

Howell, Bronwyn E.; Potgieter, Petrus H.

Conference Paper

Triple-play (un)bundled pricing – cui bono?

28th European Regional Conference of the International Telecommunications Society (ITS):
"Competition and Regulation in the Information Age", Passau, Germany, 30th July - 2nd
August, 2017

Provided in Cooperation with:

International Telecommunications Society (ITS)

Suggested Citation: Howell, Bronwyn E.; Potgieter, Petrus H. (2017) : Triple-play (un)bundled pricing – cui bono?, 28th European Regional Conference of the International Telecommunications Society (ITS): "Competition and Regulation in the Information Age", Passau, Germany, 30th July - 2nd August, 2017, International Telecommunications Society (ITS), Calgary

This Version is available at:

<https://hdl.handle.net/10419/169466>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Triple-play (un)bundled pricing – cui bono?

Bronwyn E Howell – School of Management, Victoria University of Wellington
Petrus H Potgieter – Department of Decision Sciences, University of South Africa

June 2017 (for ITS Europe in Passau)

Abstract

Bundling of broadband access with other services has been a defining characteristic of internet access markets for as long as broadband technologies have been available. Initially, cable television competitors entered telecommunications markets by bundling first voice telephony and subsequently (broadband) internet access with their television products. The fear that bundling broadband access with live sport content could distort competition in broadband markets by first facilitating the assumption of a dominant position in broadband markets and then the squeezing-out of small rivals with low levels of investment but higher costs led to the New Zealand Commerce Commission recently declining to grant clearance for a merger between the dominant pay television provider and the number two (by market share) fixed line broadband provider also the number one mobile operator (Commission 2017; B. E. Howell and Potgieter 2017a; B. E. Howell and Potgieter 2017b).

We investigate the situation where a basic content package, a premium content package and broadband are offered by a firm and analyse the firm's price-setting behaviour when customers react to a given set of prices by maximising their individual consumer surplus. Numerical simulations with random customer valuations is used to illustrate the multiplicity of outcomes that can be expected from a regulatory intervention. We discuss issues arising from this analysis that should be pertinent to decisions in similar cases.

Introduction

Bundling of broadband access with other services has been a defining characteristic of internet access markets for as long as broadband technologies have been available. Initially, cable television competitors entered telecommunications markets by bundling first voice telephony, and subsequently (broadband) internet access with their television products. Telecommunications firms rapidly followed suit by reselling access to pay television (either via third-party infrastructures or their own), leading to the ubiquitous 'triple play' offering coming to dominate residential market purchase. Initially, such bundling likely led to higher levels of broadband uptake than would have occurred under mandatory unbundling, as those with low willingness-to-pay for broadband but higher willingness-to-pay for the other products might buy broadband in a bundle, but not at stand-alone prices (Heatley and Howell 2009).

Bundling and telecommunications markets

From the outset, concerns have been voiced that bundling access to content (television) and infrastructure (broadband) by a telecommunications provider with market power could result in foreclosure of competition in content (television) markets (e.g. Papandrea, Stoeckl, and Daly 2003; Krämer 2009; Maruyama and Minamikawa 2009). Such fears led to mandatory separation of cable television and telecommunications providers in Australia, and some other OECD countries (OECD 2001). More recently, concern has been directed at the potential for foreclosure of competition in broadband markets (FCC 2010; Ofcom 2016). The fear that bundling broadband access with live sport content could distort competition in broadband markets by first facilitating the assumption of a dominant position in broadband markets and then the squeezing-out of small rivals with low levels of investment but higher costs led to the New Zealand Commerce Commission recently declining to grant clearance for a merger between the dominant pay television provider and the number two (by market share) fixed line broadband provider

also the number one mobile operator (Commission 2017; B. E. Howell and Potgieter 2017a; B. E. Howell and Potgieter 2017b).

Theoretical models, however, suggest that even though such foreclosure may occur under some circumstances, under others bundling may yield both higher profits and higher total surplus than mandatory unbundling (à la carte sales or component pricing – CP). These include products with very low marginal costs (Bakos and Brynjolfsson 1999) and that are nonrivalrous in consumption (Liebowitz and Margolis 2009), with certain relative demand elasticities for the products in the bundle (Papandrea, Stoeckl, and Daly 2003) and where economies of scope increase consumer surplus (Arlandis 2009). Indeed, regulations to cap market share or impose à la carte pricing on cable operators may reduce total surplus and, absent offsetting increases in consumer welfare, such policy measures may reduce total welfare (Adilov et al. 2012). Furthermore, consumers need not be passive actors in the markets for bundled products. If they are experienced in the purchase of bundled products, consumers may be able to foresee the possibility of foreclosure and future price increases and therefore expect even deeper discounts for bundles than if myopically maximising their returns in just the current period (Shapiro and Varian 1999; Farrell and Klemperer 2007).

The form of bundling adopted also matters for firm strategy, profitability and welfare outcomes. Whereas foreclosure models such as proposed by Whinston (1990) rely upon the tying of two or more products in a pure bundle (PB), where the products are only sold together, the pricing strategies typically observed in telecommunications markets' 'triple play' offers have been based on mixed bundling (MB), where consumers can choose to buy one or the other or both products, maximising their surplus depending upon their willingness-to-pay (WTP) for the products and the prices at which the components and bundles are offered (Prince and Greenstein 2014). As MB is inconsistent with Whinston-style strategic foreclosure, the strategic motivation for it is rather to make consumers purchasing bundles 'sticky' – that is, unlikely to purchase a (single) product from a rival unless the rival prices it sufficiently low to overcome the effective discount the consumer receives from buying the product in the bundle from the current provider. Bundling can thus be used to reduce consumer churn, preserve a current dominant position and delay the rate at which consumers will substitute from a legacy product contained in a bundle to a newer frontier product offering higher welfare, with consequences for long-term dynamic efficiency.

As the number of products offered in the bundle increases, the more complex it becomes for firms to determine the optimal pricing strategy for any offerings other than PB or the sale of individual items, either at component prices (CP) determined from some form of cost-plus formula or uniform pricing (UP) where all are sold individually at the same price. The calculation of MB prices quickly becomes impractical, even with very high-powered computer resources, as the number of potential bundles rises exponentially when the number of products increases. Optimal bundle-size pricing (BSP), where defined numbers of products are sold for a given price (e.g. any 10 for \$10; any 15 for \$14; any 20 for \$18, etc.), offers a more easily-calculated alternative yielding profits that are nearly as high as those available under MB (Chu, Leslie, and Sorensen 2011). BSP is frequently observed in the pricing of bundles of digital products, such as audio books and music tracks and channels making up pay television packages.

Consequently, the relationship between bundling, profits and welfare in classic triple and quadruple play markets, and the wide array of different forms of product bundles emerging in modern internet and telecommunications markets (e.g. 'zero-rating' offers combined with internet access and other services – Howell and Layton (2016)) is extremely complex. Whilst dynamic efficiency may be harmed by the potential for foreclosure and harm to investment incentives, most forms of bundling lead to higher levels of static efficiency relative to CP, due to a combination of higher profits for firms and higher levels of consumer welfare in total if the gains accrued by high-valuing consumers purchasing bundles exceeds the losses from those required to purchase products for which they have little value. However, the effects depend critically upon the distributions of consumers' WTP for the products in the bundle. MB is generally more profitable than CP when consumers' valuations of at least two products are negatively correlated, and also for a range of positive correlation so long as the dependence is not too great (the range being greater when market shares under separate pricing are closer together). For a number of notable copula families (Frank, Clayton, Farlie-Gumbel-Morgenstern), MB is always more profitable than CP for the entire range of positive dependence, short of full dependence (Chen and Riordan 2013). The effects on consumer welfare are not so easily anticipated theoretically, but it is possible to estimate the effects of specific distributions using a combination of simulation and numerical methods (Chu, Leslie, and Sorensen 2011; B. E. Howell and Potgieter 2017a).

(Un)bundling and Competition Law

For many reasons, therefore, regulators overseeing the activities of dominant firms and competition authorities called on to assess the potential effects of proposed mergers will be interested in the effects of bundling – and unbundling – on market structure, firm profitability and total welfare. The recent New Zealand merger analysis is illustrative. While the risk of strategic foreclosure and reduced consumer churn attending bundled offers may be real, analysis must also take into account the magnitude of the welfare effects arising from the bundling itself. It is beholden on competition authorities to undertake at least some form of quantitative analysis to understand how the relative effects might trade off against each other. Whilst it may not be easy to estimate the magnitude of the dynamic efficiency effects, this does not preclude an estimate of the more tractable static effects being made.

In an earlier paper (B. E. Howell and Potgieter 2017b) we developed a simple model closely reflecting the options ‘on the table’ in the Sky-Vodafone merger case analysed by Commission (2017). The model builds in the complexity that comes from bundling Sky basic video and sport 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 and CP). 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. For comparison, the consequences of adopting BSP are also assessed. In that paper, it was found, using ten consumers with independently-distributed willingness to pay for the three products and prices with prices as multiples of \$10 that on average, MB delivered both higher profits and higher levels of consumer surplus than CP. If these findings for 10 consumers could be extrapolated to the wider New Zealand population, then the margin between total and consumer welfare estimated could be used as a yardstick against which to measure the expected costs to dynamic efficiency from the merger proceeding (MB prevailing) or not (CP prevailing). However, it was found that the third pricing policy examined – BSP – delivered on average comparable profits but higher total and consumer surplus than MB, so offered an attractive alternative set of choices for both the firm(s) and the competition authority as well as a higher welfare threshold against which to test the potential costs to dynamic efficiency from the merger proceeding. In this paper, we build on the earlier model and analysis, to illustrate further ways in which a combination of simulation and numerical analysis may provide valuable information to decision-makers of the potential effects on firm profitability and consumer welfare arising from different decisions made about the form of bundling adopted.

The model

In order to interrogate the findings of the Commerce Commission, we 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. This approach allows us to investigate a range of different conditions and phenomena.

Suppose a basic content package, a premium content package and broadband are offered by a single firm. The model assumes that there are n consumers, each with a known a priori willingness-to-pay (WTP). The WTP of customer i is 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 for the four bundles

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

under consideration: basic plus premium content (BPC, subscript 2), basic content plus broadband (BBC, subscript 4), premium content plus broadband (BBP, subscript 5) and basic as well as premium content plus broadband (BBBP, subscript 6). The notation follows that of our software, written in Python where arrays are indexed starting by 0.

Given a tuple of prices p_0, p_1, \dots, p_6 chosen by the firm, each customer i selects which (if any) of the products or product bundles to purchase by selecting $\chi_0^i, \dots, \chi_6^i \in \{0, 1\}$ to maximise its individual 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 (for example) always force consumers to purchase bundles instead of individual components (basic, sport or broadband) by setting the component prices very high. We assume $\{0, 0, 0, 0, 0, 0, 0\} \in H$ so that each customer is free to purchase nothing at all.

If faced with two choices (from the choice set H under consideration) that generate 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 (form among basic, premium and broadband) included over one with fewer. If otherwise indifferent between two choices, the consumer randomly chooses one.

The firm selects p_0, p_1, \dots, p_6 (possibly from a limited search space) so as to maximise its revenue

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

where the customer choices χ_j^i obviously depend on the values of 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 or, at least, can determine the consumer decisions for a given price vector (p_0, p_1, \dots, p_6) in order for it to be able to determine a maximising price vector. Our software finds the price vector by exhaustive search through a finite and discrete search space.

Now, 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 different choices. Indeed, the firm could also find many price vectors leading to the same maximal revenue. 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 is, of course, required. In principle, different but equivalent (in terms of revenue, from the point of view of the firm) price vectors might corresponded to different consumer choices and different total welfare.

Application to the New Zealand case

Motivated by the merger decision described above, we consider the following versions of the choice set H .

1. We assume that every product and every bundle is available in the market and has a price (“mixed bundling”, MB).
2. We restrict H to allow only the pricing and purchase of the three individual items (“component pricing”, CP).
3. 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 versions of H reflect the observed preferences of the two firms and of the 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. BSP is included 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 for permission to merge to be granted.

The consumers are assumed to have identically distributed WTP values and these are randomly assigned – in our study using the random number generators of the Python module *random*. WTP values and prices are assumed to

be integers as are prices set by the firm – these usually as a multiple of 10 or 5 dollars (for example). 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, which is the reason the prices are normally restricted to multiples of 10 or 5.

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 the sample mean will therefore tend to be slightly higher than the parameters above but this is really of no consequence except that it implies that none of the customers have a negative valuation of any of the products. In our view, these assumptions reflect the market realities sufficiently well.

Earlier work

B. E. Howell and Potgieter (2017b) discuss 500 instances of ten consumers with prices as multiple of 10, computed earlier. The mean profit of the 500 randomly selected cases was the highest for mixed bundling (MB) and lowest for component pricing (CP), as would be expected. Bundle-size pricing (BSP) was placed somewhere between the two but with a lower worst-case profit than either of the other scenarios. Mean total welfare was highest in the BSP scenario and lowest in CP. Mean consumer welfare was also highest for 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. 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 considerably less detrimental to total welfare.

The uncertainty of the efficacy of imposing a bundling regime is illustrated by the following table showing the number of instances in which each bundling scenario delivered superior results. 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 and maximal consumer surplus is far most frequently found using BSP which furthermore allows for maximal total welfare to be achieved slightly more frequently than MB.

Table 1: Summary result of earlier work with 500 instances of 10 customers, prices as multiples of 10 (B. E. Howell and Potgieter 2017b)

	Maximal	Number of instances
Profit		
MB		500
CP		0
BSP		63
Welfare		
MB		270
CP		14
BSP		272
Consumer surplus		
MB		66
CP		143
BSP		324

This outcome of this earlier study was consistent with the existing literature, e.g. Chu, Leslie, and Sorensen (2011).

It was a strong motivation for our decision to look at BSP again in this contribution. 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. With BSP, the firm has to choose three prices only whereas the MB scenario requires it to choose seven prices which perforce requires the consideration of a vastly greater number of price combinations. BSP appears to allow 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.

New results

In this paper, we discuss the result of 10 instances of randomly chosen WTP for 10 consumers and compute the optimal prices to a multiple of 5 for MB and for all integers for BSP. It is feasible to do so for BSP since the search space is so much smaller, being in 3 rather than 7 dimensions. This still reflects a bound on the discernment power of the firm but a relatively weak one.

In order to better illustrate the working of the model, consider the first of these 10 instances. It has the following customer WTP.

Table 2: WTP for instance (i) of 10 users

BC	PC	BPC	BB	BBC	BBP	BBBP
51	34	85	89	140	123	174
59	38	97	107	166	145	204
45	17	62	71	116	88	133
47	29	76	107	154	136	183
54	19	73	53	107	72	126
37	37	74	89	126	126	163
43	34	77	71	114	105	148
40	28	68	89	129	117	157
59	4	63	53	112	57	116
29	28	57	53	82	81	110

Running the model yields the following revenue-maximising prices for MB and BSP, respectively. These prices are not unique in this respect – as discussed above – they are merely the ones produced by our procedure on this run.

Table 3: Revenue-maximising prices (one run) for instance (i)

Regime	BC	PC	BPC	BB	BBC	BBP	BBBP
MB	60	25	80	80	110	105	125
BSP	53	53	98	53	98	98	110

One can compute the maximal revenue/profit, total welfare and consumer surplus associated with these prices and for instance (i), they are as follows.

Table 4: Profit, welfare and consumer surplus for instance (i)

Regime	Maximal profit	Welfare	Consumer surplus
MB	1135	1428	293
BSP	1088	1510	422

Doing the calculations (with multiple 5 prices for MB and integer prices for BSP) for the 10 instances discussed here, took just under five days on a reasonably powered laptop. This should be compared to the less than 2 days that it took to compute 500 instances of 10 consumers with prices as multiples of 10 in the previous study (B. E.

Howell and Potgieter 2017b). The summary results for the 10 instances follow.

Table 5: Overall outcomes for MB

Mixed bundling (MB)	Profit	Welfare	Consumer surplus
max	1500.0	1731.0	480.0
mean	1234.0	1532.6	298.6
min	1050.0	1389.0	164.0

Table 6: Overall outcomes for BSP

Bundle-size pricing (BSP)	Profit	Welfare	Consumer surplus
max	1284.0	1912.0	752.0
mean	1134.5	1575.8	441.3
min	1038.0	1288.0	222.0

As in the previous study (B. E. Howell and Potgieter 2017b), we see that mean total welfare is higher under BSP than under MB although the mean profit is considerably lower for BSP. In the previous study, we did however observe an instance of very low profit for BSP but this could be due to us having looked only at prices that are a multiple of 10 instead of 5, as here. Since BSP optimal prices are simpler to compute, these optimal values can be found by searching the space of all integer values for BSP in less time than it takes to search for optimal multiple of 5 prices for MB. This is a feature that should make BSP attractive to service providers as well as regulators.

Table 7: Consumers' purchases under mixed bundling (MB)

MB purchases	BC	PC	BPC	BB	BBC	BBP	BBBP
max	0.0	1.0	3.0	0.0	2.0	3.0	9.0
mean	0.0	0.2	1.2	0.0	0.4	1.2	6.4
min	0.0	0.0	0.0	0.0	0.0	0.0	4.0

Table 8: Consumers' purchases under bundle-size pricing (BSP)

BSP purchases	BC	PC	BPC	BB	BBC	BBP	BBBP
max	0.0	0.0	0.0	1.0	2.0	1.0	9.0
mean	0.0	0.0	0.0	0.2	0.6	0.2	8.0
min	0.0	0.0	0.0	0.0	0.0	0.0	6.0

Table 9: Total number of products sold

Number of products sold	MB	BSP
max	27.0	29.0
mean	25.0	25.8
min	22.0	20.0

Table 10: Customers making no purchase

Excluded consumers	MB	BSP
max	2.0	3.0

Excluded consumers	MB	BSP
mean	0.6	1.0
min	0.0	0.0

On average, there is a higher uptake of the triple-play (BBBP) bundle under BSP in our 10 examples than under MB. In none of the ten cases was there a 100% uptake of the BBBP. Under MB there was a relatively large uptake of broadband plus premium content (the bundle BBP) as well as the content bundle (BPC) or even premium content (PC) only whereas our 10 examples under BSP show consumers either selecting a bundle containing broadband or buying nothing at all.

Indeed, as the preceding table shows, there is a higher incidence under BSP of complete exclusion but this is simply because customers unwilling to purchase broadband under BSP generally do not have the option of purchasing only a content package since these are priced too high. This is a natural feature of BSP where one of the products is significantly more highly valued than the others. The same feature is responsible for the average (and minimal) uptake of BBBP to be significantly higher under BSP than under MB. Also, the average uptake of broadband or a bundle containing broadband is 9 under BSP (90%) but only 8 under MB (80%). The average total number of products sold is also higher under BSP.

Table 11: Customer preference order

Preference order	BB>BC>PC	BB>PC>BC	BC>BB>PC	BB>PC=BC	BC>PC>BB
max	7.0	2.0	5.0	1.0	1.0
mean	5.9	1.6	2.1	0.2	0.2
min	4.0	0.0	0.0	0.0	0.0

It is interesting to examine the orderings of customer valuations appearing in the randomly generated WTP cases. On average 5.9 of the 10 customers have the usual preference BB>BC>PC but in our sample this ranges from a low of 4 to a high of 7 which is a relatively large difference. BC>BB>PC occurs for 5 out of 10 customers in one instance and if we take this preference order together with BC>PC>BB (the other occurring order in which BB does not dominate) then we have on average 2.3 out of 10 customers not valuing broadband highly. This illustrates one of the applications of bundling – to enable the firm to set prices so that the customers with a high valuation of broadband are forced to also purchase the content with the consequence that the customer with a low broadband valuation and high preference for content will also have broadband access. Many would see this as an advantage from a policy point of view.

Table 12: Ranges of prices observed for 10 simulations

Case			BC	PC	BPC	BB	BBC	BBP	BBBP
(i)	MB	max	60	25	85	110	110	125	125
		min	60	25	75	65	110	90	125
	BSP	max	98	98	98	98	98	98	110
		min	53	53	98	53	98	98	110
(ii)	MB	max	70	45	70	125	155	125	155
		min	45	40	70	100	130	125	155
	BSP	max	126	126	126	126	126	126	152
		min	94	94	126	94	126	126	152
(iii)	MB	max	65	45	65	170	170	170	170
		min	45	30	65	105	160	145	170
	BSP	max	96	96	96	96	96	96	121
		min	53	53	96	53	96	96	121

Case			BC	PC	BPC	BB	BBC	BBP	BBBP
(iv)	MB	max	90	45	125	105	135	105	135
		min	85	35	120	90	125	105	135
	BSP	max	89	89	123	89	123	123	136
		min	89	89	122	89	122	122	136
(v)	MB	max	75	45	75	125	180	135	180
		min	70	30	75	105	160	135	180
	BSP	max	114	114	114	114	114	114	130
		min	71	71	114	71	114	114	130
(vi)	MB	max	85	45	90	120	170	120	170
		min	65	35	90	100	135	120	170
	BSP	max	122	122	122	122	122	122	130
		min	82	82	113	82	113	113	130
(vii)	MB	max	75	30	105	80	105	80	125
		min	55	30	75	55	105	80	125
	BSP	max	53	53	105	53	105	105	128
		min	53	53	105	53	105	105	128
(viii)	MB	max	70	55	120	110	125	125	125
		min	45	30	75	60	105	95	125
	BSP	max	108	108	120	108	120	120	126
		min	61	61	103	61	103	103	126
(ix)	MB	max	65	50	90	160	180	160	180
		min	55	40	90	120	155	160	180
	BSP	max	104	104	104	104	104	104	133
		min	71	71	104	71	104	104	133
(x)	MB	max	90	50	90	100	125	100	145
		min	45	45	90	95	125	100	145
	BSP	max	108	108	135	108	135	135	138
		min	96	96	135	96	135	135	138

Finally, we consider the ranges of optimal prices for the 10 instances observed in this numerical experiment. The table immediately above shows the range of prices observed. The columns should be read independently since it is not necessarily the case that all of the price vectors in the cross product of the ranges in the table are optimal.

Generally, the takeup is highest for the triple-play bundle BBBP and hence this is the most important price and is uniquely determined in each of our examples (within the search spaces of multiples of 5 and integers, respectively). The component prices are often observed in a relatively broad range but this varies widely from instance to instance. Although the price of the triple-play is usually higher (sometimes substantially) for MB, this is not always the case. It is however possible that the three cases of triple-play price being higher for BSP than for MB that we observe here could be an artefact of having restricted the MB prices to multiples of 5 and that for integer prices, this would disappear.

Further work

This work has not yet 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 optimisation 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 because it had not been able to find an optimal pricing strategy in the earlier regulatory environment, for example. We also intend to expand this work to an analysis of cases with a larger number of customers although the computational challenges remain considerable. At the same time, we also intend to consider bundles with more than three components.

Conclusion

We have outlined the basic parameters of our model of three products which could potentially be bundled for sale in any of unbundled components (CP), mixed bundles (MB) and bundle-sized pricing (BSP). These could represent the three components of a ‘triple play’ (television, broadband and voice telephony), or, as in the New Zealand case assessed in Commission (2017), a basic video content bundle, a premium video content bundle and broadband access. Next, for illustrative purposes, we calibrated the model, to the best of our judgement, to the New Zealand circumstances prevailing at the time the merger was proposed. We then ran a number of simulations, varying structural elements of the model specification to test its sensitivity to various parameters, including the resources (computing and transaction costs) available the firm(s) and/or competition authority to evaluate the various options.

These analyses in large part reinforce the findings of B. E. Howell and Potgieter (2017b) regarding the relative and absolute magnitudes of the benefits of MB and the superiority of BSP in many respects. However, an important additional finding is that for three products at least, there is a wide range of equally-profitable and/or equally consumer welfare-maximising prices at which MB and BSP product bundles can be sold. Whilst BSP prices of very much finer granularity can be calculated for the same resources used to calculate much coarser MB prices, the variety of optimal price vectors remains.

The implication of these findings for both firms setting prices and competition authorities in assessing the effects of bundles on market structure and welfare outcomes is that numerical simulation can help understand the range of possible outcomes to be expected from ex ante imposition of a bundling regime. Our results reinforce those of earlier work (B. E. Howell and Potgieter 2017b) showing that bundle-size pricing (BSP) has many attractive features, for consumers, regulators as well as producers.

References

- Adilov, Nodir, Peter Alexander, B. Cunningham, and others. 2012. “Smaller Pie, Larger Slice: How Bargaining Power Affects the Decision to Bundle.” *The BE Journal of Economic Analysis & Policy* 12 (1): 1–25. [https://www.degruyter.com/dg/viewarticle.fullcontentlink:pdfeventlink/\\$002fj\\$002fjeap.2012.12.issue-1\\$002f1935-1682.2733\\$002f1935-1682.2733.pdf?t:ac=j\\$002fjeap.2012.12.issue-1\\$002f1935-1682.2733\\$002f1935-1682.2733.xml](https://www.degruyter.com/dg/viewarticle.fullcontentlink:pdfeventlink/$002fj$002fjeap.2012.12.issue-1$002f1935-1682.2733$002f1935-1682.2733.pdf?t:ac=j$002fjeap.2012.12.issue-1$002f1935-1682.2733$002f1935-1682.2733.xml).
- Arlandis, Antonin. 2009. “Bundling and Economies of Scope.” SSRN Scholarly Paper ID 1374389. Rochester, NY: Social Science Research Network. <https://papers.ssrn.com/abstract=1374389>.
- Bakos, Yannis, and Erik Brynjolfsson. 1999. “Bundling Information Goods: Pricing, Profits, and Efficiency.” *Management Science* 45 (12): 1613–30. doi:10.1287/mnsc.45.12.1613.
- Chen, Yongmin, and Michael H. Riordan. 2013. “Profitability of Product Bundling*.” *International Economic Review* 54 (1): 35–57. doi:10.1111/j.1468-2354.2012.00725.x.
- Chu, Chenghuan Sean, Phillip Leslie, and Alan Sorensen. 2011. “Bundle-Size Pricing as an Approximation to Mixed Bundling.” *The American Economic Review* 101 (1): 263–303. <http://www.jstor.org/stable/41038789>.
- Commission, New Zealand Commerce. 2017. “Determination: Vodafone Europe B.V. and Sky Network Television Limited [2017] NZCC 1; Sky Network Television Limited and Vodafone New Zealand Limited [2017] NZCC.”

<http://www.comcom.govt.nz/dmsdocument/15364>.

Farrell, Joseph, and Paul Klemperer. 2007. "Chapter 31 Coordination and Lock-in: Competition with Switching Costs and Network Effects." In *Handbook of Industrial Organization*, edited by M. Armstrong and R. Porter, 3:1967–2072. Elsevier. <http://www.sciencedirect.com/science/article/pii/S1573448X06030317>.

FCC. 2010. "Broadband Decisions: What Drives Consumers to Switch-or Stick with-Their Broadband Internet Provider." Working Paper. <https://www.fcc.gov/document/broadband-decisions-what-drives-consumers-switch-or-stick-their>.

Heatley, Dave, and Bronwyn Howell. 2009. "The Brand Is the Bundle Strategies for the Mobile Ecosystem." *Communications & Stratégies*, no. 75: 79–100. <http://cat.inist.fr/?aModele=afficheN&cpsidt=22077547>.

Howell, Bronwyn E., and Roslyn Layton. 2016. "Evaluating the Consequences of Zero-Rating: Guidance for Regulators and Adjudicators." SSRN Scholarly Paper ID 2757391. Rochester, NY: Social Science Research Network. <https://papers.ssrn.com/abstract=2757391>.

Howell, Bronwyn E., and Petrus H. Potgieter. 2017a. "Never a Sporting Chance: Broadband and Content Bundling in the Merger of Two Dominant Firms." SSRN Scholarly Paper ID 2965966. Rochester, NY: Social Science Research Network. <https://papers.ssrn.com/abstract=2965966>.

———. 2017b. "Competition and Vertical/Agglomeration Effects in Media Mergers: Bagging Bundle Benefits." SSRN Scholarly Paper ID 2992394. Rochester, NY: Social Science Research Network. <https://papers.ssrn.com/abstract=2992394>.

Krämer, Jan. 2009. "Bundling Vertically Differentiated Communications Services to Leverage Market Power." *Info* 11 (3): 64–74. doi:10.1108/14636690910954980.

Liebowitz, Stan J., and Stephen E. Margolis. 2009. "BUNDLES OF JOY: THE UBIQUITY AND EFFICIENCY OF BUNDLES IN NEW TECHNOLOGY MARKETS." *Journal of Competition Law & Economics* 5 (1): 1–47. doi:10.1093/joclec/nhn013.

Maruyama, Masayoshi, and Kazumitsu Minamikawa. 2009. "Vertical Integration, Bundled Discounts and Welfare." *Information Economics and Policy* 21 (1): 62–71. doi:10.1016/j.infoecopol.2008.10.002.

OECD. 2001. *OECD Communications Outlook 2001*. OECD Publishing.

Ofcom. 2016. "The Communications Market Report 2016." *Ofcom*. <https://www.ofcom.org.uk/research-and-data/multi-sector-research/cmr/cmr16>.

Papandrea, Franco, Natalie Stoeckl, and Anne Daly. 2003. "Bundling in the Australian Telecommunications Industry." *Australian Economic Review* 36 (1): 41–54. doi:10.1111/1467-8462.00266.

Prince, Jeffrey, and Shane Greenstein. 2014. "Does Service Bundling Reduce Churn?" *Journal of Economics & Management Strategy* 23 (4): 839–75. doi:10.1111/jems.12073.

Shapiro, Carl, and Hal R. Varian. 1999. *Information Rules: A Strategic Guide to the Network Economy*. Harvard Business Press.

Whinston, Michael D. 1990. "Tying, Foreclosure, and Exclusion." *American Economic Review* 80 (4): 837–59. <https://ideas.repec.org/a/aea/aecrev/v80y1990i4p837-59.html>.