Welfare effects of UCLL and UBA uplift

Comments on the Application of the Dobbs 2011 model

Ian M Dobbs

29/05/2015

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1 Terms of Reference

1. The Dobbs (2011) model provides a rationale for choosing a percentile of the WACC distribution significantly above the 50th for the allowed rate of return whenever some of future investment is discretionary and possibly deferrable. The Commerce Commission of New Zealand has asked me to comment on the relevance and use of this model in the context of UCLL and UBA pricing, and to comment on its application in the CEG (2015) report. The CEG report makes extensive use of a version of the Dobbs model developed by Frontier Economics (2014). I commented in detail on that work in an earlier report (Dobbs, 2014) to the Commerce Commission; in what follows, I will naturally make reference to that work when the issues covered there are relevant to the present case.

2 Summary and Conclusions

2.1 General

2. There are clearly reasons for uplift in price caps (whether or not via an uplift in the allowed rate of return[1]) because of the impact of technical progress and also because of the presence of a variety of 'real option' effects. The impact of all these effects is uni-directional – they motivate an increase in the price cap. That said, the specifics of the case suggest that these factors may impact much less in the case of UCLL/UBA uplift than in other applications.

3. The Dobbs-Frontier model has been used by CEG (2014) to suggest what the extent of uplift might be. My view, also expressed in my earlier report (Dobbs, 2014) to the NZ Commerce Commission, was that the Dobbs model is useful in that it shows that real option effects associated with uncertainties concerning the cost of finance can provide a rationale for a significant uplift in initial price caps associated with new investment. However, it is important to note that the model ignores the impact of technical progress (impacting on future prices) and a range of other real option effects (including choice of initial scale and pace of roll out of subsequent investment) that would actually suggest even higher uplifts in initial price caps.

4. At the same time there are a range of reasons why the 'uplift' in price caps might be smaller. Firstly, in the case of NZ Telecoms, there is the question of to what extent there are any significant real option effects of the type described above – if firms have

[1] The Dobbs 2011 model used an increase in the allowed rate of return as a mechanism for increasing the price cap. Naturally, it makes no difference whether this or some other mechanism is used to adjust the price.

little or no scope for adjusting their investment programs, they do not have these real options. This point has been raised by various parties (see Annex 5.2). Secondly, there are reasons 'within the Dobbs model' why the overall predicted uplift might be smaller than indicated by then CEG(2015) benchmark runs.

5. In fact, within the framework of the Dobbs model, there are both reasons for a larger uplift and a smaller uplift. The reasons for greater uplift 'within the model' associate with treatment of uncertainties concerning the WACC – these argue for the use of a higher standard deviation for the WACC than used in the CEG scenario work (see section 4.6 below). The reasons for smaller uplift are (i) because of substantial cross-elasticity effects (ii) lower weight on profit in the welfare objective function, and (iii) lower levels for new investment than assumed by CEG in their benchmark scenarios.

6. There appear to be errors in the CEG calculations of truncation prices (the assessment of maximum willingness to pay. These in themselves appear to be fairly significant (see section 4.4 and annex 1; CEG base case uses $523 as the truncation price for both existing and new lines; if I am correct, my calculations suggest that they should be $415 for existing lines and $1118 for new lines). Further, truncation prices should vary with elasticity, so as elasticity values are varied across scenarios, so should truncation prices. However, the impact on the optimal percentile, from making these adjustments to truncation prices is relatively modest.

7. Of all the above reasons for varying uplift, I consider the most important is that concerning cross elasticity of demand between existing and new services. The fact is that the services are economic substitutes – and when new services come on stream, there is likely to be a significant negative impact on the demand for old services. Within the model, this is 'roughly' equivalent to a *substantial* reduction in the truncation prices used for the new service (see annex 1).

8. Overall, lower weighting on profit in the welfare measure, arguably lower estimates for levels for new investment, and the strong impact of cross-elasticity (new and existing services are substitutes) means the predicted uplift *within the model* is likely to be significantly less than in the scenarios considered by CEG.

9. Finally, the above discussion has focused on the need for 'uplift' in price caps relative to simply setting a TSLRIC price. There are clearly reasons why current cost models for TSLRIC may also under-estimate 'true' TSLRIC. Vogelsang (2014) notes that possibilities for asset re-use are not properly accounted for. As far as I am aware, the extent of possible under-estimation has not been assessed, but it may be material.

10. Overall, it is very unclear whether or not there is a need for additional uplift in UCLL/UBA price caps, over and above current estimates of TSLRIC. In my view, the 'devil is necessarily in the detail'. Before considering the case for uplift based on real option considerations, it would be desirable to have a quantitative assessment of

the likely extent of under-estimation for TSLRIC associated with asset re-use, along with some explicit assessment of the possible importance of technical progress on future prices (in future regulatory reviews). The former suggests reduction in price caps whilst the latter suggests uplift - and neither seem to be clearly or fully accounted for in the current TSLRIC cost models.

2.2 Some more detailed comments

11. Various commentators have criticised the CEG application because the modelling does not account for the fact that existing and new services are economic substitutes (the original Dobbs model assumed they had independent demands). The issue is discussed in detail in section 4.3 below (with discussion of reviewer comments in Annex 5, section 5.4). This is an important issue, and one that makes a material difference. The original model assumed there was a welfare gain from introducing the new service, and that this was essentially independent from welfare gained from the existing service. In the NZ UCLL/UBA case however, because the new and existing services at the retail level are economic substitutes, it is clear that, when a new service is made available, it impacts on the demand for existing services. There are technical issues associated with measurability of consumer surplus in such circumstances, but roughly speaking we can say that the welfare gained from the new service (as measured in the model) is to an extent offset because customers are no longer using the old service (and this is not accounted for in the model). To put it another way, when thinking about the value the new service gives to customers, it is, in effect, a question of how much customers are willing to pay, *over and above* what they already pay for the existing service. This is clearly not the same as willingness to pay for the new service *per se* (that is, in the absence of the existing service).

12. I am not familiar with the approaches taken to estimation of demands for NZ broadband, or with the basis used by CEG for estimating consumer surplus in the NZ context. However, roughly speaking, we are talking about whether the consumer surplus estimates used by CEG are appropriate – or whether much lower estimates should be used in order to account for the presence of cross-elasticity. Within the model, the impact is roughly equivalent to using much lower values for the maximum willingness to pay (‘choke price’ or ‘truncation price’) for both new and existing services. Using significantly lower values for truncation prices will inevitably lead to significantly lower optimal percentiles and lower predicted ‘uplifts’ for price caps.

13. In view of the above, it would be of some interest to run the model with a range of much lower values for the truncation prices (in my view, it is likely that much lower predicted uplifts will result when truncation prices are lowered substantially).

14. The Dobbs 2011 model also assumes the new investment is in an 'all-or-nothing' start up service, where the firm's decision is that of whether to initiate the service or not. In this model, the consequence of setting too low a price cap is that the new service is more likely to be deferred, to at least the next regulatory review period (RRP). It is the risk that this may happen that drives the high percentile uplift for new investment. In the present application, as I understand it, the UCLL/UBA price caps will be set at a geographically uniform rate, based on a geographically averaged TSLRIC cost estimate. This suggests the incentive to invest is likely to differ geographically, and that it is unlikely that <u>all</u> investment would be deferred to the next RRP. That is, for any given price cap, there is likely to be still an economic incentive to develop the lowest cost areas in the first RRP, with deferred investment for higher cost areas. On this view, the welfare cost of setting too low a price is that the pace of roll-out will be slowed, rather than that it does not happen at all. This is another reason why the model may <u>*over-estimate*</u> the need for uplift.

15. All the above suggests the model may over-estimate the need for uplift – however, the model is partial in the sense that there are various other real option effects present in the market that are not included in the model. These omissions suggest the model could <u>under-estimate</u> the need for price cap uplift. This is why I argued, in my earlier report (Dobbs, 2014), that overall the model cannot be used to give in any sense a 'precise' estimate for uplift. It is useful mainly because it gives an 'indication' of how important real option effects may be.

16. Professor Vogelsang (2014) notes that current estimates of TSLRIC do not take account of the re-use of existing assets. He is of the view that there is material over-estimation of TSLRIC as a consequence. In view of this, he suggested that no further uplift in the price caps are warranted in order to account for real option effects.

17. The New Zealand Commerce Commission (NZCC) puts significant weight on 'dynamic efficiency' *vis a vis* 'static efficiency', and accepts there are arguments concerning real option impacts,[2] and that some uplift in price caps may be warranted in such circumstances. In the consultation paper, NZCC (2014) accepted the Vogelsang view that, because TSLRIC had been over-estimated, no further uplift was required to account for real option effects.[3]

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[2] The Commission (2014b) writes

> *"217. Our draft decision is that this asymmetric cost we were concerned with in setting the UBA IPP remains in respect of the UCLL FPP. In particular, the costs of mistakenly setting a price that is too high would include the welfare loss to end-users from higher retail prices for copper-based services. However, a price that is too low could slow migration to fibre-based services, with consequential impacts on the welfare benefits arising from migration to fibre networks. On balance, we continue to hold the view that, in principle, we should give weight to erring on the high side to avoid the negative consequences of setting a price that is too low, and adverse effects on incentives to invest in innovative services."*

[3] The relevant quotes are as follows: Vogelsang (2014) writes

18. In the absence of quantification, the arguments seem reasonable, and Professor Vogelsang's, and following that, the Commission's, overall judgement, may seem 'plausible'. However, as far as I can see, neither the Commission nor Professor Vogelsang has actually quantified the overall extent of 'under-estimation' of costs (associated with the re-use of assets), nor the extent of uplift warranted by real option effects, so it remains unclear (to me) whether the overall assessment is reasonable or not.

19. Ideally, it would be good to start with getting an unbiased TSLRIC estimate. This would need to address the concerns raised by Professor Vogelsang concerning asset re-use, but also would need to address the question of whether the modelling of TSLRIC properly accounts for changes in MEAs over time. I can see the potential for the price of bandwidth (and services) to continue to fall over time but in the time available, I have not been able to check whether the TSLRIC modelling includes enough 'tilt in the annuity' to account for this; as far as I can see, there appears to be some tilt to account for changes in capacity utilisation, but not for the prices (the possibility, at each regulatory review, that the estimate of MEAs etc. are different/lower). Technological progress is a reason why there is need for uplift in the initial value for Price Caps – to account for the likely lower price caps at later RRPs. Even under certainty, there is a rationale for uplift for this reason - ***uncertainty*** associated with the evolution of technical changes and demands for services etc. then further increases this rationale for uplift to account for the real option effects.

"If the Commission sticks to its preliminary decisions to stay with the classical TSLRIC approach and therefore not to consider re-use of civil works and not to make a performance adjustment for the FTTH MEA, then as compared to application of the modified TSLRiC [sic] methodology being advocated by the EU, the NZCC classical application results in a higher price. This would likely offset any efficiency argument (Alfred Kahn), investment risk or lumpiness that would go against the classical TSLRIC. It would also take care of any net positive externalities from incentivizing migration to UFB. Thus, there would, in my view, be no case to be made for an uplift to the WACC or for a generous approach to any other cost components." (2014, para 18).

The commission (2014b) writes:

" 208. Consistent with the UBA IPP, when considering whether to depart from our midpoint WACC estimate, our primary concern was the asymmetric consequences of setting UCLL And UBA Prices too low, relative to setting them too high. In particular, a price that is too low could slow migration to fibre-based services, with consequential impacts on the welfare benefits arising from migration to fibre networks, and adverse effects on incentives to invest in innovative services.

209. Our view remains that, in principle, we should give weight to erring on the high side to avoid the negative consequences of setting a price that is too low. However, for the reasons described in paragraphs 212 to 220 below, our draft decision is that a WACC uplift is not required to address the asymmetric consequences of estimation error. In particular, we accept Professor Vogelsang's advice that an uplift is not warranted, … "

20. Of course, the issue of whether to set higher prices for access to the local loop turns on whether such higher prices will actually incentivise roll out by both the incumbent and potential un-bundlers, and whether these prices will (through their impact on retail prices) affect the rate of migration of end-users between networks. If they do, then there are clearly important welfare benefits (and ensuing beneficial spillover externalities).

21. I have not had time to study the structure of the Fibre roll out contracts program – as a consequence I am unclear whether or not there are issues associated with financing and the pace of roll out. Insofar as the pace of rollout is restricted by access to finance, higher UCLL/UBA prices may still encourage faster roll out for the whole program. Access prices may also affect QOS and replacement investment in the copper loop and roll out of FTTH etc.

3 Real Option Effects in Telecoms

22. UCLL and UBA services are subject to price caps where each price cap is fixed in nominal terms for the duration of the regulatory review period (thus Chorus could voluntarily choose to set a lower price at any point in the review period if it so wished). A key issue is whether a central estimate for TSLRIC should be used for these price caps, or whether some uplift on these estimates is warranted to account for 'real option effects'.[4]

23. Although my remit is restricted to considering uplift in the allowed rate of return, it is useful to briefly review some key background points that are crucial to an understanding of what is at issue (whilst these points have been discussed to some extent in other reports, it is helpful for my discussion of the specific case at hand to have them set out here).

24. Basic economics texts (and teaching) emphasise that a firm should accept a project if it has NPV greater than or equal to zero. However, this is only correct if the firm has 'fixed size, fixed duration' projects, these projects are either undertaken 'now or not at all', and there are no financing/budgeting constraints. In practice, there is usually flexibility concerning when a project is initiated, the choice of initial scale of the project, and the choice of the rate at which the project scale is subsequently expanded.[5] The extent of competition may limit some of this flexibility of course; for

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[4] I am aware that there are a range of other issues concerning the setting of prices caps for UCLL and UBA (discussed for example by Vogelsang, 2014, Bourreau et al, 2012, and Cambini 2015). In this report I solely focus on real option effects and technical progress, as these have not been extensively discussed elsewhere.

[5] There are other project flexibilities, associated with temporary cessation of production, and the timing of final termination, which also give rise to real option effects.

example, it may be that if there is a delay in initial investment, there is a risk that other firms may 'scoop' the market opportunity.

25. An important feature of projects in Telecoms (as in many industries) is that they often feature a high degree of irreversibility. That is, once capacity is built, it becomes a sunk and largely irrecoverable cost. A further feature affecting all long lived projects is that their value is dependent on parameters (notably the cost of finance, the level of demand, the rate of technical progress) that are properly viewed as stochastic processes that evolve over time.

26. Whenever projects are flexible (concerning start date, initial scale and pace of roll out), irreversible, and whenever demand/cost/financing costs are evolving stochastic variables, value maximising firms will take account of the 'real options' that arise. They will not simply implement a project because it has NPV slightly greater than zero; they will aim to maximise value by either delaying the start date, or, more importantly, reducing the initial scale and the subsequent pace of roll out of the investment program.

27. For example, Jerry Hausman writes

> *"..the use of TSLRIC creates negative economic incentives for new investment and innovation in telecommunications. If the new investment succeeds, the competitors to the incumbent can purchase the unbundled element at cost, as set by TSLRIC. If the new investment does not succeed, the competitor does not bear any of the cost, but the shareholders of the incumbent bear the cost of the unsuccessful investment. Thus the regulators force the incumbent to provide a free option on its investment to its new competitors…. The result is a level of investment and innovation by the incumbent below the economically efficient level." (Hausman, 1999, p. 22)*

28. There is in fact a considerable academic literature on these real options effects. For example, in my own work, Dobbs (2004) shows how uncertainty over evolution of future demand, along with uncertainty over the evolution of technical progress, affects the optimal price cap that should be set for a firm. Essentially, the idea is that when capacity is installed, even under certainty, it needs a higher price (price cap) initially in order to compensate for the fact that technical progress will take the price downward over time (as it has to compete with new technologies coming on stream). Adding uncertainty concerning the evolution of technology, alongside uncertainty concerning the evolution of demand for services over these technologies, means that initial prices need to be even higher (because of the real option effects discussed above). The Dobbs (2004) model shows that the firm faced with these irreversibilities and uncertainties, if faced with a price cap close to TSLRIC, will from a welfare perspective start with too little initial investment and will tend to unduly delay subsequent roll out. Although this model does not deal with a stochastic interest rate,

it is clear that adding an uncertain and evolving interest rate will simply increase these tendencies.

29. TSLRIC, whether or not it includes some allocation for common costs ("TSLRIC plus") does not take any account of the above real option effects. Further, when there may be new technologies coming on stream in the future that will adversely affect the value and selling prices for old technologies, there is a need for some 'tilting' of the 'annuity schedule'; that is, when new technology becomes 'old' and faces competition from new technology, the prices it can command will be lower. Even under certainty, for an NPV=0 intertemporal price cap schedule, the price cap must feature higher prices in the initial years (to compensate for the lower prices later). This is true even if the price cap is set constant in nominal terms over the period of regulatory review; that is, the price should be uplifted in the first regulatory review to account for the expectation that prices will be lower in later periods.[6]

30. Thus, when a new technology is being rolled out, relative to TSLRIC, it would appear that the short run price for access to this technology should be higher than would be indicated by a TSLRIC price. Essentially, the need is to offer a higher return initially, because of the risks (that demand may not materialise, that new technology will either steal the market, or reduce the price that can be got in future years for the old technology, which must compete with new technologies coming on stream).

31. The question is – by how much? Hausman's early work (including the less technical paper cited above) has argued that the answer could be a quite substantial uplift. My own work on price caps (Dobbs, 2004) has shown uplift to be warranted, although the extent of uplift is limited by the extent of competition. The model used in the CEG report (the Dobbs 2011 model) focuses on real option effects that arise when there is solely uncertainty over financing costs; although there are some reasons (pointed out in section 2 above) why the model may exaggerate the uplift, it is fair to say that the extent of uplift is likely to be greater than revealed by such a model when the above factors (uncertainty over future technology and the growth of demand for bandwidth) are considered.

32. However, these are abstract models; they assume that demand and technology are (stochastically) trending, and that the firms have control over their investment scale and timing. Thus the key question is 'to what extent' is uplift warranted in the specific case of New Zealand UCLL/UBA?

33. In my view, the 'devil is necessarily in the detail'. Potential issues are:

[6] Note that, if this is done, at each subsequent review, the regulator is at liberty to re-assess the TSLRIC, and hence price cap, based on the current values for MEAs. That is, there is no need to worry about expropriation – since this has been accounted for in the original up lift in price cap.

(a) Fibre roll out contracts are already held by Chorus and three other local fibre companies (with Chorus taking around 70% of the contract issued so far). The design of the contracts may be an important issue. The question is one of, having won a contract, to what extent is the pace of Fibre roll out investment still at the discretion of the firm that owns the contract. If in practice it is, then the real option effects associated with scale and pace of roll out still apply.

(b) The pace at which the fibre contract program itself is rolled out.

(c) The impact of future technological developments on the future costs associated with UCLL and UBA. For example, the costs associated with Fibre-to-the Home (FTTH) and new technologies that can increase bandwidth down the copper loop..

(d) The likely impact of the resulting retail prices on the rate of migration of end-users to new networks.

(e) The extent to which geography matters; when one imposes a geographically uniform price cap, this clearly creates incentives for entrants to unbundle in high density areas. In the UK there is now (I understand) de facto geographic pricing, simply because deals and discounts vary geographically.

4 The CEG Implementation of the Dobbs Model

34. The CEG implementation of the Dobbs (2011) model uses the Frontier (2014) program. If 'WACC uplift' is applied uniformly to new and existing investments, CEG find that the model predicts a significant uplift in price caps (significant increase in allowed rate of return). This is especially so if a 'total welfare' approach is taken, although the uplift remains significant even in the case where only 'consumer surplus' counts.

35. In what follows, I discuss some preliminary points (sub-sections 4.1 and 4.2 below) and then deal with the major issues (cross elasticity in sub-section 4.3 and truncation in sub-section 4.4).

4.1 CEG on Commission Objections to the Dobbs Model

36. CEG (2015) disagrees with the Commission's rationale for rejecting the use of the Dobbs model as follows:

> *89. In the draft cost of capital decision, the Commission stated that:*

> *… we considered a 2011 paper by Professor Ian Dobbs, which was relevant in our recent IMs WACC percentile review. However: consistent with the IMs WACC percentile review, we have placed little weight on Professor Dobbs' model because it does not address the risk of misestimating the WACC (and instead addresses the risk created by fixing the allowed WACC over the regulatory period)…*

90. In our view, this objection is not well founded. Whilst the Commission is correct that Dobbs (2011) is capturing the effect of fixing the allowed WACC over the regulatory period, the Commission is wrong to not observe that this approach captures both:

- *The effect of misestimating the WACC due to uncertainty in the parameters; and*
- *The effect of fixing the WACC for the regulatory period.*

91. That is, Dobbs (2011) simulation of outturn WACCs over the regulatory period from the possible distribution of WACC captures uncertainty in the initial estimate (what the Commission is concerned with) and deviations in the required WACC over the regulatory period (another factor the commission should be concerned with if fixed price caps are set for the duration of the regulatory period).

37. I agree totally with the CEG assessment here; there may be other reasons for rejecting the model as a basis for assessing uplift (as I discussed in Dobbs, 2014), but I do not think this is one. It may be useful to quote from my earlier report (Dobbs, 2014, on the NZ Electricity/Gas pricing review):

23 …. In practice, economic (financing) conditions evolve continuously as random processes over time; a more sophisticated approach would have had interest rates and other variables as continuous stochastic processes – the simplification in the model is that it is simply a single 'resolution of uncertainty' in each regulatory review period. In this model then, notice that if the regulator indexed the allowed rate of return (AROR) to account for changes in financing conditions through time (just as with fuel cost adjustment clauses for airlines), the rationale for the uplift would disappear. …..

24 *Although not discussed in the original paper, it is also true that the idea that the uncertainty in the cost of finance is resolved totally as in the model is somewhat unrealistic. In truth, estimating the WACC is a theory laden process (for example, picking a number for the market premium – different modelling processes will give different estimates). This means there is scope for different 'players' (the firms, the regulator) to take a different view on what the WACC might be – and for those players to be also uncertain regarding any point estimate. It can be argued that this tends to increase the rationale for uplift. The Lally report (p13 para4 et seq) discusses this idea– the details of his modelling may be debated, but the broad thrust of what he is saying seems to me to be correct. (Dobbs, 2014).*

25 Thus, the Commission focussed on the para 23 point in my report without giving (in my opinion) due weight to para 24, where I say that uncertainty concerning the estimate for the WACC is indeed a relevant rationale for uplift. Thus I actually

consider there are further reasons (than those given above by CEG) for considering the uncertainty to be greater than is represented by the empirical estimate of standard deviation for the WACC. These issues were considered by various parties, including, in particular, Dr. Lally (2014), who presented a simple model explaining what was at issue. Uncertainty concerning the WACC is endemic, and it can even be argued the use of a higher standard deviation than that traditionally estimated for the WACC distribution may be merited.

4.2 CEG on Long Term Benefit of End Users

26 The Commerce Commission recognises that there are dynamic efficiency reasons why *some* weight should be put on profit. CEG (2014) argues even more strongly that

> *" ... in our view, the LTBEU would direct an economist to a total welfare standard, not a consumer welfare standard." (CEG, 2014, para 98)*

and that

> *"In producing our results we have given consideration to both a consumer and total welfare standard. We consider that it would not be appropriate to have sole regard to consumer welfare in a static model, as this will lead to prices for existing services that expropriate past sunk costs (and would therefore be harmful to future incentives to invest)."*

27 The Frontier model provides estimates of the optimal WACC percentile only for the case where the objective function is 'total welfare' (where consumer surplus and profit have equal weight) or where it is solely 'consumer surplus' (with a weight on profit of zero). I argue in some detail in Annex 2 below that the long term best interests of end users (LTBEU) is probably best modelled by using a weighting on profit significantly greater than zero, but also a weight that is definitely less than unity. Since the predicted uplift depends on this weighting, it would be useful to parameterise the welfare function in the Frontier program, so that intermediate results can be shown.

4.3 CEG on Cross-Elasticity of New and Existing Services

28 CEG briefly discuss the assumption in the Dobbs model that there is a zero cross-elasticity between category 1 and category 3 services. CEG suggest that they have attempted to address this through sensitivity analysis, but also comment

> *"... that as the FD model solves for a uniform WACC across new and existing services, the optimal percentiles are determined in a manner that maintains relativity between the prices for new and existing services. This is likely to go some way to addressing the fact that cross-price effects are not explicitly being modelled."* (CEG, 2015, para 96)

29 Now, this seems logical, but I think ultimately it is incorrect. In what follows, I explain how CEG's position might make sense – and then explain the problem with it.

30 The CEG argument makes some sense if we view the demand for category 1 (existing) and category 3 (new) services as a function of the retail prices (p_1, p_3) charged for them.[7] Thus demands can be written, in an obvious notation, as $q_1 = f^1(p_1, p_3), q_3 = f^3(p_1, p_3)$. Let the mark-ups on wholesale prices be written as $p_1 = (1+m_1)w_1,\ p_3 = (1+m_3)w_3$ where w_1, w_3, m_1, m_3 denote wholesale prices for the two services and their mark-ups, respectively (it is argued in section 4.4 below that fixed proportional mark-ups are a reasonable assumption). Since the wholesale price cap is the same for both services ($w_1 = w_3 = w$), and mark-ups can be assumed fixed, it is possible to write

$$\begin{aligned} q_1 &= f^1(p_1, p_3) = f^1((1+m_1)w_1, (1+m_3)w_3) \\ &= f^1((1+m_1)w, (1+m_3)w) = g^1(w) \end{aligned}$$

and similarly, $q_3 = g^3(w)$. That is, the demands for both category 1 and category 3 services can be viewed as simply functions of the underlying wholesale price, and hence can be treated '*as if*' separate and independent demand functions. The price responses of these quasi-demand functions would of course be different from those 'estimated' from normal demand functions ($\partial q_1 / \partial p_1, \partial q_3 / \partial p_3$) and the elasticity estimates for these quasi demands would in general differ from the own price elasticities $\varepsilon_{11} = (\partial q_1 / \partial p_1)(p_1 / q_1), \varepsilon_{33} = (\partial q_3 / \partial p_3)(p_3 / q_3)$, but it would *appear* that this can be taken care of via sensitivity analysis (and results are relatively robust to significant variation in demand elasticities). In what follows, I explain why this is (probably) not the case.

31 The original model treated the new investment as if it was a 'new good' with an independent demand from that of the 'old good'. In the original model, the costs were actually the same for both services, but it was possible to vary them. That is, the "TSLRIC price" in the original model was defined simply as

$$p = c + (r + \gamma)K \qquad (1)$$

where c is marginal cost, r is the allowed rate of return, γ the rate of depreciation and K the unit capacity cost. If r is taken as the mean of the WACC distribution, this accords with the usual idea of TSLRIC within the context of this model. Choosing a higher value for r (a higher percentile) would then give some uplift in the price cap. If different services have different variable costs, depreciation etc., these parameters can be varied across the services, but by assumption within the model, the same value for r, the allowed rate of return, is chosen. For example, labelling them category 1 and 3 as in the original paper, then the price caps would be

[7] I am using static demands to illustrate a point here.

$$p_1 = c_1 + (r + \gamma_1)K_1 \qquad (2)$$

and

$$p_3 = c_3 + (r + \gamma_3)K_3 \qquad (3)$$

if the parameter values c, γ, K were different for the different services. Clearly, as *r* is varied, the prices move in tandem (if not exactly proportionately). Hence there is a sense in which the demands can be treated 'as if' independent.

32 The problem with this, when the services are economic substitutes and are in fact inter-dependent, is that when the new service is not provided, the demand for the existing service is in effect $q_1 = f^1(p_1, \infty)$ (the existing service is not available, in terms of the above demand function, equivalent to setting $p_3 = \infty$). Only when the new service is implemented do we have $q_1 = f^1(p_1, p_3)$ where p_1, p_3 are given by (2), (3). That is, only when both services co-exist do the prices move in tandem.[8]

33 So what is missing, when trying to measure the overall economic impact using the above quasi demands, is the discrete impact on the existing service as the new service is introduced. The effect of dropping the price of the new service from 'infinity' to the TSLRIC price has a significant discrete negative impact on demand for the existing service. It follows the gain in economic welfare from introducing the new service is likely to be considerably less than would be measured under an assumption that demands are independent.

34 By how much 'less' rather depends on the methods used to estimate willingness to pay for the new service in the first place. I have not had time to track down or explore the methods used for estimating consumer surplus, and hence I am unable to comment on whether the consumers surplus estimates used by CEG in their calculations of maximum willingness to pay (truncation prices) are sensible or not. It <u>*could be*</u>, for example, that those estimates already can be viewed as 'incremental' (in the sense of identifying the extra or incremental willingness to pay for the new service over and above the old service (and how it varies with the prices of the two services), rather than simply the 'stand alone' willingness to pay estimates for the new service. If so, then roughly speaking, the welfare gain to be had from introducing the new service may not be exaggerated. However, if it *is not* an incremental measure, then the welfare gain <u>*is*</u> exaggerated.

35 It seems to me that treating the services 'as if' they are independent is likely to exaggerate the welfare gain from introducing the new service and hence is likely to exaggerate the need for price cap uplift. The extent to which the uplift is exaggerated is also clearly a function of how close the services are likely to be as substitutes.

[8] In the original model, existing demand q_1 was solely a function of its own price (p_1) so the problem discussed here does not exist.

36 An *ad hoc* way of adjusting for this is to lower truncation prices. If a rough estimate of the incremental welfare gain can be adduced, it is possible to make this calculation (along the lines explained in section 4.4 and Annex 1 to this report).

37 The CEG scenario analysis covers the possibility of significantly lower truncation prices only in a limited way (i.e. only in scenario 14 of CEG Table 1). This is an area where the scenario analysis needs to be much expanded (indeed, arguably, the low truncation price scenarios should be viewed as the benchmark scenarios). The impact of lower truncation prices is further discussed in the next section.

4.4 Maximum Willingness to Pay and Estimates of Uplift

38 CEG mainly use an iso-elastic demand curve in the modelling. Following the work done by Frontier, it is clear that truncation is necessary in order to make iso-elastic demand consistent with estimates for overall consumer surplus. I explained the correct procedure in Dobbs (2014). However, the 'maximum willingness to pay' figures calculated by CEG appear to be *incorrect* in the base cases of iso-elastic demand. This is because CEG appear to use a linear formula relating consumer surplus to the truncation price. CEG use a maxWTP figure of $523 for both services. Using the correct (non-linear) formula, I calculate that the MaxWTP should be around $414.8 for existing investment and $1,118 for new investment (the analysis explaining this is given in Annex 1). My calculations make use of some 'back-calculated' inferences for consumer surplus which need to be validated. However, making the adjustments, overall, the impact on the model predictions obtained by CEG turn out to be minor.

39 Much more important is the impact of adjusting truncation prices to account for the 'cross price elasticity effects' discussed in section 4.3 above. For example, my back-calculated estimate of consumer surplus used by CEG is $385M for existing lines and $288.8M for new lines. For example, if this is reduced to say $100M for existing and new lines ($200M total), then I calculate the truncation prices become $149.8 and $207.4 respectively. As a general point, it would be useful to have more scenarios where much lower truncation values are used.

40 In what follows, I have used the results obtained by CEG in scenario 14 along with some linear interpolations to illustrate impacts (in practice the variation is likely to be slightly non-linear, but using linear interpolation is unlikely to give a material error). Note that Scenario 14 is the only one reported by CEG where truncation prices are in the range that might result from taking account of the cross-elasticity effect (although not from reducing the level of new investment – it is still at 75% of existing lines in scenario 14). The first point to observe is how the results vary with the weight placed on profit in the welfare functions; here welfare is defined as $W = CS + \psi\Pi$ where CS denotes consumer surplus and ψ is the weight placed on profit Π.

Table 1: Allowed Rate of Return - Results

Scenario	Welfare Weight	EW Percentile
1	1	97
2	0.9	95
3	0.8	93
4	0.7	91
5	0.5	87
6	0.3	83
7	0.1	79
8	0	77

Data Inputs: CEG Table 1 Scenario 14 for weight 1 and 0. Other values are then simple linear interpolations.

41 It is interesting to calculate the extent of uplift in price cap implied by these uplifts in WACC. This is straightforward to do in the original model, since the price cap is defined simply as

$$p = c + (r + \gamma)K \qquad (1)$$

where *c* is marginal cost, *r* is the allowed rate of return, γ the rate of depreciation and *K* the unit capacity cost. Thus, a base 'TSLRIC price' is calculated using the mean value for WACC of 7.24%, depreciation of 3%, variable cost zero and capital cost $374.9, giving

$$p = (0.0724 + 0.03) \times 374.9 = \$38.4$$

Given the estimate of standard deviation (of 1.1%), for each of the above percentiles, it is possible to calculate the allowed rate of return (*AROR*), and plug this into (1) in order to calculate the implied price cap. The price uplift is of course, relative to the 'TSLRIC' based on the mean WACC, given simply as $\Delta p = \Delta r K$. Table 2 below gives these results.

Table 2 – Implied Price Cap and Price uplift (CEG Scenario 14)

Scenario	Welfare Weight	EW Percentile	AROR	Price CAP	Price Uplift†	% Price Uplift†
1	1	97	0.0933	46.22	7.83	16.9
2	0.9	95	0.0907	45.23	6.84	15.1
3	0.8	93	0.0888	44.53	6.14	13.8
4	0.7	91	0.0873	43.97	5.58	12.7
5	0.5	87	0.0849	43.08	4.69	10.9
6	0.3	83	0.0830	42.36	3.97	9.4
7	0.1	79	0.0814	41.75	3.36	8.0
8	0	77	0.0806	41.46	3.07	7.4

† Relative to using the Mean WACC

42 Thus, with these input values, and with a welfare weight in the range of say $\psi \in [0.3, 0.7]$ (for the reasons discussed in Annex 2), the model is predicting something like a 9-13% uplift in the price cap.

43 Whilst it would be better to adjust the model to allow a range of welfare weights to be considered, I consider the simple linear interpolation results reported above are likely to be close to the correct values (for the CEG scenario 14 input values). Of course, it would be desirable to re-run the model not only with variations in welfare weights, but also with a range of scenarios in which much lower values are used for truncation prices.

4.5 Proportion of New Investment

44 I am not familiar with the NZ context, and so am not able to comment on the realism of CEG's assumptions concerning new investment in proportion to that for existing services. The benchmark scenarios use a figure of 75% for new *vis a vis* existing services. This seems a fairly high figure, and it is clearly one which commentators have taken issue with.

45 Wigley (2015, section 6 in particular) is critical of CEG's assessment of what counts for new/existing investments, clearly suggesting the former should be much lower (without being specific about what percentage might be appropriate). Vodafone (2015, section B4, and B4.5 in particular) also suggests the likely proportion of new investment is much lower than CEG's base case (75% of existing investment), commenting

> *"While we retain our view that the correct application of the Dobbs model would not include investment that is not regulated, if CEG is to argue that the Commission consider incentives on new investment, the relevant proportion must lie between 3.2 - 13.5%."* (Vodafone 2015, para B4.5)

46 Network Strategies (2015, section 2.4) also considers this issue in some detail. Much of the debate here is about 'facts' concerning NZ Telecoms (and as I remark above, I do not have the knowledge base to comment on it).

47 However, it is clearly important to attempt to identify the appropriate levels (and clearly there is significant difference in using a 75% figure as compared to a 3.2% figure). CEG (2014) do consider lower levels of new investment in some scenarios (but not as low as 3%). One issue that likely affects the assessment of what qualifies as new investment is whether non-regulated business should be included. CEG has argued that it should be because it is heavily influenced (in terms of pricing) by the regulated business

> *".. the pricing of services provided over new infrastructure modelled by the Commission will indirectly constrain or 'anchor' the pricing of new*

> *investment in infrastructure capable of providing new and/or enhanced services". (CEG, 2014, Para. 36)*

This seems to me to be plausible – however, clearly, Network Strategies/ Vodafone/Wigley disagree.

48 If the proportion of new investment is significantly lower than assumed by CEG, then the extent of uplift indicated by the Dobbs model will be likewise significantly attenuated.

4.6 Other Issues

49 The CEG modelling of wholesale and retail markets assumes a constant mark-up relation between them, as in the original Frontier (2014) analysis for the Electricity/Gas markets. In my opinion, this is not an issue - it is a reasonably robust and pragmatic assumption (for example, it means that estimates for retail price elasticity can be used at the wholesale level).[9] The CEG (2015) base case assumes 100% pass through, although scenarios with lower rates are considered. However, altering the pass through does not significantly alter the general thrust of the CEG conclusions.

50 There is a potential issue with how the pass through is modelled. In the Dobbs 2011 model, everything is couched in terms of retail demands. In the present case however, we are focusing on wholesale pricing. However, the wholesaler, in maximising profit, is effectively maximising profit at the retail level, given there is a constant assumed mark-up on wholesale price. The calculations of economic welfare (and truncation prices etc.) are also naturally done at the retail level. Thus it seems to me that the natural way to interpret the model is to compute the optimal price cap 'as if' it is being set at the retail level, and then subtract from this the constant mark-up (the $46.61) to get the optimal price cap at the wholesale level. Within the model, the price cap is set according to $p = c + (r+\gamma)k$ where *c* is marginal cost, γ is the rate of depreciation, *k* is capital cost and *r*, the allowed rate of return. At the wholesale level there is zero marginal cost in most CEG scenarios. Hence we have a wholesale price at mean WACC of $(r+\gamma)k = (0.0724+0.03)\times 374.9 = \$38.39$. There is an additional $46.61 mark-up to get to retail price. Within the model, this suggests interpreting 'marginal cost' c as $46.61, so the 'retail price cap' at mean WACC becomes $46.61+(0.0724+0.03)\times 374.9 = \$85$. The optimisation can then be conducted in the usual way. Once the optimal percentile is obtained, this gives the new price cap at the retail level, and then the wholesale price cap is obtained by deducting

[9] Professor Cambini concurs with this assessment; he suggests (Cambini, 2015, page 5) that the "retail market for copper based broadband services is substantially competitive and therefore every increase in the cost of input is translated into a higher cost of the output."

the $46.61 mark-up from this. The Frontier model amended by CEG has marginal cost set at zero (in most scenarios) so presumably deals with pass through is some other way.

51 CEG (2015) argues that, while the Dobbs 2011 model assumes a monopoly provider of both new and existing services,

> *"We do not, however, consider this to be a material limitation as the pricing of services provided over new infrastructure modelled by the Commission will indirectly constrain or 'anchor' the pricing of new investment in infrastructure capable of providing new and/or enhanced services". (CEG, 2014, Para. 36)*

I consider this a reasonable and pragmatic assumption.

52 CEG (2015) notes the model only considers uncertainty over the allowed rate of return – but suggests that the WACC distribution can be used to 'proxy' other sources of uncertainty.

> *"That is, while Dobbs (2011) assumes that uncertainty in costs stem only from uncertainty in the cost of capital, it could also stem from other sources such as the level of fixed costs, the level of variable costs, the appropriate rate of depreciation and, in the context of the Commission's modelling of forward-looking costs, the degree of uncertainty around the assumptions used for optimisation and efficiency adjustments (such as target line fault rate, choice of technology (e.g., fixed wireless), mix of aerial versus underground infrastructure, pole sharing agreements, opex reduction). (CEG, 2014, Para 40)."*

53 Essentially, CEG suggest that *one* way of accounting for these other 'uncertainties' would be to increase the standard deviation used in the simulations (see CEG, para 40-43). There is logic to this argument. In so far as there is uncertainty regarding other cost components (and rates of depreciation etc.), it is indeed possible to incorporate these in an *ad hoc* way by increasing the standard deviation of the WACC distribution. There are of course other uncertainties (associated with the level of demand, the path of future technological change) which also generate real option effects and hence suggest further uplift in the price cap (see e.g. Dobbs, 2004).

54 CEG comment that there is an inconsistency in the Dobbs model in the case where the same uplift in WACC is to be applied to both existing and new investment. Specifically, at paras 49-51

> *"49. ....However, the Dobbs (2011) framework implicitly sets aside these reasons by assuming that the regulator would seek to optimise the rate of return by taking into account the 'sunk' nature of existing investment. Existing investments today were new investments at a previous time. By determining a cost of capital percentile that takes into account their sunk nature to allow a lower rate of return than for new investment which may be cancelled or delayed, Dobbs (2011) appears to be capturing in the very framework of this model a form of regulatory opportunism that he assumes will not occur in the future.*

50. Although it is not captured within the Dobbs model, we consider that if a regulated firm were to give weight to the prospect that the uplifted return allowed on its new investment would be withdrawn soon after investment rather than committed to indefinitely, then the firm would require a commensurately higher uplift on its new investment. The extent of the higher uplift would likely depend on the period to which the regulator could credibly commit to its allowed rate of return – likely to be the length of the regulatory period.

51. For this reason we consider that it would be reasonable to focus attention on the optimal cost of capital uplift that needs to be provided in order to incentivise new investment. In our view, the same uplift may reasonably be applied to sunk investment since doing so represents part of a commitment to adequately compensating new investment as well as existing investment."

55 I agree with the CEG comment at para 49 above, except insofar as 'implicitly' should read 'explicitly', since I 'explicitly' commented in the paper that I assumed that regulatory commitment was credible. Thus I also agree with the comment at para 50. The idea that the regulator might choose different allowed rates of return for new and existing investment in the future, or might exploit the sunk nature of existing assets in other ways, is indeed a potential issue. In terms of investment incentive, it would imply a need for a higher uplift in the initial period. Even if this is put to one side, of course, there are reasons for uplift associated with the (uncertain evolution of the) falling price of supplying bandwidth, as explained in section 2 above.

56 The CEG comment at para. 51 above seems less clear, in my opinion. Insofar as the same price is used for both new and existing investment (an assumption motivated by the fact that they are in direct competition with each other), as assumed in the model, the welfare trade-offs are properly assessed. In CEG's empirical analysis (reported in Table 2 of the CEG report, page 22), it appears the actual focus is on the case where the allowed rate of return (and hence price cap) applies to both new and existing investment. In this case, since overall, there is an uplift in the allowed rate of return, there is no actual exploitation of the sunk assets. That would only arise if one were to use different allowed rates of return for different classes of investment.[10]

57 CEG use different demand elasticities for new and existing investments and consider different values for elasticity for new investment demands. It is clearly reasonable and sensible to use different values for elasticity, and the values seem plausible (but I really do not have a view concerning what the elasticity of demand for the various services involved in New Zealand Telecoms might be). It should be noted that assumptions concerning elasticity drive the values to be set for truncation prices; CEG use a value of $523 for both new and existing investments

[10] This is the point about commitment; it is an assumption of the model that the allowed rate of return, and hence price cap, will not be disaggregated at some future regulatory review.

in most scenarios, so this is generally incorrect - truncation prices must vary with elasticity (see Annex 1 for details).

58 In the original model, demand growth was exponential. This can be problematic if initial growth is rapid (since rapid initial growth must eventually dissipate, as saturation levels are hit (certainly in terms of lines or users, and no doubt eventually, in terms of bandwidth). Demand growth in the CEG application is modelled primarily by assuming zero growth and by considering alternative levels of 'instantaneous' penetration for the new services (by way of sensitivity analysis). In my opinion, this is a reasonable and pragmatic approach.

59 A final and potentially important point concerning the estimate of TSLRIC. CEG calibrate 'capital cost' using the current regulated price of $38.39. That is, assuming variable cost is zero the TSLRIC price in the Dobbs model is simply $(r+\gamma)k$ where r,γ,k denote allowed rate of return, depreciation, and capital cost respectively. With $r = 0.0724, \gamma = 0.03$ the calculation is that

$$(r+\gamma)k = (0.0724+0.03)k = p_0 = 38.39$$
$$\Rightarrow k = p_0 / (r+\gamma) = 38.39 / 0.1024 = \$374.9.$$

This clearly assumes that the current price ($38.39) is a reasonable estimate for the underlying TSLRIC. The model uses this when calculating the optimal percentile of the WACC to use.

60 In fact, the model is reasonably robust to variation in the capital cost estimate – that is, errors in the value used for capital cost will not significantly affect the optimal percentile found by the model (this is something that could be established via sensitivity analysis using the Frontier model). However, note that the predicted price cap within the model ***is*** highly sensitive to the estimate used for capital cost. To see this, note the formula for price cap is $p = (r^* + \gamma)k$. Whilst using the wrong value for *k* in the model will not particularly affect the optimised value r^* found for the allowed rate of return (the optimal percentile), using a wrong value for *k* will clearly give a wrong value for the price cap *p*. For example, if current price is an *over-estimate* of TSLRIC, then the results will *over-estimate* the price cap to set. To sum up, using the model in this way (benchmarking capital cost using current price) is reasonable for estimating the percentile (the value for *r**),[11] but not the price cap; for the latter, one needs the 'best estimate' for TSLRIC one can get.

[11] Putting to one side for the moment the other issues, such as cross elasticity, discussed in section 4.

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Annex 1 Calculations for truncation prices

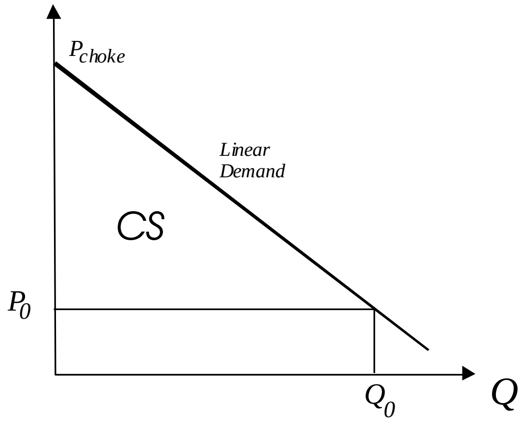
1. With iso-elastic demand, when demand is inelastic, consumer surplus is unbounded. Given an estimate of consumer surplus at current price, it is possible to truncate the assumed iso-elastic demand to conform to this estimate. The rationale for doing so is discussed in detail in Dobbs (2014). This annex suggests the CEG (2015) estimates for the MaxWTP choke price are rather different for the case where demand is iso-elastic demand.

2. At para 70, CEG (2015) use the following formula for Maximum willingness to pay;

$$MaxWTP(P_{choke}) = \frac{Revenue}{Number\ of\ subscribers} + \frac{Consumer\ Surplus \times 2}{Number\ of\ subscribers}. \qquad \text{(A1.1)}$$

It would appear this formula is based on linear demand, but is used to determine the truncation point for iso-elastic demand. To see this, let p_{choke} denote the intercept of a linear demand, with p_0, q_0 the initial prices, as in figure 1 below.

Figure 1 Choke price with linear demand



Then clearly

$$CS = 0.5\left(P_{choke} - p_0\right)q_0 \ , \qquad \text{(A1.2)}$$

which rearranges to give

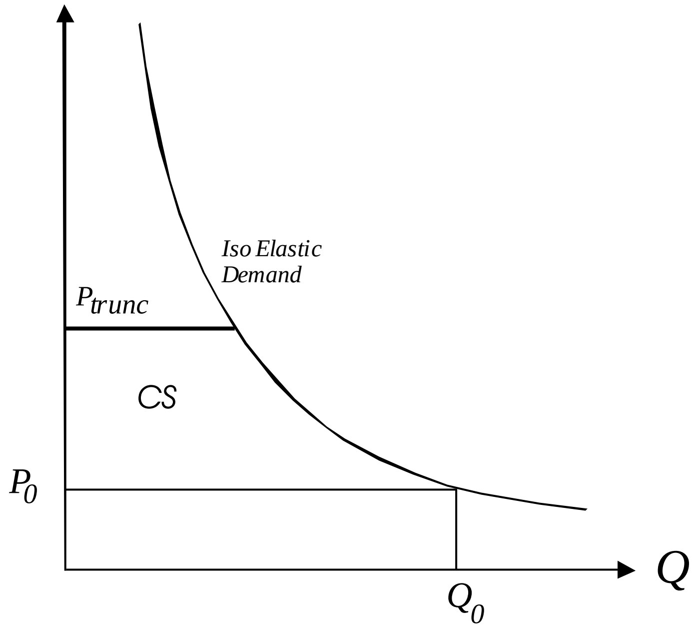
$$P_{choke} = p_0 + \frac{2 \times CS}{q_0} = \frac{p_0 q_0}{q_0} + \frac{2 \times CS}{q_0} , \qquad \text{(A1.3)}$$

which is identical with (A1.1). That is, in using (A1.1), CEG appear to have mistakenly calculated the truncation price for iso-elastic demand as the choke price from a linear demand curve.

3. CEG do not mention the estimated figure for consumer surplus used in their work, but it can be back-calculated using (A1.2); thus it would appear that with p_{choke}=\$523, $p_0 = \$85$ and $q_0 = 1,758,153$ for existing lines, then using (A1.2), the implied consumer surplus is $CS = 0.5 \times (523 - 85) \times 1,758,153 = \$385\text{M}$ for existing lines and $CS = 0.5 \times (523 - 85) \times 1,318,615 = \$288.8\text{M}$ for new lines, with an implied total surplus of \$673.8M.

4. It is these figures that need to be assessed in the light of the idea that, given significantly cross elasticity, total surplus might be significantly lower.

Figure 2 Truncation price with iso-elastic demand



5. In my view, the correct truncation price for iso-elastic demand is ***not*** given by the above (A1.1) formula. Referring to figure 2, the calculation should be as follows.

6. Firstly, the iso-elastic demand curve passing through the point $\left(p_0, q_0\right)$ is defined as

$$q = q_0 \left(p / p_0\right)^{\varepsilon} , \tag{A1.4}$$

where ε is the own price elasticity of demand. Hence

$$CS = \int_{p_0}^{p_{trunc}} q dp = q_0 p_0^{-\varepsilon} \int_{p_0}^{p_{trunc}} p^{\varepsilon} dp = \frac{q_0 p_0^{-\varepsilon}}{1+\varepsilon} \left\{ p_{trunc}^{1+\varepsilon} - p_0^{1+\varepsilon} \right\} . \tag{A1.5}$$

Rearranging this, the truncation price p_{trunc} can be calculated as

$$p_{trunc}^{1+\varepsilon} = p_0^{1+\varepsilon} + \frac{\left(1+\varepsilon\right) p_0^{\varepsilon} CS}{q_0} , \tag{A1.6}$$

so that

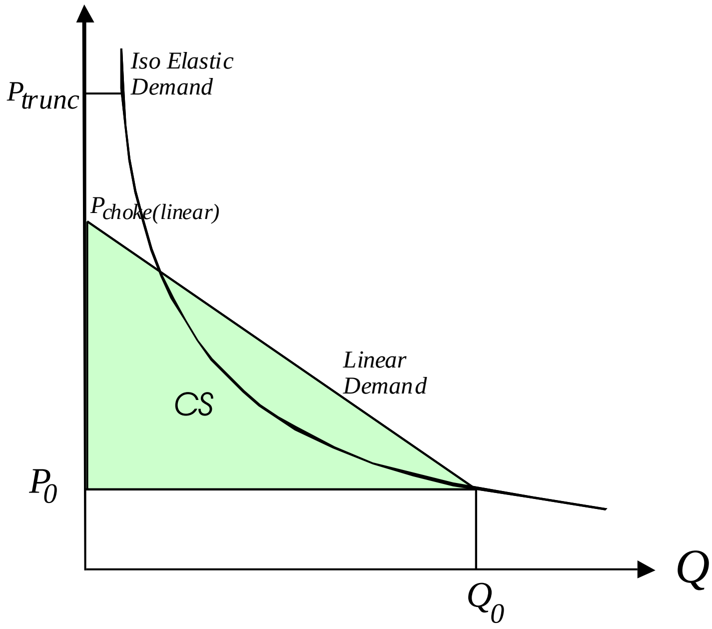
$$p_{trunc} = \left\{ p_0^{1+\varepsilon} + \frac{\left(1+\varepsilon\right) p_0^{\varepsilon} CS}{q_0} \right\}^{\frac{1}{1+\varepsilon}} \tag{A1.7}$$

(note a different integral calculation, and hence different formula is needed for elasticity exactly equal to -1; I do not show this as it suffices to use the above formula with a value near to unity in such a case – such as -0.9999 or -1.0001).

7. Using this calculation and the implied estimates of CS above, I get a truncation price of around $414.8 for existing investment when the elasticity is -0.43 and for new investment, when elasticity is -1, an implied truncation price of around $1,118.

8. These truncation prices (particularly the latter) may seem surprising. Figure 3 below explains what is at issue.

Figure 3 Why truncation price may be above choke price



9. Clearly, given p_0, q_0 and an estimate of consumer surplus, *CS* ($385M for existing lines as calculated above, for example), this defines completely the position of a linear demand curve through the point (p_0, q_0) and hence defines the price CEG calculate as the maximum willingness to pay or choke price using the formula (A1.1) which is based on a linear demand curve. Note also that the slope of this linear demand curve is also uniquely defined, given these three numbers (CS, p_0, q_0). This in turn means that the elasticity of a linear demand curve at the point (p_0, q_0) is also uniquely defined by these three numbers.

10. However, what is required is a truncation price for *iso-elastic demand*, in order that the consumer surplus comes to the correct value (i.e. in the above, the $385M).

11. Now, CEG assume that the demand elasticity is known at the current price (e.g. -0.43 for existing demand). An iso-elastic demand curve is uniquely defined by the elasticity figure (here -0.43) and the fact that it must pass through the point (p_0, q_0). Notice that, given the actual numbers for (CS, p_0, q_0), the slope of the iso-elastic demand curve turns out to be flatter at (p_0, q_0) than the linear curve. Recall that the choice of truncation price is the price that gives consumer surplus for the iso-elastic demand curve (the integral of *q* between p_0 and p_{trunc}) equal to a specified amount

(in the above, \$385M for existing lines). Referring to figure 3, clearly the correct truncation price for an iso-elastic demand curve has to be higher than the choke price calculated using the linear demand curve. Notice also that if demand is made even more elastic (moving to -1 for example), this makes the iso-elastic demand curve even flatter at $\left(p_0, q_0\right)$ and pushes the curve more to the left for prices above p_0. It then follows that, the more elastic the demand, the higher the truncation price has to be to get the result that the area to the left of the truncated iso-elastic demand curve is equal to the CS estimate (the \$385M).[12]

12. Using iso-elastic demand (with truncation) is a satisfactory approach when using the Dobbs 2011 model, so in the main report, I have not considered the alternative possibility of using a linear demand specification. CEG actually consider this in some scenarios. It is worth pointing out that, *in linear demand scenarios*, there must be an inconsistency between the CEG linear demand specification and the estimate they have used for broadband consumer surplus. As explained above, the figures for $\left(CS, p_0, q_0\right)$ uniquely define a linear demand curve – and hence uniquely define the elasticity at the current price. Thus using the figures above, the gradient of the linear curve, defined by the choice of elasticity, is $-\left(p_{choke} - p_0\right)/q_0$,[13] so the elasticity at $\left(p_0, q_0\right)$ is

$$\begin{aligned}\varepsilon &= \left(\partial q/\partial p\right)\left(p_0/q_0\right) = -\left(q_0/\left(p_{choke} - p_0\right)\right)\left(p_0/q_0\right)\\ &= -p_0/\left(p_{choke} - p_0\right) = -85/(523-85) = -0.194\end{aligned}$$

Thus, when using a linear demand curve (as CEG do in some scenarios), it is important to realise that you actually need to truncate the linear demand (and use a truncation price rather than a choke price) if you want to use a more elastic demand value at the initial price than is implied by the three numbers $\left(CS, p_0, q_0\right)$.

13. To put this another way, when CEG uses the linear demand specification to calculate the implied choke price (maxWTP) for linear demand at para 73 using the estimated demand elasticity at the current price (-0.43), this gives an implied choke price of $p_{choke} = p_0\left(1 - \frac{1}{\varepsilon}\right) = 85 \times (1 - \frac{1}{-0.43}) = \$282.6$. However, this then implies an estimate for broadband consumer surplus; the calculation for existing lines is $0.5 \times (282.67 - 85) \times 1{,}758{,}153 = \$173.8M$ which appears to be inconsistent with that I calculated above as the value CEG must have used in the iso-elastic demand analysis

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12 Notice that if demand is set ‘too elastic’, there may be no finite truncation price that yields the required consumer surplus estimate – that is, it is possible for the estimate for consumer surplus and the choice of demand elasticity at the current price to be incompatible.

13 To see this, write the inverse demand curve as $p = a + bq = p_{choke} + bq$ and note that $p_0 = p_{choke} + bq_0 \Rightarrow b = -\left(p_{choke} - p_0\right)/q_0$.

($385M) .

14. Returning to the main case, that of *<u>iso-elastic demand</u>*, in the discussion of cross elasticity, it was suggested that the net welfare gain is likely to be much lower; to illustrate the impact on the implied choke price, if *CS* in the above is reduced say to $100M (to $100M for existing, $100M for new, $200M total), using equation (A1.7), the truncation prices fall to $149.8 and $207.4 for existing and new services respectively.

Annex 2 The LTBEU - What should count as Economic Welfare?

1. Ultimately, what is to count as part of the welfare measure is a value judgement . A value judgement cannot be proven to be 'right' or 'wrong'. Value judgements are inherently things that one either agrees with/approves of – or disagrees with/disapproves of. However, this does not mean that the choice of 'what counts' is essentially arbitrary. That is, the 'internal coherence' of value judgements can be subject to scrutiny, and it is also possible to test whether value judgements have been applied consistently or not.

2. In the UK, Ofcom has sometimes argued that it only has to be concerned with callers and call-recipients and that this allows it to restrict its focus when measuring economic welfare. In the case of New Zealand Telecoms, this appears to correspond to the LTBEU – the long term best interests of end users. This might (and has been) construed as suggesting the focus should be on (discounted) consumer surplus for Telecom end users.

3. Firstly, it is important to note that pretty much all citizens in New Zealand use Telecom services – that is, pretty much all citizens are either fixed line or mobile phone users, both as callers and call recipients. Thus, all the consequences of a regulatory policy change should account for impacts on almost <u>all</u> NZ citizens.

4. One of the most widely used measures for economic welfare is the simple sum of (changes in) consumer surplus, taxes and profits. This criterion has been used in countless studies, reports and academic papers.[14] The idea is that a given change in the first instance leads to (a) possible retail price changes, and hence to changes in consumer surplus and (b) profit impacts (along with associated tax revenue impacts

[14] To illustrate its pervasiveness, I checked through my own published output and found that, although cost benefit analysis is only a small part of what I have done by way of research, nevertheless, 10 of my published papers make use of this welfare criterion.

including VAT and corporation tax). Using this measure, we simply add up these impacts. [15]

5. Of course, rather than just using the direct profit impacts in the welfare measure, it is possible to try to trace through where these initial profit impacts ultimately manifest. That is, it is possible to consider how the profit impacts flow through to individuals. These flow-throughs include

   (i) direct flows through to end users (through possible impacts on wages, bonuses, dividends etc.),
   (ii) indirect flows to end users via taxes (VAT and corporation tax; increases in taxes relax the Government budget constraint, and facilitate Government increases in spending and hence eventually give rise to benefits which flow to citizens[16]),
   (iii) indirect flows through changes in investment levels facilitated by greater retained earnings (for example, the pace of superfast broadband rollout) leading to longer term benefits.[17]
   (iv) indirect flows that arise out of possible 'general equilibrium' perturbations to prices.

6. All of these are conduits through which citizens/callers/call-recipients may receive benefits. Naturally, trying to tease out these possible flow-through impacts is rather complex, because it is difficult to pin down how much of the profit is likely to flow down each of the various channels and because of the time dimension of these flows (which would thus require time-discounting).

7. Whatever the conduits, when benefits or costs finally arrive in the bank account or pocket or an individual citizen, logically, it should make no difference what 'route' those benefits or costs took. That is, to an individual, $1 of benefit or cost is $1 of benefit of cost, whatever the source. It makes no sense to say that we will count the $1 of benefit that arises out of a change in telecom price to a citizen, whilst ignoring the $1 of (say) dividend (or reduction in tax or whatever) that that same citizen also

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[15] It is possible to weight the benefits and costs visited on different individuals differently – for example, according to some measure of that individual's wealth, on the rationale that people tend to 'value' each £ more highly, the less well-off they are. Although it has some merit, this kind of weighting is contentious and is rarely used in practice.

[16] It would be odd indeed to argue that tax revenues have no welfare value at all.

[17] According to the 'pecking order theory' regarding corporate financing, in which businesses prefer to finance investment from retained earnings rather than having recourse to external capital markets equity or bond issues), increases in retained earnings facilitate increased levels of new investment; in the case of Telecoms, for example, it could well facilitate faster rollout of fibre and superfast broadband. This is without recourse to the additional arguments concerning the benefits associated with the importance of profits for innovations in dynamic markets where firms compete 'for' the market as well as 'in' the market (see Lind et al, 2002).

received by way of benefit flow through. All benefits and costs that affect any given individual should be weighed equally.

8. It is worth making this point more starkly. For every individual Telecom user, it is clear that changes to UCLL/UBA price caps will generate a range of benefits and costs which ultimately flow-through ‘into the pocket’ of each one of these users. These users care about the total amount of money that ultimately arrives in their pocket - they do not care where each $ comes from.

9. Note that it is possible to adjust downward benefit estimates associated with e.g. dividend payments by accounting for the fact that some of these benefits will flow to individuals who lie outside New Zealand.[18]

10. Thus, profit impacts should be seen as impacting on the long term best interests of end users, and should be included in the welfare function. If one chooses to use the traditional welfare measure of consumer surplus plus profits, this suggest this should take the form $W = CS + \psi\Pi$ where W is economic welfare, CS is consumer surplus, Π is profit, and α is a weight somewhere between 0 and 1.

11. Given the time delays associated with the various flows and given leakages (of benefits to non-NZ citizens) it is clear that significant weight should be put on profit – but that the weight should also be significantly less than unity. The natural way to deal with what this weighting issue, within the context of the present model, is through sensitivity analysis.

Annex 3 Why the Weighting on Consumer Surplus Matters in the Dobbs Model

1. Regulators explicitly or implicitly tend to use a welfare standard which is a weighted average of consumer surplus (CS) and profit Π ; for example,

$$W = CS + \psi\Pi$$

where $\psi \in [0,1]$. In the Dobbs (2011) model, if demand is fairly inelastic, this weighting on consumer surplus relative to profit is likely to be quite important. The reason for this lies with the impact of changes in *WACC* on welfare for the existing network. Basically under a total welfare criterion (when $\psi = 1$) and inelastic demand, changes in *WACC*, leading to changes in consumer price, have

18 It is a value judgement to say which individuals should be counted as ‘citizens’ for the purposes of conducting a cost benefit analysis. That said, it is a common enough value judgement to draw a boundary at the nation state - and not to count benefits/costs to those who lie outside that boundary.

relatively small impacts on total welfare. Thus, even when there is only a small amount of new investment, the welfare consequences of losing the customers that would have been served by that investment tend to outweigh any impact that price increases might have on consumers on the existing network. However as relatively more weight is put on consumer surplus (reducing ψ towards 0), the impact of price increases on existing customers becomes much more important. This is illustrated in a stylised way in figure 3 for a case where marginal cost is always constant. The demand curve is drawn steeply ('inelastic' at current price), and profit at price p_0 is simply $\Pi = (p_0 - MC)q_0$; consumer surplus is then the area to the left of the demand curve above the price line p_0. Consider a price increase to price p . Consumer surplus decreases by the amount equal to the areas 'a+c' whilst total welfare (when $\psi = 1$) only decreases by the relatively small amount 'b+c'.

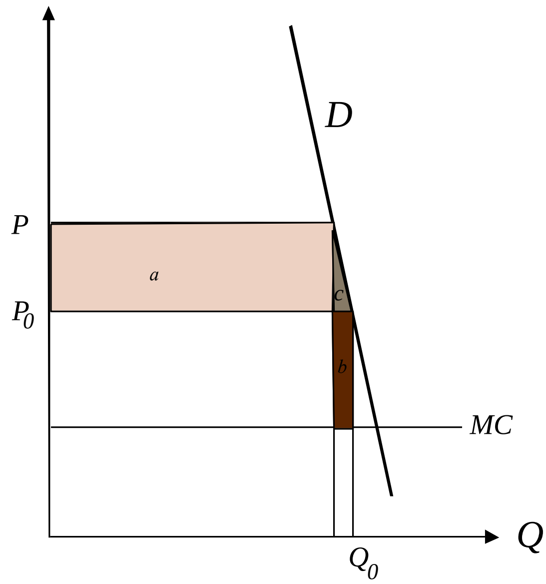

Figure 3: Components of Economic Welfare

2. Notice also that any price decrease (induced by a reduction in *AROR*) will lead to an increase in CS; this is why, as the Lally (2014) report points out, the optimal *AROR* for existing network, under a consumer surplus welfare criterion would be a 0% *AROR*! It is easy to see that this will tend to counter-balance the welfare benefits of uplift in *AROR* for new investment if one is applying the same *AROR* across all categories of investment. That is, a lower weight on profit will inevitably reduce the overall optimal percentile.

Annex 4 – Some comments on submissions

1. In what follows, I make reference to 4 reports in what follows; Vodafone (2015), Network Strategies (2015), Spark (2015) and Wigley (2015). Since the submissions all cover a large range of issues, it would be unduly repetitious for me to comment point by point for each submission; it is more efficient if I identify the key issues raised in the submissions that relate specifically to the application of the Dobbs model and comment on these.

A4.1 Whether firms respond to incentives – or – more importantly, whether there are any significant real options (whether investment is in any sense deferrable)

2. This issue is discussed at various points in this report. Price cap uplifts affect incentives to invest and also incentives for consumers to migrate to the new services. Various commentators pick up on the limited scope for investment discretion concerning new Fibre service contracts:

> *"In the context of the UCLL / UBA pricing review the Dobbs model can therefore only be relevant to existing sunk copper investment and new copper investment. The Dobbs construct cannot apply to fibre pricing in New Zealand as fibre prices have been set in commercial contracts."* (Network Strategies, 2015, s2.2)
> (See also Vodafone , 2015, B2.8, B3.1)
>
> *"Furthermore, the Dobbs model is based on the premise that firms respond to incentives. Results from the model are valid only if there is a real possibility of the regulated entity either deferring particular investment or declining to undertake potential investment Clearly Chorus cannot defer or decline to undertake its existing UFB contract. Indeed as it is already engaged in this project additional incentives at this stage are irrelevant as regards UFB investment".* (Network Strategies, 2015 page 3, Exec Summary Para 3; see also Network Strategies, page 6 para 3)
>
> *"In respect of the second adjustment – the adjustment to the WACC – the case for an adjustment is incredibly difficult to make because (a) there is next to no Chorus investment occurring in the regulated services that could be impacted by regulatory price settings; and (b) the key investments driving innovation in respect of retail broadband are being undertaken by RSPs and/or over the top application providers, which investments would be reduced rather than increased, by* such an uplift to the WACC." Spark (2015, para 7)

3. Investment options include the option to set the scale of initial investment and also the pace of roll out. In the NZ context, I am not familiar with the details of the contracts already signed, or indeed concerning those 'still in the pipeline'. I would say that some assessment of the extent to which firms can delay rollout subsequent to winning contracts, and also whether there are issues with the pace at which contracts themselves are issued and get sold will affect the extent of real option effects. Finally, consideration needs to be given to all those investment options not covered within the fibre contracts program.

A4.2 Whether a Total Welfare Standard is appropriate

4. Vodafone (2015, para 4, exec summary, B2.11) disagrees with the 'total welfare' objective. Likewise, Network Strategies (2015, page 7/8 comment

> *"Although the Telecommunications Act is not explicit on this matter, it seems clear that its primary emphasis on the long-term benefits of end-users is consistent with a consumer welfare standard. However CEG considers that a total welfare standard would better serve consumer interests."*
> and the NZCC itself has commented
>
> *"… we do not consider a total welfare standard is consistent with the purpose statement of Part 4."* (NZCC, 2014, para 37)

5. The Frontier (2014) report considered (discounted) 'total welfare' and 'consumer surplus' as polar extremes for the welfare function. I consider this reasonable; I explained my view concerning what should be counted in 'economic welfare' in some detail in Annex 2 above. I argued there that a weighted average of (discounted) consumer surplus and profit is sensible, as a measure of the LTBEU (long term benefit of end users). On this basis uplift would be intermediate between the extremes of (discounted) consumer surplus and (discounted) total welfare.

A 4.3 Cross-Elasticity Issues

6. In my commentary on the Electricity/Gas supply case, I mentioned the issue of cross price elasticity as a potential concern, without really analysing the issue in any detail. CEG (2015) made the following comment

> *"We would also note that as the FD model solves for a uniform WACC across new and existing services, the optimal percentiles are determined in a manner that maintains relativity between the prices for new and existing services. This is likely to go some way to addressing the fact that cross-price effects are not explicitly being modelled."* (CEG, 2015, para 96)

7. This is a technical issue, considered in detail in section 4.3 above. There are some reasons why the CEG argument for dealing with cross-elasticity via sensitivity analysis is plausible but ultimately, I consider it is incorrect (for the reasons explained in section 4.3). It is likely, as a consequence, that the CEG approach exaggerates the extent of uplift in price caps needed.

8. Overall, therefore, I am inclined to agree with Vodafone 's (2015, B3.3) comment that

> *"CEG attributed a more elastic demand to new fibre services*

> *than to legacy copper services, potentially to address Dobbs' concerns on cross elasticity between copper and fibre. CEG's 'fix' does not address Dobbs' concerns."* Vodafone, 2015, B4.7)

and Network Strategies when they comment that

> *".., the Dobbs model does not allow for demand cross-elasticity between sunk and new investment. Apart from characterising fibre broadband services as more elastic than copper broadband services, CEG offers no robust methodological fix for this."* Network Strategies exec summary para 1, page 4; see also Network Strategies page 14-16)

9. The problem is that it is unclear how much 'loss of consumer surplus' impact on the existing service is likely to be. Given an estimate of the overall net gain in consumer surplus from introducing the new services (i.e. net of impacts on the existing service), it is possible to calculate the implied truncation price that would (roughly) take this into account. I illustrate how to do this in section 4.4 in the report.

10. Overall, this merely reinforces my view that the Dobbs model gives an indication of the 'kinds of magnitude' for uplift that real option effects can generate, but it is not possible to use the model to give a robust quantitative estimate in a case like this. One might think that the Dobbs model with independent demand gives an upper bound on the likely extent of real option uplifts – but as I have explained in my 2014 report, there are reasons why uplift might be greater as well as reasons (including cross elasticity) why it might be lower.

A4.4 Maximum Willingness to Pay

11. Model predictions are influenced by the assumption concerning consumers' willingness to pay (and note it is important to distinguish their 'total willingness to pay', the maximum 'marginal willingness to pay' or 'choke price' and the 'truncation price' needed to make iso-elastic demand consistent with estimates of total willingness to pay – these concepts are discussed in detail in my earlier report (Dobbs 2014).

12. Network Strategies (2015, pages 15-17) consider maximum willingness to pay in some detail and argue that

> *".. a maximum willingness to pay of $127.50 per month is more feasible than CEG's assumption of $523.01 but based on recent survey data may still be too high. "*

and Vodafone 2015, B4.13 :

> *"We echo NWS's view that CEG may be completely wrong regarding New Zealanders' willingness to pay profiles, and suggest that $127.50 may even be too high.*

13. I have commented myself on what appear to be errors in the use of maximum willingness to pay used by CEG. Including the issue of cross-elasticity, I therefore tend to agree with these comments (see section 4.4 above). Lowering these truncation prices would of course significantly lower the predicted price uplifts.