Pricing under the new regulatory framework provided by Part 6 of the Telecommunications Act

Ingo Vogelsang and Martin Cave

May 16, 2019

Executive Summary

Legal background for pricing issues

1. For this report the Commission asked us to inquire into Chorus' pricing, in particular, to consider that Chorus will be under a revenue cap, that there is a great array of layer 2 products with different demand elasticities affecting allocative efficiency, and that prices may influence competition. We were also asked for international experience on harms arising from pricing under a revenue cap.
2. We have at this stage decided not to treat information disclosure regulation and have very limited international experience to report about. This report therefore concentrates on insights derived from the economics literature and from our experience in telecommunications and electricity regulation.

3. The pricing issues raised by the new regulatory framework for Chorus are guided by the purpose statements in the Act, by the Commission's economic principles and by legal price constraints and the revenue cap imposed on Chorus.

The normative guidance provided by the purpose statements s162 and s166(2)(b) and by the three economic principles

4. s162 concerns "fibre fixed line access services", for which prices shall "promote the long-term benefit of end-users" by "promoting outcomes that are consistent with outcomes produced in workably competitive markets". While s162 contains a multi-purpose statement, it appears to be quite compatible with an efficiency objective with some emphasis of dynamic efficiency over static efficiency.

5. s166(2)(b) adds that the Commission or Minister must make a recommendation or determination "to the extent that the Commission or Minister considers it relevant, to the promotion of workable competition in telecommunications markets for the long-term benefit of end-users of telecommunications services". The relevance of s166(2)(b) for the current report therefore concerns whether and in what way pricing rules are likely to affect actual competition.

6. The three economic principles established by the Commission concern real financial capital maintenance (RFCM), risk-sharing and asymmetric benefits. If the revenue constraint is binding Chorus will earn its building block costs. Thus, the RFCM will be fulfilled.

The pricing rules legally imposed on Chorus

7. Total revenue cap with wash-ups: According to s195 the Commission must for the price-quality paths for each three year period that starts before the reset date specify the maximum revenues to be recovered by a regulated fibre service provider but must not specify the maximum price or prices. s196 calls for wash-ups to ex post adjust over- or under-recoveries relative to the revenue cap.

8. Price capped anchor services: According to s198 anchor services shall be provided everywhere in a regulated fibre service provider's network at or below a regulated maximum price.

9. Price caps for Direct Fibre Access Services (DFAS): s199 establishes a similar price cap for DFAS.

10. Geographically consistent pricing: This can be interpreted as requiring geographically uniform pricing.

11. Non-discrimination and equivalence of inputs for Layer 1 services: s200 allows for a price cap for unbundled (Layer 1) services. Non-discrimination and Equivalence of Inputs (EoI) are prescribed in the "Chorus Limited Deed of Open Access Undertakings for Fibre Services" (Chorus Fibre Deed), Clauses 5 and 6.

What do we know about a firm's performance under total revenue caps?

12. Total revenue caps have mostly been used for the regulation of electricity distribution companies, the objective being to induce electricity companies to make consumers conserve electricity. In contrast, total revenues caps for telecommunications regulation appear to be unusual, because here the objective is to supply telecommunications services at low prices and to increase their use. Thus, total revenue caps may lead to unintended consequences when applied to the telecommunications sector.

13. Two theoretical results in the economics literature about total revenues caps for a profit-maximizing firm stick out. The first is the so-called Crew-Kleindorfer effect (Crew & Kleindorfer, 1996), which says that a profit-maximizing single-product firm under a binding total revenue cap will charge a price that exceeds the unconstrained monopoly price. The reason is that the revenue cap will typically cut the revenue curve of a monopolist at two points, one representing low output/high price and one representing high output/low price. Because the low output is cheaper, yet yields the same revenue, the firm chooses this one. As an immediate consequence of this cost-minimizing tendency Chorus would have less incentives to invest in high-cost areas than in low-cost areas. It also means that the firm is incentivized to minimize its cost for any given output.

14. The second theoretical result we derive is that in a multi-product setting the revenue constraint reduces the inverse elasticity effect of Ramsey pricing but does not go counter to it. If the constraint is barely binding we get an approximate inverse elasticity rule, while at a strongly binding constraint proportional markups would prevail. Interestingly under the dampened inverse elasticity rule

services with inelastic demands are less exploited by monopoly power than services with elastic demands.

15. The main reasons for the choice of revenue caps in the new NZ legislation seem to be (a) the pricing flexibility it provides for Chorus, (b) the shielding of revenue risks and (c) the compatibility with the building block approach to regulation.

16. Among the common pricing approaches, such as price caps, average revenue caps, or FDC pricing, total revenue caps certainly provide the most price flexibility. In particular, the total revenue cap generates no maximum constraint on any prices.

17. Total revenue caps along with the pricing flexibility they provide also shield the regulated firm from revenue fluctuations, which translates into a shield against profit fluctuations, given the short to medium term cost stability. The potential effect of the resulting profit stabilization on the cost of capital may have to play a role in assessing the relevant WACC percentile.

18. Last, the total revenue caps will be based on the firm's costs under the building block approach, again shielding the firm against profit fluctuations, as long as the total revenue constraint is binding. Adjustments to building block costs occur with a lag. Depending on the length of the lag the effects of the revenue cap on pricing and costing discussed above will likely be reduced.

19. Since revenue-cap regulation in practice has been largely restricted to electricity networks, the economic research on revenue caps concentrates on monopoly regulation. A very simple analysis suggests that under (pure) Cournot competition the Crew-Kleindorfer effect persists, because the firm under revenue caps will always choose the low output on the residual demand curve. Under (pure) Bertrand competition the usual competitive outcome is maintained, but the regulated firm's market share in equilibrium tends to be lower than without revenue constraint. Thus, Chorus under pure revenue caps will be a soft competitor. Since under deregulation Chorus would no longer be subject to revenue caps for the deregulated services, Chorus' pre-deregulation behavior may not be a good predictor for Chorus' post-deregulation behavior. Effective competition without deregulation would leave the cap in place. Since deregulation requires an affirmative act, this case can realistically happen.

20. To the extent that Chorus' network costs (except in the very long run) hardly depend on output one can argue that the Crew-Kleindorfer effect is unlikely to hold, because Chorus may feel safer against competitive threats with a low price/high output than with a high price/low output.

21. Revenue caps depend on total costs under regulation using the building-blocks approach. Since for a given network build-out Chorus' overall costs do not significantly depend on output the revenue caps can lead to large price increases if demand declines (stranding).

22. To the extent that the revenue cap for Chorus may not be binding one would expect Chorus to be an aggressive competitor charging the monopoly price structure.

The interaction of total revenue caps with the other pricing rules imposed on Chorus

Basic characteristics of the other pricing rules

23. In the absence of data on the results of the building block approach to Chorus' network cost it is hard to predict if any price shocks can be expected and if Chorus could and has an incentive to game the wash-up rule by purposefully over- or under-shooting revenues.

24. Regulated prices for anchor services should fulfil two functions. The first is to provide for acceptable prices in their own right. Anchor services should therefore be a reasonable substitute for many other services and carry enough volume.

25. Spark (Submission, p.7) and Vodafone (Cross-submission, p. 7, Table 1) note that s166(2)(b) may require the Commission to pay closer attention to price relativities, which would require cost allocation rules at the service level. In contrast, Chorus (Submission, p.42, para 191) notes that cost allocations can only go so far and that efficiency requires consideration of the characteristics of demand.

26. Both anchor pricing and DFAS pricing will affect infrastructure competition (5G, FWA) but possibly in different ways. Anchor pricing will make Chorus' regular fibre services stronger competitors to new infrastructure competition, while DFAS will both be substitutes and inputs to these new infrastructures. It is therefore important that both anchor pricing and DFAS pricing maintain technological neutrality.

27. Geographically uniform pricing by Chorus will have differentiated effects on the fierceness of its competitive approach. Chorus is likely to be a less aggressive competitor in low-cost areas than without the uniform pricing constraint and therefore will have a lower market share and will invite entry by others. Potential entrants in low-cost areas can interpret Chorus' uniform pricing constraint as a commitment by Chorus not to reduce prices significantly upon entry. In contrast, in high-cost areas the comparatively low average price by Chorus will keep competitors out.

28. If geographically uniform pricing softens competition *in* the market it will increase competition *for* the market and that can have beneficial effects on the market structure and could make deregulation in low-cost areas more feasible (except for keeping the uniform pricing constraint). From a pricing perspective such deregulation could also be feasible in high-cost areas

29. Because the profit contribution of sales in low-cost areas will be high, uniform pricing may, compared to efficient outcomes, lead to over-investment/excessive quality in low-cost areas. In contrast, the low or negative profit contributions of sales in the high-cost areas could lead to under-investment/insufficient quality there.

30. The submissions and cross-submissions in this proceeding put a large emphasis on the relative pricing of Layer 1 and Layer 2 services, although Layer 1 services do not yet have to be offered and regulated prices for these services, if any, are still years away. We therefore interpret this early

discussion as a way to influence potential pricing decisions by the Minister or Commission via the input methodology, for example, in order to disclose Layer 1 and Layer 2 costs in different geographic regions from 2022 onward and through guidance on EoI compliance under the Deeds from 2020 onward.

31. Most regulators world-wide formulate a non-foreclosure requirement based on the forward-looking costs for the downstream service of an efficient entrant rather than on the forward-looking costs saved by the incumbent by not selling the downstream service. Basing the price difference between Layer 1 and Layer 2 services on the forward-looking costs of an efficient entrant means that the policy maker wants to provide entry help.

The interaction between the other legal pricing requirements and the total revenue cap: Pairwise interactions

32. The price caps for anchor services and for DFAS will constrain Chorus' pricing freedom for substitute services. Our calculations indicate that anchor services and DFAS price regulation will be effective in holding Chorus' pricing in check, but the overall effect will be less than without a binding revenue cap.

33. To the extent that a binding revenue cap will make Chorus a less aggressive competitor there may also be less incentives for Chorus to use a price squeeze to exclude unbundlers as downstream competitors.

34. To the extent that the revenue cap is binding the combination with the uniform pricing constraint will likely make Chorus an even less aggressive competitor than with only one of these constraints. Thus, the combination will have a price-increasing effect.

Concluding evaluation of the currently envisaged price regulations imposed on Chorus

35. It is impossible for us to fully evaluate all the interactions playing out between the various pricing rules that Chorus is subject to. However, it appears quite clear that the other pricing rules besides the total revenue caps have largely beneficial effects by reducing the potentially bad effects of total revenue caps. Table 1 summarizes these findings for the three areas (a) monopoly exploitation, (b) allocative and dynamic efficiency, and (c) infrastructure and service competition.

    a) Monopoly exploitation: A pure revenue cap will lead to very high prices, particularly for services with more elastic demands. Overall, the additional pricing rules will, from the consumer perspective, largely eliminate these potentially bad effects of the revenue cap.

    b) Efficiency effects: A pure revenue cap will create a large dead weight loss (DWL) and induce the regulated firm to keep costs, output and investment low. Overall, compared to pure revenue caps the additional pricing rules will reduce DWL, will somewhat lower cost efficiency and lead to some increase in investment.

c) Competitive effects: A pure revenue cap will make Chorus a soft competitor in the area of infrastructure competition and will lead to less service competition because of high input prices. Overall, the geographic price averaging is likely to be decisive in keeping Chorus a fairly soft infrastructure competitor, while the other pricing rules will help service competition by holding input prices low.

Table 1: The effects of pure revenue caps and the other rules on Chorus pricing performance

	Effect on monopoly exploitation	Effect on efficiency - Allocative (a) - Dynamic (d)	Effect on competition - Infrastructure (i) - Service (s)
Pure revenue cap	High prices (-)	(a)Large DWL (-), cost minimized (+) (d) Withholding investment (-)	(i) Soft competitor (+) (s) High input prices (-)
Building block regulation	Keeps prices on average closer to cost (+)	(a) reduces DWL (+) and cost-minimizing incentives (-) (d) No particular investment incentives (0)	(i) More aggressive competitor (0/-) (s) Lower input prices (+)
Anchor price regulation	Holds prices of anchor services low (+) Reduces prices of substitutes (+)	(a) Lessens DWL (+) (d) Increases investment (+)	(i) More aggressive competitor (0/-) (s) Lower input prices (+)
Geographically uniform pricing	Low prices in high-cost areas (+) High prices in low-cost areas (-)	(a) Large DWL in both areas (-) (d) (+) in low-cost areas, (-) in high-cost areas	(i) Softer competitor on low-cost areas (+) (s) Lower input prices in high-cost areas (+), higher input prices in low-cost areas (-)
Level 1 unbundling at avoided cost	Probably little effect, because it kills Level 1 unbundling	Probably little effect, because it kills Level 1 unbundling	Increases Level 2 competition (+), reduces Level 1 competition (-)
Level 1 unbundling at efficient competitor cost	End-users will probably have to pay more (0/-)	Probably more product differentiation (+)	Reduces Level 2 competition (-), increases Level 1 competition (+)
Overall effect of the other pricing rules on pure revenue cap outcomes	Substantial reduction in monopoly exploitation except for services that are no close substitutes of anchor services or of DFAS services.	Substantial reduction in DWL, some increase in investment	On balance Chorus a fairly soft infrastructure competitor. Service competition increased

36. There are two competing views on how Chorus will fare in light of future infrastructure-based competition and future demand uncertainty. One is that Chorus will be able to use its market power and will be constrained by the revenue cap. In this case the revenue cap will likely be inefficient, but the other pricing rules and building block regulation with a lag will largely compensate this. The other view is that Chorus (or the other fibre providers) will lose revenue to competitors or to low prices necessitated by competition so that the revenue cap will not be binding (Northpower Fibre Limited, Submission, p.3). In this case the revenue cap is likely to cause no major harm. Since those uncertainties will be at least partially revealed by then our main recommendation from this analysis is therefore to wait and see before reconsidering revenue caps for the next regulatory period.

37. Our further recommendations are (a) to set a regulatory lag for building block regulation that balances the cost efficiency effects with the price reducing effects, (b) to define anchor services in such a way that they have substantial price-reducing effects on Chorus' other prices, and (c) to lay the basis for a potential later pricing principle for Layer 1 unbundled services.

Is there room and the necessity for any pricing principles beyond the requirements already in place that were discussed in Sections 2-4?

Principles promoting competition

38. Applied to pricing such principles could include

    - A general no-foreclosure requirement. It is questionable if such a requirement beyond that required for Layer 1 unbundling is necessary at this time, since Chorus currently does not offer other downstream services.

    - A requirement against predatory pricing. Predatory pricing is generally viewed as being rare in practice and unlikely to occur in view of Chorus' various pricing requirements.

    - Pricing between incremental and stand-alone costs. Monitoring such a rule would require detailed cost information at the service level.

Principles for efficient pricing, such as Ramsey pricing or the like

39. Chorus (cross-submission, p.5 and pp.16/17) alerts to the fact that it is already subject to non-cost-based pricing rules that might contradict and interfere with any attempt to impose additional price efficiency rules. To the extent that this argument is valid it may mean that any additional rules would have to go along with the elimination of some of the existing rules, such as the revenue caps.

Conclusion

40. At this stage there does not appear to be a strong case for a specific pricing principle beyond the rules already imposed on Chorus.

Overall Conclusions

41. The price regulations imposed on Chorus along with the total revenue constraint lead to multiple interactions and constraints that prevent clear conclusions and policy recommendations. While revenue constraints are usually imposed as a regulatory tool to reduce the regulated firm's outputs, the legal pricing constraints and the building block approach used for determining the revenue cap will likely counteract the potentially undesirable effects of revenue caps. We have added recommendations on the building block approach to regulation, on the scope of anchor services and on laying the basis for Layer 1 unbundling.

42. We do not currently recommend any new pricing principles beyond those already established.

1. Legal background for pricing issues

1. For this report we were asked to inquire into pricing:

   a) In addition to any risk of harm arising from regulated fibre providers using price to deter/lessen competition, do you see any remaining risk of harm in relation to pricing?

   b) In particular, considering that:

      i) Chorus will be under a revenue cap

      ii) There is a greater array of FFLAS products (eg layer 2 products ranging from speeds of 30/10 Mbps to many Gig ones) and likely difference in price elasticities between them. This means that price structures and levels can have a greater impact on end-user welfare (ie allocative efficiency)

      iii) What international experience can we draw on as relevant precedent/case studies, particularly as they relate to harms arising from pricing under a revenue cap

2. We have at this stage decided not to treat information disclosure regulation and have very limited international experience to report about. This report therefore concentrates on insights derived from the economics literature and from our experience in telecommunications and electricity regulation.

3. The pricing issues raised by the new regulatory framework for Chorus are guided by the purpose statements in the Act, by the Commission's economic principles and by legal price constraints and the revenue cap imposed on Chorus.

1.1. The normative guidance provided by the purpose statements s162 and s166(2)(b) and by the three economic principles

4. s162 concerns "fibre fixed line access services", for which prices shall "promote the long-term benefit of end-users" by "promoting outcomes that are consistent with outcomes produced in workably competitive markets". In particular, they should give "regulated fibre service providers" (a) incentives to innovate and invest, (b) incentives to improve efficiency and supply "fixed line access services of a quality that reflects end-user demands", (c) allow end-users to share the benefits of efficiency gains, including through lower prices, and (d) are limited in their ability to extract excessive profits. While this is a multi-purpose statement, it appears to be quite compatible with an efficiency objective with some emphasis of dynamic efficiency over static efficiency.

5. s166(2)(b) adds that the Commission or Minister must make a recommendation or determination "to the extent that the Commission or Minister considers it relevant, to the promotion of workable competition in telecommunications markets for the long-term benefit of end-users of telecommunications services". This section is broader than s162 in that it concerns all telecommunications markets, not just "fibre fixed line access services". Furthermore, it addresses

actual competition, not just mimicking the outcome of competition. While s162 seems to be more concerned with monopoly regulation, s166(2)(b) adds a workable competition objective to s162. This objective appears to be restricted to certain situations to be determined by the Commission or Minister. Spark (Submission, p.7) notes that the legislator must have introduced this section out of fear that Chorus might distort competition in other markets through price or non-price terms. The relevance of s166(2)(b) for the current report therefore concerns whether and in what way pricing rules are likely to affect actual competition.

6. The three economic principles established by the Commission concern real financial capital maintenance (RFCM), risk-sharing and asymmetric benefits. The first and last of these will be covered in a potential WACC uplift and in depreciation rules, while the second is addressed in the application of the building block model of regulation. The RFCM principle predominantly only concerns the pricing issues discussed here to the extent that the revenue cap is not a binding constraint on Chorus' pricing. If the revenue constraint is binding Chorus will earn its building block costs. Thus, the RFCM will be fulfilled.

1.2. The pricing rules legally imposed on Chorus

7. Total revenue cap with wash-ups: According to s195 the Commission must for the price-quality paths for each three year period that starts before the reset date specify the maximum revenues to be recovered by a regulated fibre service provider but must not specify the maximum price or prices. This holds for the initial price-quality paths and may be changed at a later date. s196 calls for a wash-up mechanism to ex post adjust over- or under-recoveries relative to the revenue cap.

8. No price shocks when starting new regime: s197 calls for a smoothing of revenues over two or more regulatory periods in order to avoid price shocks to end-users or financial hardships for a regulated fibre service provider.

9. Price capped anchor services: According to s198 anchor services shall be provided everywhere in a regulated fibre service provider's network at or below a regulated maximum price.

10. Price caps for Direct Fibre Access Services (DFAS): s199 establishes a similar price cap for DFAS.

11. Geographically consistent pricing: s201 calls for geographically consistent pricing, meaning that the provider must "regardless of the geographic location of the access seeker or end-user, charge the same price for providing fibre fixed line access services that are, in all material respects, the same". This can be interpreted as requiring geographically uniform pricing.

12. Non-discrimination and equivalence of inputs for Layer 1 services: s200 allows for a price cap for unbundled (Layer 1) services. Non-discrimination and Equivalence of Inputs (EoI) are prescribed in

the "Chorus Limited Deed of Open Access Undertakings for Fibre Services" (Chorus Fibre Deed), Clauses 5 and 6.[1]

2. What do we know about a firm's performance under total revenue caps?

13. Total revenue caps have mostly been used for the regulation of electricity distribution companies, for example in many US states. The objective here has been to encourage electricity saving and induce electricity companies to make consumers conserve electricity. Brennan (2010) discusses total revenue caps as one of several methods for "decoupling" electricity distribution revenues from the amount of electricity delivered. He states that the method runs against the dominant findings in regulatory economics in the last 20 years, although decoupling may in the case of energy serve its purpose by actually reducing energy consumption. Empirical evidence from Jamaica (Campbell, 2018), shows welfare-reducing effects of revenue cap regulation of electricity networks. Littlechild (2003) notes that total revenue caps brought profit stability for electricity transmission companies in the UK but led to fluctuating user prices. In contrast to electricity, total revenues caps for telecommunications regulation appear to be unusual, because here the objective is to supply telecommunications services at low prices and to increase their use. Thus, total revenue caps may lead to unintended consequences when applied to the telecommunications sector.

14. Two theoretical results in the economics literature about total revenues caps for a profit-maximizing firm stick out. The first is the so-called Crew-Kleindorfer effect (Crew & Kleindorfer, 1996), which says that a profit-maximizing single-product firm under a binding total revenue cap will charge a price that exceeds the unconstrained monopoly price.[2] In a simple model of monopoly profit maximization with a revenue cap constraint Stoft (1995, p. 4-23) finds the following expression for the Lerner index for a service i with the Crew-Kleindorfer effect:

$$L_i = \frac{p_i - \frac{\partial C}{\partial Q_i}}{p_i} = \frac{1-\lambda}{\varepsilon_i} + \lambda \quad (1)$$

Here $0 \leq \lambda \leq 1$ is the Lagrange multiplier for the total revenue constraint. Under a non-binding constraint λ vanishes and we get the usual monopoly markup. If the constraint is tightened more and more the Lerner index approaches $L_i = 1$, which is the maximum it can theoretically reach.

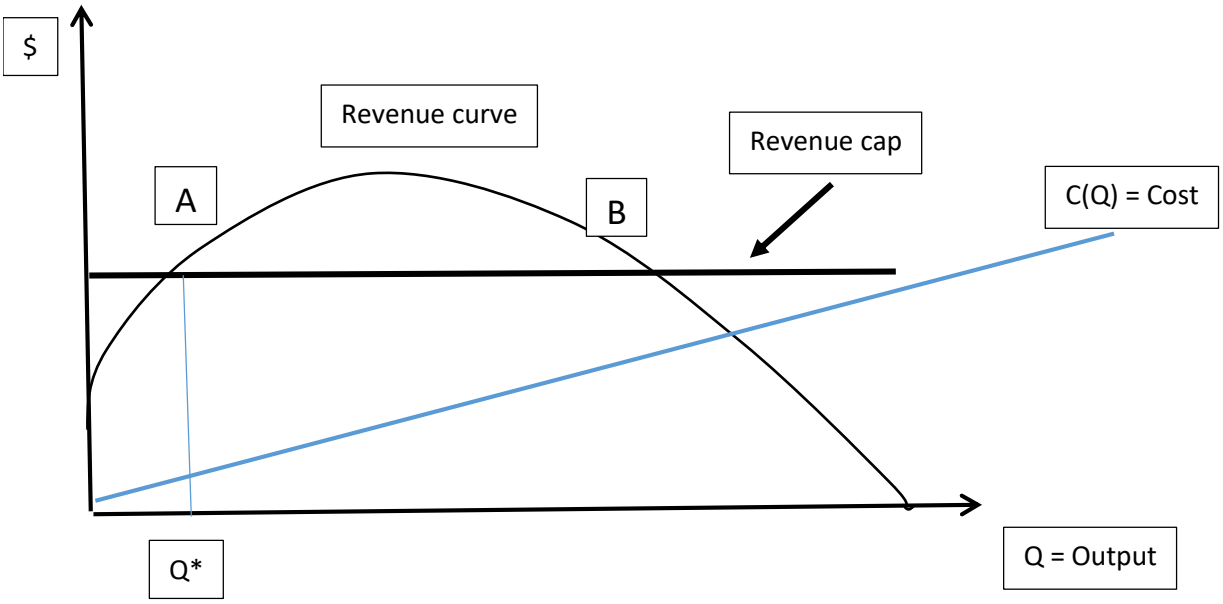
15. The intuition for this result is easily gathered from Figure 1, where the inverted U-shaped curve represents the unconstrained total revenues achievable by a monopoly firm as a function of output, and the horizontal line represents the total revenue constraint. The upward-sloping curve C(Q) represents the firm's total cost. Now, there are two points, A and B, at which the total revenue constraint cuts the achievable revenues. Because costs are upward sloping, the firm will have higher profit by choosing point A corresponding to the lower output Q* compatible with the constraint. If

[1] The deeds for the other local fibre companies, Enable, Ultrafast Fibre and Northpower Fibre, also include clauses for non-discrimination and equivalence of inputs. See https://comcom.govt.nz/regulated-industries/telecommunications/industry-levy-and-service-obligations/telecommunication-deeds.

[2] Lantz (2005) extends this result to two-part tariffs.

the constraint is binding this will result in a price above the monopoly price. Another intuition for this result is that under a binding total revenue cap the firm will minimize its costs on the revenue cap, and this at the same time means minimizing its output on the revenue cap. As an immediate consequence of this cost-minimizing tendency Chorus would have less incentives to invest in high-cost areas than in low-cost areas. It also means that the firm is incentivized to minimize its cost for any given output, because it receives all the benefits from any cost reduction.

Figure 1: Monopolistic output choice Q* under a total revenue cap



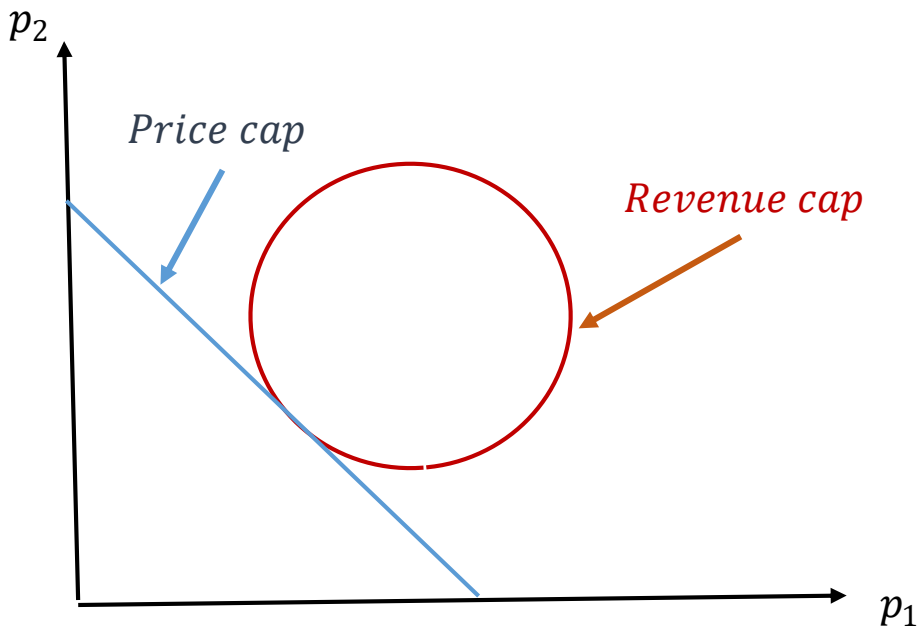
16. The second theoretical result from the literature has been that profit-maximizing prices for a multi-product firm will deviate from the Ramsey price structure so that the firm will charge perverse (counter Ramsey) relative prices (Stoft, 1996). Such distortions not only would hurt allocative efficiency but also would affect the regulated firm's competitive responses. This result, however, appears not to hold and appears to be based on Stoft's statement that the Lagrange multiplier in Equation (1) above is $\lambda > 1$. However, $0 \leq \lambda \leq 1$ has to hold because of the interpretation of the size of λ as the value of relieving the constraint by one unit. In case of a non-binding constraint this value is zero, while it can never be larger than one, because the increase in revenue by one unit can never lead to a profit increase of more than one unit. Now, if $0 \leq \lambda \leq 1$ holds the ratio between the Lerner indices of every two outputs will be

$$\frac{L_i}{L_j} = \frac{\frac{1-\lambda}{\varepsilon_i}+\lambda}{\frac{1-\lambda}{\varepsilon_j}+\lambda} \quad (2)$$

17. If the constraint is not binding ($\lambda = 0$) this gives the inverse elasticity rule $L_i/L_j = \varepsilon_j/\varepsilon_i$.[3] In contrast, if the constraint is very binding ($\lambda = 1$) one gets equal markups. Thus, the revenue constraint reduces the inverse elasticity effect but does not go counter to it. If the constraint is barely binding we get an approximate inverse elasticity rule, while at a strongly binding constraint proportional markups would prevail.[4] An interesting feature of the dampened inverse elasticity rule is that services with inelastic demands are less exploited by monopoly power than services with elastic demands.

18. The main reasons for the choice of revenue caps in the new NZ legislation seem to be (a) the pricing flexibility it provides for Chorus, (b) the shielding of revenue risks and (c) the compatibility with the building block approach to regulation.

Figure 2: Pricing freedom under price cap versus revenue cap



19. Chorus (Submission p. 43, para 194) notes that a revenue cap implies pricing freedom to achieve the MAR (Maximum achievable revenue) within a regulatory period. Among the common pricing approaches, such as price caps, average revenue caps, or FDC pricing, total revenue caps certainly

[3] Note that for simplicity we have here assumed that the demands of the two services are independent of each other. With interdependent demands one can expect to get a similar result in super-elasticities.

[4] A more difficult interaction between Chorus' different services could arise between Chorus fibre and copper networks that are under different regulatory regimes. If one takes into consideration Chorus' tendency under revenue caps to withhold output Vocus (Submission, para 66(ii)) may be right that Chorus might slow down the transition from copper to fibre.

provide the most price flexibility. This can be seen in Figure 2 presenting prices on the axes and regulatory constraints as curves. Traditional basket-based price caps are represented by the downward-sloping blue straight line. Here only prices below the line are permissible. In contrast, total revenue caps are circles-like figures, where all prices outside the circle are permissible. In particular, the total revenue cap generates no maximum constraint on any prices.

20. Total revenue caps along with the pricing flexibility they provide also shield the regulated firm from revenue fluctuations, which translates into a shield against profit fluctuations, given the short to medium term cost stability. As Axiom Economics (Submission p. 6) notes, Chorus' demand may be hard to predict and "price caps are very hard to implement, when demand is volatile." According to Axiom Economics assuming 100% of the volume risk "creates a natural incentive to 'game' the demand forecasts by systematically understating expected volume growth." The question is if this justifies using an otherwise inefficient approach, such as total revenue caps. The potential effect of the resulting profit stabilization on the cost of capital may have to play a role in assessing the relevant WACC percentile, though.[5]

21. Last, the total revenue caps will be based on the firm's costs under the building block approach, again shielding the firm against profit fluctuations, as long as the total revenue constraint is binding. If the building block approach perfectly mimicked Chorus' costs and if the revenue cap were perfectly adjusted to the building block cost Chorus would have no incentives to do anything, wrong or right. Adjustments to building block costs are, however, likely to be imperfect and occur with a lag. Depending on the length of the lag the effects of the revenue cap on pricing and costing discussed above will likely be reduced. The longer the lag the more will the above effects hold for a pure revenue cap. The most likely outcome here will be that the lag will not be long enough to make the effects work fully.[6]

22. Since revenue-cap regulation in practice has been largely restricted to electricity networks, the economic research on revenue caps concentrates on monopoly regulation. We have so far found nothing in the literature on the effects of revenue caps, when the regulated firm faces competition. One would expect that (a) prices under revenue caps above monopoly prices would invite competition and would therefore not be sustainable in the absence of high barriers to entry. Also, they should not be compatible with actual competition. However, to the extent that the Crew-Kleindorfer effect still applies in principle, one should expect a competition-dampening effect from revenue caps. A very simple theoretical analysis suggests that under (pure) Cournot competition the Crew-Kleindorfer effect persists, because the firm under revenue caps will always choose the low

[5] To the extent that the revenue cap is below the unconstrained profit-maximizing level of revenue and to the extent that the wash-up mechanism works as desired Chorus' risk factor β under revenue cap should actually be lower than under unconstrained profit maximization.

[6] We assume here that the building block regulation is not subject to an Averch-Johnson effect but note that the Crew-Kleindorfer effect and the Averch-Johnson effect would go in opposite directions and therefore could cancel each other. The Averch-Johnson effect says that a firm under rate of return regulation has incentives to use more capital assets relative to other inputs than would be efficient provided the allowed rate of return is higher than the firm's effective cost of capital (Averch and Johnson, 1962; Averch, 2008). This can, in particular, lead to excessive capacity that can be used aggressively against rivals.

output on the residual demand curve. Under (pure) Bertrand competition the usual fiercely competitive outcome is maintained, but the regulated firm's market share in equilibrium tends to be lower than without revenue constraint. If under Bertrand competition the other firm(s) face capacity constraints price will be higher than without the revenue constraint.

23. To the extent that Chorus' network costs (except in the very long run) hardly depend on output one can argue that the Crew-Kleindorfer effect is unlikely to hold, because Chorus may feel safer against competitive threats with a low price/high output than with a high price/low output.

24. Revenue caps depend on total costs under regulation using the building-blocks approach. Since for a given network build-out Chorus' overall costs do not significantly depend on output the revenue caps can lead to large price increases if demand declines (stranding). Fear of stranding can lead to abbreviated depreciation, which implies higher revenue requirement now (before demand declines) rather than later.

25. To the extent that the revenue cap for Chorus may not be binding one would expect Chorus to be an aggressive competitor charging the monopoly price structure. It may be interesting to pursue how the wash-up mechanism will lead Chorus back to a binding revenue constraint. There are likely to be two mechanisms at work here. The first is the wash-up mechanism. A non-binding revenue constraint here means that the firm has under-collected and therefore would be entitled to further revenues. The second is the building-block regulation, which might signal that actual revenues are above costs and therefore need to be reduced. We do not know how the Commission will handle these two mechanisms and if such contradictory outcomes can actually occur, but such consistency problems may have to be addressed.

3. The interaction of total revenue caps with the other pricing rules imposed on Chorus

3.2. Basic characteristics of the other pricing rules

3.2.1. Wash-ups, revenue smoothing and the no price shocks requirement

26. In the absence of data on the results of the building block approach to Chorus' network cost it is hard to predict if any price shocks can be expected. However, the revenue-smoothing rule should prevent them if any. The revenue smoothing rule and the wash-up rule should in that case lead to catch-up effects over time. Chorus (Submission, p. 26) notes that the wash-up rule for the revenue cap applies symmetrically in order to correct for forecasting errors. It is hard for us to predict if Chorus could and has an incentive to game the wash-up rule by purposefully over- or under-shooting revenues, although the above analysis suggests that Chorus will want to stay on the revenue cap.

3.2.2. Price caps for anchor services and DFAS

27. Regulated prices for anchor services should fulfil two functions. The first is to provide for acceptable prices in their own right. This would depend on how many consumers directly benefit from anchor

services, e.g., lower income telephone users. The second function lies in their effects on the other services provided by Chorus. Here the question is, how do they affect Chorus' freedom to set other prices? Section 3.3 below will look at the effects this will have on Chorus' pricing incentives under total revenue cap. As Vodafone, 2degrees and other RSPs have expressed in their submissions and cross-submissions, anchor services have to be defined in such a way that they are relevant in fulfilling the anchor role, which is to affect other service prices. They should therefore be a reasonable substitute for many other services and carry enough volume (2degees, cross-submission, p. 21, citing Vodafone submission; Vodafone submission, p.34; InternetNZ, submission, p.4).

28. Vodafone (Cross-submission, p. 7, Table 1) suggests for the Commission to establish a separately identifiable cost base for anchor services and DFAS. They argue that this would be necessary for future cost-based price regulation of those services and for assessing the appropriateness of current anchor prices. They also call for direct pricing rules on non-anchor services in order to avoid price discrimination that would (inversely) follow demand elasticities (Vodafone Submission, p. 35). Thus, Vodafone wants to prevent Chorus from following profit-maximizing or Ramsey-type pricing rules.

29. Spark (Submission, p.7) notes that s166(2)(b) may require the Commission to pay closer attention to price relativities, which would require cost allocation rules at the service level. In contrast, Chorus (Submission, p.42, para 191) notes that cost allocations can only go so far and that efficiency requires consideration of the characteristics of demand.

30. Anchor services and DFAS price caps automatically fulfil the "no price shock" requirement. To the extent that they also constrain Chorus' other service prices this statement would also extend to those services. In the future, anchor services shall be cost based. This could lead to a price shock at that time, depending on the result of the IM methodology.

31. Both anchor pricing and DFAS pricing will affect infrastructure competition (5G, FWA) but possibly in different ways. Anchor pricing will make Chorus' regular fibre services stronger competitors to new infrastructure competition, while DFAS will both be substitutes and inputs to these new infrastructures. It is therefore important that both anchor pricing and DFAS pricing maintain technological neutrality.

3.2.3. Geographically consistent pricing

32. As stated above in Section 1 we assume that geographically consistent pricing means that geographically uniform pricing is required for Chorus.

33. In contrast to New Zealand in the US geographically differentiated wholesale prices have been the norm for many years. This holds for geographic price differentiation between different US states and within US states. Under regulation it has usually been based on cost differences established in cost models.[7]

[7] For an extensive treatment see Vogelsang and Mitchell (1997).

34. Geographically uniform pricing by Chorus will have differentiated effects on the fierceness of its competitive approach. It is safe to assume that Chorus faces or will face less competition in high-cost areas than in low-cost areas. Then Chorus is likely to be a less aggressive competitor in low-cost areas than without the uniform pricing constraint and therefore will have a lower market share and will invite entry by others. Potential entrants in low-cost areas can interpret Chorus' uniform pricing constraint as a commitment by Chorus not to reduce prices significantly upon entry. In contrast, in high-cost areas the comparatively low average price by Chorus will keep competitors out.

35. Because geographically uniform pricing reduces the fierceness of competition in those areas, where infrastructure entry is most likely, it will enhance these entry tendencies and will lead to a more competitive market structure there. This is the classic trade-off between competition *for* the market and competition *in* the market. If geographically uniform pricing softens competition *in* the market it will increase competition *for* the market and that can have beneficial effects on the market structure and could make deregulation in such areas more feasible (except for keeping the uniform pricing constraint). From a pricing perspective such deregulation would also be feasible in high-cost areas, but quality regulation would have to be maintained there. However, when it comes to a deregulation decision the Minister and Commission may have to take into consideration that the obligation for geographically uniform pricing will then fall by the wayside for deregulated services.

36. The latter holds because a uniform geographic pricing constraint could have strong effects on investment incentives and quality provision. In particular, because the profit contribution of sales in low-cost areas will be high, uniform pricing may, compared to efficient outcomes, lead to over-investment/excessive quality in low-cost areas. In contrast, the low or negative profit contributions of sales in the high-cost areas could lead to under-investment/insufficient quality there.

3.2.4. Equivalence of inputs (EoI) and non-discrimination for Layer 1 services

37. The submissions and cross-submissions in this proceeding put a large emphasis on the relative pricing of Layer 1 and Layer 2 services, although unbundled Layer 1 services do not yet have to be offered and regulated prices for these services, if any, are still years away. We therefore interpret this early discussion as a way to influence potential pricing decisions by the Minister or Commission via the input methodology, for example, in order to disclose Layer 1 and Layer 2 costs in different geographic regions from 2022 onward and through guidance on EoI compliance under the Deeds from 2020 onward.
38. Layer 1 services have to be provided on a non-discriminatory basis and on an EoI basis. Both are spelled out for the current Layer 1 prices for DFAS in the Chorus Fibre Deed. For those non-discrimination is required under Clause 5 in conjunction with Schedule 1. This section of the deed is of particular interest, because it spells out that Layer 2 service prices that are not currently under price caps are to be built up from the DFAS prices and that Chorus will keep a record of the costs incurred over and above the DFAS prices when providing the Layer 2 services, including the costs of individual components.

39. EoI is a rule aimed at a level playing field between Chorus and unbundlers. According to Clause 6.3. of the Chorus Fibre Deed, which would be relevant for Layer 1 prices for DFAS, this includes both quality of service and price. In particular, according to Clause 6.3.(b) Chorus currently has to offer the "Input Service to itself and the Access Seekers….on the same terms and conditions….". Since Chorus is a single entity, it does not charge itself a price for the input. Thus, this price has to be imputed. There is no unique way to do such an imputation. Rather, different methods yield a range of possible results. Since we are currently not addressing regulated prices for the Layer 1 service, we here suggest using the incremental costs for the service plus the "opportunity cost" in the sense of Baumol. This opportunity cost is the downstream profit contribution foregone by selling the input to downstream competitors rather than to use it to produce and sell the own downstream product. This opportunity cost has been analyzed extensively in connection with the ECPR (efficient component pricing rule), yet its measurement is controversial. We here discuss three methods of measurement with their main properties. They are (a) the costs saved by Chorus by only supplying the Layer 1 service and not supplying the Layer 2 service, (b) the incremental costs incurred by Chorus of supplying the Layer 2 service, when it only supplies Layer 1 service, and (c) the incremental costs an efficient Layer 1 access seeker would incur for supplying the Layer 2 service.

    a) <u>The costs saved by Chorus by only supplying the Layer 1 service:</u> This is the price difference between Layer 1 and Layer 2 service that would make Chorus indifferent between supplying one unit of each of these services and corresponds to the simple margin rule from Chorus' perspective. It will, however, foreclose Layer 1 access seekers (i) if their Layer 2 outputs are perfect substitutes for Chorus' Layer 2 outputs, (ii) if there are economies of scale for the downstream portion between Layer 1 and Layer 2, and (iii) if there are sunk costs for the downstream portion between Layer 1 and Layer 2. Since the main argument for requesting the Layer 1 unbundling is that it enables access seekers to offer more differentiated products, condition (i) is unlikely to be fulfilled. However, conditions (ii) and (iii) are very likely to be fulfilled and are likely more than to compensate for the non-fulfillment of condition (i). In other words, under method (a) foreclosure of Layer 1 access seekers is very likely and Layer 1 unbundling will be rare. The question whether Chorus will actually have incentives to engage in price squeezes in order to sell its Layer 2 services and avoid selling Layer 1 services will depend on the relative profitability of the two services and on Chorus' interpretation of the EoI and non-discrimination requirements. If Layer 2 services of Layer 1 access seekers are imperfect substitutes to Chorus' Layer 2 services Chorus will have much less of a foreclosure incentive than if they are close substitutes.

    b) <u>The incremental costs incurred by Chorus of supplying the Layer 2 service, when it only supplies Layer 1 service:</u> This method differs from the previous one by including the sunk costs, which still have to be incurred but have not yet. What would non-discrimination in price mean in view of sunk costs for Chorus' Layer 2 services? In light of the fact that Chorus has sunk assets to supply a full set of users with Layer 2 services the Commission will in any later proceeding have to find a fine line between allowing Chorus to price Layer 1 services at a discount of the almost zero actual costs saved by Chorus and allowing for economic space by using the costs of an

efficient entrant as the measuring rod for the discount. As we understand it, the latter method does not represent Chorus' current situation, where it already has its Layer 2 network in place. Thus, when this method is applied, Chorus will prefer selling Layer 2 services rather than Layer 1 services, provided the services are perfect substitutes in the sense of exhibiting a displacement ratio of one. In other words, under this condition Chorus will lose money on Layer 1 sales if Layer 2 sales just break even. In contrast, under the same condition of a displacement ratio of one access seekers may not be able to break even if there are downstream economies of scale. So, there may still be foreclosure of Layer 1 access seekers, although to a lesser degree than under method (a).

c) The incremental costs an efficient Layer 1 access seeker would incur for supplying the Layer 2 service: In contrast to methods (a) and (b), applying an economic replicability test as is done in the European Union would base the price difference between Layer 1 and Layer 2 services on the cost of an efficient rival who generally cannot take advantage of the same economies of scale and scope as Chorus. Most regulators world-wide formulate a non-foreclosure requirement based on these forward-looking costs for the downstream service of an efficient entrant rather than on the forward-looking costs saved by the incumbent by not selling the downstream service. The decision between these two approaches would be non-controversial if the downstream service were produced with no sunk costs and no economies of scale. This, however, is unlikely to be the case for the incremental cost of providing Layer 2 services over Layer 1 services. In this case basing the price difference between Layer 1 and Layer 2 services on the forward-looking costs of an efficient entrant means that the policy maker wants to provide entry help.

40. We understand that Layer 2 services are highly differentiated going along with currently prescribed price differentiations that do not correspond to cost differences. Since some Layer 2 services will be anchor services and since Layer 1 services may or may not be under a price cap, there may exist consistency problems that may at this stage have to be addressed at the cost allocation level.

41. If Chorus were free to price the difference between Layer 1 and Layer 2 services what incentives would Chorus have to foreclose unbundlers? This would depend largely on the displacement ratio or business stealing effect of Layer 1 sales to downstream rivals. If the displacement ratio equals one it means that for every Layer 1 unit sold Chorus would lose one Layer 2 unit sale. In this case Chorus could have strong incentives for foreclosure, unless Layer 1 sales are as profitable as Layer 2 sales, which would mean that the Layer 1 unbundling price would have to equal the Layer 2 price minus Chorus' costs saved. If in contrast the displacement ratio were significantly below 1 it would mean that service differentiation by unbundlers would lead to a smaller loss of sales of Layer 2 services. From Chorus' perspective it would justify a lower Layer 1 price. Layer 1 unbundlers might even increase demand for all of Chorus' services against upcoming rival networks. This could lead to a tradeoff between Layer 2 profit and profit from expansion of total demand for Chorus' network.

42. Based on the legal non-discrimination and EoI stipulations Chorus has some possibility for a price squeeze if it uses its own downstream incremental or decremental cost as the basis for setting the

relative price difference between Layer 1 and Layer 2 services. The incentive to actually keep this narrow price difference could be tempered to the extent that the unbundlers' downstream services are differentiated from those offered by Layer 2 input buyers. In order to be able to resolve these issues as they become relevant, we recommend that the Commission should establish a separately identifiable cost base for Layer 1 GPON services so that a margin squeeze test can be applied (and such cost base could be a guide for future price regulation of Layer 1 services). Our advice is not to decide now, but put yourself in a position in which you will have the data to implement whatever you or your successors decide. It has to be kept in mind here that the input methodologies are unlikely to directly reveal sunkness, economies of scale and economies of scope. Rather, they will likely have to be compatible with the building block approach. Thus, any more sophisticated pricing approach will require further analysis with different cost data.

3.3. The interaction between the other legal pricing requirements and the total revenue cap: Pairwise interactions

3.3.1. Total revenue cap and price caps for anchor services and DFAS

43. The pricing freedom that Chorus enjoys for non-anchor services under the total revenue cap is controversially discussed in the submissions and cross-submissions. Spark (cross-submission, p.8, para 34b) suggests that the Commission should specify how Chorus should set price differentials between anchor and non-anchor services. We believe this to mean that Chorus should not be able to determine price differentials constrained by the total revenue cap (and by the other applicable pricing rules) only. Below, we present some analysis of this issue and then provide some recommendation.

44. The price caps for anchor services and for DFAS will constrain Chorus' pricing freedom for substitute services. Calculations similar to those for Equations 1 and 2 above indicate that such anchor price caps will have a price-reducing effect on substitutes whether the revenue cap is binding or not. However, the price-reducing effects will be smaller with binding revenue caps than without them.[8] Assume that the price for the anchor service 1 is set at $p^\wedge_1$ and assume that the firm offers a substitute product 2. Then under profit-maximizing pricing with a revenue cap the resulting Lerner index for product 2 will be

$$L_2 = \frac{p_2 - \frac{\partial C}{\partial Q_2}}{p_2} = \left[\frac{1-\lambda}{\varepsilon_2} + \lambda\right] - (1-\lambda)\frac{p^\wedge_1}{p_2} \cdot \frac{\partial Q_1}{\partial p_2} \quad (3)$$

45. Again, $0 \leq \lambda \leq 1$ with $\lambda = 0$ for the case of a non-binding revenue constraint and $\lambda = 1$ for an extremely binding constraint. There are two effects here. The first is captured by the terms in the right-hand side brackets of Equation (3). While those terms look similar to the right-hand side of Equation 1 above, the presence of a substitute low-priced anchor service or DFAS reduces the

[8] Interestingly, revenue caps in this case would have a less price-*increasing* effect on complements to the anchor services than without such a cap. The question therefore is if Chorus offers any services that would either be complements or not be demand-related to the envisaged anchor services and DFAS.

demand (shifts the demand curve) for the non-anchor services downward, which should usually increase the demand elasticity for any given price and therefore should lead to lower prices. To see this for a parallel shift of the demand curve we differentiate the service 2 demand elasticity w.r.t. the price of service 1 and noting that for substitutes $\partial p_1/\partial Q_2 > 0$ we get[9]

$$\frac{\partial \varepsilon_2}{\partial p_1} = -\frac{\partial\left(\frac{p_2}{Q_2}\frac{\partial Q_2}{\partial p_2}\right)}{\partial p_1} = -p_2 \frac{\partial p_1}{\partial Q_2} \cdot \frac{\partial Q_2}{\partial p_2} > 0 \quad (4)$$

Thus, ε_2 will be different than in equation 2 above. This effect is subject to the Crew-Kleindorfer effect for a binding revenue constraint (i.e., $\lambda>0$) and therefore smaller than under non-binding revenue cap. Second, in Equation 3 there is a cross effect on the quantity of the anchor service. Since for substitutes the cross-price elasticity is positive, this effect will lead to an additional price reduction of the non-anchor services. Again, the effect is smaller under a binding revenue cap than without it. Thus, anchor services will be effective in holding Chorus' pricing in check, but the overall effect will be less than without a binding revenue cap.

3.3.2. Interaction between revenue cap and non-discrimination for Layer 1 services

46. To the extent that a binding revenue cap will make Chorus a less aggressive competitor there may also be less incentives for Chorus to use a price squeeze to exclude unbundlers as downstream competitors.

3.3.3. Interaction between revenue cap and uniform pricing constraint

47. To the extent that the revenue cap is binding the combination with the uniform pricing constraint will likely make Chorus an even less aggressive competitor than with only one of these constraints. Thus, the combination will have a price-increasing effect.

3.3.4. Interaction of revenue cap with no price shock rule

48. To the extent that the Crew-Kleindorfer effect would lead to price shocks the no price shock rule would at least for some time prevent the Crew-Kleindorfer effect to occur. The obviousness of price shocks under the Crew-Kleindorfer effect has been used as a counter to criticisms of total revenue caps in the electricity industry. In particular, the Commission in its Input Methodologies Review Decisions (NZCC, 2016, Attachment A, paragraphs 331 and 332ff) has addressed this issue.

3.4. Bringing it all together

49. Under binding revenue caps Chorus might be in danger of exploiting customers in areas and for services, where it has monopoly power, and be a less aggressive competitor in competitive areas than without such cap. How do the pricing constraints interact to limit these tendencies and how does that affect the efficiency of pricing?

[9] If the shift in demand is associated with a change in slope for a given price then the above effect will increase if the slope becomes steeper from a price increase in service 1 and will decrease if the slope becomes flatter. Thus, if the slope becomes much flatter the effect may theoretically vanish or turn in the other direction.

50. Constraints on exploiting customers: Price caps for anchor services and DFAS keep those prices and those of close substitutes below monopoly levels and thereby prevent the Crew-Kleindorfer effect from doing substantial damage, provided the anchor services are defined sufficiently broadly and reflect the then current consumer preferences. Whether this extends to all monopoly services depends on the scope of anchor services and DFAS and their adaptation over time. Theoretically it could happen that low prices for anchor services and DFAS services and for their close substitutes could under revenue caps leave room for high prices for other services. In that case the revenue caps would not be "very" binding so that the Crew-Kleindorfer effect would be weak. Also, in a multi-product setting revenue caps would in theory lead to price ratios that deviate from Ramsey prices in the direction of uniform percentage mark-ups. This would lead to a blend between Ramsey pricing and cost-based regulation, which would lead to comparatively higher prices for more elastic than for less elastic services. This tendency may also hold for the relationship between prices for anchor services/DFAS and for other non-anchor services/non-DFAS. Geographic averaging means that the protection against exploiting customers is particularly strong for rural areas, where monopoly will persist longer than in urban areas. The no price shock rule may help for non-anchor services/non-DFAS, but it may not be applying at all. The non-discrimination for Layer 1 services may increase competition but may lead to higher prices for Layer 2 services or (via an increase in the RAB) to an increase in prices for potentially all its services if Chorus were forced to maintain "economic space" between the two service layers. Last, the updating of the building block costs will have a dampening effect on Chorus' overall price level but may reduce cost-minimizing incentives. If Chorus' costs turn out to be low the revenue cap will with a lag be adjusted downward and this should induce Chorus not to reduce costs, which could either mean not to increase prices by too much or to skimp on cost efficiency.

51. Constraints on predatory pricing and foreclosure: Geographic price averaging should make Chorus a softer competitor in competitive low-cost areas, because otherwise Chorus would forego monopoly profits in rural areas. A direct foreclosure issue only arises for Layer 1 services. This may require a political decision on whether to promote unbundling by basing the discount for Layer 1 unbundling on the cost of an efficient competitor and compensating Chorus for it or to let Chorus set the discount based on its own cost savings. The latter will probably lead to very little unbundling.

52. Although there may be other potential price squeeze issues for backhaul and DFAS services used for 5G and FWA as new infrastructure competitors, we believe that for Chorus these are more horizontal issues between its various services. Also DFAS services are price-regulated, which should reduce price squeeze issues. In contrast, most backhaul services are currently not regulated, although in the case of 5G this may no longer hold. To the limited extent that DFAS and backhaul are viewed as substitutes from the customer perspective DFAS can act as anchor services for backhaul. Thus, except possibly for Layer 1 services the danger of price squeezes and predatory pricing by Chorus do not appear to be so imminent as to justify preemptive regulatory action.

4. Concluding evaluation of the currently envisaged price regulations imposed on Chorus

53. It is impossible for us to fully evaluate all the interactions playing out between the various pricing rules that Chorus is subject to. However, it appears quite clear that the other pricing rules besides the total revenue caps have largely beneficial effects by reducing the potentially bad effects of total revenue caps. Table 2 summarizes these findings for the three areas (a) monopoly exploitation, (b) allocative and dynamic efficiency, and (c) infrastructure and service competition.

Table 2: The effects of pure revenue caps and the other rules on Chorus pricing performance

	Effect on monopoly exploitation	Effect on efficiency - Allocative (a) - Dynamic (d)	Effect on competition - Infrastructure (i) - Service (s)
Pure revenue cap	High prices (-)	(a)Large DWL (-), cost minimized (+) (d) Withholding investment (-)	(i) Soft competitor (+) (s) High input prices (-)
Building block regulation	Keeps prices on average closer to cost (+)	(a) reduces DWL (+) and cost-minimizing incentives (-) (d) No particular investment incentives (0)	(i) More aggressive competitor (0/-) (s) Lower input prices (+)
Wash-up mechanism	Depends on how practiced (+/-)	Depends on how practiced (+/-)	Depends on how practiced (+/-)
Anchor price regulation	Holds prices of anchor services low (+) Reduces prices of substitutes (+)	(a) Lessens DWL (+) (d) Increases investment (+)	(i) More aggressive competitor (0/-) (s) Lower input prices (+)
Geographically uniform pricing	Low prices in high-cost areas (+) High prices in low-cost areas (-)	(a) Large DWL in both areas (-) (d) (+) in low-cost areas, (-) in high-cost areas	(i) Softer competitor on low-cost areas (+) (s) Lower input prices in high-cost areas (+), higher input prices in low-cost areas (-)
Level 1 unbundling at avoided cost	Probably little effect, because it kills Level 1 unbundling	Probably little effect, because it kills Level 1 unbundling	Increases Level 2 competition (+), reduces Level 1 competition (-)
Level 1 unbundling at efficient competitor cost	End-users will probably have to pay more (0/-)	Probably more product differentiation (+)	Reduces Level 2 competition (-), increases Level 1 competition (+)
Overall effect of the other pricing rules on pure revenue cap outcomes	Substantial reduction in monopoly exploitation except for non-substitutes of anchor or DFAS services.	Substantial reduction in DWL, some increase in investment	On balance Chorus a fairly soft infrastructure competitor. Service competition increased

a) Monopoly exploitation: A pure revenue cap will lead to very high prices, particularly for services with more elastic demands. Building block regulation applied with a lag will reduce this tendency and help keep prices closer to cost. The effect of wash-up mechanism will depend on the way it is handled and can go both ways. Anchor price regulation should be the strongest mechanism for helping customers see low prices, but that will depend on the scope and choice of the anchor services. As mentioned above, a potential downside is that under revenue caps low prices for regulated services and their close substitutes could leave room for higher prices for the remaining services. The stipulation of geographically uniform pricing will have the likely effect of reducing prices and quality/availability in high-cost area, while increasing prices and quality/availability in low-cost areas. This may not be efficient but it obviously is politically desirable and may lead to earlier deregulation than otherwise. The effect of Level 1 unbundling will strongly depend on the way it will be priced. If the Layer 1 discount is priced at Chorus' avoided cost there may be very little effect. If the Layer 1 discount is priced at an efficient competitor's cost there is likely to be more product differentiation for consumers, but overall prices may be higher. Overall, the additional pricing rules will, from the consumer perspective, largely eliminate the potentially bad effects of the revenue cap.

b) Efficiency effects: A pure revenue cap will create a large dead weight loss (DWL) and induce the regulated firm to keep costs, output and investment low. Building block regulation with a lag should reduce the DWL and help increase investment but should reduce the strong cost-minimizing incentives of pure revenue caps. Again, the effect of the wash-up mechanism will depend on the way it is practiced. Anchor price regulation should reduce DWL sharply and help increase investment. Geographically uniform pricing will ordinarily lead to major DWL in both high-cost areas (for under-pricing) and in low-cost areas (for over-pricing). Combined with a revenue cap the over-pricing will be enhanced and the under-pricing reduced or even eliminated. Dynamic efficiency will likely be increased in high-cost areas and reduced in low-cost areas. Level 2 unbundling will have little effect under the avoided cost rule and will lead to product differentiation under the efficient competitor cost rule. Overall, compared to pure revenue caps the additional pricing rules will reduce DWL, will somewhat lower cost efficiency and lead to some increase in investment.

c) Competitive effects: A pure revenue cap will make Chorus a soft competitor in the area of infrastructure competition and will lead to less service competition because of high input prices. Building block regulation with a lag will increase service competition via lower input prices and will make Chorus a more aggressive competitor in infrastructure competition. Again, the effect of the wash-up mechanism will depend on the way it is practiced. Anchor price regulation and DFAS regulation will make Chorus a more aggressive infrastructure competitor and will lower input prices for service competition. Geographically uniform pricing will have

opposing effects for high-cost and low-cost areas. It will make Chorus a softer competitor in low-cost areas and a more aggressive one in high-cost areas, keeping infrastructure competitors out there and providing service competitors with low input prices. Level 1 unbundling will have opposite effects depending on the pricing rule. The avoided cost rule will almost eliminate Level 1 competition, while the efficient competitor cost rule will increase Level 1 competition. Overall, the geographic price averaging is likely to be decisive in keeping Chorus a fairly soft infrastructure competitor, while the other pricing rules will help service competition by holding input prices low. Since under deregulation Chorus would no longer be subject to revenue caps and to geographically uniform pricing for the deregulated services, Chorus' pre-deregulation behavior may not be a good predictor for Chorus' post-deregulation behavior. Effective competition without deregulation would leave the cap in place. Since deregulation requires an affirmative act, this case can realistically happen.

54. There are two competing views on how Chorus will fare in light of future infrastructure-based competition and future demand uncertainty. One is that Chorus will be able to use its market power and will be constrained by the revenue cap. In this case the revenue cap will likely be inefficient, but the other pricing rules and building block regulation with a lag will largely compensate this. The other view is that Chorus (or the other fibre providers) will lose revenue to competitors or to low prices necessitated by competition so that the revenue cap will not be binding (Northpower Fibre Limited (Submission, p.3). In this case the revenue cap is likely to cause no major harm. Since those uncertainties will be at least partially revealed by then our main recommendation from this analysis is therefore to wait and see before reconsidering revenue caps for the next regulatory period.

55. Our further recommendations are (a) to set a regulatory lag for building block regulation that balances the cost efficiency effects with the price reducing effects, (b) to define anchor services in such a way that they have a substantial effect on Chorus' other prices, and (c) to lay the basis for a potential later pricing principle for Layer 1 unbundled services.

5. Is there room and the necessity for any pricing principles beyond the requirements already in place that were discussed in Sections 2-4?

5.1 Pricing commitment

56. Axiom Economics (Submission, pp. iv and 16) points out uncertainty surrounding the shape of future prices as a reason for supporting a pricing principles IM. According to them such uncertainty could have "undesirable chilling effects on investments - including the 5G technologies and in competing layer 2 infrastructures". They furthermore state that Chorus' incentives for foreclosure competition should be ruled in by reducing Chorus' discretion to act in its commercial interest.

5.2 Principles promoting competition

57. Principles promoting competition could give content to the s166(2)(b) requirement. They have been suggested in the Spark submission (pp.7 and 14), the Vocus submission (p.10) and the Vodafone submission (p.8). Applied to pricing such principles could include:

- A general no-foreclosure requirement. It is questionable if such a requirement beyond that required for Layer 1 unbundling is necessary at this time, since Chorus currently does not offer other downstream services.

- A requirement against predatory pricing. Spark (Submission p. 14, para 65) gives an example of potential predatory pricing by Chorus but it is not concrete enough to assess its empirical relevance. Predatory pricing is generally viewed as being rare in practice and unlikely to occur in view of Chorus' various pricing requirements.[10]

- Pricing between incremental and stand-alone costs. Spark (Submission p. 22) suggests that the Commission assure common cost allocation in such a way that prices cannot exceed stand-alone cost levels. Monitoring such a rule would require detailed cost information at the service level.

5.3. Principles for efficient pricing, such as Ramsey pricing or the like

58. Chorus (cross-submission, p.5 and pp.16/17) alerts to the fact that it is already subject to non-cost-based pricing rules that might contradict and interfere with any attempt to impose additional price efficiency rules. To the extent that this argument is valid it may mean that any additional rules would have to go along with the elimination of some of the existing rules, such as the revenue caps.

59. Ramsey pricing may require imposing a price cap with a tariff basket on top of the revenue cap. Kao et al. (2010) claim that this can lead to Ramsey-type price ratios. While we believe that they make some unrealistic assumptions, there is some intuition behind the possibility of their result. To see this, assume that price caps are constructed in such a way that (in the absence of revenue caps) they would lead to Ramsey prices. Then we have to consider two cases:

    a. At an equilibrium the price cap is binding, but the revenue cap is not. This would be the case in Figure 2 above. Depending on how the wash-up mechanism will be applied this can lead to an even looser revenue cap. However, if costs have outstripped revenues it could lead to a tighter revenue cap until the revenue cap and the price cap are binding together. In any case at the equilibrium one would observe Ramsey-type prices.

    b. At an equilibrium the revenue cap is binding, but the price cap is not. Then prices would be below the allowed price caps and there would be no guarantee that they would correspond to Ramsey principles. However, regulators might tighten price caps in that case, similar to the wash-up mechanism for revenue caps (Chorus could game this, though).

[10] The view that predation has to be rare is based on the observation that a predator via high prices has to recoup all losses from below cost pricing after having induced rivals to exit the market. Following this logic the US has had a de facto moratorium on predation cases, since in 1993 the US Supreme Court decided the case Brooke Group v. Brown & Williamson Tobacco, 509 U.S. 209 (1993). For a different academic perspective emphasizing the possibility of predatory pricing, see Bolton, Brodley & Riordan (2000).

Conclusion

60. At this stage there does not appear to be a strong case for a specific pricing principle beyond the rules already imposed on Chorus.

6. Overall Conclusions

61. The price regulations imposed on Chorus along with the total revenue constraint lead to multiple interactions and constraints that prevent clear conclusions and policy recommendations. While revenue constraints are usually imposed as a regulatory tool to reduce the regulated firm's outputs, the legal pricing constraints and the building block approach used for determining the revenue cap will likely counteract the potentially undesirable effects of revenue caps. We have added recommendations on the building block approach to regulation, on the scope of anchor services and on laying the basis for Layer 1 unbundling.

62. We do not currently recommend any new pricing principles beyond the rules already established.

7. References

Averch H. (2008), "Averch–Johnson Effect". In: Palgrave Macmillan (eds) The New Palgrave Dictionary of Economics. Palgrave Macmillan, London.

Averch, H., & Johnson, L.L. (1962), "Behavior of the Firm Under Regulatory Constraint". *American Economic Review* 52, pp. 1052–1069.

P. Bolton, P., Brodley, J. & Riordan, M. (2000), "Predatory Pricing: Strategic Theory and Legal Policy", *Georgetown* Law *Journal* 88, pp. 2239-2330.

Brennan, T.J. (2010), "Decoupling in electric utilities", *Journal of Regulatory Economics* 38, pp. 49-69.

Campbell, A. (2018), "Cap prices or cap revenues? The dilemma of electric utility networks". *Energy Economics* 74, pp. 802-812.

Chorus Limited Deed of Open Access Undertakings for Fibre Services. Deed submitted by Chorus in accordance with section 156AH of the Telecommunications Act 2001 on 6 October 2011. Includes variation under Telecommunications(Approval of Variation to Undertakings) Notice 2014. Available at https://comcom.govt.nz/__data/assets/pdf_file/0025/90466/Chorus-Fibre-Deed-6-October-2011.PDF.

Crew, M. A., & Kleindorfer, P. R. (1996). "Price caps and revenue caps: incentives and disincentives for efficiency, pricing and regulatory innovations under increasing competition". pp. 39-52: Springer.

Every-Palmer, J. (2016). "Equivalence of input obligation: Implications for pricing of layer 1 services", Letter to Tom Thursby, Lead Council, Legal and External Affairs, Vodafone New Zealand Limited, September 2.

Kato, H., Tanabe, K., & Ohta, K. (2010), "Welfare Implications of Price Cap Regulation Combined with Total Revenue Constraint", 12th WCTR Conference, July 11-15, Lisbon, Portugal. Available at https://www.researchgate.net/publication/267805862_WELFARE_IMPLICATIONS_OF_PRICE_CAP_REGULATION_COMBINED_WITH_TOTAL_REVENUE_CONSTRAINT.

Lantz, B. (2005), "Two-part pricing under revenue cap regulation", FE Rapport 2005-408, School of Economics and Commercial Law at Göteborg University, Department of Business Administration.

Littlechild, S. (2003), "Reflections on Incentive Regulation", *Review of Network Economics* 2, pp. 289-315.

NZCC (2016), *Input methodologies review decisions, Topic paper 1: Form of control and RAB indexation for EDBs, GPBs and Transpower*. Available at https://comcom.govt.nz/__data/assets/pdf_file/0018/60534/Input-methodologies-review-decisions-Topic-paper-1-Form-of-control-and-RAB-indexation-for-EDBs-GPBs-and-Transpower-20-December-2016.pdf.

Stoft, S. (1995). "Price Caps vs. Revenue Caps: Implications for DSM", Chapter 4 of LBL Report #37577, November 11, pp. 4-1 – C38.

Vogelsang, I., & Mitchell, B. (1997), *Telecommunications Competition: The Last 10 Miles*, Cambridge, Mass., London, and Washington, D.C.: MIT Press and AEI Press.