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Competition and vertical/agglomeration effects in media mergers: bagging bundle benefits

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Abstract

Existing frameworks (such as used by the New Zealand Commerce Commission in its recent evaluation of the proposed merger between Sky Television and Vodafone) require, as a first step, the definition of the relevant markets affected by the merger or vertical integration activity. Historic precedents in the telecommunications sector have tended towards finding that vertical agglomeration effects when network operators integrate downstream into the provision of applications and services to end-consumers are harmful to competition.

Such Structure-Conduct-Performance methods of evaluating mergers and other aspects of market performance are problematic when the firm(s) concerned supply many different products, both together in various different bundle forms and separately as individual components. Defining the markets for (merger) analysis on the basis of only one of the components in a possible bundle that the (merged) firm may supply risks overlooking the complex interactions that occur on the demand side when consumers make their purchase decisions.

This is especially likely to be an issue in the supply of internet applications and content bundled with broadband internet access. Consumers have heterogeneous preferences for different applications and content (hereafter ‘content’), and will purchase (or access) many different content types. Even though ownership of rights to distribute one content may confer a degree of market power in for the owner-provider over those consumers with very strong preferences for this content over all others, it is not axiomatic that the firm will be able to exert this power over consumers whose preferences are more evenly distributed. The more variety there is in the content bundles available, and the more heterogeneous are consumers’ preferences across the various content types, the greater is the number of possible markets in which interaction is likely to occur and the more problematic it becomes to identify the relevant markets for analysis of mergers and antitrust cases.

We propose that classic merger and antitrust analysis based on econometric cost-benefit analysis can be augmented by using simulation and numerical analysis of a range of bundle offers expected to be relevant in decision-making. We develop a simple model and use it to demonstrate how this approach could have informed the recent New Zealand Commerce Commission decision about the proposed Sky-Vodafone merger by offering some quantitative estimates of total and consumer welfare and provider profits under the proposed factual (with bundling) and counterfactual (individual component sales) cases. The approach may also inform other analyses, such as the assessment of the effects of two-sided markets and firm pricing decisions.

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Introduction

On February 22 2017, the New Zealand Commerce Commission (the Commission) declined to give clearance for the proposed merger between the country's number one (by revenue and market share) pay television provider (Sky Network Television Limited – Sky) and the number one (by revenue) mobile operator also simultaneously the number two (by market share) fixed line broadband operator (Vodafone New Zealand Limited – Vodafone). As the Commission could not exclude the possibility that the merged firm would not use its market power derived from ownership of the rights to broadcast live sport content to foreclose competitors in broadband internet access markets, it was obliged under its statutory mandate and judicial precedents to decline the application (Commerce Commission, 2017).

In coming to this conclusion, the Commission relied strongly on the strategic foreclosure theory proposed by Whinston (1990), that in the presence of scale economies (a given in both telecommunications and content markets, due to the high fixed costs and very low marginal costs of access to both products), by tying two products together, the monopolist of one component can reduce the sales of its competitor in the tied product, thereby lowering competitor profits below the level that would justify continued operation. By bundling popular and highly-valued sport content with internet access, the merged firm would be able to attract a larger-than-average number of consumers 'in play' during the transition from traditional fixed line broadband access to the new government-subsidised Ultra-Fast Fibre Broadband (UFB) network.

The Commission used classical antitrust methodologies¹ to establish that in the New Zealand context, live sport content constituted a separate market with no close substitutes. Consumer preferences for sport content were presumed to be sufficiently strong, and the market sufficiently large, that it would lead to foreclosures in the telecommunications service provider (TSP) market, where under access regulation the structurally-separate wholesale connections to the UFB are retailed². Under the merger factual, competition would be softened (i.e. consumer churn reduced) because consumers buying the sport and internet access bundles from the merged firm would become 'sticky' (Prince & Greenstein, 2014). Rival firms without access to the relevant sport content would have to offer very deep discounts to attract consumers away from the merged firm. Under the counterfactual, it was presumed that the (separate) content provider would face stronger incentives to make its sport content available to all TSPs, thereby enabling them to build their own equivalent fibre internet and sport content bundles to attract consumers during the transition to the UFB network.

Two problems

However, two 'problems' emerge in the Commission's analysis.

The first is the presumption that access to and pricing of the relevant live sport content alone will be the defining factor in a sufficiently large number of consumers' selecting of their preferred bundle of broadband access and internet content that competition in the entire TSP market will be skewed.

In practice, an internet consumer will typically want to access many different applications and video contents – indeed, the very convergence of both classical computing applications and video and audio content onto a single digital platform is a defining feature of the need for more capable networks such as the UFB to be deployed. As consumers are heterogeneous in both their valuations and their preferences, it is not axiomatic that the demand function for one content alone (i.e. sport) will map neatly to consumers' bundle purchase choices. The distribution of a single consumer's preferences across all products offered in a bundle will determine if, at a given price, the bundle will be purchased (Schmalensee, 1984; Chen & Riordan, 2013). In the presence of multiple equally-priced bundles comprised of different applications and content, the relative valuations by an individual consumer of the components will influence selection. Even if sport

¹The New Zealand approach is summarised in NZ Commerce Commission (2013), available from <http://www.comcom.govt.nz/dmsdocument/10188>.

²For a discussion on the structure of the New Zealand broadband market, see Howell (2014).

is highly-valued, a consumer may derive higher welfare from a competing bundle containing other, more highly-valued components.

Determining the likelihood of the presumed factual scenario emerging therefore requires information about the makeup of different competing bundles and the distribution of consumer valuations (willingness-to-pay) across all of the different possible components. By not taking these factors into account, the Commission likely substantially overestimated in its factual the share of the total market the merged firm was likely to acquire by bundling access to its live sport content with internet access (Howell & Potgieter, 2017).

The second is the counterfactual assumption that Sky would face similar incentives without the merger to experiment with different ways of unbundling and repackaging its content for wholesale redistribution as had been observed pre-merger.

Since 2009, Sky has made its bundles of content available at wholesale prices for resale by TSPs in bundles with their own products. Bundles must be resold in the manner offered by Sky – specifically, premium content such as sport (and also other premium content channels) is tied to the purchase of a basic channel bundle. Of over 80 TSPs in New Zealand, only Vodafone has availed itself of this offer. Vodafone currently retails the Sky Sport/Sky Basic bundle to around 10% of broadband consumers. Sky Basic is retailed by Vodafone to an undisclosed additional number of broadband consumers. Vodafone offers Sky in a bundle with its broadband connections, at a price that amounts to a 20% monthly discount on basic Sky package or 14% on the most popular broadband plan. Around 50% of New Zealand’s 1.7 million households³ have pay television subscriptions – the vast majority of which are with Sky. Vodafone’s share of the 1.46 million fixed broadband line market is 29% (Commerce Commission 2017a). As pay television and fixed broadband purchase are almost certainly strongly positively correlated, it is most unlikely that the firm holds a dominant position in the provision of a Sky/broadband bundle. Rather, it appears that most Sky and fixed broadband consumers build their own bundles, buying Sky direct and then choosing a broadband provider separately.

In 2015, Sky began offering an internet-only sport product FanPass without any requirement for consumers to buy a basic bundle. FanPass sales were made by Sky alone, and offered access to selected live sport by the day, week, month and in some cases (e.g. boxing and rugby tests) a specific event. The notable feature of FanPass is that as well as unbundling sport content from basic, it also unbundled it from distribution over Sky’s proprietary satellite broadcasting network. Howell & Potgieter (2017) argue that it is not axiomatic that an integrated firm controlling the transition of activity from a legacy infrastructure (satellite) to a frontier one (IP video) will face the same incentives to bundle and price their services as two separate firms unable to internalise trade-offs between the costs of investing in and operating multiple infrastructures. Hence, Sky’s bundling decisions cannot be expected to remain unchanged following the merger application being declined.

Can Structure-Conduct-Performance deal with bundling complexity?

The two ‘problems’ draw into question the relevance of using classical Structure-Conduct-Performance (SCP) models of competitive interaction based upon the pursuit of perfectly competitive outcomes to assess the effects of mergers where bundling of products and services proliferates. Whilst a finding of market power in one component of a bundle might lead to competition concerns if demand for that component was inelastic and its purchase was essential for the enjoyment of other elements in the bundle (e.g. as broadband access is likely to be for the vast majority of consumers), it is not clear that the reverse applies. A component that is not essential, although highly-valued by some consumers (i.e. Sky Sport content) but with few close substitutes, need not distort competition in the market for the essential good. While there may not be many close substitutes for Sky Sport content, and this may lead to Sky having some market power over the consumers who value it highly, what matters is the elasticity of demand for that component over the entire addressable market for bundles of content, applications and internet access. The more competing variants there are, and the more heterogeneous are consumers’ preferences, the more likely

³http://www.stats.govt.nz/browse_for_stats/population/estimates_and_projections/DwellingHouseholdEstimates_HOTPMar17qtr.aspx

it is that competitive interaction will follow the form of monopolistic competition. While a producer holds some market power over the consumers who unequivocally prefer its variant over others, the presence of many other variants constrains the extent of the consumer surplus that can be appropriated by the producer (Carlton & Perloff, 2015).

Furthermore, as any individual broadband consumer can be expected to access many different applications and contents, it is highly unlikely that the broadband and content bundle purchase decision will be determined by the valuation of one content product in that bundle alone. The cross-elasticities of demand between the different products now matter, for both that individual's decision and for the market as a whole. The larger the number of possible products in the bundle, the more widely-distributed are consumers' preferences across the different products, and the larger the number of consumers making the relevant choices, the harder it becomes to predict the effects of a change in the characteristics of any one of the components on the outcomes of market interaction overall. Evans & Schmalensee (2013) illustrate the complexities for antitrust analysis when in a simple two-sided platform, one provider sells just two different interrelated products to two distinctly different customer types, especially when the same consumer interacts with the platform in both capacities. The order of magnitude of the complexity can be expected to increase exponentially as both product and consumer numbers increase.

A model to inform decision-making in the face of complexity

However, complexity does not necessarily preclude competition authorities from endeavouring to understand how their decisions may influence the outcomes in various markets. As theoretical approaches based upon SCP are likely unhelpful, a different set of analytical tools is required to make decisions tractable. As computing power has increased and become relatively cheaper, it has become more feasible (cost-effective) to use simulations and numerical analysis to explore the effects of different decisions – both by competition authorities and the firms involved in specific markets. In this paper, we propose that the use of simulation and numerical analysis models would have provided the New Zealand Commerce Commission with valuable additional information to use in their assessment of the likely outcomes of the Sky-Vodafone merger. We further contend that, on the basis of the information obtained from this analytical approach, different – and likely higher-welfare/lower transaction cost – options for both the firms involved and the Commission would have emerged.

We develop and apply a simple model to illustrate the effects of different choices when bundling internet access and content together, and how the understandings that come from it can inform competition and regulation decisions. The model is simple, but very closely reflects the options 'on the table' in the Sky-Vodafone case. It is calibrated, to the best of our judgement, to the prices prevailing in the relevant New Zealand markets at time of the merger analysis, and the distributions prevailing for consumers' willingness to pay for the components at that time. It draws on the fact that, even without the proposed merger, Sky was selling its sport and basic products in both a tied bundle (sport could only be purchased with a basic connection) or as a mixed bundle (MB), where consumers could choose to buy basic, sport and basic in a bundle, or sport separately via Fanpass. It builds in the complexity that comes from bundling Sky content with Vodafone broadband access, within the context of consumers being able to choose their own bundle of services based upon their own absolute and relative willingness-to-pay values for each of the components (MB). This is what could be expected to occur if the merger was allowed to proceed and the merged firm had complete freedom to set its prices to maximise profits. It also assesses the consequences for all of total and consumer welfare, and firm profits, of preventing the bundled sale of the components (CP), as might be the outcome if the merger is prevented. Finally, the consequences of mandating a third type of bundling – bundle-size pricing (BSP) – proceeds. BSP offers advantages in that, depending upon the distributions of consumers' willingness-to-pay and the number of items in the bundle(s), it can deliver similar consumer and total welfare outcomes to MB, but at much lower computational cost, especially as the number of different consumer types and products increases. Thus, it becomes an option for competition authorities and regulators to consider when evaluating the comparative harms and benefits of bundling regimes.

The paper proceeds as follows. First, we briefly discuss the economics of bundling and the expected

effects on each of firm profit, total and consumer welfare under a range of different parameters. Next, the model used for our evaluation is described. Third, the model is applied using our estimates of the parameters prevailing in the New Zealand case, and insights drawn as to how these findings could have provided important information to inform the New Zealand Commerce Commission in its Sky-Vodafone decision. Finally, we conclude by discussing how this approach could be used more generally to inform firms, competition authorities and competition policy more generally.

A quick trip through bundling theory

Bundling can lead to the leverage of market power via exclusionary practices (Whinston, 1990), reduction of competition through differentiation (Carbajo, et al., 1990; Chen, 1997) and reduction of heterogeneity in consumers' valuations enabling firms with market power to extract more surplus from consumers (Adams & Yellen, 1976; Schmalensee, 1982; McAfee et al., 1989; Stole, 2007; Crawford, 2006; Crawford et al., 2007). This is clearly detrimental to consumer welfare (for some but not necessarily for all individuals) when consumers are required to purchase products of little or no interest to them (Armstrong, 1996; Bakos & Brynjolfsson, 1999). Yet, the welfare effects can be close to neutral if far-sighted users can anticipate later surplus reduction, or competitive pressure generates seller incentives to bring these future benefits into introductory prices (Shapiro & Varian, 1999; Farrell & Klemperer, 2007). The welfare effects of reduced churn due to bundling are also contingent upon demand stability over time (Prince & Greenstein, 2014).

Furthermore, in many circumstances, bundling may yield both higher profits and higher total surplus than mandatory unbundling (*à la carte* sales i.e. component pricing). These include products with very low marginal costs (Bakos & Brynjolfsson, 1999) and that are nonrivalrous in consumption (Liebowitz & Margolis, 2008), with certain relative demand elasticities for the products in the bundle (Papandrea, Stoeckl & Daly, 2003) and where economies of scope increase consumer surplus (Arlandis, 2008). Indeed, regulations to cap market share or impose *à la carte* on cable operators may reduce producer profits, and absent offsetting increases in consumer welfare, such policy measures may reduce total welfare (Adilov, Alexander & Cunningham, 2012). Moreover, bundle form also affects the levels of profit and welfare achievable, and these may vary depending upon the form of the distributions of consumers' willingness-to-pay for each of the components in the bundle, and the joint distributions of demand for any two or more of them (Chu, Leslie & Sorenson, 2011; Chen & Riordan, 2013).

The typical antitrust view of bundling has been to evaluate its potential strategic use by firms with market power to foreclose competitors. Despite Posner's (1976) argument that a monopolist never finds it worthwhile to tie to reduce the level of competition in the market for the second product, Whinston (1990) finds that where the monopolised product is no longer essential for all the uses of the non-monopolised product(s), tying once again emerges as a profitable exclusionary strategy in two cases: the presence of an inferior, competitively-supplied product; and the existence of a second use for the monopolised product. Whinston's arguments have been especially influential in the evaluation of telecommunications markets, where network operators' ownership of upstream infrastructure opens up the possibility for both margin-squeeze in downstream service and applications markets, and strategic pricing in the delivery of two upstream monopolised products on copper networks (voice telephony and broadband internet access).

However, Prince & Greenstein (2014) argue that the most commonly-observed use of bundling in telecommunications markets has not been tying, where two products must be purchased together if one is to be obtained, but mixed bundling, where consumers can choose to buy either product alone, or both in a bundle. In most cases, the famous 'double', 'triple' and 'quadruple' play offers bundling voice services with respectively broadband, television and mobile connections have been offered at the same time as consumers are able to purchase each of the components separately. As mixed bundling (MB) is less profitable than pure bundling (PB) in most circumstances (McAfee, McMillan & Whinston, 1989), and always for two products with dispersed valuations and fixed marginal costs of zero (a plausible assumption for both telecommunications connections and video content) as long as the valuations of the two products are not perfectly correlated (Adams & Yellen, 1976; Crawford & Yorukoglu, 2012), Prince & Greenstein (2014)

argue that the strategic purpose of telecommunications bundling has been to make consumers ‘sticky’. Rival firms selling a single product seeking to lure consumers away from a firm selling bundled products must discount the single product deeply to overcome the effective discount the consumer receives by buying it in a bundle from the current firm. Forced unbundling (component pricing – CP) may increase competitiveness in the markets for each of the individual elements in the bundle, but is not necessarily welfare-enhancing as it requires some consumers to forfeit the surplus obtained from the original bundle discount. Trading-off of these two effects in a cost-benefit analysis is imperative if an intervention to prevent bundling (or force unbundling) is to be justified.

Furthermore, the welfare effects of bundling (or unbundling) depend on both the number of products in the bundle, the distribution of consumers’ willingness-to-pay for each of the goods in the bundle and the joint distribution of the valuations of the components, as well as the form of bundle pricing adopted and the marginal costs of the components. If the goods have zero marginal cost, and consumer valuations are independently distributed across the products, then as the number of goods in the bundle goes to infinity, PB in these circumstances approximates perfect price discrimination (Armstrong, 1999; Bakos & Brynjolfsson, 1999). An individual consumer’s departure from the mean of the distribution for one product does not predict the consumer’s departure from the mean for any other product. Under the law of large numbers, the variance in the average valuation of the products in the bundle gets smaller as the number of products in the bundle gets larger. For large bundles, the seller confronts demand that is very elastic around the median values for the bundle, and very inelastic away from the mean values. For large bundles, seller profits are maximised when charging a price for the bundle that is just below the price at which the reservation prices are concentrated. This has a positive effect on total welfare – for an individual consumer, the money on the table that would be left for the products valued relatively highly is offset by short money on the products that they value less than the typical consumer.

Specifically, positive à-la-carte (CP) pricing will be inefficient for any nonrival products – thus offering an imperfect solution to the ‘nonrivalrous goods problem’. Bundling allows the seller to cover the cost of creating the nonrivalrous goods comprising the bundle, while confronting the buyer with zero marginal cost for any element of the bundle (Leibowitz & Margolis, 2008). With respect to the very large number of channels of extremely varied content that pay television providers tend to offer in their basic bundles – if the demand for each of these channels is indeed independent of others in the bundle, then the practice is both profit- and welfare-enhancing. Forced unbundling of these channels is unlikely to be beneficial. However, the effects are less clear for products with positive marginal cost, and when consumers are required to purchase products in which they have little or no interest (Armstrong, 1996). While increasing marginal costs tend to favour CP over PB, increasing the number of non-zero cost goods in the bundle may favour PB over a further pricing policy – uniform pricing (UP), where all items in the bundle are priced identically when offered for separate sale (Fang & Norman, 2006).

The key result from more recent work on bundling is that the better the information decision-makers have about the interdependence of the distributions of consumers’ valuations of the goods in the bundles, the more predictable will be the effects of different forms of bundling or unbundling on both profits and welfare. Using copulas to model the stochastic dependence of variables, Chen & Riordan (2013) find for two products, MB is generally more profitable than CP when the values for the two products are negatively correlated. Furthermore, MB also achieves higher profits than CP when values are positively correlated, so long as the dependence is not too great. For a number of notable copula families, they find that MB is always more profitable than separate selling for the entire range of positive dependence, short of perfect dependence. For a single firm with market power selling multiple products, if consumer values for at least two of the products are negatively dependent, independent or have limited positive dependence, then some form of bundling is more profitable than single selling. For a multi-product firm selling two goods competing with a single-product rival producing a differentiated version of one of them, for the same dependence conditions as for the multi-product monopoly, the multi-product firm optimally chooses bundling in equilibrium, regardless of the dependence relationship between the two differentiated versions of the product that both firms produce. Whilst offering a different plausible explanation to that of Prince & Greenstein (2014) for the prevalence of MB in telecommunications markets, they are unable to reach any firm conclusions about the

effects on total and consumer welfare.

While Chen & Riordan’s general theory is tractable for firms offering only a small number of products in a bundle, it becomes rapidly intractable as the number of products in the bundle increases. Thus, simulations and numerical analysis offer perhaps the best means of assessing the likely effects of different demand distributions and bundling strategies for larger numbers of products. Chu, Leslie & Sorenson (2011) use this approach to explore the effects of consumer valuations distributed according to five parametric families - exponential, logit, lognormal, normal and uniform – across a wide range of parameter values and various numbers of goods. However, they observe that even with high levels of low-cost modern computational power, the transaction costs of calculating optimal prices for the pricing policy most likely to lead to highest profits – MB – are extremely high. They suggest that a further pricing strategy – bundle-size pricing (BSP), where one price is charged for buying one product from a selection, another for two products, a third for three products, etc. – approximates the profits from MB, so may prove more attractive for producers. BSP proves most profitable when consumer valuations are negatively correlated, but the magnitude of the margin depends upon the distribution parameters. They also find higher profits in cases where valuations are positively correlated. In some cases, negative correlation reduces the profitability of BSP relative to CP. They attribute this to negative correlation reducing the heterogeneity of consumers’ willingness-to-pay for bundles, at the same time as asymmetry in the variances diminishes with more products in the bundle, as identified by Bakos & Brynjolfsson (1999). As with Adams & Yellen (1976), the marginal costs of the component products influences the superiority of bundle profits. However, they find that for the logit and lognormal distributions, BSP is almost always more profitable than CP, regardless of the level of marginal costs. Regardless of distribution, when all marginal costs are zero, BSP is always more profitable than CP.

Using their numerical approach, Chen & Riordan confirm a number of the findings of researchers using theoretical methods. However, as their focus has been on the decisions faced by firms seeking to maximise profits, they did not take account of the effects on total and consumer welfare, as would be the interest of an antitrust authority or regulator seeking to make a decision on the expected effects of a merger or a policy to forcibly unbundle components from bundles with a large number of products. Despite the apparent merits of this approach, it does not appear to have been used previously to support antitrust or regulatory decisions. We propose to address the gap in this paper by exploring how the use of simulation and numerical analysis could inform the New Zealand Commerce Commission’s decision on the merger between Sky and Vodafone.

The model

In order to interrogate the findings of the Commerce Commission, we have constructed a model along the same lines as Chen & Riordan (2013) to establish numerical results for consumers deciding whether or not to purchase basic content, sports and/or broadband service. The simulations consist of randomly selecting consumers WTP values (with realistic distributions) and then searching through a rather large space of possible price vectors for one that would be profit-maximising for the firm.

Suppose a basic content package, a premium content package and broadband are offered by a single firm. We model and analyse the firm’s price-setting behaviour when customers react to a given set of prices by maximising their individual consumer surplus. The model assumes that there are n consumers, each with a known a priori willingness-to-pay (WTP) by customer i of w_0^i , w_1^i and w_3^i for a basic content package, a premium (sports) content package and unbundled broadband respectively. Each customer then has imputed willingness to pay

$$\begin{aligned}w_2^i &= w_0^i + w_1^i \\w_4^i &= w_0^i + w_3^i \\w_5^i &= w_1^i + w_3^i \\w_6^i &= w_0^i + w_1^i + w_3^i\end{aligned}$$

for the four bundles under consideration: basic plus premium content (subscript 2), basic content plus broadband (subscript 4), premium content plus broadband (subscript 5) and basic as well as premium content plus broadband (subscript 6).

Given a tuple of prices p_0, p_1, \dots, p_6 chosen by the monopoly provider of the services, each customer i selects which (if any) of the products or product bundles to purchase by selecting $\chi_0^i, \dots, \chi_6^i$ to maximise its consumer surplus

$$\sum_{j=0}^6 \chi_j^i (w_j^i - p_j)$$

subject to $\chi_j^i \in \{0, 1\}$ for all j and

$$(\chi_0^i, \chi_1^i, \dots, \chi_6^i) \in H$$

for each i where H is a set of available choices, restrained by possible restrictions imposed by a regulator such as a forced unbundling or a pricing strategy chosen by the monopolist firm. Obviously, the firm will have the greatest opportunity to maximise its profit if the set H is as large as possible since it can always force consumers to purchase bundles instead of individual components (basic, sport or broadband) by setting the component prices very high.

If faced with two choices from the choice set H under consideration, producing the same consumer surplus, the customer prefers a selection $\chi_0^i, \dots, \chi_6^i$ containing broadband over one without and also prefers a selection with more individual items (among basic, premium and broadband) included over one with fewer. If otherwise indifferent between two choices, the consumer tosses a coin for it.

The producer chooses p_0, p_1, \dots, p_6 so as to maximise its revenue

$$\sum_{i=0}^{n-1} \sum_{j=0}^6 p_j \chi_j^i$$

where the χ_j^i obviously depend on the price vector and are chosen by the n consumers as described above. For information goods this can be treated as identical to the profit of the producer. It is assumed that the producer knows what the WTP values are.

The choices χ_j^i are not uniquely determined by the procedure since the consumers may achieve the same consumer surplus in many instances with the same choices. We believe that the maximal revenue found is independent of which of the (for them) equivalent choices the consumers make. A simple proof of this or the exhibition of a counter-example would be required. Furthermore, many price combinations may result in the same profit form the firm so that in general the solution is usually far from unique.

Application to the New Zealand case

In the preliminary study, we consider the following possible choice sets H . First we assume that every product and every bundle is available in the market and has a price ("mixed bundling", MB). Second, we restrict H to allow only the pricing and purchase of the three individual items ("component pricing", CP). Third, we consider a scenario where the monopolist is forced (or chooses) to charged based only on the *number* of individual items purchased, viz. 1 or 2 or 3 ("bundle-size pricing", BSP). The first two choices reflect the observed preferences of the two firms and Commission. Vodafone and Sky have historically made Sky basic and sport content and broadband available as a mixed bundle, via their joint and separate product offerings. The Commission, however in its counterfactual envisages a separate Sky offering its

content components unbundled both from broadband and from each other. We include BSP for comparison as a further bundling choice available either voluntarily for the merged firm or as a possible behavioural undertaking that could be imposed by the regulator (the Commission) for permission to merge to be granted.

The consumers are assumed to have identically distributed WTP values and these are randomly assigned for each consumer. WTP values and prices are assumed to be integers and prices set by the firm, usually as a multiple of 10 dollars (for example, in this study). A revenue maximising price vector is obtained by exhaustive search with a randomised search order for each component price and indifference is resolved by the toss of a coin. This calculation requires a very large number of iterations through possible price vectors, of course.

In order to model (roughly) the New Zealand scenario, we have assume the WTP

- for a basic package to be normally distributed around 50 with standard deviation 20;
- for the sports package to also be normally distributed but around 30 with standard deviation 10, independently; and
- for broadband to be independently Poisson distributed and scaled to have mean 90 and standard deviation 40.

Further, any negative WTP is set equal to zero and we did not correct the distribution parameters for this. In practice therefore the sample mean will tend to be slightly higher than the parameters above. In our view, these assumptions reflect the market realities sufficiently well. We computed the prices and associated revenue (which we identify with profit since we ignore fixed costs), total welfare and consumer surplus for 500 instances of the problem with 10 consumers. The results are illuminating and given in the table below.

Profit	MB	CP	BSP
High	1530.0	1320.0	1480.0
Mean	1274.7	1136.2	1201.3
Low	1100.0	1020.0	870.0
Welfare	MB	CP	BSP
High	1823.0	1746.0	1861.0
Mean	1624.9	1517.7	1631.5
Low	1383.0	1348.0	1325.0
Consumer surplus	MB	CP	BSP
High	522.0	519.0	649.0
Mean	350.2	381.5	430.2
Low	88.0	276.0	241.0

The mean profit of the 500 randomly selected cases is the highest for mixed bundling (MB) and lowest for component pricing (CP), as would be expected. Bundle-size pricing (BSP) lies somewhere between the two but with a lower worst-case profit than either of the other scenarios. Mean total welfare is highest in the BSP scenario and lowest in CP. There is a somewhat wider spread for the CP scenario however. Mean consumer welfare is also highest for the case BSP.

In fact, here one should note that the CP scenario does not represent a very substantial improvement (from a regulator's point of view) over MB. BSP on the other hand, does. The greatest difference between the outcomes for CP and MB is that MB has some cases with a really low consumer surplus whereas CP does

not. A regulator that is interested in improving consumer welfare would appear to have an incentive not to unbundle but to rather enforce bundle-size pricing which is considerable less detrimental to total welfare.

Further, there is a really large spread in all cases which illustrates the uncertain nature of the outcome of any regulatory decision to impose a specific bundling (or unbundling) regime if the regulator is not perfectly aware of the consumer WTP matrix. As we shall see just below, consumer surplus is actually optimal relatively frequently when MB is allowed. We believe that our WTP choices are realistic and that this is indicative of the factual situation. Future work shall be examining model outcomes with a larger number of consumers but, naturally, one can consider this case to represent 10 equally sized groups of consumers. Another possible variation of the model would be to solve optimal pricing strategies when fixing (say) 10 groups and then assigning variable numbers of consumers to each group.

We now consider the number of instances in which each bundling scenario delivers superior results in the following table. As expected, maximal profit can always be obtained using mixed bundling but in a significant number of cases, bundle-size pricing admits the same profit to be realized. It should be noticed that it is usually the case that many sets of prices give rise to the same profit and it is possible that BSP simply forces the firm (in these instances) to choose prices that are more consumer friendly.

Maximal profit	Number of instances
MB	500
CP	0
BSP	63
Maximal welfare	Number of instances
MB	270
CP	14
BSP	272
Maximal consumer surplus	Number of instances
MB	66
CP	143
BSP	324

Maximal total welfare was achieved slightly more frequently using BSP than with MB and only in a very small number of instances by unbundling. Note that the numbers of instance in these tables add up to more than 500 since the same welfare or profit is often achieved by more than one of the scenarios. Maximal consumer surplus is achieved by the BSP scenario in a large majority of cases. This outcome of the study was consistent with the existing literature, e.g. Chu, Leslie & Sorenson (2011), but nevertheless came as a small surprise.

BSP achieves maximal total welfare as well consumer surplus very frequently. It is moreover also easier for the firm to compute the appropriate prices in BSP than MB, given perfect information about the WTP matrix of the consumers, and therefore more realistic. This is because the firm has to choose three prices only whereas the MP scenario requires it to choose seven prices which perforce requires the consideration of a vastly greater number of price combinations. BSP allows the firm to cement the welfare gains of bundling in substantially the same way as MB but allocates more of it to the consumer surplus.

Our model assumes that the firm can discern the consumer WTP perfectly –which is a “worst case” assumption that a regulator might want to consider. In this application, our restriction of possible prices to multiples of 10 dollars reflects the limited resources available to the firm. Even for a theoretical calculation such as this one, determining an optimal pricing strategy for integer dollar prices (instead of multiples of

10) is not really feasible in the MB scenario. Nevertheless, determining an optimal pricing strategy for the firm is vastly less complicated with BSP (and CP).

This work has not considered in detail the difficulties faced by the firm in determining a revenue-maximising pricing strategy. Especially in the MB scenario and in a model with more consumers, there appears to be quite a high likelihood that a firm might not in practice be able to determine an optimal pricing strategy because the mathematical problem is intractable. This further calls into question the ability of a regulator to optimise the total welfare – it is entirely feasible that a firm that has a bundling scenario imposed by regulation is able to choose a pricing strategy under the new scenario that increases revenue and detracts from consumer welfare.

Towards a more general application

Our model provides a tractable means of providing insights into the ways in which demand-side factors might affect the decisions made by firms when choosing how to bundle and price services such as Vodafone's broadband access with Sky's content. It provides insights into profitability and welfare effects of different bundling regimes, at the same time as identifying a wide range of price combinations leading to the same optimal price and welfare outcomes.

Whilst the New Zealand Commerce Commission noted there would be some positive effects on consumer welfare from the merged firm offering bundles, our model allows those benefits potentially to be quantified. If the parameters used for the ten customers in our example can be presumed representative of the 1.8 million fixed broadband customers and 850,000 pay television customers in New Zealand, then the welfare differences can be extrapolated to get estimates of the magnitude of the expected costs or benefits of imposing a particular bundling preference. The difference between the factual (MB) and counterfactual (CP) scenarios now becomes a benchmark against which the possible effects of the uncertain strategic behaviour that could be undertaken by the merged firm can be assessed. The expected welfare costs (magnitude times probability) of the possible strategic behaviour avoided by precluding the merger from proceeding would need to exceed the certain loss from requiring the unbundled sale of the component products if preventing the merger is to be economically justified.

We do not presume that our calculations as they stand here can be used to assess the efficacy of the New Zealand decision because we have not had access to the detailed information available to the Commission to calibrate the model exactly to New Zealand circumstances. However, we suggest that the approach of using simulations and numerical analysis can add to the analytical process when assessing mergers involving bundled products, and therefore lead to better-informed decisions. When there is uncertainty as to how consumers value different products relative to each other (e.g. different WTP distributions, different correlations between the demand for different products), the model can be used to generate different samples and scenarios, the outcomes of which can be assessed against each other for analysing both the factual and counterfactual cases. Whilst this does not reduce the uncertainty as to what the merged firm may do, it removes some of the uncertainty associated with the current imperfect understanding of how consumers might value the different products in the bundle relative to each other. In this way, it in part addresses some of the current practical limitations imposed when using classical SCP principles to assess complex mergers involving bundled products and possibly even two-sided markets.

The simple model presented here has been applied to a specific regulatory example. However, it can be extended for use in a wide variety of decisions, by both firms and regulators. We propose in future work to expand it to include more products, and to assess the welfare effects of BSP when used as a more calculation-efficient means of pricing bundles of products than MB.

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