Review of evidence in support of an appropriate WACC percentile

Response to Commission invitation of 31 March 2014

NZIER advice to MEUG

May 2014

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Key points

NZIER were asked to provide MEUG with additional advice in response to the Commerce Commission's invitation to provide further evidence on the WACC percentile. This advice is structured around two approaches to building evidence.

Evidence embedded in regulatory decisions

We conducted a search for recent empirical evidence from regulatory determinations in New Zealand and overseas. We found no such evidence.

Our review did highlight that:

1. Industry specific factors matter and therefore it matters how the WACC is applied in different sectors. It is clear that the WACC methodology for estimating the WACC depends on the sector specific regulatory arrangements and especially on the outlook for demand and investment in each sector.

2. There is considerable consistency of approach in Australia and the UK where regulators estimate a range for the individual parameters that are used in the calculation, and then use a point estimate within the range, depending on their particular sector conditions.

3. Investment considerations also matter. In the UK the CAA "aimed high" with the WACC estimates for Heathrow and Gatwick airports because of uncertainties about WACC parameters and the potential for a "capital strike" by Heathrow if they got the WACC estimate wrong.

4. The regulators' understanding of the demand – capacity relationship, by sector, is central to the consideration of which WACC percentile to choose. By inference the regulator needs considerable industry specific information on which to base its WACC estimate.

5. The Competition Tribunal in Australia has conducted the only recent formal review of the arguments for and against the use of a WACC percentile. They were unconvinced by the (qualitative) evidence for a higher than mid-point percentile that they reviewed and considered that a "capital strike" was unlikely because of investor's heterogeneous expectations.

Analytical evidence

We have used the Dobbs (2011) approach as a starting point for examining analytical evidence regarding the appropriate WACC percentile. The key question addressed is whether the findings from Dobbs partial equilibrium model are sufficiently stable under alternative and realistic assumptions to be used to inform the selection of WACC percentile values.

The results of our review and extension of the Dobbs approach suggest a discontinuous relationship (loss function) between welfare and WACC percentiles. This discontinuity warrants caution and industry-specific analysis before selecting a WACC percentile.

The precise shape of the loss function is very sensitive to industry and firm specific context including firm costs, form of regulation and the nature of demand.

If a regulated supplier faces inelastic and rapidly growing demand or technological change (i.e. high investment demand) then appropriate WACC percentiles will be near the top of the distribution. If investment demand is low, a WACC percentile at the bottom will be optimal.

We also conducted a high level examination of the effects across the wider economy from a "shock" in electricity prices (from a higher than optimal WACC) using our computerised general equilibrium (CGE) model. The results are indicative only at this stage however they demonstrate that higher prices for regulated services can shrink the economy.

The key message from the general equilibrium analysis is that prices which invite investment in regulated assets include wider economic costs which are not factored into partial equilibrium models and also factor in benefits which are illusory (e.g. including excess profits as producers surplus).

The analysis we have done does not have a great deal to add in terms of what the 'right' WACC percentile is. What it does say is that the shape of partial equilibrium loss functions are likely to be wrong because they overlook certain costs of excess profits and benefits of lower prices.

Additional considerations that differ between sectors

There are a range of matters that need to be considered when thinking about the differences between regulated sectors. We are of the view that the answers to two questions would be helpful in shaping these considerations.

- What does asymmetric risk look like in different sectors?

It seems from our research into empirical evidence that WACC estimation errors will have different effects depending on the sector and that these effects will likely change over time and be different in different countries.

- What would the alternative [to using a 75th uplift] courses of action look like in different sectors?

In answering the second question a range of factors are important, including the nature of the regulatory framework, who the consumers of regulated services are, the costs of substitutes for network investment, the likelihood of innovation and whether innovation is incentivised regardless of regulated returns.

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1. Further work on WACC

On 31 March the Commerce Commission (Commission) issued a notice of intention to undertake further work on the cost of capital input methodology (IM) through calendar year 2014.[1] The notice of intention was accompanied by a paper setting out the process for considering changes to the WACC IM and inviting interested parties to provide evidence regarding the appropriate weighted average cost of capital (WACC) percentile that should be used under the cost of capital IMs that apply to electricity lines services, gas pipeline services and specified airport services regulated under Part 4 of the Commerce Act. .

The invitation by the Commission specifically asked for:

> *24.1 - empirical 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 social harm done by over- estimating and under-estimating the WACC, to determine the appropriate percentile; and*
>
> *24.2 - any additional considerations (supported by evidence) that differ between sectors, which might affect the appropriate WACC percentile. Possible examples may include ex ante approval of investment, and the obligation to supply (which applies to some regulated suppliers).*

The current cost of capital IMs involves using the 75th percentile estimate of a WACC range ('75th percentile WACC') when setting default, customised or individual price-quality paths.

When the Commission made its decision to raise WACC above the mid-point, it did not have any empirical evidence to hand to support this choice. The invitation to provide evidence is attempting to resolve this problem.

In establishing the IM's the Commission decided to err on the side of a WACC which is higher than its most likely (mid-point estimate) value because of concerns about the consequences of errors inherent in estimating WACC. The concern is that setting WACC lower than its 'true' value is more costly to consumers than the costs of setting WACC too high.

Concern about asymmetric impacts from estimation errors has its basis in theoretical and analytical (non-empirical) models. The predictions from these models are that when a WACC rate is set too low investors may delay or cancel investment and the supply of goods and services falls. Consumers then cannot buy these services at any price and this means they are worse off compared to a situation where they are left paying higher than (workably) competitive prices due WACC being set too high.

[1] Further work on the cost of capital input methodologies. Commerce Commission. 31 March 2014. http://comcom.govt.nz/dmsdocument/11695

1.1. This report

In our 13 March 2014 memo of preliminary advice to MEUG we reported on our failure to find empirical evidence that supported any uplift to the WACC.

We noted that, in the absence of convincing evidence to the contrary, the mid-point is the logical value of WACC to use as it minimises estimation errors. We also observed that there is some evidence that emerging practices elsewhere seemed to point to regulators use of WACC at mid-point or lower.

This report provides our views after revisiting our preliminary advice and conducting analysis of our own.

To further our search for evidence on an appropriate WACC percentile we have considered

- domestic and overseas regulatory decisions on WACC
  - the evidentiary basis
  - the extent to which they provide support for WACC uplift
  - whether they commend or provide evidence for the use of a particular WACC percentile
- analytical evidence based on
  - the partial equilibrium model of Dobbs (2011)[2] which assesses the optimal percentile for WACC under uncertainty about its true value
  - a computable general equilibrium model assessment of economy-wide effects of WACC being set too high or too low

Throughout we consider the evidence in a more detailed manner than our earlier research but would make the point that this is by no means an exhaustive review of evidence or of the wider effects on the economy from any WACC uplift.

[2] Dobbs, I. (2011) 'Modeling welfare loss asymmetries arising from uncertainty in the regulatory cost of finance', *Journal of Regulatory Economics*, vol 39, no. 29, pp 1-28.

2. Absence of evidence here and overseas

The potential for asymmetric risks and/or costs in regulatory decisions has been considered for some years, though only more recently in the context of estimating WACC when setting rates of return for regulated firms.

This suggests that the first place to look for empirical evidence is in existing regulatory decisions. Yet our survey of such decisions produced no such evidence.

It seems that many of the uplift decisions made in the past, here and overseas, are based on concerns other than asymmetric welfare costs from estimation error.

It is also the case that where uplift has been applied it is, more often than not, a matter of judgement taking into account sector and investment specific considerations as opposed to a one-size-fits-all uplift across regulated networks.

2.1. New Zealand experience

In New Zealand the use of uplift to WACC by the Commission appears to have originated from the determination that came from the 2004 gas control enquiry. Prior to that time we note two local WACC estimates, one by PwC for Telecom[3] in the context of the TSO (which estimated a WACC range and a mid-point) and the second by Lally[4] in the context of the Commission's 2002 airfields enquiry (which estimated a WACC range only). Neither estimate considered specific uplift from the range around the midpoint.

The Commission's 2004 gas enquiry determination adopted WACC at the 75th percentile. This was the point that the Commission estimated "net benefits to acquirers" would occur.[5] Rather than taking a policy position and adopting a specific uplift for asymmetric costs, the Commission was concerned about accounting for the direct and indirect costs from the process of imposing regulatory control and they adopted the uplift for this reason.

The Commission estimated what the direct costs to the regulated firms (and themselves) would likely be and made estimates of the indirect costs, mostly allocative and dynamic inefficiencies, from regulatory control. They identified and estimated the monetary impact of five factors that could impact dynamic efficiency if the WACC estimate was wrong. One of these factors was that investment might fall if the estimate of the WACC was below the true WACC. They did however use the mid-point for modelling the net acquirer benefits (NAB) and tested the 25th/75th percentile as the lower and upper limits for each gas firm under consideration for

3 PwC. Telecom New Zealand Limited. The Cost of Capital to be Applied in Calculating the Cost of the Telecommunication Service obligation. 22 August 2002

4 Lally, M (2001) "The Cost of Capital for the Airfield Activities of New Zealand's International Airports", June, Appendix 12 to the Commerce Commission Airports Regulatory Control Inquiry, available at http://www.comcom.govt.nz/regulated-industries/airports/airports-archive/airports-regulatory-control-inquiry/. .

5 That is – with the 50th % as the best estimate of the true WACC, the Commission added a margin of 25% to account for the regulatory costs, beyond which the regulated firm acquire net benefits from excess returns.

control. They also make note of considerable uncertainty with the parameter estimates within the WACC calculation.[6]

It appears to us that by adopting the 75th percentile in the gas enquiry the Commission was concerned about the costs of the whole of (regulatory control) process rather than taking a policy position on specific asymmetric risks such as investment incentives. In his advisory report to the Commission Lally discussed asymmetric risks [natural disasters, demand shocks, stranding and the like] and suggested that a number of remedies, including WACC uplift from the mid-point, may allow for the costs of these risks. It appears to us that none were specifically implemented. Neither Lally's nor the Commissions own analysis and reporting made reference to any evidence regarding the use of a WACC percentile other than the mid-point.

The Commission returned to the use of a WACC percentile when setting the cost of capital Input Methodologies in 2010. An example of their analysis and WACC determinations can be seen in sub-part 4 of the Electricity Distribution IM's, where they decided to calculate and adopt the 75th percentile from their estimate of the midpoint WACC and the standard error. The December 2010 IM reasons paper set out their thinking behind this determination, the primary drivers being the purpose of Part 4 of the Commerce Act and the Commissions desire to provide incentives that promote dynamic efficiency in particular.[7] The mid-point estimate WACC[8] for EDB's that resulted from this process was benchmarked against estimates for regulated firms (electricity and others) in NZ, Australia and the UK for being "commercially sensible". For information disclosure of Electricity Distribution IM's, the Commission determined to use a WACC range (25th to 75th %) around the mid-point.[9]

2.2. Evidence from Australia

In Australia the ACCC's 2006 draft determination regarding the wholesale pricing of ULLS and LSS services[10] considered a proposal for WACC uplift that was part of the Telstra pricing submission but they ended up rejecting uplift, preferring to use a point estimate calculated from specific parameters. Telstra put forward considerable qualitative argument in support of uplift but in the end the ACCC determined that "substantive and quantifiable evidence is needed to move from the mid-point". No empirical evidence was forthcoming.

The ACCC noted that undesirable outcomes could occur from both over and under-estimating WACC but in the absence of evidence about both asymmetry and deviating from the mid-point, there was no reason to use any other percentile than the mid-point.

This decision was appealed to the Competition Tribunal by Telstra in 2007 for a merits review. Telstra argued that their proposed access undertakings (which

6 This point was picked up out of the advice of Lally who was concerned about the magnitude of the range of MRP and Beta estimates. See Lally, THE WEIGHTED AVERAGE COST OF CAPITAL FOR GAS PIPELINE BUSINESSES. May 14 2004

7 See EDB-GPB Input Methodologies Reason Paper Dec 22 2010. Pages 167 to 169.

8 And the 75th percentile.

9 It is worth noting that the EDB IM's allow for a Custom Price Path which could be used to accommodate step change investments rather than accommodate the potential using WACC uplift.

10 Telstra was required to provide access undertakings for local loop wholesale services, including pricing, which necessitated the estimation of cost of capital for these services.

included using their estimate of WACC to set prices for ULLS/LSS services) were, contrary to the ACCC determination, reasonable. It appears to us that the Tribunal's review was the earliest formal examination of the purported impacts of asymmetric consequences from errors in estimating WACC.

The Tribunal reviewed the Telstra application in detail and rejected it for a lack of evidence and analytical rigour. They could not conclude that there were asymmetries in the estimation errors, nor could they conclude which way the greater social damage would result but noted that in the long run the mid-point should be representative of the true WACC and that the use of any other percentile would result in over or under-recovery.

More recently, in 2009 and again in December 2013, the Australian Energy Regulator (AER) conducted an extensive review of their process for estimating WACC for use in their energy regulatory decisions. The reviews resulted in the decision to use point estimates for both the cost of equity (derived from a range of possible beta estimates) and the cost of debt which was a more straight forward matter to determine. In both reviews there was no mention of asymmetric risk or WACC uplift of any sort, nor was there reference to evidence suggesting that anything other than a mid-point estimate should be used. In terms of non-systemic risks, the AER made no allowance for risks outside of the systematic risk that is captured in the equity beta estimate, preferring instead to adjust the cash flows associated with a particular determination for one off risks.

The logic of their approach is summarised in the AER 2009 WACC review:

> *Of particular relevance in relation to the rate of return, is that the WACC be set at a level expected to be sufficient to incentivise efficient investment in electricity network infrastructure, while not set too high so as to incentivise inefficient overinvestment in electricity network infrastructure. The AER considered that if it determined values and methods for individual WACC parameters that produce an overall regulatory rate of return that is expected to achieve this outcome, then the AER will have exercised its power in a manner that will or is likely to contribute to the achievement of the NEO. In doing so, the AER also considered that, in respect of each parameter, it would have also had regard to the need to achieve an outcome which is consistent with the NEO.*

We note that there are other WACC & rate of return reviews and research studies underway in Australia that are useful when thinking about WACC issues but that do not add evidence in response to the Commissions invitation.

2.2.1. Evidence from the United Kingdom

In the UK the related issues of asymmetric risks and WACC uplift from the mid-point estimate have been argued in the context of various regulatory determinations for nearly 10 years. The earliest debate for uplift appeared in the Q5 London airports pricing consultation during 2005 when BAA (owners of Heathrow and Gatwick airports) lobbied the Competition Commission (CC) to consider a WACC higher than mid-point for these two airports to compensate for the risks that the airports face. BAA maintained that airports faced significantly more downside risk than upside and that the WACC should be lifted for the 2008/13 pricing period.

As with the Telstra argument in Australia there was very little hard evidence supporting either a WACC uplift or the existence of asymmetric risk. The CC did however agree that the airports regulatory regime made asymmetry of upside versus downside risks possible and that the airports regime made it more difficult to manage intra-period pricing adjustments than in other regulated sectors.

In their 2007 report to the UK Civil Aviation Authority (CAA) the CC noted the various views regarding these airports being exposed to asymmetric risks and the need to encourage Heathrow in particular to invest to avoid congestion problems. In the end CAA determined a WACC range based on estimates of the WACC parameters. In their 2008 decision they resisted a general uplift, instead preferring to "aim high" within the calculated range of the parameters and to make two specific, previously agreed, project uplifts.

It was about this point in time that the Dobbs analytical paper in support of asymmetric costs first appeared and reasonably quickly found its way into a 2009 British Telecom (BT) response to an OFCOM consultation that was taking place to determine the pricing framework for Openreach. Based on the CC airports WACC determination, BT argued that the Heathrow rate of return decision should apply to the Openreach pricing framework. Using advice from Dobbs but without any other substantial empirical evidence they asked OFCOM for a WACC at the 80th percentile.

Following the 2009 consultation, OFCOM rejected the notion of asymmetric risk in their consideration of Openreach WACC, preferring to consider risks of that nature on a case-by-case project basis.[11] In their statement on Openreach pricing they also made a detailed comparison of the BT WACC under their and the CC methodologies. The resulting BT WACC would be little different under either approach.[12] In this comparison OFCOM made what we see as a very important point regarding WACC, pointing out that the different approach by OFCOM and CC to estimating WACC was driven by the different regulatory and sector circumstances.

A further point that emerges from these UK determinations is that conditions in the debt and equity markets that following the 2008 GFC highlighted a range of additional risks regarding the estimation of WACC parameters which, depending on the nature of the decision under consideration, affected regulated sectors in specific ways.[13] Because of this both CC and OFCOM preferred to accommodate the potential impact of mis-estimating WACC and the flow on effects [including dis-incentivising investments] on a project and sector specific basis rather than use a generalised uplift to the WACC.

The pricing determinations for the London airports were again reviewed in 2013 ahead of the Q6 pricing period starting April 2014. The CAA received submissions regarding asymmetric risks, and in particular on skewness regarding systemic risks at Heathrow where capacity constraints limit upside potential but unknown risks could threaten an "open" downside performance. There was extensive debate between advisors on either side of the argument who attempted to present empirical

11 In their decision statement they referred to their 2005 paper on the handling of risk in WACC assessments. See Ofcom's approach to risk in the assessment of the cost of capital - Final Statement. August 2005.

12 OFCOM ended up with a narrow WACC range partly derived from point estimates of WACC parameters that "overlapped" with the upper part of the, wider, WACC range using the CC approach. BT's WACC was 0.1% different between the two approaches.

13 For example because the debt and equity markets did not adjust in the consistent way after 2008 the outlook for the range of MRP and Beta's by sector varied and the resulting impact on estimates of regulatory WACC became quite sector specific.

evidence regarding their point of view. In the end the CAA was not convinced of the validity of the evidence regarding skewness and set the WACC in a very similar manner to their Q5 2008 determination.

The most recent UK evidence comes from the CC which has very recently (April 2014) conducted an extensive review of the WACC for Northern Ireland Electricity (NIE). This review determined that an estimate around the mid-point was appropriate. Their decision was consistent with the methodology of their post GFC determinations which have reflected the lower returns in debt and equity markets and the CC tendency to estimate a WACC from the "range" of WACC parameters and to not provide for WACC uplift.

2.3. No support for one-size-fits all percentile

It appears to us that there is little material evidence on which WACC percentile to choose other than the mid-point that is calculated from the best estimates of the individual WACC parameters.

These estimates vary from sector to sector and are influenced by changes to both regulatory and market environments. Our survey of regulatory decisions has however revealed a number of issues that we think should be taken into account by the Commission when considering changes to the WACC IM's.

1. Industry specific factors matter. It is clear from the work of the ACCC/AER in Australia and especially from the work of the different regulators in the UK that the WACC methodology for estimating the WACC depends on the sector specific regulatory arrangements, the regulatory "purpose" that governs a particular sector, the economic/sector structures under which the regulated firm operates and the outlook for demand and investment in each sector.[14]

2. The survey work of the telecoms regulator OFCOM in the UK, in comparing their and the Competition Commission approaches to estimating WACC, is an informative example of the practicalities of calculating WACC and selecting the appropriate rate of return for their sector. For us the comparison highlighted that regulators mostly use the same CAPM model but differ with its application – that is how they estimate WACC parameters in their particular sector.

3. There is considerable consistency of approach in Australia and the UK where regulators estimate a range for the individual parameters that are used in the calculation, and then use a point estimate within the range, depending on a range of particular sector conditions.

4. In the UK the CAA "aimed high" within the range of WACC parameter estimates for Heathrow and Gatwick airports because of specific, and

[14] The relationship between sunk costs and investment requirements is another important factor. It is mentioned in the Telstra review several times where investments in telecommunications networks driven by technology changes/innovations are somewhat different from the investments from innovation in electricity distribution networks.

material uncertainties about components of the cost of equity calculation and of the cost of debt. They also had concerns that Heathrow in particular had both capacity constraints and uncertain demand following the 2008 GFC and that the combination of these factors could cause a "capital strike" by Heathrow and constrain the airports upside potential at a welfare cost to consumers. This is an important point. We think that the regulators' understanding of this demand – capacity relationship, by sector, is central to the consideration of which WACC percentile to choose. By inference the regulator needs considerable industry specific information on which to base its WACC estimate.

5. From our research there has been only one formal review of the arguments for and against the use of a WACC percentile other than the mid-point which was from the Competition Tribunal in Australia who ruled on the appeal by Telstra. In their 2009 report they were unconvinced by the (qualitative) arguments Telstra put forward and in their ruling they commented at length about the likelihood that in the real world investors have heterogeneous expectations and because of this there is unlikely to be a "capital strike" from mis-estimating the WACC.

6. Where a regulator "aims high" with a particular parameter estimate it appears that they do so based on a range of factors that concern them rather than from a particular focus on the overall asymmetry between the upside and downside risks and costs.

2.3.1. Without evidence default uplift is not a 'fundamental' part of IMs

In their submission to the Commission's February 2014 invitation to "have you say on WACC", Vector suggest that the 75th percentile WACC is somehow fundamental to the last 10 years of regulatory practice by the Commission.

It appears to us that it was, in reality, an ad hoc approach to compensate for the possibility that they could decide to regulate a firm when they would not do so if they could make a fully informed decision.

We observe that the Commission is in fact proceeding with a review on the basis that the 75th percentile is not "fundamental" in terms of well-defined principles.

The 75th percentile is now an add-on that is intended to guard against under-investment from error in the WACC estimate and seems to reflect a position the Commission has taken to be risk averse on behalf of consumers. However, the need for this WACC uplift appears to have some conceptual but no empirical support.

In practical terms then, this means the Commission's problem is that it needs to "back-fill" evidence regarding use of the 75th or any other WACC percentile.

We find it curious from our research and from submissions so far that no one has offered anything substantially new or definitive in that space.

Vector also suggested that there is a wider issue at stake over re-evaluation of the entire WACC IM, noting that alternative WACC models could be on the table.[15] We agree with Vector on this point – though we don't see how this precludes a search for evidence on the WACC percentile.

2.3.2. Form of regulation matters

We have shown above that the form of regulation or regulatory environment matters for choosing an appropriate WACC percentile. It is as yet unclear, however, how important the form of regulation is and quite what the implications are, empirically, in terms of selecting one particular WACC percentile or another.

These issues were partially considered in the Frontier Economics advice to Transpower that accompanied Transpower's submission to the Commissions' February invitation to have your say. Frontier notes that prospects of over-investment by Transpower are limited by an ex-ante Grid Investment Test (GIT).

While Frontier was correct to consider the regulatory framework within which the regulated supplier operates there are wider considerations than those noted in their report. For instance the GIT does reduce risks of 'over-investment' but does not eliminate all risks:

- It does not eliminate information asymmetry
- Information asymmetry is strong for reliability investments
- The CBA test does not apply for reliability investments
- The GIT does not consider resulting network charges
- Nor does it consider demand risk or the impacts of prices rising and reducing demand.

Note also that Transpower's perspective, under the individual price path is not the same as the regulated environment that the distribution networks face under their DPP/CPP framework. For instance distribution networks face quite different demand risk which of itself is a strong reason to consider sector-specific differences.

[15] We agree that the WACC model is an important consideration given model uncertainty – quite apart from estimation error from a given model. Note that there is extensive consideration of such issues in the monetary and macroeconomic literature that provide a useful frame of reference. Findings from this literature include that, if consumers are risk averse, policy should err on the side of stabilisation (low prices) over growth (increased investment), due to welfare losses from cycles – i.e. the analogy with infrastructure is that it may be better to delay rather than charge for unnecessary and lumpy investment. In NZ (Lees 2006) findings have also included that model error or uncertainty implies that policy should err on the side of being too stringent, favouring price stabilisation over growth, even if there are costs.

2.3.3. Sector specific considerations

More broadly, sector-specific considerations should include elements beyond the regulatory environment including:

- who the consumers of regulated services are
- the costs of substitutes for network investment – and hence the quantum of social risk at stake from under-investment
- the likelihood of innovation and the importance of technological progress related to investment – best exemplified by counter-examples rather than by suggesting innovation cannot occur in e.g. transmission
- where returns on innovation are likely to come from, for example:
  - is innovation incentivised regardless of regulated returns?
  - is innovation rent creating (such as new products) or cost reducing?
- whether incentivising investment or innovation in one sector is likely to crowd out investment or innovation in other sectors, which goes to general equilibrium impacts and the size of the sector.

3. Analytical evidence

3.1. Partial equilibrium analysis

We conducted an examination and extension of methods used in Dobbs (2011). The Dobbs analysis is the only analysis we are aware of that explicitly calculates loss functions characterising trade-offs from setting regulated rates of return too high or too low. This makes the framework adopted in the Dobbs paper a useful starting point for examining analytical evidence regarding the appropriate WACC percentile.

Dobbs considered the effects of regulators setting rates of return higher or lower than a firm's 'true' cost of capital and found that:

- for sunk assets, when no new investment is needed
  - costs are relatively symmetric
  - on balance it is better to err on the side of setting rates of return slightly below the 50th percentile
- for new assets, i.e. when investment is needed
  - costs are asymmetric with
  - significantly higher costs, from postponed or cancelled investment, when rates of return are set too low such that WACC should be set as high as the 97th percentile of the estimated distribution
- the costs from reduced investment in new assets is sufficiently high that even when new investment is only 5% of total assets, WACC should be set at the 74th percentile.

The intuition behind these results (and others) is that if consumers are paying above the 'true' rate of return, there is an offsetting benefit from investment which yields new or improved services.

While useful as a framework, the Dobbs results have a number of shortcomings for practical guidance in selecting appropriate WACC percentiles. For example, while a wide range of sensitivity calculations are considered, some of the key parameters – such as demand elasticity – are set at values only really appropriate for investment in new products and services, as opposed to the kind of capacity expansions which characterise most regulated network infrastructure.

The key question addressed in what follows is whether the findings from Dobbs are sufficiently stable under alternative and realistic assumptions to be used to inform the selection of WACC percentile values.

3.1.1. Sunk assets

Dobbs finds that welfare is maximised with WACC percentiles close to the 50th percentile of WACC. This is a little misleading. This result obscures the fact that all of the expected welfare gain from setting rates of return near the 50th percentile comes from producers surplus (profits) that accrue to regulated suppliers.

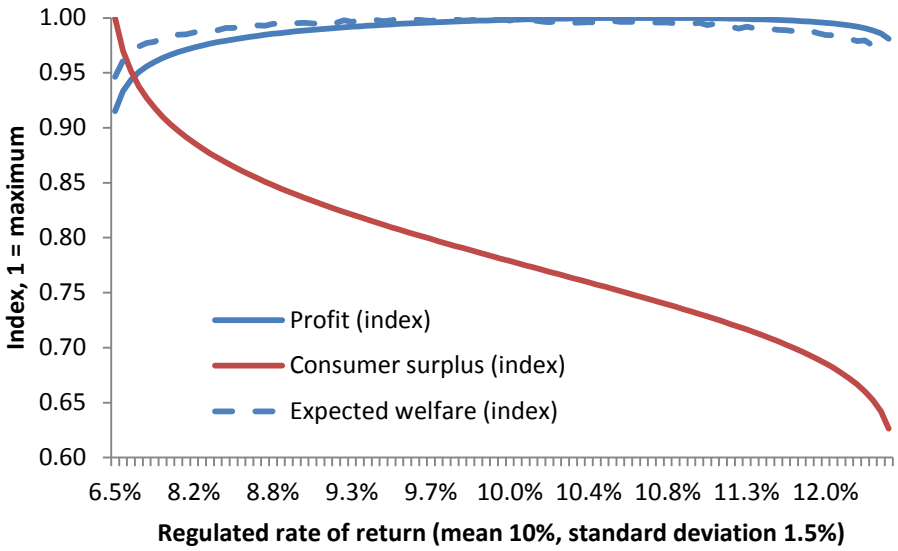
This can be seen in Figure 1 which charts indices of welfare measures relative to the maximum level attained across various rates of return. Consumer surplus (or welfare) is highest at the lowest percentile for WACC. Profit is increasing with WACC, up to the point that higher prices reduce demand - the conventional 'sweet spot' for a monopolist seeking to maximise profits where, in this example, the associated WACC percentile is the 69th percentile of WACC.

The results in Figure 1 are an important qualification to the Dobbs analysis and any other approach which calculates asymmetric costs without considering where the costs of asymmetric impacts fall.

When investment is not at risk, consumer welfare is strictly declining in price and thus strictly decreasing in the rate of return set for regulated suppliers.

Figure 1 Consumer surplus, profits and pricing of sunk assets

Indices are relative to maximum. From 'Base' case analysis values in Dobbs (2011)



Source: NZIER

In this example expected welfare tracks profits but declining consumer surplus offsets the total welfare gain leaving the WACC percentile which maximises overall welfare as the 49th percentile.

If consumer benefits are at the heart of regulatory objectives and if there is no investment at stake, it is unwise to include profits in welfare calculations. WACC percentiles lower than the mid-point should also be considered within a set of possible options – contingent on the specifics of the industry in question.

This does not necessarily imply that WACC percentiles should be chosen which are lower than the mid-point. Low rates of return on sunk assets may well have negative impacts, for investment and quality of service, over the longer term. These are not factored into this analysis – but are considered further below.

Note the results in Figure 1 are specific to the 'Base' case parameter values and demand specifications used in Dobbs (2011) and therefore the shape of the functions

in Figure 1 are sensitive to these factors. The rapid declines in Consumer surplus, for example, result from fairly extreme assumptions about the sensitivity of demand to prices – that is, a price elasticity of -3 is in the base case.

Values which are more realistic for conventional regulated services (such as gas and electricity distribution and transmission) change the dynamics in Figure 1. An elasticity of -0.5, for example, results in relatively small changes in consumer surplus over the range of WACC values while profit is maximised at the top of the range (see Figure 2)[16].

This change in dynamics, with reduced demand response, does not affect the overall finding that, whenever sunk assets are being considered, consumer welfare is maximised at the lowest WACC percentile. Although when elasticity of demand is low, the welfare of consumers is maximised at the lowest decile for WACC while total welfare including profits is maximised at the opposite end of the WACC range.

The demand function behind the results in Figure 1 is a constant elasticity of demand (CED) function – the form of demand function used in the Dobbs model. This type of demand function is one where price levels do not affect the responsiveness of demand to changes in prices.

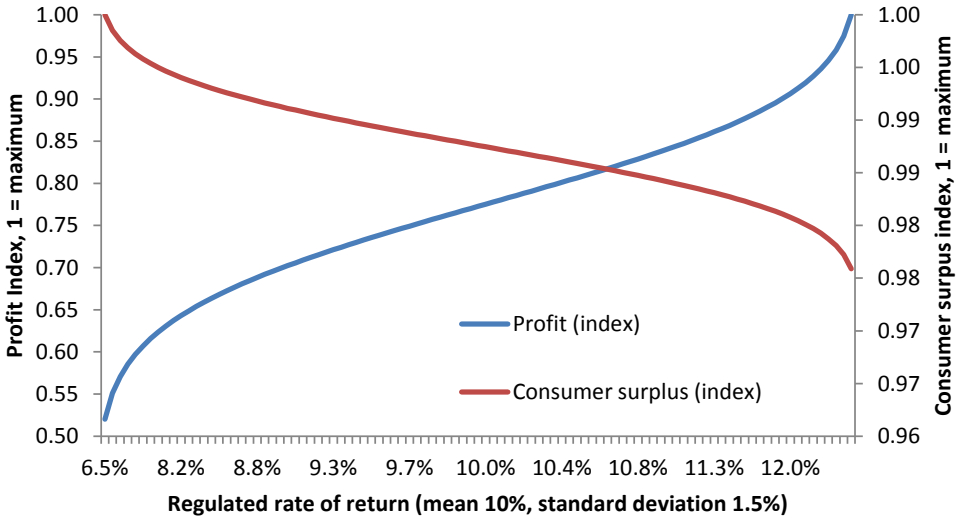
The CED function is not a good representation of reality. Expenditure on regulated network services is sufficiently large that price levels matter for demand response. The higher the price, the greater the impact on incomes and the greater the price sensitivity of consumers and the more intense becomes the search for substitute services.

A linear demand function with low price elasticity, but which move upwards as prices increase, has the effect of increasing the size of consumer surplus changes over the range of possible prices. This is more consistent with observed relationships than the constant elasticity specification.

[16] The results in Figure **2** exclude the expected welfare measure adopted by Dobbs. The welfare measure adopted by Dobbs is convenient as the consumer surplus component can be reduced to a single equation and calculated directly but it comes with the downside that consumer surplus cannot be calculated directly for elasticity greater than 1 in absolute value. To accommodate an elasticity which is less than 1 in absolute value the results shown here and throughout this report are based on direct calculation of definite integrals rather than the shorthand approach used by Dobbs.

Figure 2 Consumer surplus and profits, low price elasticity

Indices are relative to maximum, parameters as for Figure 1 except elasticity = -0.5



Source: NZIER

Regardless of the actual size of effects, it is clear that assumptions about the relationship between demand and prices have a sizeable effect on the WACC percentile at which consumer welfare is maximised.

More generally, the inclusion of profits in the welfare calculations in Dobbs is misleading. The analytical framework used in Dobbs includes a binary investment function where supply of capital is either positive, when regulated rates of return are sufficiently higher than finance costs to ensure that projects are NPV positive, or is zero. This is a useful construct for thinking about investment decisions but it does not accurately reflect producer surplus.

Counting foregone profit as a welfare cost ignores the fact that investors will be able to invest elsewhere in the economy (or elsewhere in the world) and achieve returns (profits) that are only fractionally smaller than they would have received if the investment in the regulated sector was NPV positive.

Similar claims can be made about consumer surplus. That is consumers can, to some extent, spend their money elsewhere. The key difference between the profit function in the Dobbs analysis and the demand function is that demand elasticity captures the extent to which consumers purchase other products and services when prices increase.[17] There is no analogous parameter for profits in the Dobbs framework.

If producer surplus is to be taken into account then the analytical framework needs to include a continuous capital supply function – with an elasticity of supply of capital analogous to the elasticity of demand for regulated services. This would ensure that the scale of welfare loss, due to lost profits, is not overstated relative to costs to consumer welfare.

[17] The consumer surplus value calculation used by Dobbs is only crude shorthand for consumer welfare. More accurate measures would likely yield different analytical results than are found in Dobbs.

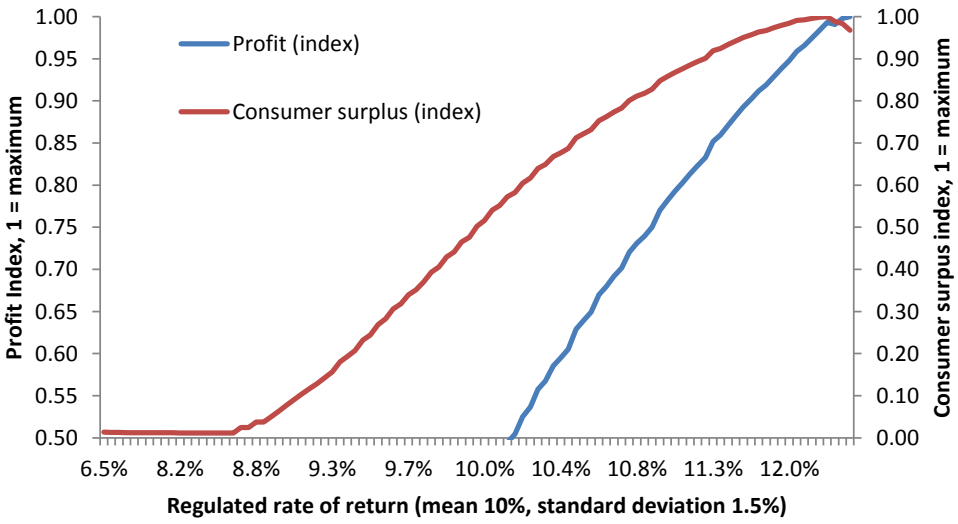
In the absence of a parameter describing capital supply responsiveness to rates of return the best method for evaluating welfare effects of WACC percentiles are consumer welfare measures. Accordingly, in what follows, we focus on consumer welfare.

3.1.2. Investment effects

When investment effects are taken into account the difference between WACC percentiles which maximise profits and WACC percentiles which maximise consumer welfare get much smaller than in the case of sunk assets. This is illustrated in Figure 3 and implies that focussing on the welfare of consumers does not radically alter analytical results for the case where new investment is under consideration. The results shown in Figure 3 and in what follows are all for the case of deferrable investment.[18]

Figure 3 Consumer surplus and profit when investment is at risk

Indices are relative to maximum. Parameters from 'Base' case analysis values in Dobbs (2011) for deferrable investment.



Source: NZIER

The Dobbs results suggest that, in general, fairly high percentiles for WACC should be chosen whenever investment is likely to be put at risk by costs of finance turning out to be higher than regulated rates of return. The range of percentiles suggested by Dobbs' illustrative analysis is between the 79th and 98th percentiles of WACC.

[18] Dobbs considered a benchmark case of investment which is not deferrable but this is not considered here as deferrable investment is generally the more realistic case. Investment which is not deferrable generally demands lower WACC percentiles to maximise welfare - other things being equal. Non-deferrable investment is most aptly considered in cases where there is competing investment in substitutes – such that when investment is deferred substitute services or infrastructure are able to capture demand and path dependency reduces further investment opportunities for an incumbent. This is an interesting scenario to consider but ads analytical difficulties as it requires considering the welfare implications of substitute investments. Thus we ignore this category of investment for the purposes of this report.

To explore the stability of this result we considered:

- ***realistic*** model values which we believe reflect the market for most regulated services in New Zealand, namely:
  - demand elasticity of -0.2 (Dobbs base = -3)
  - depreciation of 5% p.a. (Dobbs = 10% p.a.)
  - mean WACC values of 7% (Dobbs base = 10%)
  - standard deviation for WACC of 1.1% (Dobbs base = 1.5%)[19]
  - underlying demand growth of 0.5% p.a.
- ***linear demand*** where elasticity of demand changes according to price levels
- ***excess capacity*** in the regulated asset base, resulting from the regulator assuming that existing assets are used and useful and calculating revenue accordingly
- ***form of regulation*****:** the extent to which regulating revenue – as opposed to price – has a material effect on Dobbs' results

The linear demand function used was a simple one and the parameter linking price to demand was chosen to be similar to the -0.2 value used for the constant elasticity case (so as not to confuse what is driving any differences). Demand was assumed to be:

$$q_t = (B + \psi.\hat{p})e.^{\alpha.t}$$
$$\psi = -0.075$$

The possibility of excess capacity was considered given:

- the importance of the size of the regulated asset base for regulated prices in terms of the way regulation is practiced in New Zealand
- Dobbs' assumption that capacity was either less than or equal to what was required to meet demand
- that in New Zealand existing (opening) asset bases are subject to minimal scrutiny as to whether these are matched well to demand levels.

The effects of excess capacity were introduced into Dobbs' model by introducing a 'wedge' parameter, reflecting whether capacity was above or below its 'optimal' level.

Dobbs analysis assumes that initial capacity is equal to demand:

$$Q_0 = B.\hat{p}^{\epsilon} = q_0$$

Our variation considers the possibility that:

[19] This standard deviation value is taken from the Commerce Commission's 'Cost of capital determination for electricity distribution businesses to apply to a customised price-quality path proposal [2013] NZCC 16', while the mean value for WACC is an approximation to the kinds of mid-points used for regulated distribution, pipeline and transmission businesses.

$$Q_0 = B.\hat{p}^{\epsilon} = q_0.\delta$$

The 'wedge' parameter (δ) is assumed to be normally distributed with mean equal to 1 and standard deviation of 0.05. Thus there is a 50% probability that capacity is greater than optimal and a 50% probability that it is less than optimal (i.e. that investment is 'needed'). Note that this distribution restricts excess capacity to reasonably small values. For example, excess capacity of 5% or more is assigned a probability of less than 16%.

In the Dobbs model expected welfare is increasing if and only if the realised cost of finance is less than a required ('critical') rate of return. To this we add the condition that expected welfare is also increasing when δ is less than 1.

The form of regulation is taken into account by considering the case where the regulator sets revenue and a set of de-facto prices, based on the assets and costs and rate of return of a firm, while the actual price faced by consumers is a function of revenue and consumer demand i.e. the price to consumers (in the case of constant elasticity of demand) is:

$$p = \frac{Q_0.\hat{p}^{1-\epsilon}.\delta}{B}$$

The results of our analysis are presented as four scenarios:

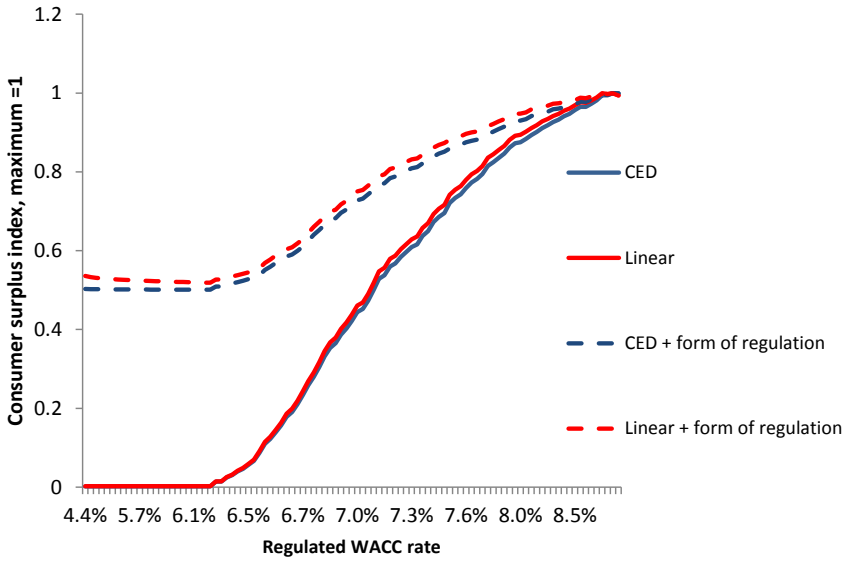
- a constant elasticity of demand (CED) scenario where our assessment uses the Dobbs model with the 'realistic' parameters outlined above
- a linear demand scenario which differs from the CED scenario only in terms of the use of a linear demand function
- a variation on the CED scenario which considers the effects of the form of regulation and potential for excess capacity
- a variation on the linear demand scenario which considers the effects of the form of regulation and potential for excess capacity.

The results of our analysis show that:

- welfare maximisation requires high WACC percentiles for new investment in all scenarios with welfare maximised at
  - the 98th percentile of WACC for the CED scenarios
  - the 96th percentile for the linear demand scenarios
- the costs of setting WACC too low are much smaller when form of regulation and potential for excess capacity is taken into account, compared to when these factors are not taken into account (see Figure 4), but welfare maximising values remain at the top end of the WACC range

Figure 4 Welfare maximising WACC for new investment

NZIER base case



Source: NZIER

These results broadly accord with findings in Dobbs (2011) which notes that low elasticities reduce the welfare maximising WACC percentile. The elasticities we employ are much lower than any used in Dobbs (2011).

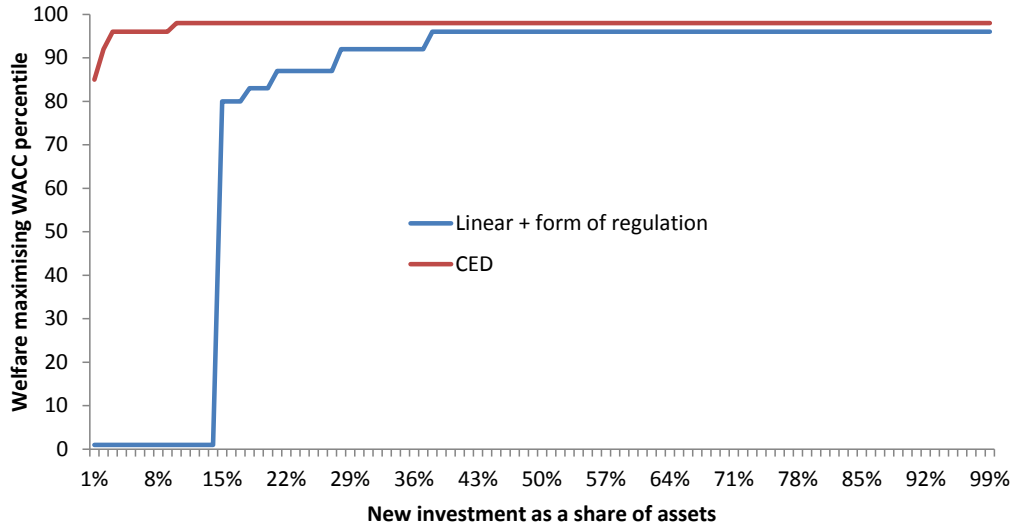
The form of regulation has little effect on the welfare maximising WACC percentile although this result is contingent on the elasticities we use. By way of example, a replica of the Base case reported in Dobbs but amended to consider form of regulation reduces the welfare maximising percentile of WACC by 5%. Thus the form of demand and the demand elasticity makes a material difference to the appropriate WACC percentile for maximising welfare in the case of new investment.

3.1.3. Overall welfare

Dobbs (2011) found that WACC percentiles well above the mid-point of the range are necessary for maximising welfare even when small amounts of new investment are put at risk. This finding is sensitive to the way that Dobbs (2011) calculates welfare from sunk assets (as discussed above).

Combining our analysis of sunk assets and investment effects we find that the welfare maximising choice of a WACC percentile is highly sensitive to the ratio of sunk assets to new investment. This can be seen in Figure 5 where we chart the welfare maximising WACC percentile contingent on proportion of assets which represent (potential) new investment.

Figure 5 Welfare maximising WACC given new investment share



Source: NZIER

These results are extremely sensitive to assumptions about functional form of demand and demand elasticity. The CED case shows the optimal WACC percentile is everywhere above the mid-point while the linear case shows that the optimal WACC percentile is the first percentile whenever new investment is less than 15% of asset value, jumping to an optimal percentile of WACC of 80% when new investment rises above 15% of assets.

Small changes in elasticity move the point at which the optimal percentile jumps from the bottom of the WACC distribution to above the mid-point moves. In the linear demand case an increase in the demand elasticity from an average of -0.2 to -0.5 (price coefficient change from -0.075 to -0.11) increases the point of a step change from new investment less than 15% of asset value, to new investment less than 20% of asset value.

Another reason for the different results observed here, as between linear and CED demand and for different elasticities, is that these assumptions affect the absolute size of consumer welfare and hence the weight that it is put on welfare from existing assets and low percentiles of WACC, versus new investment and high percentiles of WACC.[20]

We tested the extent to which real world model values might affect our results. To do this we used values indicative of Transpower's business and demand for Transpower's services using information from Transpower's current individual price path proposal and transmission pricing information.[21] The values used to parameterise the scenario were the same as for our base scenario except:

[20] This issue of welfare weights is also exacerbated by the absolute parameter values in the Dobbs model – which are general rather than reflecting actual investments or prices or asset bases.

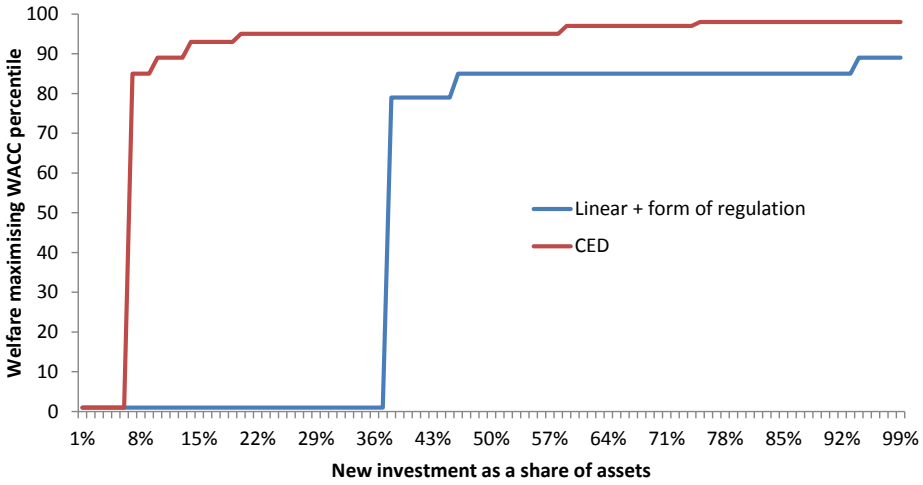
[21] We consider Transpower because information for calibrating the model is readily available. Information on assets and costs contained in 'RT01 - RCP2 Forecasts and Revenue.xlsx' downloaded from https://www.transpower.co.nz/about-us/industry-information/rcp2-submission-and-itp/rcp2-regulatory-templates and information on (coincident) peak demand and prices from 'year-specific-data-2013-14.pdf' downloaded from https://www.transpower.co.nz/about-us/industry-information/revenue-and-pricing.

- Demand "level" (B) = 16,000,000
  - the value for B which ensures that the current demand is matched to current prices
  - we use national coincident peak demand (kW) as our quantity (demand) measure – (5,775,000 in the year ended 31 August 2013)
  - we use 2014/15 forecast MAR divided by quantity as our initial price measure ($)
- unit operating cost (c) = $50
  - the value of the proposed opex allowance divided by national peak demand
- capital cost (k) = $500
  - assuming that capital costs are ten times larger than operating costs for a given increment of demand
- the price coefficient on linear demand is -62,203 – the value which ensures current demand is matched to price given that B has already been determined

The results for the CED case are that the optimal WACC percentile is at the bottom of the WACC distribution for values of new investment (as a share of assets) less than 7%, with optimal percentiles above the 84th percentile beyond that point and steadily rising towards the 98th percentile (see Figure 6).

The results for the linear case plus adjustments for form of regulation is that the optimal percentile of WACC is at the bottom of the distribution wherever new investment is less than 38% of asset value. Above this point the optima percentile is above 78th and rising steadily towards a maximum of 89th.

Figure 6 Optimal WACC percentile – Transpower example



Source: NZIER

3.1.4. Conclusions from partial equilibrium analytical evidence

The results presented here suggest a discontinuous relationship (loss function) between welfare and WACC percentiles. This discontinuity suggests caution and industry-specific analysis before selecting a WACC percentile.

The precise shape of the loss function is very sensitive to industry and firm specific context including firm costs, form of regulation and nature of demand.

If a regulated supplier faces inelastic and rapidly growing demand or technological change (i.e. high investment demand) then appropriate WACC percentiles will be near the top of the distribution. If investment demand is low, a WACC percentile at the bottom will be optimal.

3.2. General equilibrium

The above analysis provides a useful means of thinking about trade-offs at an industry level but says little about how under-investment or excess profits in a particular industry affects the wider economy.

Wider economic effects are important to consider because excess returns in one sector can reduce the productive potential of other parts of the economy by raising other industries' finance or input costs – including the costs of regulated inputs.

In addition, the required rate of return for investment is not likely to be binary. Costs of capital can be considered, to some extent, to be set within the economy. On this view rates of return are determined by propensities to save, the productivity of labour and of physical capital and international terms of trade.

For example, if a sector is experiencing strong export demand growth or a technical change to its productivity the sector will produce higher returns than other sectors. Investors will chase these higher returns and, over time, we should expect capacity to expand and rates of return to begin to diminish.

These effects may not materialise in an industry which is not workably competitive however it is the case – as discussed above – that investors who are not happy with a lower than expected rate of return can invest in the next best thing. When they do, they have to bump other investors out of the queue and in so doing they may also have to accept a lower rate of return.

This is not a predictive commentary; rather it goes to pointing out that there are a lot of offsetting effects in the economy which can work to alter the impacts of a regulatory or a policy decision – as compared to partial equilibrium analysis. This is borne out by analysis we have conducted using a Computable General Equilibrium (CGE) model of the New Zealand economy.[22]

3.2.1. CGE basics and analytical strengths

CGE models are essentially a collection of simultaneous equations describing equilibrium conditions in the economy where all markets clear.

[22] See our website. http://nzier.org.nz/nzier-cge-brochure

Such models are formal and strict expressions of some of the most important widely unappreciated tenets of economics namely:

- identities matter (a.k.a constraints)
- simultaneity of decisions
- relative prices as signals.

The imposition of strict adding-up constraints in CGE models is a particular strength because it imposes discipline on quantitative analysis and recognises that policy impacts in one part of the economy will have flow on effects on other parts of the economy and these effects to not have to be in the same direction (positive or negative) as the proximate shock.

A classic example of this strength is the measuring of impacts from "job creation" policies. Partial equilibrium analysis will often find that industry policy can create jobs purely on the grounds of increased labour demand. CGE models will only admit this kind of result if the model is deliberately set up to include disequilibrium in the labour market. Such set ups might include labour market frictions related to sticky wages or taxes on labour income.

CGE models implicitly apply a rather sceptical view of the capacity of policy to boost growth – unless those policies are removing some form of rigidity in the economy.

3.2.2. Defining the problem

That being so the general equilibrium analysis forces the analyst to confront the problem definition in a wider context. In the case of WACC percentiles the high level results are almost pre-ordained from the specification of the scenario being tested namely:

> *What happens when an industry receives a higher (lower) than average rate of return through a **boost in output prices** but without any accompanying change in productivity or demand?*

Conventional rules of thumb tell us that the first round effect is that this is a reduction in the real value of an industry's output (whether measured as a decline in quality or an increase in price for the same quality). For buyers of the industry's output this is bad news.

This may be good news for investors in the industry but it depends on the extent to which the price change chases away demand and the length of time over which the investor is invested. Over the long term, relative price increases have a compounding effect on demand for a sector's output which can mean higher prices lead to longer term lower profits (the Dobbs analysis abstracts away from this sort of effect by assuming that demand growth is autonomous and not affected by price).

If the shock to prices[23] is large enough and the industry is important enough the negative effects of the price increase mean lower output, income and consumption in the economy.

[23] We refer to the price increase from a higher rate of return as a "shock" to the CGE model.

Over the longer term offsetting effects come into play which determine who bears the cost of the higher prices. The main channel of effect is that if the economy shrinks the terms of trade improve – locally traded products and wages fall relative to international prices. This means export industries do well and the costs of the price shock fall squarely on consumers and domestically focussed industries.

For the case of an output price reduction one should expect a reversal of these effects.

3.2.3. Macroeconomic impacts of adjustments to WACC

Below we provide results for long term 5% increase and a 5% decrease in prices for gas and electricity distribution and transmission output.

Table 1 Macroeconomic impacts of WACC above or below optimum

		5% below	5% above
PRICES	Consumer price Index (CPI: Numeraire)	-	-
	Investment	0.054	-0.087
	Government	0.375	-0.319
	Exports	-0.066	0.035
	Imports (c.i.f.)	-0.075	0.039
	Imports (NZ$, local currency)	-0.075	0.039
	GDP price deflator	0.083	-0.078
	Real exchange rate	-0.075	0.039
	Terms of trade	0.009	-0.004
	Returns to capital	-0.168	0.014
	Returns to land	-8.491	9.777
	Nominal wage	0.703	-0.597
	Value added price	0.097	-0.090
VOLUME	Household consumption	0.601	-0.538
	Investment	0.584	-0.440
	Government consumption	0.601	-0.538
	Exports	-0.112	0.063
	Imports	0.139	-0.115
	Gross domestic product	0.517	-0.460
	Capital	1.147	-1.019
	land	0.000	0.000
	employment	0.000	0.000
	Value added	0.541	-0.482

Source: NZIER

As intuition suggested, the macroeconomic results from our CGE model are that an arbitrary (here 5%) increase in output prices reduces the overall size of the economy but increases the size of the export sector by improving the export sector's competitiveness.

Industry level effects vary considerably but, in general, domestically focussed sectors and those which are not especially competitive internationally are the ones which shrink (compared to what they otherwise would be) - such as domestic textile manufacturing – while export sectors (including pulp and paper) do well.

Note that overall investment in the economy increases under the scenario of a reduction in output prices and declines when output prices rise.

3.2.4. Implications

The key point here is that prices which invite investment include costs which are not factored into partial equilibrium models and also factor in benefits which are illusory (e.g. excess profits). Conversely, low(er) prices can have offsetting benefits by encouraging demand and boosting income and then spurring more investment over the longer term.

Ideally these kinds of dynamics would be considered in careful analysis determining an appropriate WACC percentile. However we note that doing so is not straight forward. The results above are indicative in the sense that more detailed analysis of adjustment dynamics is needed to more fully evidence the implications of WACC percentile choices. This has not been possible in the time available.

The analysis we have done does not have a great deal to add in terms of what the 'right' WACC percentile is. What it does say is that the shape of partial equilibrium loss functions is likely to be wrong because they overlook certain costs of excess profits and benefits of lower prices.