COMPETITION ECONOMISTS GROUP

# Welfare effects of UCLL and UBA uplift

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# 1 Summary

1. We have been asked by Chorus to quantify the welfare effects of uncertainty in estimating the true cost of capital or price of the unbundled copper local loop (UCLL) and unbundled bitstream access (UBA) services. As we discussed in our earlier paper, asymmetries in the costs of under or overestimating the true cost of capital or price may arise if low regulated prices would:[1]

   - Reduce incentives for investment in UFB services and other infrastructure capable of delivering new services;
   - Provide weaker incentives to maintain and invest in the copper network;[2] and
   - Impede the migration to fibre services through lower relative prices for copper services with resulting negative effect on the development of applications.

2. In this report we model the welfare effects of misestimating the price and whether they indicate that the price of UCLL and UBA services should be increased or 'uplifted' to address this uncertainty.

3. **First**, we have considered the effect of this uncertainty on incentives to invest in existing infrastructure and new investment in infrastructure capable of providing new and/or enhanced services, where new investment relates to investment either by Chorus or other access network operators. We have quantified this effect using the loss simulation model developed by Frontier Economics for Transpower (the Frontier model).[3] The Frontier model was developed as an application and extension of the model described in Dobbs (2011) to the electricity sector in New Zealand. The Dobbs (2011) model which, according to Professor Dobbs, was originally developed with a telecoms application in mind.[4]

4. We find that with reasonable assumptions the Dobbs model indicates an uplift in the cost of capital for the UCLL and UBA in the range of 56$^{th}$ to 88$^{th}$ percentile based on a consumer welfare standard and above the 95$^{th}$ percentile on a total welfare standard. We consider that the 75$^{th}$ percentile is likely to be a lower bound for the appropriate uplift having regard to both welfare standards.

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1 CEG, Uplift asymmetries in the TSLRIC price, para 3. We note that this report does not deal with the issues of asymmetric risk as outline in that report.

2 We do not model the effect of this in this report due to the absence of a definite relationship between incremental expenditure and change in fault rates.

3 Frontier Economics (2014) *Application of a loss function simulation model to New Zealand*, A Report Prepared for Transpower, August 2014

4 Dobbs (2014) *Proposed amendment to the WACC percentile for the Allowed Rate of Return: Comments on the Application of the Dobbs [2011] model Ian M Dobbs*, September2014

5. An uplift from the median to the 75th percentile would imply significant gains in consumer surplus from new services of around $5.09 billion over time in present value terms.

6. We consider that the Frontier-Dobbs model, previously considered in the context of assessing the WACC percentile to adopt in the regulation of electricity and gas distribution companies, to be instructive, with some modifications, in considering the uncertainty in the current regulatory exercise. While the model only captures uncertainty in estimating the cost of capital, whereas with a forward-looking cost model uncertainty will arise from other considerations as well. However, we consider that the model can be adapted to take that uncertainty into account. That is, the model can serve as a proxy for modelling the uncertainty a regulator faces when estimating the cost of regulated services in a forward looking cost model more generally.

7. The Frontier-Dobbs model provides a basis by which to consider the welfare effects in estimating price for regulated services as it balances the welfare loss of higher prices against the welfare gains that might result from investment in new services. This is obviously relevant to the considerations the Commission must take into account under s 18, particularly as clarified in s 18(2A).

8. **Second**, we have considered the effect a higher price of the UCLL and UBA services would have on migration to fibre-based services and the welfare gains this may deliver in terms of new applications that rely on the higher quality of service fibre can deliver. The Commission has already commented, higher prices for UCLL and UBA services will encourage migration to fibre resulting in welfare benefits, though this needs to be balanced with the cost of accelerating migration (we do this below).[5] Such new investment is likely to lead to significant long-term benefits for end-users as identified in section 6 below, such as arising from cloud applications and medical and farming applications. We model the effect of having higher prices for the UCLL and UBA services as avoiding a delay in the development of these applications and the benefits these bring.

9. It needs to be recognised that these benefits are difficult to model because they require predictions of 'new application' development in the future. Nevertheless, reports relating to the New Zealand market predict substantial consumer surplus gains from fibre-dependent applications in the healthcare, education, business, and farming sectors.

10. In the case where new applications are expected to emerge in five years from now, we estimate the impact on the net present value of consumer surplus of not delaying the benefits by one and two years is $757 million and $1.4 billion, respectively (in present

5 Commerce Commission, Draft pricing review determination for Chorus' unbundled copper local loop service, Under section 47 of the Telecommunications Act 2001, Draft determination, 2 December 2014, para 415

value terms). This can be compared with a consumer welfare loss of around $720.0 million (in present value terms)[6] from higher regulated prices based on the 75th percentile of the WACC.

## 1.1 Structure of this report

11. This report is structured as follows:

- Section 2 describes the FD model and its applicability in the current circumstance;
- Section 3 discusses the results of the FD model and undertakes sensitivity analysis around some of the key assumptions;
- Section 4 considers the objections raised by the Commission to the use of the FD model in these and previous proceedings; and
- Section 5 discusses the welfare benefits of new applications developed from fibre migration.

[6] We calculate a figure of $723 million in section 4.5, whilst the Dobbs model indicates a figure of $718 million.

# 2 Frontier-Dobbs model

12. This section describes our use of the Frontier-Dobbs (FD) model and its application to the welfare effects of setting regulated access prices for fixed line services in New Zealand.

13. The FD model is the label that we apply to describe the modelling conducted by Professor Ian Dobbs in his 2011 paper *"Modeling welfare loss asymmetries arising from uncertainty in the regulatory cost of finance"*[7] and modifications and extensions subsequently made to this model by Frontier Economics for the regulatory electricity network sector in New Zealand.[8] Frontier's revised model and the code that implements it is available on the Commission's website.[9] The modelling and results that we describe at section 3 below is based on our use and adaptation of Frontier's implementation of Dobbs (2011).

14. We have used the code developed by Frontier Economics, which we understand has been reviewed to be a reasonably faithful application and extension of Dobbs (2011).[10] We have made a number of modifications to the model and adjusted parameters to reflect the circumstances of the fixed line telecommunications sector in New Zealand. We have tested the sensitivity of our results to these parameters including different functional forms for demand, elasticities and maximum willingness to pay. In particular, we have modelled scenarios with a high own-price elasticity for new services. We did this, in part, to address the concern that Dobbs (2011) does not allow cross-price effects between existing and new services.

15. On the whole we found our results to be reasonably robust to alternative specifications and assumptions. However, we would consider further sensitivity and testing of the model to be prudent.

## 2.1 Description of the Dobbs model

16. Dobbs (2011) modelled the asymmetry in the welfare loss arising from uncertainty in the allowed cost of capital for regulated businesses. A key contribution of this paper

7 Dobbs, I.M. (2011) "Modeling welfare loss asymmetries arising from uncertainty in the regulatory cost of finance," *Journal of Regulatory Economics*, Springer, vol. 39(1), pp. 1-28

8 See Frontier Economics (2014)

9 http://comcom.govt.nz/publicassets/Frontier-Economics-Loss-Model-110914.zip

10 Dobbs (2014), page 3

was that it separately modelled the effect of uncertainty in the cost of capital on existing and new investment. Dobbs (2011) concludes:[11]

> *... the asymmetry in the welfare function for new investment (vis a vis that for sunk investment) is so strong that even if the proportions of potential new investment are quite small, this can still induce a significant uplift in the optimal choice for the AROR compared to the WACC mean.*

17. Dobbs (2011) defined three types of investment made by a regulated firm:

- Category 1 investment, which are existing (and sunk) assets used to provide existing services. The firm is obligated to continue to provide these services and must therefore maintain and operate these assets;
- Category 2 investment, which is non-deferrable new investment to provide new and/or enhanced services. The firm must decide whether to make this investment or not; and
- Category 3 investment, which is deferrable new investment to provide new services. The firm has the option of deciding whether it makes this investment or defers it to a later period.

18. Dobbs (2011) focus is on category 1 and 3 which was considered likely to be the most important categories of investment. Category 2 is included because it provides a useful starting point for analysis.

19. Dobbs (2011) assumes that the cost of capital of the regulated firm is unknown but that the distribution it is drawn from is common knowledge and does not change over time. The regulator sets a fixed allowed rate of return and determines price caps for the existing service and the new service based on this rate of return using a long-run marginal cost framework that compensates a firm for its variable and fixed costs.

20. The model implemented by Dobbs (2011) examines the regulator's optimal choice of the allowed rate of return given uncertainty. The regulator must trade off the knowledge that:

- if it overestimates the rate of return and sets regulated prices too high, then it will give rise to a reduction in total welfare, since the decrease in consumer welfare of higher prices is only partially captured by higher profits of the regulated firm; whereas
- if it underestimates the rate of return and sets regulated prices too low, then category 2 and category 3 investments may be cancelled or delayed and any consumer and producer surplus that would have been created through that investment will not be realised.

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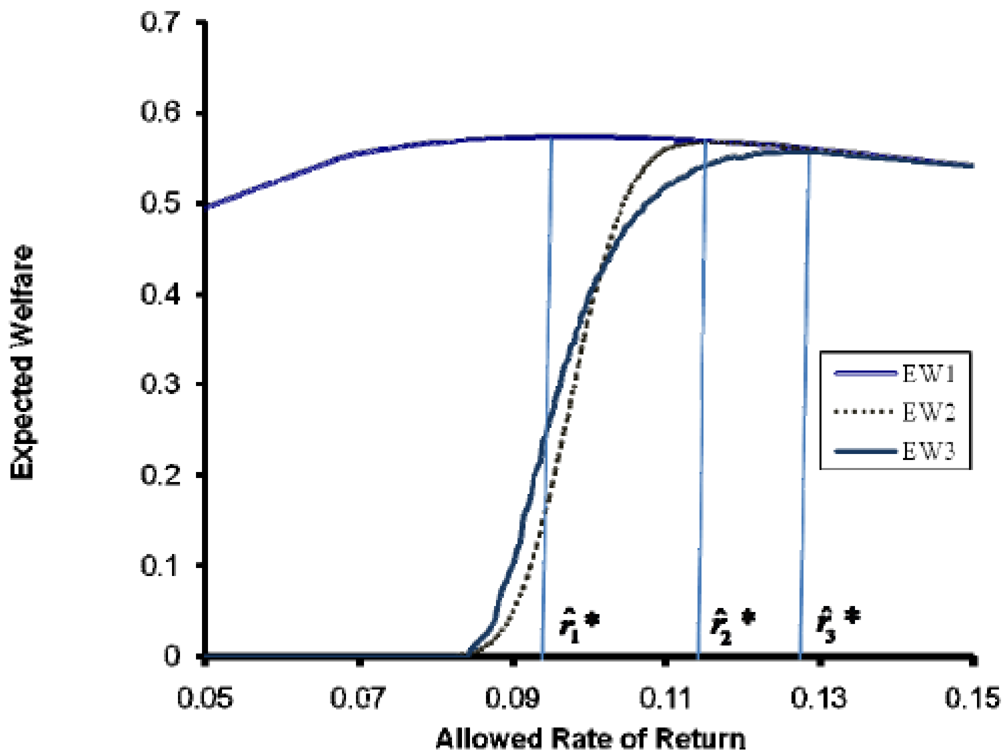
[11] Dobbs (2011), p. 33

21. The implications of setting prices too low are therefore more damaging for new investment, because surplus that would otherwise be gained may be lost. Setting prices too low for existing investment will harm the profitability of the regulated business but by assumption will not result in a withdrawal of existing service, albeit it may affect the incentives to invest in optimal maintenance of the network providing the existing service.

22. Dobbs (2011) models different WACC percentiles for different categories of investment. However, if the regulator is constrained to set a single allowed rate of return for all investment, then the optimal WACC percentile depends upon the characteristics of demand for the services provided by these investments. Most importantly, it depends upon the level of demand assumed for the existing service and the new services that could potentially be cancelled or delayed. The expected welfare function for existing (or category 1) investments is quite different to the expected welfare function for new (or category 2 and 3) investments. This is shown graphically by Dobbs (2011) Figure 2.

**Figure 1: Reproduction of Figure 2 in Dobbs (2011)**




23. As shown in Dobb (2011) Figure 2, the welfare expected from category 2 and category 3 investments increases steeply in line with the shape of the cumulative density function of the normal distribution that the cost of capital is drawn from, reflecting the probability that the investment will be made and the service will be provided. At

high allowed rates of return expected welfare declines as the effect of higher prices on deadweight loss in supplying the new service outweighs the much smaller incremental probability that the remaining surplus provided by the service will be realised.

24. Conversely, the expected welfare function for category 1 investment is much flatter, since it does not admit any optionality for the business to cancel or delay its investment and therefore there is no possibility of lost surplus. Dobbs (2011) assumes there is a strict "universal service obligation" once a service is launch. Dobbs (2014) observed that this effectively meant the firm had no discretion with respect to investment relating to quality of service:[12]

> *... QOS must be maintained, and incremental investment must be made to cope with any increments in demand for that service over time.*

25. If the regulator must set a single allowed rate of return across investment that includes both existing and new investment, then as Figure 2 shows even a relatively small proportion of new investment will contribute to an optimal allowed rate of return that is well in excess of the expected cost of capital (which is 10% in Figure 2).

## 2.2 Modifications made by Frontier Economics

26. In August 2014, Frontier Economics developed a welfare loss function model for the regulated electricity network sector in New Zealand using the approach set out by Dobbs.[13] Frontier made a number of modifications and extensions to Dobbs (2011). These included:

    a. Changing the form of demand function used by the model. Dobbs (2011) assumed a constant elasticity demand function. However, this assumption is problematic for use with a service that has inelastic demand since consumer surplus is unbounded in this scenario. Frontier resolved this issue by truncating the demand function at a maximum willingness to pay.

    b. Taking into account the structure of the electricity market where the prices for distribution and transmission services are only one component of the final price for electricity faced by end users. Taking into account the effect of changed prices for network services on the final demand for electricity requires an assumption

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[12] Dobbs (2014) at para 11. We discuss the implication if this is not the case, as appears to be so for Chorus, later in this report.

[13] Frontier Economics (2014)

about the extent of pass-through of those prices to end-users. Frontier assumes full pass-through of network charges to end-users.[14]

c. Adapting the Dobbs (2011) model to consider an alternative welfare standard that gives weight only to consumer surplus, rather than the total surplus measured used by Dobbs (2011).

d. Parameterising the Dobbs (2011) model for the circumstances of the electricity transmission and distribution sectors.

27. Frontier found that the using the total welfare measure, the optimal WACC was very high and at the 99th percentile. This estimate was higher than Dobbs (2011) original estimates because the inelastic nature of demand for electricity. Frontier also reported that the optimal WACC using the consumer surplus measure was at the 87th percentile.

28. The Commission rejected the use of Frontier's implementation of the Dobbs model, in part, because it noted the advice of Professor Dobbs that the model was developed for telecommunications and hence may not be a good fit for the electricity sector. We discuss the Commission's rationale for rejecting Frontier's implementation of the Dobbs model in more detail below.

## 2.3 Relevance of Frontier-Dobbs model

29. The Dobbs-Frontier model provides a reasonable framework for analysis from which to draw conclusions about optimal regulatory policy for pricing the UCLL and UBA services in New Zealand. It is a framework that is particularly suited for the telecommunications industry because its focus is on new investment in infrastructure (or capacity) capable of providing new and/or enhanced services.

### 2.3.1 Dobbs is a 'good fit' to the current regulatory determination

30. As noted above, Dobbs (2011) was initially considered in the context of the Part 4 regime for regulating electricity and gas businesses. In that context, the Commission was largely focussed on the effect of uncertainty in estimating the true WACC on investment in network reliability. Dobbs (2011) was not considered by the Commission to be a 'good fit' for that purpose because its main contribution was to model the effects on new investment in infrastructure capable of providing new and/or enhanced services. In particular, the Dobbs model was designed with investment in new innovative services in the telecommunications sector in mind.

14 The level of pass through would be determined by the nature and intensity of competition at the retail level. Whilst we have not undertaken a specific analysis, we would expect pass through of between 75% and 100% to be plausible.

31. In the current regulatory process the Commission should be interested in the effect regulated prices will have on both investment in the maintaining and/or improving service quality on the existing network (investment that would be consistent with network reliability)and new investment in infrastructure capable of providing new and/or enhanced services. However, a key consideration will be the effect on incentives for new investment, such as high-speed broadband and associated investment in downstream applications that rely on high-speed broadband.[15] This is required by s18 of the Act.

32. In the current proceedings, the Commission is modelling the costs of a hypothetical operator providing modern equivalents to the regulated services. The output from the model is the forward-looking costs of providing the service with the cost allocated on a long-run incremental cost basis. The ultimate outputs of the model are TSLRIC prices, which the Commission has indicated it will fix in nominal terms over the regulatory period. The Commission state:[16]

> *The effect of this formula is that we set a constant nominal price over the regulatory period such that the stream of cash flows arising from this price has the same NPV as the stream of cash flows arising from the nominal prices (the latter being a tax-adjusted tilted annuity) over the regulatory period.*

33. That is, the Commission is setting regulated price caps for individual services for the 5 year regulatory period. In many respects, the approach to setting prices based on forward-looking prices described in the Commission's draft determination mirrors the regulatory problem addressed by Dobbs (2011). The problem that Dobbs (2011) address is described as follows:[17]

> *The paper focuses on the problem of setting a fixed allowed rate of return for the duration of a fixed regulatory review period, given that this is but the first of an ongoing sequence of review periods and that the allowed rate of return influences price caps and controls. When the AROR is set 'too low' relative to the welfare maximizing level, this tends to result in under investment and under pricing, whilst if it is set too high, this tends to give rise to over-investment and over pricing.*

34. As the Commission is setting price caps for the regulated services based on an estimated cost of a fibre-based network deployment, these prices will materially affect

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15 We discuss the effect on incentives to invest in high-speed fibre infrastructure and associated investment in downstream applications in section 6 below.

16 Commerce Commission, *Draft pricing review determination for Chorus' unbundled copper local loop service Under section 47 of the Telecommunications Act 2001*, Draft determination, 2 December 2014, para 412.

17 Dobbs (2011), page 33.

incentives for efficient investment in equivalent fibre-based infrastructure capable of providing new and/or enhanced services. Accordingly, setting the price of the regulated services based on the cost of the fibre services will directly constrain the pricing of fibre services through substitution by end-users. This is consistent with the effect on new investment modelled by Dobbs (2011) model. It is also consistent with the economic objectives within purpose statement in section 18(2A) of the Telecommunications Act, which states:

> *To avoid doubt, in determining whether or not, or the extent to which, competition in telecommunications markets for the long-term benefit of end-users of telecommunications services within New Zealand is promoted, consideration must be given to the incentives to innovate that exist for, and the risks faced by, investors in new telecommunications services that involve significant capital investment and that offer capabilities not available from established services.*

35. It may be argued that, as Chorus and other LFCs are contractually bound (subject to liquidated damages) to deploy fibre under the existing UFB contracts, the Commission's modelling will have no effect on incentives for new investment. In our view, this does not negate the requirement on the Commission to set prices that signal to investors that new investment will be given a return appropriate with the risk faced and the benefits this brings to end-users. We would also note, as discussed below, the Commission's approach will likely have an effect on incentives for new investment by Chorus and other parties which are not contractually bound.

36. We recognise that Dobbs (2011) assumes that there is a monopoly provider of both existing and new services, which may not be a perfectly accurate reflection of the circumstances in New Zealand where other parties (local fibre companies) are deploying fibre services.[18] 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. This would include yet unknown, but potential investments by Vodafone and Spark in further unbundling.

37. In addition, it should be remembered that there are other potential new investment options that are available to Chorus and other operators, including:

   - investment in broadband infrastructure in rural areas outside the UFB and rural broadband initiative (RBI) footprints;
   - investment options to engage in future UFB contractual arrangements;

[18] We note that the Commission has decided to include in the demand of an HEO the demand already served by LFCs thus, arguably, the Commission has assumed the HEO will be a monopoly provider of existing and new services.

- other investment in high-speed broadband above and beyond the UFB contractual requirements; and
- investment options to enhance service quality and network capacity on the existing network

38. In section 3 below, we parameterise the FD model to reflect demand for new services equal to 75% of total demand. This reflects the future expected demand for fibre services in New Zealand. We consider this to be a conservative assumption given that the price caps based on fibre costs may materially affect incentives for migration to fibre services. We also test a modelling scenario in which new services reflect between 25% and 10% of demand that might more closely reflect new investment outside of the terms of the existing UFB contractual arrangements, including the Government's new UFB extension and RBI extension programmes, which will extend coverage of these programmes further into rural areas.[19]

### 2.3.2 Uncertainty cost of capital proxy for uncertainty in prices

39. The focus of the Dobbs (2011) model is on the uncertainty faced by the regulator in selecting the allowed rate of return as part of determining prices equal to the long run marginal cost of the regulated business. However, this can more generally be understood as a proxy for uncertainty that the regulator faces in estimating the cost of service more generally. If such uncertainty about the correct estimate of the cost of service is captured in the cost of capital, this is likely to imply a greater underlying variability in the cost of capital than is captured by the uncertainty associated solely with measuring the cost of capital.

40. The long-run marginal cost is defined by Dobbs (2011) to be equal to the variable cost plus a return on and of the fixed cost of providing the service. Therefore when the regulator determines the allowed rate of return it is also determining a key component of its overall estimate of the firms costs. The other components of cost are assumed by Dobbs to be common knowledge. 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).

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19 http://www.beehive.govt.nz/sites/all/files/Media-QAs-Next-step-on-broadband-programmes.pdf
http://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=11319104
https://www.national.org.nz/news/news/media-releases/detail/2014/08/26/$150-million-boost-for-rural-broadband-initiative

41. An alternative way to conceptualise these wider sources of uncertainty in the costs of the regulated business is to express them all as uncertainty in the cost of capital. For instance, Dobbs (2011) in equation (7) shows the regulator determining an allowed long-run marginal cost based on the allowed rate of return as:

$$\hat{p} = c + (\hat{r} + \gamma)k$$

42. In this equation, the only uncertainty in the price comes from uncertainty in the allowed cost of capital. However, if uncertainty is also derived from other components of the price then one option is to express all sources of uncertainty in this equation:

$$\hat{p} = \hat{c} + (\hat{r} + \hat{\gamma})\hat{k}$$

43. However, making errors in other components of the price can equivalently be thought of as making errors in the allowed rate of return. For example, given an asset base of $100 with no depreciation and a 10% rate of return, if the regulator underestimates variable costs by $1 then this could instead be considered as providing for a rate of return that is 1% below the rate of return nominally allowed by the regulator.

44. This relationship between uncertainty in the cost of capital and uncertainty in the price is discussed of our previous report on uplift.[20] In that report we describe why it is the case that uncertainty in the cost of capital is only a subset of the uncertainty in the modelled TSLRIC costs of providing the UCLL and UBA services. Taking into account the full amount of uncertainty in TSLRIC costs and attributing it all to uncertainty in the cost of capital is technically feasible. It would result in a standard deviation for the cost of capital that is higher than would be implied by its measurement error.

45. In this report we follow the framework of the FD model in referring to a "cost of capital uplift". However, as stated in our previous report on uplift for Chorus we continue to consider that a reasonable, and potentially a more intuitive approach to compensating for uncertainty in the TSLRIC is to consider the uplift as applying to price generally and not simply the cost of capital. Where we refer to a cost of capital uplift recommended by application of the FD Model we could equivalently express this as a price uplift.

### 2.3.3 Dynamic implications of FD model

46. The Dobbs (2011) model describes the problem faced by a regulator in determining an optimal cost of capital for existing investment and the optimal cost of capital for new investment in providing new services. However, the model is static because it does not take into account the effects of the repeated regulatory game (in the

[20] CEG, *Uplift asymmetries in the TSLRIC price*, February 2015

economic sense) that is played between the regulator and the regulated business. This likely results in the optimal cost of capital percentile being underestimated by the Dobbs (2011) model.

47. Dobbs (2011) analytical framework assumes that the regulator commits to a rate of return and price caps over time. That is, his framework assumes that a regulator could incentivise new investment by allowing a higher rate of return and that a commitment to this policy would be credible to the regulated business. That is, there is no probability placed on a scenario that once the new investment is brought online, the regulator would subsequently remove the uplift.

48. As Dobbs (2011) observes:[21]

> *Gaming issues or commitment problems are not addressed (notably, the problem that, once investment is sunk, the regulator has an incentive to reneg [sic] on the regulatory compact... The reasons why the regulator choose to commit to a fixed AROR and fixed price caps ex ante (with no subsequent adjustment) also lie outside the model.*

49. This quote describes sound policy reasons for a regulator to commit to an allowed rate of return and/or prices for a new investment. We agree that there are very good reasons for providing these commitments. 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. In the context of investment in new infrastructure capable of providing new and/or enhanced services

21 Dobbs (2011), page 7, footnote, 10

in New Zealand, such as fibre-based or fixed-wireless network roll-outs, this is particularly important since the magnitude of such new investments is significant. In describing our result below, we also report the optimal cost of capital percentiles for existing services and for the blended services.

# 3 Application of the Frontier-Dobbs model

52. The FD model is applicable to a regulated business making new investments in infrastructure (or capacity) capable of providing new and/or enhanced services over time. This makes it particularly suitable for application to the telecommunications sector in New Zealand. In particular, the large investments in new fibre and fixed wireless infrastructure that Chorus and other parties are currently making is particularly relevant to the FD model framework. As already discussed above, we consider this falls within category 3 investment under the FD model.

53. In this section, we seek to parameterise and apply the model for the purpose of determining the optimal cost of capital percentile to apply to UCLL and UBA services. We discuss the inputs that are required to populate the model and our rationale for selecting values and potential sensitivities to these values. We parameterise the FD model to represent 'existing' investment and services as the copper network and services provided using it, and 'new' investment and services as the UFB and/or investments in complementary or competing infrastructure by Chorus or other parties and services provided over these networks. We discuss this assumption in more detail at section 2.3.1.

54. In addition, in this section we discuss the optimal cost of capital percentiles under these assumptions. In our base case scenario we find that:

- the optimal cost of capital percentile for existing services is 45%;
- the optimal cost of capital percentile for new services is 99%; and
- the optimal cost of capital across all services is 99%.

55. We explain at section 2.3.3 above why we consider little weight should be placed on the optimal cost of capital percentile for existing assets alone. If the Commission is to provide appropriate incentives for ongoing investment that brings innovative new services, then setting a cost of capital percentile that effectively expropriates earlier investment will not achieve this. If a commitment to applying the cost of capital percentile for new services does not extend to investments made in the past then it may not be regarded as credible by investors.

56. We find that alternative assumptions support an overall optimal cost of capital percentiles of 95% based on a total welfare standard or 75% based on a consumer welfare standard. However, we do not consider that a welfare standard placing sole reliance on consumer surplus is appropriate for the reasons set out in section 4.3 below.

## 3.1 Description of inputs

57. The FD model requires a large number of inputs. These inputs may potentially be different for existing and new investment. We take into account different estimates for existing and new investment where we consider that the differences are particularly germane to copper and fibre investment. However, our parameterisation of this model is one of many potential implementations of it. We consider that greater consideration should be given to appropriate implementation of the model to produce outcomes that are relevant to a cost of capital or price uplift for the UCLL and UBA.

58. Our base case assumptions are set out at Table 1 below. We discuss the basis for these assumptions and potential sensitivities to them further below.

**Table 1: Base case input assumptions for the Frontier-Dobbs model**

| Parameter | Existing investment | New investment |
|---|---|---|
| Retail price | $85 / line / month | $85 / line / month |
| Demand served | 1,758,153 lines | 1,318,615 lines |
| Elasticity of demand | -0.43 | -1.00 |
| Maximum willingness to pay | $523.01 / line / month | $523.01 / line / month |
| Demand growth | 0% | 0% |
| Input price | $38.39 | $38.39 |
| Cost of capital mean | 7.24% | 7.24% |
| Cost of capital standard deviation | 1.11% | 1.11% |
| Percentage variable cost component | 0% | 0% |
| Annual depreciation | 3% | 3% |
| Regulatory length | 5 years | 5 years |
| Demand curve | Truncated isoelastic | Truncated isoelastic |
| Welfare standard | Total welfare | Total welfare |

*Source: CEG analysis*

### 3.1.1 Current prices

59. The FD is designed to model a single service supplied over each investment. To populate the model we have assumed that the input price for the existing service is set in line with the Commission's draft decision on the final pricing principle for the UBA of $38.39 per line per month.

60. We also assume that the same input price applies to the new investment. We note that the input prices for fibre services are not very different to this level.

61. We further assume average retail prices of $85.00 per line per month for both services based on Chorus' survey of retail providers' unlimited naked broadband plan prices observed on 8 March 2015. Since we want to capture consumer surplus and price elasticity of demand estimates are available for the retail broadband market, we

modelled *retail* demand rather than wholesale demand. We assume that the margin between retail prices and input prices remains constant in response to modelled changes to input prices. That is, there is full pass-through of input prices into retail prices. As noted above, the level of pass through will depend on the intensity of competition in the retail market and is likely to be plausibly within the range of 75% to 100%.[22]

### 3.1.2 Cost of capital

62. The mid-point vanilla weighted average cost of capital (WACC) proposed by the Commission in its draft decision of 7.24% is used to populate the model.[23] We assume that the same mean cost of capital applies to the new investment.

63. Given the cost of capital parameters set by the Commission we estimate a standard deviation for the vanilla WACC of 1.11%. This calculation follows from the Commission's methodology to calculate standard error for the WACC as applied in its Input Methodologies for Electricity Distribution and Gas Pipeline businesses. We assume that the same standard error applies for new investment.

64. Consistent with the assumptions used by Frontier's application of the Dobbs model, we model the distribution of the vanilla WACC as a normal distribution, truncated at ±4 standard deviations from the mean. In practice, this is a very trivial truncation, excluding only about 0.006% of observations.

### 3.1.3 Demand

65. The TERA model assumes a quantity of UCLL services of 1,758,153 lines. We use this as the demand for existing services.

66. Further, we understand that the UFB will eventually extend to 75% of New Zealand premises. Consistent with this, we assume quantity for the new service to be 1,318,615 lines. However, we also consider sensitivities to demand for new services that would capture scenarios in which fibre services provided under the existing UFB contractual arrangements would not be considered the new investment. We model alternative scenarios by assuming that demand for the new service is only 10% of demand for the existing service. This assumption might, for example, reflect investment in new services by non-Chorus operators, or it might reflect investment by Chorus in non-UFB services (e.g., high-speed broadband outside the UFB and RBI footprint) and/or investment resulting from the Government's new UFB extension and RBI extension

[22] We note Spark have indicated a figure of 75% as reasonable. Spark New Zealand, UBA and UCLL FPP pricing review draft decision, 20 February 2015, Attachment D, page 83

[23] We note that, strictly speaking since the Dobbs model takes into account a price formula that does not provide compensation for taxation it may be appropriate to use a pre-tax WACC of 8.99% as an input.

programmes. As discussed in section 2.3.1, the alternative scenarios are included to test the sensitivity of the result to the assumption that the fibre services provided by Chorus and other LFCs under the existing contractual arrangements should be modelled as 'new services'.

### 3.1.4 Demand elasticity

67. The own-price elasticity of demand for copper broadband services is relatively inelastic due to the lack of perfectly substitutable products and the 'need' for broadband services to utilise wide-range of internet-based services and products. A more inelastic demand results in a higher optimal cost of capital uplift because a price increase of a given value leads to a smaller percentage reduction in consumption when demand is more inelastic.

68. Our base case assumes a demand elasticity of -0.43 based on the OECD's estimate for OECD countries in 2007,[24] we have also tested a sensitivity of 0.95 as proposed by Spark.[25] We consider that this can reasonably be applied to services provided over existing investments particularly given new services would include demand for ordinary telephony services (supplied via the unbundled copper low frequency service) which typically have been shown to be very inelastic to price. However, the elasticity for services provided over new investments is less certain. We consider alternative scenarios of -1.00 and -2.00.[26] Capturing a higher elasticity may at least partly take into account the likely effects of a cross-price relationship between the existing service (copper) and the new service (fibre).

### 3.1.5 Maximum willingness to pay and demand curve

69. We follow Frontier's implementation of the Dobbs model in assuming a truncated demand curve with a maximum willingness to pay. We also consider a sensitivity using a linear demand curve.

#### *3.1.5.1 Based on estimates of consumer surplus*

70. Our base case willingness to pay is calculated using Greenstein & McDevitt's (2012) estimates of broadband consumer surplus, revenue and number of subscribers in

24 Cadman, R. and C. Dineen, *Price and Income Elasticity of Demand for Broadband Subscriptions: A Cross-Sectional Model of OECD Countries*, February 2008

25 Spark New Zealand, UBA and UCLL FPP pricing review draft decision, 20 February 2015, Attachment D, page 83

26 http://www.communications.gov.au/__data/assets/pdf_file/0003/243039/Cost-Benefit_Analysis_-_FINAL_-_For_Publication.pdf and Dutz, M., Orszag, J. and Willig, R. 2009, The substantial consumer benefits of broadband connectivity for US households, Commissioned by the Internet Innovation Alliance.

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2010 in New Zealand.[27] We estimate maximum willingness to pay as price according to the following formula:

$$Maximum\ willingness\ to\ pay = \frac{Revenue}{Number\ of\ subscribers} + \frac{Consumer\ surplus * 2}{Number\ of\ subscribers}$$

71. This approach results in an estimate of maximum willingness to pay of $523.01 per month, more than six times the current retail price. We also consider a sensitivity of $250 per month.

##### 3.1.5.2 *Estimated based on demand elasticity*

72. As sensitivity, we also model a straight-line demand curve. We use our estimate of demand elasticity, as well as our current retail price and current demand to infer a maximum willingness to pay that is consistent with these, assuming straight-line demand and using the following formula:

$$Maximum\ willingness\ to\ pay = -\frac{Current\ price}{Price\ elasticity\ of\ demand} + Current\ price$$

73. The estimate of maximum willingness to pay based on a linear demand curve with elasticity of -0.43 is $282.67 per month. This is approximately three times the current retail price and is lower than the base case maximum willingness to pay.

### 3.1.6 Demand growth

74. The FD model cannot accommodate demand growth assumptions which are higher than the lower bound of the cost of capital. Such assumptions would cause future profitability of the firm to increase faster than the discount rate, and would mean that no investment would be made in anticipation of higher profits in the future.

75. We estimate that growth in fixed broadband connections between 2013 and 2014 was 4.90%. This estimate relies on OECD estimates of New Zealand broadband penetration and Statistics New Zealand estimates of population.[28] The average annual growth projected by Statistics New Zealand for 2014 to 2018 is 1.27%.[29]

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27 Greenstein, S. and R. McDevitt, "Measuring the Broadband Bonus in Thirty OECD Countries", OECD Digital Economy Papers, No. 197, 2012

28 Seehttp://www.oecd.org/sti/broadband/oecdbroadbandportal.htm; http://www.stats.govt.nz/browse_for_stats/population/estimates_and_projections/NationalPopulationEstimates_HOTPAt30Jun14.aspx

29 http://nzdotstat.stats.govt.nz/wbos/Index.aspx?DataSetCode=TABLECODE7514 - a rate for the past year is available in "demand growth" sheet

76. However, population growth and increased demand per capita will be offset by fixed to mobile substitution. We therefore assume demand growth of 0%. This measure of demand growth captures growth in both existing and new services. We perform sensitivities to understand the impact on results of higher growth rates, with the expectation that population growth is likely a lower bound for demand growth, particularly for new services.

### 3.1.7 Cost and depreciation

77. The FD model considers the impact of changes in regulated WACC. It estimates the effect of regulated WACC on the dead weight loss via changes to the regulated price. The relationship between regulated WACC and regulated price is given by the following formula:

$$\begin{aligned} &Regulated\ price \\ &\qquad = variable\ capital\ cost + (annual\ rate\ of\ depreciation \\ &\qquad + regulated\ WACC) * upfront\ capital\ cost \end{aligned}$$

78. The annual rate of depreciation in our model is 3%, based on an assumed average 34-36 year asset life in the TERA model.

79. The value of capital costs are estimated by assuming the proportion of the regulated price that relates to variable capital costs which then implies a value of upfront capital costs based on the current regulated price and the relationship set out in the formula above. Our base case assumption is that the variable cost component is zero which means a variable capital cost of $0 per line per month and an upfront capital cost of $374.90 per line per month. We also consider an alternative scenario that the variable cost is 30% of the input price.

80. The lower the variable capital cost proportion, the higher the value of upfront capital costs. As can be seen in the equation above, the regulated price increases in regulated cost of capital by the value of upfront capital cost. Therefore, the lower the variable capital cost proportion assumed, the larger the increase in price – and therefore the larger the dead weight loss - that results from a given increase in allowed rate of return. In the Frontier-Dobbs model, this higher sensitivity in dead weight loss to increases in the allowed rate of return would lead to a lower optimal cost of capital percentile, *ceteris paribus*.

81. The zero variable cost assumption is reasonable for existing network investment since the quantum of capital costs relating to the maintenance of existing networks does not increase in the number of subscribers. For new investment, we would expect large variable capital costs due to the need to connect customers. We consider zero variable costs to be a conservative assumption which serves as a lower bound.

## 3.2 Modelling results

82. Results of the modelling are shown below in Table 2, which also shows the results of a number of alternative scenarios that were modelled.

## Table 2: Results of Frontier-Dobbs modelling

| Scenario | Elasticity for existing services | Elasticity new services | Demand for new services (% of existing) | Demand function | Maximum price | Percentage of variable cost | Optimal percentile (consumer surplus) | Optimal percentile (total surplus) |
|---|---|---|---|---|---|---|---|---|
| 1 | -0.43 | -1.00 | 75% | Isoelastic | $523.01 | 0% | 88% | 99% |
| 2 | -0.43 | -2.00 | 75% | Isoelastic | $523.01 | 0% | 77% | 97% |
| 3 | -0.43 | -1.00 | 75% | Linear* | | 0% | 1% | 97% |
| 4 | -0.95 | -1.00 | 75% | Linear* | | 0% | 56% | 97% |
| 5 | -0.95 | -1.00 | 75% | Linear* | | 30% | 69% | 97% |
| 6 | -0.43 | -1.00 | 25% | Isoelastic | $523.01 | 0% | 77% | 97% |
| 7 | -0.95 | -1.00 | 25% | Isoelastic | $523.01 | 0% | 78% | 97% |
| 8 | -0.43 | -2.00 | 25% | Isoelastic | $523.01 | 0% | 1% | 97% |
| 9 | -0.95 | -2.00 | 25% | Isoelastic | $523.01 | 0% | 61% | 96% |
| 10 | -0.43 | -1.00 | 10% | Isoelastic | $523.01 | 0% | 61% | 97% |
| 11 | -0.95 | -1.00 | 10% | Isoelastic | $523.01 | 0% | 66% | 96% |
| 12 | -0.95 | -1.00 | 75% | Isoelastic | $523.01 | 0% | 88% | 99% |
| 13 | -0.95 | -2.00 | 75% | Isoelastic | $523.01 | 0% | 77% | 97% |
| 14 | -0.43 | -1.00 | 75% | Isoelastic | $250.00 | 0% | 77% | 97% |
| 15 | -0.43 | -1.00 | 75% | Isoelastic | $523.01 | 30% | 88% | 99% |

** For linear scenarios maximum willingness to pay is calculated based on current price, quantity and elasticity as $282.67 per line per month at elasticity of -0.43, $170 per line per month at elasticity of -1.00 and $127.50 per line per month at elasticity of -2.00. A maximum willingness to pay of $127.5 is likely to be unrealistically low for either new or existing services given current retail prices of $85 per line per month. We include this as a demonstration of the model sensitivity.*

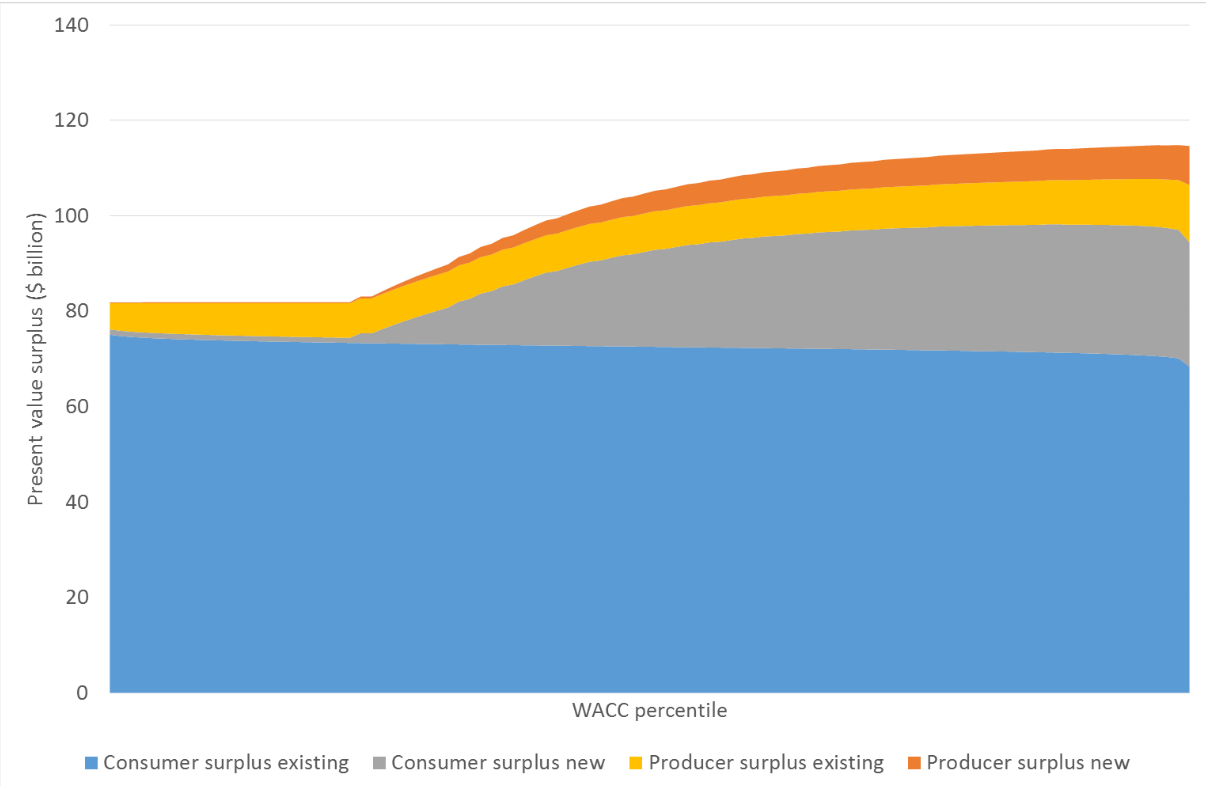
83. In realistic scenarios the modelling results in Table 2 result in optimal cost of capital percentiles in the range of 56%-88% with a median of the scenarios at 77% for the consumer welfare standard. We consider that this supports an optimal cost of capital percentiles of 75% based solely on a consumer welfare standard (which we consider is inadequate). The total welfare results indicate an optimal percentile above 95%.

84. We note that for some scenarios where only consumer surplus is maximised, the optimal cost of capital percentile for existing investment is 1% - that is, the lowest possible cost of capital. This highlights the issues of maximising only consumer surplus. This assumption will tend to result in expropriation of sunk investment and will not give rise to appropriate incentives for innovative new investments. We do not believe that it is appropriate to maximise only consumer surplus when seeking to promote the long term interests of end users.

85. We therefore consider that the 75th percentile is likely to be a lower bound for the appropriate uplift.

86. Figure 2 shows the breakdown between the four components of total surplus in the base case, being present value expected consumer and producer surplus on existing and new services respectively.

**Figure 2: Breakdown of total surplus by WACC percentile, base case**




*Source: CEG analysis*

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# 4 Commission objections to the Dobbs model

87. In its draft cost of capital decision[30] the Commission indicated that it would place little weight on the Dobbs (2011) model as the Commission considered that it was directed to a different question than uncertainty in estimating the WACC. The Commission has also previously objected to the use of the Dobbs (2011) model in the context of the regulation of electricity and gas businesses under the Part 4 regime.[31]

88. We discuss the relevant objections to the use of Dobbs (2011) in the sections below.

## 4.1 Addressing issue of misestimating the WACC and

89. In the draft cost of capital decision, the Commission stated that:[32]

> *... 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).

30 Commerce Commission, *Cost of capital for the UCLL and UBA pricing reviews*, Draft decision, 2 December 2014 (hereafter "Cost of capital draft decision")

31 Commerce Commission, *Amendment to the WACC percentile for price-quality regulation for electricity lines services and gas pipeline services*, Reasons paper, 30 October 2014, in particular Appendix B (hereafter "WACC percentile reasons paper")

32 Cost of capital draft decision, para 226

92. Therefore, far from being a valid reason for not using the approach in Dobbs (2011) to model the effects of misestimating the WACC, the approach identifies an additional risk faced by the service provider if the WACC is used to set price caps for a fixed regulatory period. This means that even if the Commission, incorrectly, had the view that Dobbs (2011) only captured the latter effect, this would still be a material issue warranting consideration of whether an uplift should be applied.

93. We note the Commission has previously stated:[33]

> *Dobbs notes that if the regulator were to index the allowed WACC, the rationale for the WACC uplift would disappear.*

94. However, unlike Part 4 regime where we understand that businesses have the option to seek a customised price path which would trigger the WACC to be reset, the WACC set by the Commission for the UCLL and UBA services will not be revisited during the regulatory period. The WACC will be used to set price caps that will apply for the duration of the regulatory period.

## 4.2 Elasticity of new and existing services

95. We do recognise the FD model assumes zero cross price elasticity between category 1 and 3 services. The Commission noted that this created issues with applicability of the model for reliability investment.[34] A similar, though weaker, criticism may be levelled at an approach that modelled fibre services as new services and copper services as existing services when there are likely to be cross-price elasticities that are not reflected in the model.

96. We have attempted to address the absence of cross-price elasticities between new and existing investment by modelling scenarios with higher own-price elasticities of new investment. 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.

## 4.3 The long-term benefit of end-users

97. In the recent regulatory proceedings for electricity and gas businesses under Part 4, there was much debate regarding the appropriate welfare standard to assess whether an uplift was in the long-term interest of end-users. The Telecommunications Act

33 WACC percentile reasons paper, para B31

34 WACC percentile reasons paper, para B35

directs the Commission to have regard to the long-term benefit of end-users (LTBEU). We do not propose to revisit this debate in great detail.

98. Nevertheless, in our view, the LTBEU would direct an economist to a total welfare standard, not a consumer welfare standard. A static consumer welfare analysis would potentially indicate that prices should be reduced to marginal cost, and the loss to producers of pricing below cost would ignored. However, as the Commission itself recognises this would not be in the LTBEU. This is because any firm that fails to recover its costs of production, including a normal risk-adjusted return on capital, will exit the market over the longer term by redeploying its capital elsewhere.

99. Consistent with the above analysis, when the FD model is adjusted so as to give weight only to consumer surplus the optimal pricing of *existing services* falls to the 1st percentile. That is, the model indicates that consumer surplus would be maximised with a price based on the lowest WACC allowable.[35]

100. We note that the Commission has indicated that producer surplus may be given weight as a proxy for dynamic efficiency considerations:[36]

> *… notwithstanding our in principle view that using the consumer welfare standard is more consistent with an overall objective of the long-term benefit to consumers, it may be appropriate in practice to give some weight to producer surplus. However, this would only be to the extent producer surplus provides an appropriate proxy for some otherwise difficult to quantify (or unquantifiable) longterm (net) benefit to consumers, in particular as an indicator of the margin for error regarding incentives to invest. In the current context, the effect of giving some weight to producer surplus would be a higher WACC percentile than would otherwise be the case.*

101. 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). This is confirmed in our investigation of the FD model that recommends the 1st percentile of the WACC distribution (or the lowest WACC possible) for existing services when a consumer welfare standard is adopted. We consider that giving some weight to producer surplus would be a reasonable, though indirect means to giving weight to investment incentives (i.e., dynamic efficiency) which is in the long-term interests of end-users.

35 Note that we have disaggregated the FD model results into optimal WACC percentile recommendations for existing and new investment. The uniform WACC percentile recommendations in the FD model depend on the weights given to existing and new investment.

36 WACC percentile reasons paper, para 2.37

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102. Nevertheless, in this report we do present results based on both a consumer and total welfare standard.

## 4.4 Risk of over-investment

103. In the Part 4 proceedings, the Commission noted that Dobbs assumes that all new investment is economic. As such, the Commission considered:[37]

> *The Dobbs model does not consider the risk that setting an allowed WACC above the real WACC may incentivise uneconomic investment.*

104. As we have previously indicated, the potential for overinvestment does not appear to be a particularly important concern in relation to the forward-looking costing as the Commission determines the scope of investment by the efficient operator. In this case it has determined that a "rational profit maximising" hypothetically efficient operator would deploy a fibre to the premise network in New Zealand. These modelled prices would therefore anchor investment decisions in these and other services.

## 4.5 Preference for the analytical approach adopted by Oxera

105. In its final decision, the Commission preferred the analytical framework provided by Oxera over the Dobbs (2011) approach as implemented by Frontier. It did so for three reasons:[38]

   a. it focussed on the main reason for applying an uplift – which in that case was to mitigate under-investment in service quality on the network leading to potential outages;

   b. it was based on a consumer welfare standard – however as indicated above the Commission did have regard, to some extent, to producer surplus in determining the appropriate percentile; and

   c. it explicitly recognise the need to apply judgement – in contrast to the Dobbs approach that seeks the optimal percentile.

106. Oxera adopted what it described as a 'probability of loss' analysis, which was essentially a cost benefit framework which compared the cost to consumer welfare of setting a higher WACC and avoiding underinvestment with the consumer welfare

37 WACC percentile reasons paper, para B44

38 WACC percentile reasons paper, para 5.28

impact of underinvestment (which was based on the probability of network outages caused by underinvestment combined with the welfare effects of such events).[39]

107. In its draft determination, the Commission stated that it believed the consumer welfare costs of higher prices would be outweighed, not by the effect of underinvestment on network quality, but by the consumer welfare benefits of accelerated migration to fibre services (in the form of new services and applications that rely on fibre take-up):[40]

> *In particular we noted that underestimating the price would adversely impact on returns to investment in new and innovative services and these costs were likely to be greater than the likely costs of over-estimating the price. We noted:*
>
> > *The Commission considers that accelerated migration implies a* ***welfare cost to end-users because they could have continued to consume the cheaper copper*** *broadband services rather than the more expensive fibre broadband services. However, as discussed above, this cost needs to be weighed against the* ***benefits of accelerated migration in bringing forward services dependant on UFB take-up****. Thus over time we would expect the value of the additional capabilities of fibre to grow and benefits to end-users to accrue, offsetting the welfare costs of accelerated migration. [emphasis added]*

108. It is possible to undertake some analysis that would allow these costs and benefits to be compared. This analysis would begin by calculating the consumer welfare effect of higher prices for existing services (say from choosing a percentile of the WACC above the median). The table below provides the percentile range of the WACC used in the TERA model. We have calculated standard errors using the approach adopted by the Commission, and run the TERA model to determine prices for the UCLL and UBA services.[41] We then calculate the welfare effect of these higher prices. We assume that there would be 100% pass through in network costs to the retail prices, reflecting a very high intensity of competition between retail service providers (RSPs) at the current estimated retail prices of $85 per month. As noted above, a plausible range for the level of pass through would be between 75% and 100%. We note that adopting an assumption of 100% pass through increases the estimate of welfare cost of higher prices as set out in the table below.

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39 Oxera, *Review of the '75th percentile' approach,* Prepared for New Zealand Commerce Commission 23 June 2014, page 5

40 Commerce Commission, Draft pricing review determination for Chorus' unbundled copper local loop service, Under section 47 of the Telecommunications Act 2001, Draft determination, 2 December 2014, para 415

41 An alternative, but equivalent process, would have been to undertake Monte Carlo simulations using the TERA model to reflect uncertainty in the WACC parameters. This approach would have allowed the uncertainty in other parameters to be captured. This would likely have broadened the range in in prices.

109. A number of functional forms are possible for the demand function. We have used a truncated constant elasticity demand function with an elasticity of -0.43 to calculate consumer surplus changes.[42]

**Table 3: Percentile WACC prices and welfare effects**

| | WACC | UCLL | UBA | ΔCS (annual) | ΔCS (NPV) |
|---|---|---|---|---|---|
| 50th percentile | 6.47%[43] | $28.22 | $38.4 | | |
| 75th percentile | 7.22% | $30.72 | $41.22 | $52.4million | $723.9million |
| 90th percentile | 7.89% | $33.06 | $43.85 | $113.4million | $1.56billion |
| 95th percentile | 8.3% | $34.53 | $45.5 | $147.1million | $2.03billion |

*Source: TERA model and CEG analysis*

110. The next step in the analysis is to compare the welfare costs of having a higher WACC or price with what the Commission sees as the potential costs of setting the WACC too low, which is the welfare benefit due to accelerated migration to fibre. We estimate these benefits in section 5. We find that the welfare benefits of accelerated migration (which we model as the avoided cost of slowing migration) are significant.

111. We estimate in section 5 that the effect on consumer welfare of not delaying migration to the fibre service by one and two years to be $757 million and $1.4 billion, respectively (in present value terms). If migration is further delayed by, say, 5 years to $3.3 billion. These estimated benefits are significantly greater than the costs of not having lower prices in the short term.

112. For clarity, we note that this comparison does not include the benefits of incentives for investment in UFB services and other infrastructure capable of delivering new services (which we estimate using the Dobbs model, or the welfare benefits of incentives to maintain quality on the copper network.

42 There is only marginal differences in welfare assessment for changes in price for linear or constant elasticity demand curves with the same elasticity assumption. A higher elasticity, say the 0.95 used by Spark, would not materially affect the results.

43 Note this is a post-tax nominal WACC, whereas given the absence of tax from the Dobbs model we use a vanilla WACC of 7.24%

# 5 Investment in new applications

113. In this section we consider the effect a higher price of the UCLL and UBA services would have on migration to fibre-based services and the welfare gains this may deliver in terms of new applications that rely on the higher quality of service fibre can deliver. Lower prices for UCLL and UBA services will delay migration to fibre services as those services are economic substitutes. The delay in migration to fibre services will delay the development of applications and downstream services that are dependent on uptake in fibre services. We note that this is a separate consideration to the effect of prices for the UCLL and UBA prices on incentives to invest in the fibre infrastructure or infrastructure capable of delivering a similar quality of service.

114. We consider studies that have attempted to quantify the consumer surplus benefits that are derived from existing and future applications of ultra-fast broadband in combination and we estimate the costs of delaying such benefits.

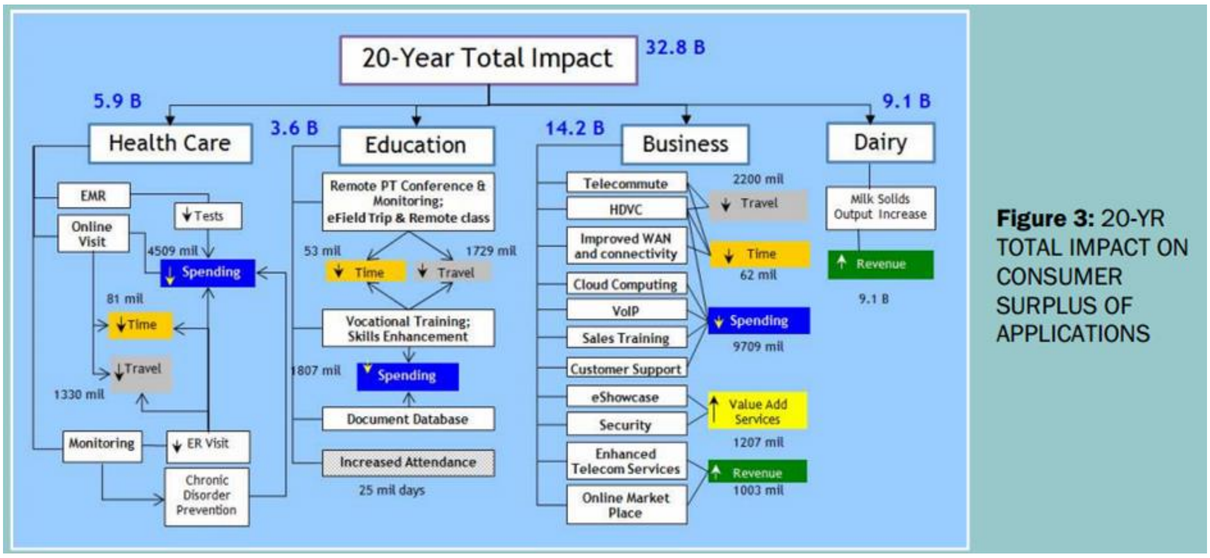
## 5.1 Bell Labs

115. In 2012, Bell Labs analysts estimated the consumer surplus a select number of some high-speed broadband applications which will be enabled by ultra-fast broadband and the Rural Broadband Initiative in New Zealand.[44] It estimated $32.8 billion in likely end-user economic benefits (consumer surplus) over a 20 year period derived from applications in healthcare ($5.9 billion), education ($3.6 billion), business services ($14.2 billion) and dairy ($9.1 billion) sectors.

116. Bell Labs undertook what it describes as a 'grass-roots' approach in which it considered likely applications of high-speed broadband in each sector, as set out in Figure 3. It considered existing technologies which require high-speed broadband as well as some potential new applications which will require a critical mass of ultra-fast broadband subscribers to be introduced to the New Zealand market.

44 Bell Labs (2012) Building the benefits of broadband – How New Zealand can increase the social & economic impacts of high-speed broadband, available online at http://www.tmcnet.com/tmc/whitepapers/documents/whitepapers/2013/6687-building-benefits-broadband-how-new-zealand-increase-social.pdf

### Figure 3 Consumer surplus impact of applications




*Source: Bell Labs (2012)*

117. Bell Labs (2012) also considered the GDP impact from direct and indirect economic activities relating to the investment. The result was 5.5 billion dollars' contribution to GDP over 20 years, with $4.7 billion of that in the first six years.[45] We have not included the contribution to GDP in our quantification of the costs of delayed migration in Section 5.1.1 below.

#### 5.1.1 Quantification of the consumer surplus cost of delayed migration

118. As described by the Commission, if the price of copper services is set too low, migration to ultra-fast broadband would be slowed. To estimate the consumer surplus impact of slower migration, we model the impact of delaying the $32.8 billion benefits estimated by Bell Labs. We assume that $32.8 billion in consumer surplus is a sum of the consumer surplus in each of the 20 years (rather than a net present value.

119. We estimate the present value of the delayed consumer surplus assuming that the surplus is delayed by one, two, three, four and five years.[46] However, since there is uncertainty around when this 20 year benefit period will begin, we model each of these delays beginning next year, and then five and 10 years later (in 6 and 11 years).

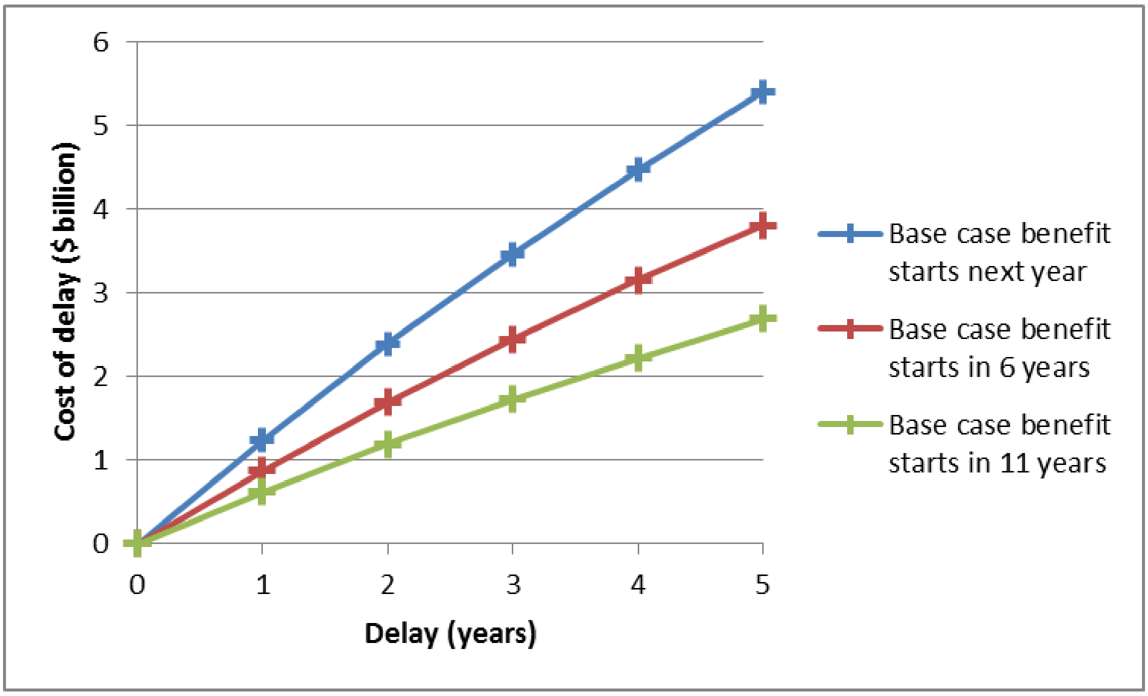
120. In the case where the 20 year period begins next year, the impact on the net present value of consumer surplus of delaying by one and five years is $1.1 billion and $4.7

45 *Bell Labs (2012) p. 4, available online at http://www.tmcnet.com/tmc/whitepapers/documents/whitepapers/2013/6687-building-benefits-broadband-how-new-zealand-increase-social.pdf.*

46 We assume vanilla WACC as the discount rate consistent with the Cost of capital draft decision.

billion, respectively. Figure 4 shows these results (in blue) and demonstrate that even when we assume the 20 year period starts in the future (in 6 and 11 years), we still see large costs associated with delaying the benefits of ultra-fast broadband applications.

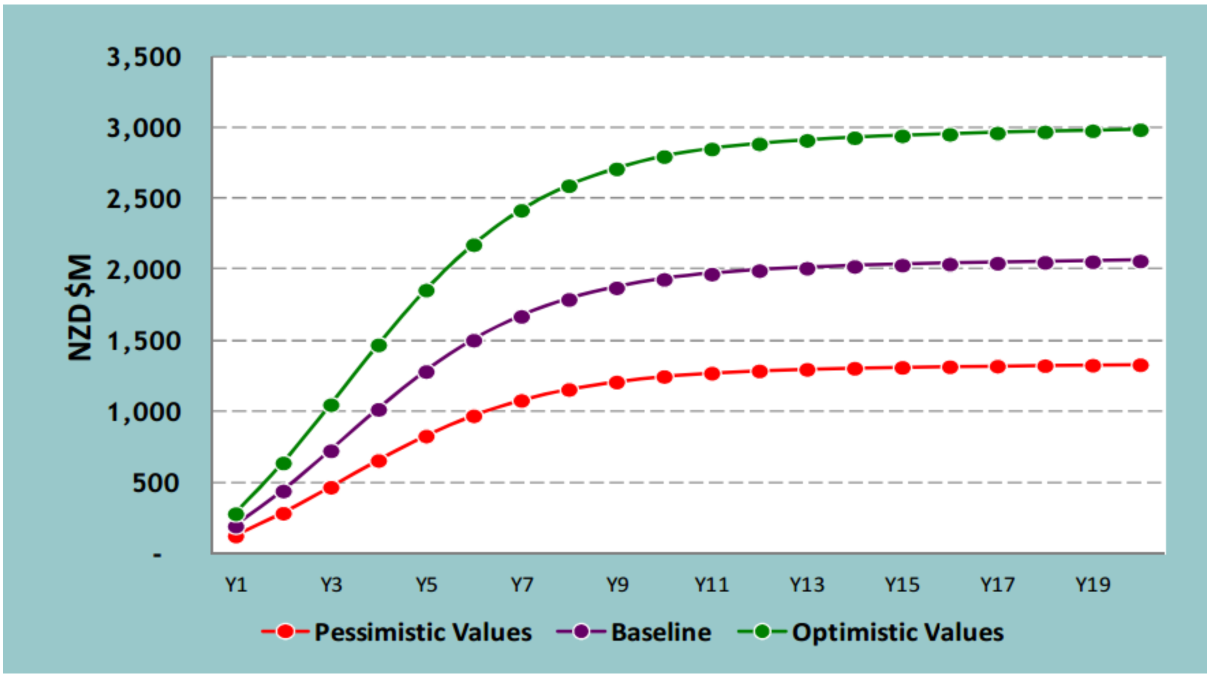
### Figure 4 Costs associated with delayed migration




*Source: CEG analysis of Bell Labs (2012) estimates*

121. Bell Labs found that the availability of relevant applications, speed of application adoption and total level of broadband application were key variables determining the size of the consumer surplus benefits achieved. As its baseline, it assumed an uptake level of 40%, taking 6.4 years to get achieve that rate. If the speed and level of uptake were both increased by 20%, it found a 45% increase in the total consumer surplus benefit achieved to $47.6 billion. Figure 5 shows the timing and levels estimated by Bell Labs in pessimistic (speed and level of uptake reduced by 20%), baseline and optimistic (speed and level of uptake increased by 20%) scenarios.

**Figure 5 Contribution of high-speed broadband applications to consumer surplus - application uptake sensitivities**




*Source: Bell Labs (2012)*

122. This might also be used as an alternative way of modelling the impacts of slowed migration to ultra-fast broadband due to low copper prices. We consider the possibility that slowed migration would affect the speed and *level* of uptake during the 20 year benefit period rather than delaying all the benefits.

123. We estimate the difference in the net present value of consumer surplus benefits over the 20 year period between the baseline scenario and the pessimistic scenario. The result is a reduction in net present value consumer surplus of $5.8 billion, assuming the 20 year period begins next year. The reduction in consumer surplus in the pessimistic scenario relative to the baseline scenario if we assume the 20 year period starts in 5 or 10 years' time is $4.1 billion and $2.9 billion, respectively. These results show that if a low copper price slows the speed and steady state level of high-speed broadband application uptake by 20%, the costs associated with reduction in consumer surplus over Bell Lab's estimated 20 year benefit period is very large – between $2.9 billion and $5.8 billion in net present value terms.

## 5.2 Other studies

124. There have been other studies on the benefits of ultra-fast broadband. Deloitte Access Economics (2013) and Sapere (2014) attempted to quantify the benefits in New Zealand and Australia and have estimated large-scale benefits associated with its applications which are broadly consistent with the Bell Labs' result we have relied on.

125. Deloitte Access Economics (2013) considered 10 different 'typical' households in Australia (such as older single, young couple, single parent family etc.) and estimated potential benefits of high-speed broadband to them.[47] It estimated average annual benefits per household at $3800 (in AU 2013 dollars), made up of $2400 in financial benefits and $1400 in consumer benefits such as travel time savings and e-commerce convenience. It considered many applications specific to different households such as a falls monitoring system for elderly people, video contact with nurse, teleconferencing, secure cloud storage, virtual classrooms and sensor network for garden to increase yield. This estimate of $1400 per household per annum in consumer benefits is broadly consistent with the Bell Labs' estimate we relied upon which comes to an average annual consumer surplus of $1312 (in NZ 2015 dollars) or $1262 (in Au 2015 dollars) per household.

126. Sapere (2014) looks at the value of the internet to *businesses* in various sectors in New Zealand and gives an indicative estimate of $6 billion dollars as the value added by connectivity to fibre for those not presently connected to fibre.[48] This estimate excludes benefits to households so underestimates the total consumer benefits.

127. In 2014, the Australian Department of Communications considered applications of ultra-fast broadband in its cost benefit analysis for ultra-fast broadband rollout. It considered diverse applications including SmartAgriFood (an EU initiative to increase efficiency for farming), 1080p telepresence technology, the SIMPill (a device on medication packets that reports when medications are not taken), smart grids/intelligent buildings and tele-rehabilitation.[49]

128. PricewaterhouseCoopers (2004) estimated net benefits of increased connectivity (whatever technology would likely be supplied by suppliers) of 141 Euros per subscriber in 2013. This includes direct benefits based on price paid (which underestimates the total benefit), benefits to suppliers of public services (e.g. health

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47 Deloitte Access Economics (2013) *Benefits of high-speed broadband for Australian households,* http://www2.deloitte.com/au/en/pages/economics/articles/benefits-high-speed-broadband-australian-households.html.

48 Sapere (2014), *The value of internet services to New Zealand businesses,* p. 47, available online at http://www.innovationpartnership.co.nz/wp-content/uploads/2014/03/Sapere-Google-INZ-The-value-of-internet-services-to-New-Zealand-Businesses_-_Report-31-March-2014.pdf.

49 Department of Communications (2014) *Independent cost benefit analysis of broadband and review of regulation – volume II – The costs and benefits of high-speed broadband,* pp. 123 – 136, available online at http://www.communications.gov.au/__data/assets/pdf_file/0003/243039/Cost-Benefit_Analysis_-_FINAL_-_For_Publication.pdf.

and education) based on case studies and external effects such as the reduction in external costs associated with transport, based on case studies.[50]

[50] PricewaterhouseCoopers (2004) Technical assistance in bridging the "digital divide": A cost-benefit analysis forbroadband connectivity in Europe, report for the European Space Agency, http://telecom.esa.int/telecom/www/object/index.cfm?fobjectid=14864.

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# Appendix A Consumer surplus

## A.1 Constant elasticity demand curve

129. The constant elasticity demand curve is expressed (as in Dobbs equation 1) as:

$$q_t = Be^{\alpha t}{p_t}^{\varepsilon}$$

130. Under this framework, consumer surplus is:

$$CS_t = \int_{\hat{p}}^{\infty} q_t dp_t = \int_{\hat{p}}^{\infty} Be^{\alpha t}{p_t}^{\varepsilon} dp_t = -\frac{1}{\varepsilon + 1} Be^{\alpha t}\hat{p}^{\varepsilon+1}$$

where $\varepsilon < -1$, otherwise $CS_t$ is unbounded (consistent with Dobbs equation 20).

## A.2 Truncated constant elasticity demand curve

131. This alternative demand curve is constant elasticity but caps willingness to pay at $p_{max}$:

$$q_t = \begin{cases} Be^{\alpha t}{p_t}^{\varepsilon} & p_t < p_{max} \\ 0 & p_t \geq p_{max} \end{cases}$$

132. Then, consumer surplus is:

$$CS_t = \int_{\hat{p}}^{\infty} q_t dp_t = \int_{\hat{p}}^{p_{max}} Be^{\alpha t}{p_t}^{\varepsilon} dp_t = -\frac{1}{\varepsilon + 1} Be^{\alpha t}(\hat{p}^{\varepsilon+1} - {p_{max}}^{\varepsilon+1})$$

133. Unlike consumer surplus under constant elasticity, consumer surplus is bounded where $p_{max}$ is finite.

## A.3 Linear demand curve

134. Suppose that we have a linear demand curve, with demand growing at $\alpha$ per year:

$$q_t = \begin{cases} e^{\alpha t}(a + bp_t) & p_t < p_{max} \\ 0 & p_t \geq p_{max} \end{cases}$$

135. In this framework, $p_{max}$ serves the function of defining the price at which quantity demanded is equal to zero. This is different to its use in defining the truncated constant elasticity demand curve above.

136. Then consumer surplus is:

$$CS_t = \int_{\hat{p}}^{p_{max}} e^{\alpha t}(a + bp_t)dp_t = ae^{\alpha t}(p_{max} - \hat{p})(a + b\hat{p})$$

137. To calculate consumer surplus we need to estimate the components of the linear demand function, $a$ and $b$.

138. Elasticity of demand, $\varepsilon$, is equal to

$$\frac{p_t}{q_t}\frac{dq_t}{dp_t}$$

139. That is, on a straight line demand curve where slope is the same at all points, elasticity varies along the demand curve being highest where price is high and quantity low, and lowest where price is low and quantity high.

$$\varepsilon = \frac{p_t}{q_t}\frac{dq_t}{dp_t} = \frac{p}{q}e^{\alpha t}b$$

140. That is, given an initial point on the demand curve, the slope of the demand curve can be solved as:

$$b = \varepsilon\frac{q}{p}e^{-\alpha t}$$

141. Further, the intercept, $a$, can be solved as:

$$q = e^{\alpha t}(a + bp) = e^{\alpha t}\left(a + \varepsilon\frac{q}{p}e^{-\alpha t}p\right) = ae^{\alpha t} + \varepsilon q$$

$$a = e^{-\alpha t}q(1 - \varepsilon)$$