.[60] This means that if under-investment of the forms described above lead to even small reductions in reliability — whether through frequent short, or occasional long, power outages — this can be expected to impose large costs on households, businesses and the wider community.

208. This is more than a theoretical notion. Just a few years ago, Alpine Energy was found to have breached the relevant quality standards at four out of five assessment dates under the targeted control regime (from 2004/05 to 2008/09). In 2009/10 its SAIDI result of 328 minutes was nearly three times the allowable level and its SAIFI result of 2.1 interruptions was nearly double the allowable level. In 2011, the Commission appointed Strata Energy Consulting (Strata) to conduct a review of Alpine Energy's distribution network[61]

209. Strata concluded that breaches had arisen for a number of reasons.[62] Chief among them was the fact that Alpine Energy's asset management practices and resources had not enabled it to understand its network sufficiently and operate proactively at a strategic level. Strata noted that, unless future capital and operating expenditure was sufficient and applied appropriately, the quality standards would continue to be breach – the clear inference being that investment had *not been sufficient* to that point.

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58 *Electricity Industry Participation Code* 2010, Schedule 12.2, clause 4.

59 Frontier Economics, *Evidence in support of setting allowed rates of return above the midpoint of the WACC range, A report prepared for Transpower New Zealand Ltd,* March 2014, pp.13-14.

60 *See:* Australian Energy Market Operator, *Value of Customer Reliability Issues Paper*, March 2013.

61 Strata Consulting, *Report on the reliability performance of Alpine Energy, Produced for the Commerce Commission*, 13 April 2012.

62 *Ibid*, p.16.

210. Similar examples can be cited from Australia.[63] For example, in 2004, the Queensland Government asked an independent panel to provide a report on the state's electricity and distribution networks following a series of outages caused by storms and hot weather. The panel concluded that the companies had allowed the network to deteriorate to a level where it could not meet current demand or future growth. They had focused on improving financial results and neglected service quality.[64]

211. To reiterate, we are not suggesting that these types of disruptions will become commonplace if the WACC is set below the true $WACC^{Median} + \alpha$ Rather, businesses can be expected to respond by cutting spending in ways that increase the probability of these major disruptions occurring. That increase in likelihood might be small but, given the costs of unserved energy, it can have a significant effect on the expected social costs.

5.2.3 Penalties are not necessarily an answer

212. If the regulatory regime imposes substantial penalties if a business' quality of service is seen to decline, this may reduce the incentive to under-invest. However, such penalties are very difficult to design and they represent a very blunt instrument. Moreover, reductions in quality of service are not the only way that the costs of under-investing manifest themselves. If the WACC is set below the true value of $WACC^{Median} + \alpha$ a distributor might respond by inefficiently substituting operating expenditure for capital expenditure.

213. The effect of this would be to raise its overall costs (and the prices to its customers) without necessarily leading to quality of service reductions (or at least sufficient quality of service reductions to trigger penalties). It is also worth remembering that the incentives of the managers of a business may differ materially to the incentives of its investors. Even if penalties are designed perfectly and would discourage a rational investor from inefficiently reducing quality, they may not discourage managers.

214. Where managers can take risks in order to earn – and be rewarded for – higher accounting profits they may have an incentive to do so even if this comes at a cost of embedding greater risk in the firm's earnings. This will be the case where it hard for owners to fully monitor the risks that managers are taking and where it is not possible to force managers to bear the costs if/when those risks manifest in losses.

215. The classic example of this is risk taking by managers at large financial institutions who are rewarded with high performance pay if risks "pay off" but who only lose

63 *See for example:* Productivity Commission 2013, *Electricity Network Regulatory Frameworks*, Report No. 62, Canberra, Box 16.1, p.585.

64 *Detailed Report of the Independent Panel, Electricity Distribution and Service Delivery for the 21st Century*, Queensland, July 2004, p.8.

their bonuses – not their base salary – if the risks give rise to losses. The equity owners of the firm would ideally only reward higher profits adjusted for the level of risk underlying these profits – those shareholders are often unable to measure those risks as accurately as managers.

216. There may be some parallels for distributors. Managers whose risk taking cannot be easily observed by equity owners (and regulators) may have an incentive to under invest for long periods without this manifesting in a material deterioration in the quality of service, until unusual events (rapid demand growth, storm damage etc.) put the system under stress. Indeed, such events may never occur and the poor expected quality of service may never be observed. An increment to the WACC may help combat this incentive.

5.3 Comparison to other jurisdictions

217. The material in the previous sections suggests that the expected social costs of setting the WACC "too high" may well outweigh the costs of setting the WACC "too low" by an equivalent margin. Although this material is, by necessity, largely qualitative in nature, the available indications are that the costs of under-investment may well exceed the costs of over-investment. If so, this would warrant yet another increment on the median WACC, i.e., in addition to the margin required for cash-flow asymmetries ("**α**").

218. However, the precise magnitude of this additional increment ("**β**") is very difficult to quantify for the reasons set out in section 3.2 – even more so in a narrow 21 day window. But this problem is not unique. *All regulators* must grapple with the problem of where to set the WACC, and whether it should reflect any perceived asymmetry in social consequences (and/or cash-flows). It is consequently instructive to consider how the Commission's WACC compares to those used in other jurisdictions. More specifically, it is potentially informative to compare:

- the Commission's allowed premium above the New Zealand Government bond rate for New Zealand distributors; relative to
- the allowed premium above the government bond rate for similar businesses in Australia, the United Kingdom and the United States of America.

219. The premium above the government bond rate allowed in these other countries presumably reflects, in part, the relevant jurisdictional regulator's view on the perceived magnitude of cash flow ("**α**") and social cost ("**β**") asymmetry. To be sure, whether that view is correct is a matter for debate. However, in the absence of country specific loss functions these premiums nonetheless represent a useful reference point for assessing the Commission's current WACC estimates.

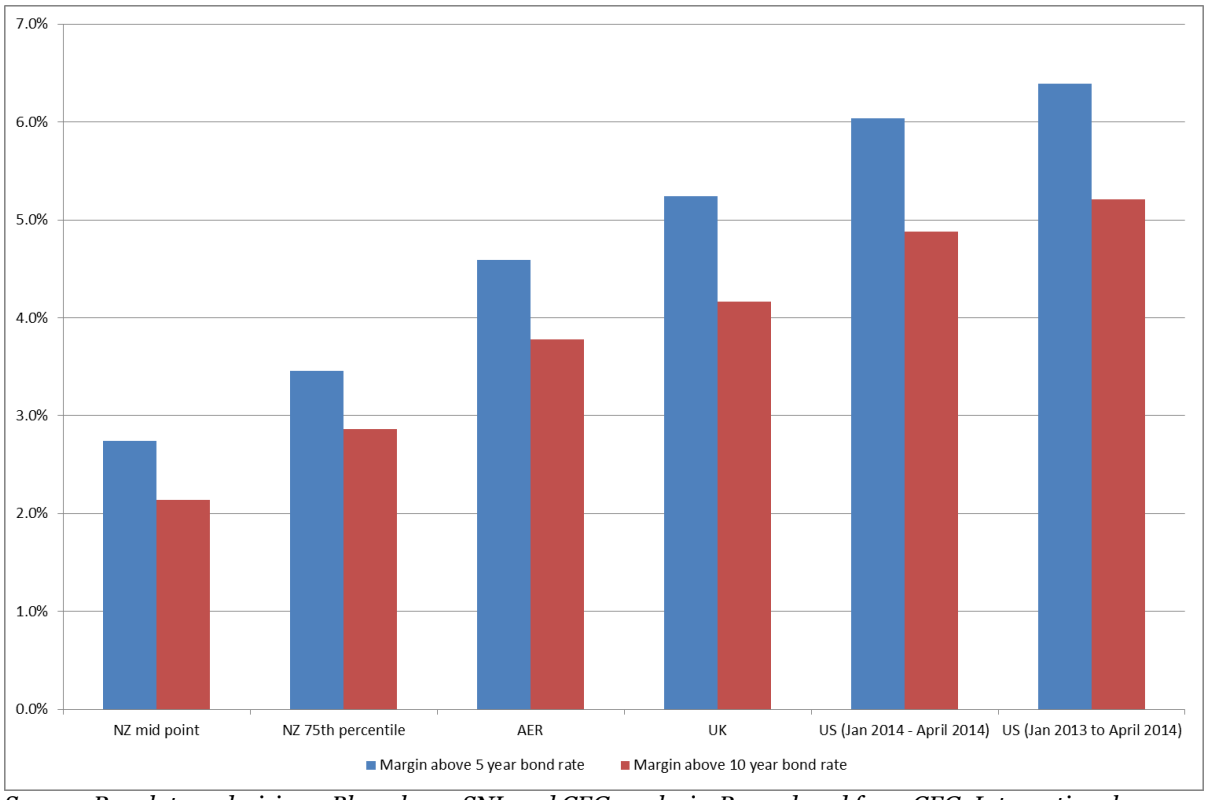
220. We undertake such a comparison in a report prepared for Wellington Electricity – also submitted as part of this consultation process.[65] The methodology that we have used for that exercise is described in detail in that report and we do not repeat it here. However, the calculations and results are summarised in Table 2 and Figure 8 below – both reproduced from our report for Wellington Electricity. These show the premia allowed in the various regulatory decisions relative to both the 5 and 10 year government bond rates.

Table 2: Calculation of international regulatory risk premia

	NZ		AER	UK	US	
	Midpoint	75th percentile			2014	2013-2014
Post tax WACC	6.69%	7.41%	8.10%	3.79%	7.65%	7.66%
5 year Gov. bond rate	3.95%	3.95%	3.51%	-1.45%	1.61%	1.27%
10 year Gov. bond rate	4.55%	4.55%	4.32%	-0.38%	2.77%	2.45%
Risk premium (rel. 5 year rate)	2.74%	3.46%	4.59%	5.24%	6.03%	6.39%
Risk premium (rel. 10 year rate)	2.14%	2.86%	3.78%	4.17%	4.88%	5.21%

Source: Regulatory decisions, Bloomberg, SNL and CEG analysis. Reproduced from CEG, International precedent relevant to the 75th percentile, May 2014, Table 1, p.4.

Figure 8: International WACC premia allowed by regulators



Source: Regulatory decisions, Bloomberg, SNL and CEG analysis. Reproduced from CEG, International precedent relevant to the 75th percentile, May 2014, Figure 1, p.4.

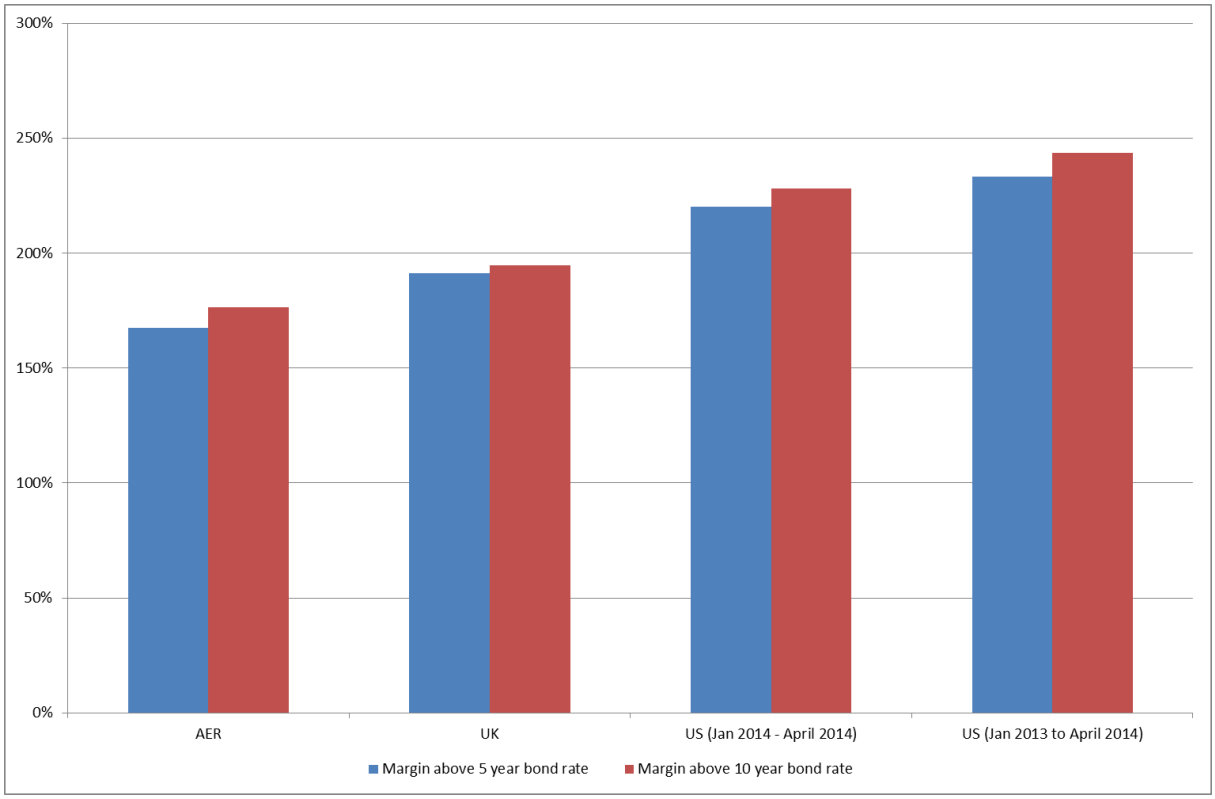
65 CEG, *International precedent relevant to the 75th percentile,* May 2014.

221. It can be seen that the premium allowed by the Commission, which currently includes the 75th percentile increment, is materially below the premia allowed by other regulators. Obviously, the same conclusion applies, although with more force, when comparing to the premium associated with the Commission's mid-point WACC.

222. The current gaps between the Commission's (inclusive of the 75th percentile) and foreign regulators' allowed risk premium relative to 5 year bonds are between 1.1% and 2.9%.[66] If the Commission were to drop the 75th percentile increment and simply adopt the mid-point WACC, the range of the gap between it and other regulators would become 1.8% to 3.6%.

223. Expressing the foreign premia as a percentage of the NZ mid-point WACC premium gives a range of 167% to 243%. That is, if the Commission adopted the 50th percentile WACC, then foreign regulators' risk premia would be between 1.7 to 2.4 times as large as the allowed New Zealand risk premium. This is illustrated in the Figure 9 below.

Figure 9: Risk premia relative to Commission midpoint WACC risk premium – the former expressed as a % of the latter



Source: Regulatory decisions, Bloomberg, SNL and CEG analysis. Reproduced from CEG, International precedent relevant to the 75th percentile, May 2014, Figure 2, p.5.

66 1.13% is relative to the AER decision and 2.9% is relative to the average US premia since January 2013.

224. The charts above imply that overseas regulators currently provide much higher premia above the risk free rate than the Commission. This suggests that regulators in these countries believe that investors require a materially higher increment above the risk free rate than the Commission is currently providing – even with the application of the 75th percentile.

225. Unless the Commission has some reason to believe that the premium above the risk free rate does not need to be as high in New Zealand (and we cannot think of any), the above analysis suggests that the 75th percentile may not be sufficient to compensate for asymmetries in cash flows ("**α**") and social costs ("**β**"). At the very least, it suggests that the 75th percentile is unlikely to be too high.

Appendix A Modelling assumptions

226. In this appendix we set out the key assumptions that we have made in the Monte Carlo simulations presented in section 4.1

A.1 Distribution of volumes growth

227. Monte Carlo simulation of variations in sales volume growth requires an assumed distribution of volume growth. We have sourced parameters for assumed distributions for growth in electricity supplied and connections from the Commerce Commission's modelling.

228. With its 2010-2015 DPP final determination, the Commission published a dataset of information disclosures from distributors that it used to estimate elasticities of operating costs against volumes.[67] The dataset includes estimates of electricity supplied and total connections for each business across years from 2004 to 2011. We estimated year on year growth in these factors and calculated the mean and standard deviation in growth across the panel dataset.

229. Some of the observed growth in electricity supplied and connections are clearly aberrant, due to mergers, divestments or other major changes. For the purposes of this calculation, we excluded:

- growth in Powerco's electricity supplied to 2005, 2008 and 2009;
- growth in Vector's electricity supplied and connections in 2009; and
- growth in Wellington Electricity's electricity supplied in 2010.

230. We note that this visual inspection of the data may not have removed all aberrant observations. After excluding these observations, we calculate:

- mean growth in electricity supplied of 1.71% and standard deviation of 4.39%; and
- mean growth in connections of 1.13% and standard deviation of 1.31%.

231. In the Monte Carlo analysis, we have assumed that actual results for these variables are drawn from a normal distribution with these parameters.

232. It is not likely to be appropriate to model independent observations of growth of electricity supplied and connections over a 5 year regulatory period. In this modelling, we estimate the outturn growth in electricity supplied and connections in each year of the regulatory period using a single random seed. This means that the

67 This dataset is available at: http://www.comcom.govt.nz/dmsdocument/9683.

outturn growth for electricity supplied will be constant across the five year period and will be perfectly collinear with outturn growth in connections.

A.2 Elasticity of operating costs to volumes

233. The Commission's final model estimated network operating costs as a function of network length and number of connections and non-network operating costs as a function of number of connections. For the purpose of our modelling we need to assume a relationship between revenues and costs.

234. In order to achieve this we have estimated an econometric relationship between operating costs and the two revenue drivers – connections and energy supplied. The elasticities estimated can be thought of as mapping the relationship between the cost drivers in the Commission's final regression (line length and connections) against the determinants of revenue (energy and connections).

235. Based on operating cost econometrics in 2010/15 draft decision,[68] we estimate the following elasticities:

- for network opex, 0.543 for electricity supplied and 0.296 for connections; and
- for non-network opex, 0.084 for electricity supplied and 0.711 for connections.

236. The data set does not allow us to estimate any elasticities between capital expenditure and energy/connections. However, we are able to illustrate the potential impact of such elasticities using assumed elasticities.

A.3 Capital expenditure elasticity

237. The Commission has not estimated capital expenditure using regression analysis and we are not able to do so reliably from available data. However, we have used as sensitivities two assumptions:

- an elasticity of 0.5, i.e., forecast capital expenditure increases by 0.5% for each 1% increase in sales volumes; and
- An elasticity of 1.0, i.e., forecast capital expenditure increases by 1% for each 1% increase in sales volumes.

68 *See:* data in zip file located at: http://www.comcom.govt.nz/dmsdocument/410.

Appendix B Professor Grundy's report

The Costs of Financial Distress and Allowed Revenues for Regulated Firms

28-4-2014

The author

1. The author of this report is Bruce Grundy. Bruce Grundy has a Ph.D. in Finance from the University of Chicago and 30 years' experience in Finance academia and consulting.

Scope of this Report

2. This report examines how gearing should affect allowed revenues for regulated firms. In particular, this report examines how gearing should affect regulatory forecasts of the future cash flows to the firm's owners.

Understanding the Costs of Financial Distress

3. The costs and benefits of gearing have long exercised the minds of CFOs and financial economists. The 1990 award of the Nobel Prize in Economics to Merton Miller was in part in recognition of his work with Franco Modigliani on the effect of gearing on firm value, in particular the classic Modigliani and Miller[69] (M&M) theorem. The M&M theorem recognises that if there were zero costs of repackaging a given set of cash flows generated by a firm's assets into more dividends to equity and less coupons to debt, or vice versa, gearing would not affect the value of a business. Equivalently, gearing would not affect the return on investment enjoyed by the firm's debt and equity financiers in aggregate.

4. The M&M theorem of capital structure irrelevance is often described as applicable in a world without transactions costs, taxes or differences in information. But the result is more general. The result applies so long as there is no *difference* in the transactions costs and informational asymmetries of firms with high versus low gearing. For a discussion of

[69] Modigliani, Franco and Merton H. Miller, 1958, "The cost of capital, corporation finance and the theory of investment," American Economic Review 48, 261–297.

the generality and implications of the M&M theorem see Grundy[70] (2001) and Grundy[71] (2002).

5. Increasing gearing makes equity more risky and therefore increases the cost of equity. Increasing gearing simultaneously decreases the weight put on the cost of equity (the higher cost source of funding) in the determination of a firm's weighted average cost of capital (WACC). More debt means a higher cost of equity but a lower weight on that source of finance with no net effect on the firm's cost of capital. Absent transactions costs and information asymmetries, not only is the aggregate amount to be distributed to the owners of a firm unaffected by gearing, the firm's WACC is also unaffected.

6. In practice transactions costs and information asymmetries mean that a firm's gearing affects its value and its WACC. For example, corporate taxes paid reflect the firm's gearing since interest payments are tax deductible. There are in fact many ways in which the amount that can be distributed to the firm's owners is affected by gearing. Therefore forecasts of future payments to the owners of the firm must reflect the firm's gearing if those forecasts are to be unbiased. Regulators recognize this when, for example, they build an allowance for the costs of issuing future debt and equity securities into the determination of allowed revenues.

7. While gearing reduces corporate taxes, it is important to recognize that there are many ways in which gearing can reduce the payoff to a firm's owners. These negative effects of gearing are discussed in paragraphs 8 through 14 below.

8. One subtle influence of gearing on future payoffs is its effect on future investment incentives. Debt financing can make a firm less innovative in seeking out new investment opportunities. Consider a setting in which the payoff from a new project serves to make existing debtholders' claims on the firm safer and more valuable. Suppose the project requires an investment of $100 and that its future payoffs have a

[70] Grundy, Bruce D., 2001, "Merton H. Miller: His contribution to financial economics," *Journal of Finance*, 56: 1183 - 1206.

[71] Grundy, Bruce, D., 2002, *Selected works of Merton H. Miller - A celebration of markets Volume 1: Finance*, The University of Chicago Press.

present value of $101; i.e., the project has a $1 positive net present value. Such a project would be attractive to an ungeared firm.

9. Suppose though the project were being considered by a firm that already had $1,000 worth of assets and had existing risky debt worth $600 in the absence of the project. The firm's equity is worth $400 in the absence of the project. If the firm does raise the $100 necessary to undertake the new project, doing so will increase the total firm value by $101. With more assets in the firm, the risky debt will become safer. Suppose the debt's value increases to $603. The value of the original shareholders' claim on the firm will actually decline by $2 to $398.

10. The post-investment value of the equity will be the difference between the new total value of the firm's assets and the sum of the value of the firm's debt and the value of the new claim issued to finance the project; i.e., $1,101 – ($603 + $100) = $398 < $400. The project will not be undertaken. The diminution in a firm's future investment incentives and consequent reduction in firm value today is known as the debt overhang problem. An ungeared firm with access to the new project would be worth $1,001 (the sum of the $1,000 value of the existing assets plus the $1 value of the firm's positive NPV growth opportunity). An otherwise equivalent geared firm (which would, because of its gearing, reject the new project) would be worth only $1,000.

11. The debt overhang problem grows with the amount of existing risky debt relative to the size of the new investment opportunities (see Diamond and He[72] (2014)). The reason no debt overhang problem arises in a Miller-Modigliani setting is that given no transactions costs, sufficiently complex terms could always be written into a debt contract so as to readjust the contract appropriately as future investment opportunities arose. But because in practice it is prohibitively costly to contract over every eventuality, debt overhang problems have a negative effect on the value of geared firms.

[72] Diamond, Douglas and Zhiguo He, 2014, "A theory of debt maturity: The long and short of debt overhang," *Journal of Finance* 69(2), 719–762.

12. Another way in which gearing leads to a diminution in firm value is that if a firm has not been profitable and if meeting its debt obligations requires selling assets, the assets may have to be sold at "fire-sale" prices. Titman[73] (1984) observes that firms that make products requiring specialized servicing and spare parts will find liquidation especially costly and concludes that firms manufacturing machines and equipment should optimally be less geared because of potential costs should asset sales be necessary to repay debt.

13. More generally, higher gearing increases the probability of incurring costs associated with financial distress and bankruptcy. These costs are real and significant. If a business faces a financial crisis the existing value of the company can be 'eaten up' in short-term management decisions (e.g., through a failure to invest in otherwise valuable capital maintenance), fractured management decisions (driven by different stakeholders' interests), selling assets at "fire-sale" prices in order to raise cash, and the legal fees of bankruptcy and/or restructuring.

14. The set of future costs associated with debt financing are known in the finance literature as the costs of financial distress (CFD). The future expected benefit from debt financing is treated in regulatory determinations of allowed revenues as the product of the corporate tax rate and promised future interest payments. The existence of non-debt tax shields and the realizations of levels of earnings before interest that are less than promised interest payments mean that promised interest payments do not always give rise to tax savings. The difference between the potential tax savings and actual tax savings is then another cost that must be included in the set of CFD in order to offset the overstatement of the tax benefits from debt financing that arises when all interest payments are assumed to reduce corporate taxes.

15. Allowed revenues must be set at a level such that the firm's owners actually expect to earn the cost of capital, not at a level where at best they do so. The actual expected corporate taxes payable given the firm's gearing should be reflected in allowed revenues. If the benefit of debt financing is overstated because expected corporate tax payments are

73 Titman, Sheridan, 1984, "The effect of capital structure on a firm's liquidation decision," *Journal of Financial Economics* 13, 137-51.

understated because all promised interest payments are treated as tax deductible, the expected difference between the potential tax saving and the actual tax saving associated with interest payments must then be recognized as a cost of debt financing.

16. Similarly overlooked in regulatory determinations of allowed revenues, are the other components of CFD inherent in even an optimal capital structure. An optimal capital structure is not the level of gearing at which there are zero CFD. Regulatory determinations of allowed revenues that overlook CFD effectively assume that at an optimal capital structure the CFD is zero. If in fact the CFD were really zero, then firms should be much more highly geared than they are in order to capture more of the potential tax savings associated with interest deductibility.

17. Nor is it the case that an optimal capital structure minimizes CFD – that would require not issuing any debt. An optimal capital structure trades off the marginal benefit (of the tax saving) associated with substituting a dollar of debt financing for a dollar of equity financing with the marginal CFD.

18. At an optimal level of gearing the marginal benefit and marginal cost of financing with debt rather than equity are equal. If the (annual) marginal benefit is the product of the corporate tax rate and the (annual) interest on a dollar of debt financing, i.e., $\tau_c \times r_d$, then the marginal CFD on the last dollar of debt in an optimal capital stricture must also equal $\tau_c \times r_d$. At higher levels of gearing the marginal CFD will be higher and would exceed the marginal tax saving from debt financing. Conversely, if the firm used less than the optimal amount of debt its marginal CFD would be less than the marginal tax saving.

19. Regulatory regimes do not allow realized CFD to be passed on in higher revenues at the time of an insolvency event (which seems sensible and consistent with giving businesses an incentive to avoid these costs). But a regulatory regime should make an allowance for the actuarially expected level of these costs in determining allowed annual revenues. Ignoring CFD will mean allowed revenues are set at a level whereby the firm is actually worth less than the cost of efficiently reproducing its capital.

20. One can get a rough figure of the annual CFD that should be built into allowed revenues by assuming that the marginal CFD is zero on the first dollar of debt financing and increases linearly as debt increases to the optimal level. The annual CFD is then [(0 + τ_c × r_d)/2] × Optimal Gearing Ratio × RAB. Given τ_c = 28% and an Optimal Gearing Ratio of 0.44, the annual CFD that needs to incorporated within the building blocks of allowed revenue is r_d × 6.16% × RAB.

21. But we need not rely on this rough estimate of r_d × 6.16% × RAB. Empirical investigations of CFD have been undertaken in recent years.

Empirical Estimates of the Costs of Financial Distress

Korteweg (2007)

22. From an examination of 269 US firms between 1994 and 2004, Korteweg[74] (2007) estimates that the present value of the expected future CFD is equal to 5% of firm value for a typical non-bankrupt firm, and equal to 31% for firms in bankruptcy. It is the high cost of financial distress that inhibits firms from using higher gearing to minimise their corporate tax liabilities. Korteweg's analysis leads him to conclude that CFD are primarily the result of debt overhang problems and distressed asset fire-sales.

23. Korteweg estimates the costs of financial distress by examining firms in the same industry and relating differences in their values to differences in their size and their gearing. Korteweg examines 23 different industries. Firms within an industry are assumed to have the same optimal level of gearing. Firms deviate temporarily from that optimum because of firm-specific relatively good or bad performance. Firms that have done well (poorly) will tend to have become under-geared (over-geared) relative to the industry optimum. Because of the costs of recapitalizing a business, firms do not immediately move back to their optimal gearing levels.

24. The observed value of a levered firm is then

74 Korteweg, Arthur G., 2007, "The costs of financial distress across industries," Available at SSRN: http://ssrn.com/abstract=945425.

- the value of an otherwise unlevered firm, plus
- the present value of the tax saving that would be enjoyed if coupon payments were to always give rise to a saving in corporate taxes, less
- the present value of CFD including the tax benefits not received when the firm's otherwise taxable income turns out to be less than its coupon payments.

25. By relating the observed values of levered firms to their gearing levels, Korteweg is able to back out the present value of this measure of CFD. Korteweg's estimate is an estimate of the present value of the reduction in firm value due to debt financing relative to a situation where debt were to always lead to a tax deduction and were never to lead to other costs of financial distress. When Korteweg refers to his estimate as an upper bound on CFD he means the reduction in the value of a business associated with debt financing relative to the valuation when promised coupons are assumed to always reduce corporate taxes (just as regulatory determinations of allowed revenues assume) and all other components of CFD are zero.

26. Korteweg estimates that the present value of CFD as equal to 5% of the market value of the average firm. For utilities, the estimated present value of CFD is 8.8% of firm value — see Table VIII of Korteweg (2007).

27. The higher estimated presented value CFD for utilities is actually consistent with utilities having lower marginal CFD than the typical firm. Utilities will therefore optimally choose a higher level of gearing than the typical firm. Consider again paragraph 20's intuitive estimate of the annual CFD for a firm with a gearing ratio of 0.44. Suppose that firm is a utility and suppose that for any given level of gearing the marginal CFD for the typical firm is twice that of a utility. The utility will optimally choose a level of gearing twice that of the typical firm—for a utility the marginal CFD will only equal the marginal tax saving associated with an additional dollar of debt financing at twice the gearing level of the typical (lower marginal CFD) firm. The intuitive estimate of the annual CFD for a typical firm (with a gearing ratio of 0.22) is $r_d \times 3.08\% \times$ RAB; i.e., half that a utility. In this scenario, the typical firm has twice the <u>marginal</u> CFD of a utility and therefore half the gearing and half the annual total CFD of a utility.

28. If the present value of future CFD is equal to 5% of the value of an optimally-levered firm, then ignoring these costs when determining the allowed revenues of a regulated firm will mean that the firm's true value will be 5% below the cost of efficiently reproducing its optimal physical and human capital.

29. This 5% undervaluation occurs when a regulated firm employs its value-maximizing gearing level. If the regulatory regime correctly assumes the optimal gearing level then the regulatory regime will tend to capture, and pass onto customers, all of the benefits of higher gearing in the form of lower corporate taxes. However, if the regulatory regime does not also compensate for the higher costs of gearing (i.e., for the actuarially expected level of CFD) then the firm's total compensation will be lower than its total costs (other things equal). Based on the Korteweg (2007) results for the average firm, the value of this under-compensation would be around 5% of firm value.

30. If the regulatory regime actually assumes a higher level of gearing than the regulated firm optimally employs, the effect is to increase the notional corporate tax saving associated with leverage, a deemed saving that means lower allowed revenues, while continuing to ignore what would be even higher CFD if the firm were to increase its gearing to the assumed regulatory gearing level. The effect will then be to further reduce the firm's true value, down to a level *more* than 5% below the cost of efficiently reproducing its optimal physical and human capital.

31. How should allowed revenues be adjusted so that there is not a 5% diminution in the value of a regulated business? The future annual allowed revenues need to be increased by such an amount that the present value of the future annual allowed revenues is increased by 5%. Treating the annual increase as a perpetuity, the allowed revenues should be increased by WACC × 5% × RAB. Using the 8.8% estimate for the present value of CFD for utilities, the adjustment to allowed revenues for a utility should be an increase equal to WACC × 8.8% × RAB.

van Binsbergen, Jules H., John R. Graham and Jie Yang (2010)

32. van Binsbergen, Graham and Yang[75] (2010) examine panel data from 1980 to 2007 to estimate firm's marginal CFD functions. By integrating and discounting the marginal cost functions the authors obtain an estimate of the present value of future CFD for the average firm of 6.9% of asset value. While the econometric technique is quite different from that employed in Korteweg (2007), the resultant estimates of the present value of CFD are quite similar.

33. van Binsbergen, Graham and Yang estimate that the default costs associated with debt financing amount to approximately half the total CFD, implying that agency costs and other non-default costs (e.g., poor investment incentives associated with a debt overhang problem and short-term decision making in times of financial stress such as the failure to invest in otherwise valuable capital maintenance) contribute about half of the total ex-ante CFD.

Almeida and Philappon (2007)

34. Almeida and Philippon[76] (2007) estimate the present value the direct legal fees of bankruptcy and/or restructuring and the losses associated with selling assets at "fire-sale" prices in the event of a debt default as a percentage of the pre-distress value of a firm. Column 2 of Panel B of Table IV of Almeida and Philippon (2007) reports the author's estimates of the present value of this component of CFD. The estimates are 0.32% for AAA-rated bonds; 1.84% for AA bonds; 3.83% for A; 4.53% for BBB; 6.81% for BB; and 9.54% for B-rated bonds.

35. Because debt default is more likely to occur in bad times, the default costs examined by Almeida and Philippon are borne in states of the world in which an additional dollar has a particularly high value (relative to the value of an additional dollar to be received in a

[75] van Binsbergen, Jules H., John R. Graham and Jie Yang, 2010, "The cost of debt," *Journal of Finance* 65(6), 2089-2136.

[76] Almeida, Heitor and Thomas Philippon, 2007, "The risk-adjusted cost of financial distress," *Journal of Finance*, 62(6), 2557-2586.

future boom). A simplistic valuation that ignored the fact the costs borne in bad times should be discounted at very low rates would have given an incorrect under-valuation of the present value of these costs as, say, only 1.4% (as opposed to 4.53%) of the pre-distress value of a BBB-rated firm.

36. Almeida and Philippon conclude that even the default cost component of CFD can be high and that this helps explain why firms appear to use debt conservatively. Absent any CFD, firms would optimally minimize corporate taxes payable by financing almost entirely with debt and thereby maximizing interest deductions and minimizing taxes.

37. Recall that van Binsbergen, Graham and Yang estimate that the default costs of debt as examined by Almeida and Philippon amount to approximately half the total CFD. Thus it is not surprising that the Almeida and Philippon (2007) estimate of the present value of a portion of CFD for investment grade firms less than the Korteweg (2007) and van Binsbergen, Graham and Yang (2010) estimates of the present value of total CFD for the typical firm.

Conclusion

38. The level of revenues allowed in a regulatory setting should include compensation for all expected costs and benefits associated with gearing. This includes the relatively easily explicitly measured benefit due to the reduction in corporate tax liabilities associated with interest payments on debt. It also includes the more difficult to measure expected CFD. While difficult to measure, this cost can be non-trivial.

39. To appropriately recognize the existence of CFD in regulatory determinations, allowed annual revenues should be increased by WACC $\times$ z $\times$ RAB, where z is the present value of CFD expressed as a percent of the RAB.

40. The empirical value of z has been estimated by Korteweg (2007), van Binsbergen, Graham and Yang (2010) and Almeida and Philippon (2007). Almeida and Philippon (2007) estimate the present value of the costs incurred in the event of bankruptcy (these costs are only a portion of total CFD) as 3.83% (4.5%) of firm value for A-rated firms

(for BBB-rated firms). The present value of total CFD is estimated in Korteweg (2007) as 5% of firm value for a typical non-bankrupt firm, and 8.8% for the typical non-bankrupt utility. van Binsbergen, Graham and Yang (2010) estimate the present value of total CFD as 6.9% of firm value for a typical non-bankrupt firm.