Contracts and Competition in the Pay TV Market*

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Abstract

We analyze the effects of contracts for the sale and resale of premium programming on competition in the pay TV market. The main finding is that competition is ineffective when resale contracts specify per subscriber, as opposed to lump sum, fees. Pay TV companies can achieve monopolistic market outcomes by agreeing on the per subscriber fee which extracts all of the consumer surplus from the premium product, and consumers would prefer a ban on resale contracts. A number of potential remedies are considered. A ban on exclusive contracts would intensify downstream competition and transfer the social benefits of premium programming from firms to consumers.

Key words: Pay TV market, contracts, Hotelling model

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1. Introduction

This paper analyses competition in the market for pay TV using a simple model inspired by the current market situation in the UK. Our purpose is to gain an understanding of how different contractual arrangements for the sale and resale of premium broadcasting rights affect downstream competition, the distribution of rents between upstream rights owners and downstream pay TV companies, and overall economic welfare. The UK's Office of Fair Trading (OFT) is currently conducting a Competition Act inquiry into BSkyB's wholesale pricing and other practices to determine whether the company's position in the UK pay TV market is having a damaging effect on competition. This calls for an economic analysis of these contractual arrangements to determine whether they are anticompetitive.

Pay TV companies in Britain compete by purchasing the rights to broadcast programs and selling subscriptions to viewers.[1] The companies' products are differentiated both in terms of the programming packages they offer, and in the means of delivery. There are currently three types of network: the direct to home (DTH) satellite network operated by British Sky Broadcasting (BSkyB) (with approximately 53% of subscribers), local cable networks (with 37% of subscribers), and a digital terrestrial network (DTT) operated by the most recent entrant, ONdigital.

Each company offers various packages of "basic" programming which must be taken by all subscribers. So-called "premium" programming, typically major sports events and Hollywood movies, can then be purchased for an additional monthly fee. Access to premium programming is widely viewed as being crucial for attracting customers. As Armstrong (1999) notes: "premium programming, where BSkyB currently holds an extremely strong position, is the major driver of subscriptions."[2]

As the first entrant in the market, BSkyB early on acquired the exclusive broadcasting rights to practically all of the Hollywood studio's first run films, and to the majority of the major sports events available to pay TV. BSkyB purchases these rights under exclusive vertical contracts with upstream rights sellers, and then resells the programming to its downstream competitors for variable, or per subscriber, fees. For example, the UK's Premier League has sold the exclusive rights to broadcast live football matches to UK pay TV companies in periodic auctions since 1992.[3] BSkyB has so far always acquired these rights, and it resells the programming to its retail competitors in the pay TV market for a per subscriber (monthly) fee. The implications of these contractual arrangements for competition and economic welfare are not yet well-understood.

To address these issues we use a relatively simple model of competition in the pay TV market which allows us to analyze the effects of both vertical contracts between an

[1] See Cave and Crandall (2001) for an overview of the UK industry.

[2] There is fairly overwhelming evidence that the acquistion of premium programming rights confers monopoly power on broadcasters. See Armstrong (1999)(2000), Monopolies and Mergers Commission (1999) and Harbord, Hernando and von Graevenitz (2000).

[3] Harbord and Binmore (2000) and Klemperer (2000) discuss these auctions.

upstream rights seller and downstream firms, and horizontal (i.e. resale) contracts between the downstream firms. Our point of departure is the recent paper by Armstrong (1999) which analyses competition in the pay TV market in the context of a classic Hotelling model, with asymmetries in the value of firms' products to consumers and in the firms' costs.[4]

In Armstrong's version of the Hotelling model, firms initially compete in prices to sell differentiated products ("basic programming") to customers.[5] When the rights to premium programming become available in an upstream market, acquisition of the programming symmetrically increases attractiveness of each firm's programming to subscribers. The outcome of the sale of the rights in the upstream market, however, can have a substantial impact on the competitive balance in the downstream pay TV market. A downstream firm which acquires the *exclusive* rights to premium programming obtains a competitive advantage over its rival, and the rival suffers a loss (a negative externality). Competition to purchase the rights can therefore be modelled as an auction with externalities in which downstream competition is affected by the outcome of the auction (see e.g. Jehiel and Moldovanu, 2000).

In the absence of resale, the industry leader's willingness to pay for the rights always exceeds that of its smaller rival, hence it will acquire the rights in an auction. Armstrong (1999) considers what happens when the industry leader is able to resell the programming to its downstream competitor for a fixed (i.e. lump sum) payment, and concludes that reselling will not take place since it would reduce the competitive advantage of the advantaged firm.[6] Although the smaller downstream firm (and its consumers) would benefit from having access to the premium product, this gain is less than the industry leader's loss in competitive advantage from reselling. Hence reselling will typically be socially optimal, but not privately profitable, in this set up.

Armstrong also considers alternative mechanisms (i.e. different vertical contracts) the upstream rights seller might adopt for selling premium programming rights, and concludes that the seller will prefer exclusive contracting when programming is sold for either lump sum or per subscriber fees. Essentially, exclusive contracting allows the upstream rights seller to exploit the negative externality suffered by a downstream firm which fails to acquire the rights, and hence increases its payoff.[7]

In this paper we extend Armstrong's analysis by allowing downstream firms to resell premium programming obtained under an exclusive vertical contract for variable, or *per subscriber fees,* and obtain very different conclusions. We show that reselling via per

[4] The Hotelling model has been widely used in a variety of similar contexts. See especially Laffont, Rey and Tirole (1998a)(1998b) who analyse reciprocal network access pricing.

[5] One firm – the advantaged firm or "industry leader" – is assumed either more efficient than its rival, or else to have previously acquired a more attractive package of basic programming.

[6] Armstrong (1999) does not consider what would happen if the smaller firm acquired the exclusive rights and considered reselling to the industry leader. We explore this case below.

[7] See also Armstrong (2000) for a simple example of this effect.

subscriber fees will always occur when the exclusive rights are originally purchased for either lump sum or per subscriber fees from the upstream rights seller, and that this has profound effects on the nature of competition in the pay TV market. The model thus predicts that reselling will take place under precisely the conditions observed in this market. Like Armstrong's analysis, our model also realistically predicts that the upstream rights seller will prefer exclusive to nonexclusive vertical contracts. The remainder of this introduction summarizes the principal conclusions of our analysis.

1.1. Effects of resale contracts on downstream competition

Our key result is that downstream competition to supply premium programming to consumers is ineffective when resale contracts specify per subscriber rather than lump sum (i.e. fixed) fees. Reselling for per subscriber fees means that all consumers in the market will be served (i.e. purchase the premium product), thus avoiding one of the contracting inefficiencies identified by Armstrong (1999). It does so however, in a manner which does not dissipate the monopoly rents available from the sale of premium programming. Resale for per subscriber fees allows a downstream firm which acquires the exclusive rights to prevent the dissipation of downstream profits by increasing the marginal cost of its competitor, i.e. *raising rival's costs*, while simultaneously increasing the *opportunity cost* of serving its own customers. This increased opportunity cost has exactly the same effect as an increase in the reselling firm's marginal costs, and gives both firms an incentive to increase their retail prices to monopolistic levels.[8]

The resale price thus acts as an effective mechanism for relaxing downstream price competition and extracting consumer surplus from the premium product. In fact, the highest resale fee which can be implemented without a bribe or a penalty extracts all of the surplus available from selling the premium good to consumers in our model, and this surplus accrues to the reselling firm. Consumers are therefore deprived of the benefits of competition. *It is as if the premium programming market were monopolized by a single firm, and consumers would prefer a ban on resale contracts, even though this typically reduces social welfare!*

If instead the premium product were sold by both downstream firms who faced 'uninflated' marginal costs (i.e. if both firms acquired the rights for a lump sum fee) fierce downstream competition to sell the programming to consumers would result in the rents being competed away, and the surplus captured by consumers. This observation suggests that one remedy for the competition problem identified would be to regulate the way in which premium programming rights are sold and resold.

When downstream firms are able to write enforceable *contingent* contracts specifying

[8] Another way of saying this is that in the Hotelling model, an increase in the per subscriber resale fee shifts the reaction functions of both firms outwards in exactly the same way, inducing both firms to increase their retail prices. This opportunity cost effect of resale on the selling firm's competitive incentives is always present in differentiated product Bertrand price competition.

a bonus (or penalty) for implementing the prices desired by the seller, even more collusive outcomes can be attained, and in some circumstances the joint monopoly (i.e. perfectly collusive) outcome can be implemented. Such unrestricted contingent contracts are likely to violate competition laws however, so they may be unenforceable. Quantity forcing contracts, or quantity discounts, are imperfect substitutes since they give rise to additional incentive compatibility constraints. However more collusive market outcomes can be implemented using this type of contract, and they are likely to escape antitrust scrutiny, and hence be enforceable.[9]

1.2. Effects of resale contracts on upstream competition

Another conclusion of our analysis is that the upstream rights seller will usually prefer to sell programming rights exclusively to one downstream firm, rather than nonexclusively to both firms. Nonexclusive vertical contracts are either equivalent to exclusive contracts in terms of extracting surplus for the upstream rights seller, or perform strictly worse.[10]

Our analysis thus predicts a number of the key features of competition in the UK pay TV market, and in particular the form of the rights selling and resale contracts. A key conclusion for competition policy purposes is that these vertical and horizontal contracts may actually harm consumers *compared to the case of no resale, in which some consumers do not get served.*

1.3. Key conclusions and related literature

Although our conclusions are derived from a specific model of competition between pay TV companies, which abstracts from many potentially relevant features of the industry, they are not entirely novel, and similar results have been shown to hold elsewhere. The well-known papers by Salop and Scheffman (1983), (1987) and Krattenmaker and Salop (1986) are standard references on raising the costs of competitors via the sale of an essential input, and have obvious relevance here.[11]

The most closely related results come from the literature on patent licensing - especially Katz and Shapiro (1985), Shapiro (1985), and Kamien and Tauman (1986). Katz and Shapiro (1985) consider a model in which the owner of a cost-reducing innovation may license it to a downstream rival for a fixed fee, a per-unit charge (royalty rate) or under a two part tariff. The two firms then compete a la Cournot in a homogeneous product final goods market.

[9] Perhaps paradoxically, quantity forcing contracts tend to be more acceptable to competition authorities than contracts specifying noncontingent negative fixed fees.

[10] One exception occurs when the initial asymmetry between the firms is large, and the market share of the industry leader in the absence of premium programming exceeds 75% (see Armstrong, 1999, p. 275). In this case the upstream rights seller still prefers exclusive contracts, but would like to prohibit reselling.

[11] See also Riordan and Salop (1995) and Vickers (1996).

Licensing for a fixed fee to a rival is not always in the interest of the licensor in this model, for the same reason that reselling for a lump sum fee is not always optimal in the basic Hotelling model.[12] Katz and Shapiro (1985) also consider variable fee licensing contracts and find that there is always a licensing agreement which is preferred by both firms to the 'no licensing' alternative. Under Cournot competition, the licensor chooses a royalty rate such that the reaction function of the licensee is identical to its reaction function in the absence of licensing. Hence the licensing agreement does not change the pattern of industry output, but results in cost savings which the licensing firm appropriates via the royalty rate, or which firms may share via the fixed component of a two part tariff.

More generally however, as Shapiro (1985) explains, firms can use licensing agreements to facilitate collusion. Essentially the licensor can induce the rival to reduce its output to zero by imposing a high enough per unit royalty rate. The fixed fee can then be used as a "bribe" to induce the licensee to accept the output reduction, thus implementing the collusive market outcome.[13]

The main difference between the Katz and Shapiro analysis and our own is that, in the Cournot model, a per subscriber fee induces firms to produce exactly the same outputs they would have *in the absence of a resale agreement*, thus sharing some of the benefits of the cost reducing innovation with consumers.[14] A negative fixed fee is required to compensate the rival for reducing its output further, and increasing market price to the collusive level. In the Hotelling model, a per subscriber resale fee shifts the reaction functions of both firms outwards *in exactly the same way*, inducing both firms to increase their retail prices. The resale contract results in both firms producing the same outputs they would have in the absence of the premium programming being available, while retail prices increase by the willingness to pay of consumers for the premium product.

Per subscriber resale fees in the Hotelling model therefore extract all of the rents from the availability of premium programming, and consumers would be better off in the absence of resale contracts. The effect of a linear two part tariff (i.e. a variable fee and a noncontingent fixed payment) in this setting is merely to redistribute the monopoly rents from selling premium programming to consumers between the firms, without changing the market equilibrium.

[12] In particular, "large" innovations which result in monopolization will not be licensed by either firm. "Small" innovations will not be licensed by the industry leader but may be licensed by the smaller, rival firm. In both of these cases however, the industry leader's preemption incentive exceeds the preemption incentive of the smaller firm, hence it will outbid its rival in an auction to acquire the innovation. These conclusions thus parallel exactly the conclusions reached in our analysis of the Hotelling model.

[13] Indeed, Shapiro (1985) points out that even a "sham" innovation can be used to implement the collusive market outcome by choosing a royalty rate and a negative fixed fee, and notes that, "such a side payment, in exchange for which the licensee would reduce its output, is likely to be illegal under the antitrust laws, and for a good reason!"

[14] In the Cournot equilibrium the licensor will have reduced its costs by acquiring the innovation and thus increased its output, while its rival reduces its output. The net effect is an increase in the equilibrium quantity and a reduction in the market price.

The important point, however, is that both the analyses of Katz and Shapiro (1985) and our own reveal the anticompetitive effects which may arise from licensing or resale contracts which specify per subscriber charges. Such contracts dampen downstream price competition and allow the reselling firm - via raising its rival's costs and, in the Hotelling model, its own opportunity costs - to avoid the rent dissipating effects that licensing for a fixed fee would induce. Monopoly power is thus extended downstream and consumers may receive little or no benefit from the innovation or premium programming. As Shapiro (2001) writes in his recent survey paper:

> "The traditional concern with cross-licenses among competitors is that running royalties will be used as a device to elevate prices and effectuate a cartel.... Clearly, such concerns do not apply to licenses that involve small or no running royalties, but rather have fixed up-front payments."

1.4. Remedies

The key competition problem identified by our analysis is that scarce premium programming endows upstream rights owners with monopoly power and this monopoly power is transferred downstream under exclusive vertical contracts, resulting in higher prices and lower consumer welfare. Horizontal resale contracts specifying per subscriber fees make consumers worse off in aggregate than they would be in the absence of any reselling.

We consider a number of possible competition policy remedies, some of which have already been implemented by the UK authorities. We show that neither a price-squeeze test nor forced rights splitting (equivalent to forced rights divestiture) have any effect on pricing, profits or consumer welfare, at least in our simple model. Since both of these remedies have been used by the OFT in the pay TV market, this demonstrates the importance of undertaking a more rigorous market analysis. A ban on exclusive vertical contracts, however, would intensify downstream competition and transfer the social benefits of premium programming from firms to consumers. In more realistic versions of the model, this remedy also increases aggregate social welfare.

1.5. Outline of the paper

Section 2 explains our key results on resale contracts within the context of the basic Hotelling model. Section 3 considers the selling options of the upstream rights seller, given the equilibrium analysis of the resale subgame. In Section 4 we consider various remedies, and Section 5 concludes. An appendix contains a mathematical analysis of reselling in Cournot, Bertrand and Hotelling models and considers BSkyB's actual reselling scheme, which makes wholesale prices proportional to retail prices.

2. Contracting with Rivals in the Basic Hotelling Model

This section describes our analysis of the sale and resale of premium programming in the basic Hotelling model adopted by Armstrong (1999).[15] Two downstream television broadcasters or retailers offer horizontally differentiated products to consumers. Horizontal differentiation refers to the fact that some buyers prefer the ("basic") product of one firm to the product of the other. Differentiation may stem either from the different basic programming packages offered by the firms, or from the means of delivery (satellite, cable, digital terrestrial). Following Hotelling, a consumer's taste for a firm's product is represented by its location on the unit interval. Since in this model all consumers wish to purchase the premium product, the premium and basic products are offered by firms only as pure bundles.

More formally, we consider two firms A and B supplying programs to a population of consumers indexed by their location on the unit interval $x \in [0,1]$, and distributed uniformly. Consumer x receives utility $u_i - tx - p_i$ from purchasing firm $i's$ product at price $p_i, i = A, B$. The two firms are located at the end points of the interval: firm A at 0 and firm B at 1. Firm i's production cost is denoted c_i. Let $s_i \equiv u_i - c_i \geq 0$ denote the utility of the consumer with highest valuation for good i net of the production cost of that good. We allow for asymmetries between the firms by assuming (without loss of generality) that firm A has a competitive advantage, so $s_A \geq s_B$.[16] Firm i's profits are denoted by $\pi_i(s_i, s_j)$, and the quantity sold by firm i by $x_i(s_A, s_B)$.

2.1. Equilibrium in the competitive regime

The analysis focuses on the "competitive" regime in which both firms are active and the market is "covered", i.e. all consumers derive positive utility (net of the price paid and the transportation cost incurred) from consuming the product of one of the firms. This requires that $t \in \left[\frac{s_A - s_B}{3}, \frac{s_A + s_B}{3}\right]$, which amounts to assuming that there is enough but not "too much" product differentiation.

In equilibrium, firm i's profits are given by

$$\pi_i(s_i, s_j) = \frac{1}{2t}\left(t + \frac{s_i - s_j}{3}\right)^2$$

for $i = A, B$, Firm i's market share is

$$x_i(s_i, s_j) = \frac{1}{2} + \frac{s_i - s_j}{6t}$$

[15] A companion paper analyzes resale contracts in a richer model which allows for both horizontal and vertical differentiation in the tastes of consumers.

[16] This competitive advantage may be thought of as deriving from a 'first mover' advantage, which has allowed firm A to acquire a more attractive package of basic programming rights for instance, or from a technological advantage, e.g. a satellite digital network is not capacity constrained, while digital terrestrial is, so a satellite broadcaster can offer a larger programming package.

and the corresponding equilibrium prices are given by

$$p_i = t + \frac{1}{3}\left(u_i - u_j + c_j + 2c_i\right). \tag{2.1}$$

The sum of firms' profits in equilibrium, denoted by Π, is calculated to be

$$\Pi = \pi_A + \pi_B = t + \frac{\left(s_A - s_B\right)^2}{9t},$$

and equilibrium consumer surplus is

$$V = \frac{s_A + s_B}{2} + \frac{\left(s_A - s_B\right)^2}{36t} - \frac{5t}{4}.$$

Total welfare may then be written as

$$W = V + \Pi = \frac{1}{2}\left(s_A + s_B\right) + \frac{5\left(s_A - s_B\right)^2}{36t} - \frac{1}{4}t.$$

We can now illustrate the simple economics of resale contracting with rivals in the classic Hotelling model.

2.2. Reselling premium programming

Following Armstrong (1999) we now suppose that the broadcasting rights to some type of premium programming (e.g. a sporting fixture or a film) are made available by an upstream rights owner. All consumers value this content equally, and are prepared to pay up to $\alpha > 0$ for it.[17] For simplicity we assume that the marginal cost of supplying the premium programming is zero for both firms, and that

$$t \geq \frac{s_A + \alpha - s_B}{3}, \tag{2.2}$$

so that both firms remain active when one of them acquires the premium programming rights, i.e. the firms remain in the competitive regime.[18]

The rights owner can choose to sell the premium programming rights either exclusively to one downstream firm or nonexclusively to both broadcasters. It can also choose between selling for a lump sum fee, on a per subscriber basis, or using a two part tariff. The downstream firm which acquires the exclusive rights can also choose to resell the programming to its rival for a lump sum fee, a per subscriber fee or under a two part tariff. We assume initially that the upstream rights owner sells the rights exclusively for a lump sum payment and focus here on the downstream firms' resale decisions. We will subsequently show in Section 3 that this assumption is innocuous.

[17] So if firm i acquires the programming and makes it available, the gross utility it offers increases from u_i to $u_i + \alpha$.

[18] This assumption is made to simplify the exposition. When it is violated acquisition of the rights can lead to one firm becoming a monopolist. It can easily be shown that reselling of premium programming for fixed fees will never occur, and that reselling for per subscriber fees will always occur, in this case.

2.2.1. No reselling

It is useful to establish what the downstream firms are willing to pay for the exclusive broadcasting rights to α in the absence of any reselling. If firm i acquires the rights, its downstream profits then increase by b_i, where

$$b_i = \pi_i(s_i + \alpha, s_j) - \pi_i(s_i, s_j) = \frac{1}{2t}\left(\frac{2}{3}\alpha\left(t + \frac{s_i - s_j}{3}\right) + \frac{\alpha^2}{9}\right) > 0.$$

If instead firm i fails to acquire the exclusive rights when firm j does, then its downstream profits *decrease* by

$$l_i = \pi_i(s_i, s_j) - \pi_i(s_i, s_j + \alpha) = \frac{1}{2t}\left(\frac{2}{3}\alpha\left(t + \frac{s_i - s_j}{3}\right) - \frac{\alpha^2}{9}\right) > 0,$$

where l_i is the *negative externality* imposed on firm i from the acquisition of exclusive rights by its competitor in the absence of reselling.

Each firm's total willingness to pay Γ_i , $i = A, B$ for the exclusive rights which cannot be resold is the sum of the benefit from acquiring the rights and the negative externality suffered when they are acquired by a competitor,

$$\Gamma_i = b_i + l_i = \frac{2}{3}\alpha\left(1 + \frac{s_i - s_j}{3t}\right).$$

Since $s_A \geq s_B$, A's willingness to pay for the rights exceeds B's, so firm A will have an advantage in acquiring the rights under any selling procedure.

The revenue which the upstream rights seller will obtain for the rights, denoted R_S, depends upon its bargaining power vis à vis downstream firms, and on informational conditions. Following Armstrong(1999) we will suppose throughout that there is complete information (i.e. $\Gamma_i, i = A, B$ are common knowledge), and consider two alternative selling schemes which reflect different degrees of bargaining power for the upstream rights seller:

1. The upstream rights seller has all of the bargaining power and is able to make a take it or leave it offer to downstream broadcasters.[19]

2. The upstream rights seller does not have all of the bargaining power and holds an ascending bid (second price) auction with no reserve price.

If we think of the rights seller holding an auction for the rights, these two schemes are differentiated by the ability of the seller to make a commitment to a reserve price. Under the first scheme the seller can commit himself to not selling the rights at any price less than a specified reserve price. The optimal reserve price for the seller is then the maximum

[19] This is equivalent to the rights seller holding an ascending bid (second price) auction with an optimal reserve price of $\max\langle\Gamma_A, \Gamma_B\rangle$.

willingness to pay of the two potential bidders. Under the second scheme the seller cannot commit himself to a reserve price: if the rights remained unsold at a specified reserve price, he would be free to hold another auction or selling procedure.[20]

When the upstream rights seller has all of the bargaining power (i.e. is able to make a take it or leave it offer), firm A acquires the rights for a price of Γ_A. Using the symbol δ to denote the change in a variable with respect to the equilibrium in the absence of the premium programming, we have $\delta\pi_i = -l_i$ and $R_S = b_A + l_A$. So both downstream broadcasters are made worse off by the availability of the premium programming. When the rights seller holds an ascending bid auction with no reserve price, firm A will win the auction for a price of Γ_B, hence $\delta\pi_A = b_A - \Gamma_B$, $\delta\pi_B = -l_B$ and $R_S = b_B + l_B$. In either of these cases, once it has acquired the rights, firm A will increase its price to its own consumers by $\frac{\alpha}{3}$, firm A's profits increase and firm B's fall. Further,

$$\begin{aligned}
\delta\Pi &= \frac{\alpha}{9t}\left(2\left(s_A - s_B\right) + \alpha\right) - R_S \\
\delta V &= \frac{\alpha}{2} + \frac{\alpha\left(2\left(s_A - s_B\right) + \alpha\right)}{36t} > 0 \\
\delta W &= \frac{\alpha}{2} + \frac{5\alpha\left(2\left(s_A - s_B\right) + \alpha\right)}{36t} > 0.
\end{aligned}$$

When only firm A has access to the premium programming, the benefits are shared between firm A and its consumers since each of firm A's customers receive a utility increment of α while firm A's price increases by $\frac{\alpha}{3}$. In addition, firm B's customers benefit from the reduction in firm B's price induced by firm A's acquisition of the exclusive rights. Hence aggregate consumer surplus increases as do downstream profits (i.e. profits gross of R_S) and total welfare. The total welfare gain may exceed α if the initial asymmetry $s_A - s_B$ is large enough (see Armstrong, 1999, p. 276).

2.2.2. Reselling programming for lump sum fees

We now consider what happens when downstream broadcasters are able to resell the premium programming to their competitors for a fixed (i.e. lump sum) fee. If the rights are resold in this way it is immediate that the two firm's profits from downstream sales to consumers are the same as they would be in the absence of the premium programming being available, i.e.

$$\pi_i\left(s_i + \alpha, s_j + \alpha\right) = \frac{1}{2t}\left(t + \frac{s_i - s_j}{3}\right)^2.$$

In other words, the additional profits available from the provision of premium programming are dissipated by downstream competition, and all of the benefits are captured by consumers. (From equations (4) it is easy to check that equilibrium prices are unchanged

[20] When the rights are sold nonexclusively the upstream seller cannot implement a standard auction procedure. In this case we assume that the seller can either make a take it or leave it offer, or that the outcome will be the symmetric Nash bargaining solution

even though all consumers now receive the utility increment α). Total downstream profits are unchanged while both consumer surplus and total welfare increase by α. Will firms ever resell premium programming in this way?

If firm A acquires the rights it will only resell to firm B for a fee which (weakly) exceeds b_A - firm A's benefit from retaining the rights exclusively. Firm B's maximum willingness to pay is l_B, or firm B's loss from not having access to the rights given that firm A does. Since $b_A > l_B$ firm A will not resell to firm B.

When firm B acquires the rights, reselling for a fixed fee can result in an *increase* in asymmetry compared to no reselling, and may therefore increase total profits. Hence reselling can be mutually advantageous. When B resells to A for a lump sum fee, B's loss is b_A and A's gain is l_A. Reselling therefore occurs if and only if $l_A \geq b_B$ which requires that $2(s_A - s_B) \geq \alpha$. Assuming that in this case firm B will sell to firm A for a fixed fee of l_A, each firms' willingness to pay for the rights is then

$$\begin{aligned} \Gamma_A &= b_A + l_A \\ \Gamma_B &= l_A + l_B. \end{aligned}$$

Firm A is still willing to pay more for the rights, since $b_A > l_B$.[21]

If $2(s_A - s_B) \leq \alpha$ reselling by firm B results in a *decrease* in asymmetry, and firm B will not resell. In this case Γ_A and Γ_B are the same as they would be in the absence of reselling. If we assume that the upstream rights seller has all of the bargaining power he will again sell the rights to firm A for a take it or leave it offer of Γ_A.[22] Hence $\delta\pi_A = -l_A$, $\delta\pi_B = -l_B$ and $R_S = b_A + l_A$. If the rights seller holds an ascending bid auction for the rights with no reserve price, firm A will win the auction for a price of Γ_B, hence $\delta\pi_A = b_A - \Gamma_B$, $\delta\pi_B = -l_B$ and $R_S = l_A + l_B$. Downstream profits, consumer surplus and total welfare are all the same as they would be under no reselling. However since $\Gamma_B = l_B + \max\langle l_A, b_B\rangle$ in this case, A pays (weakly) more for the rights in an ascending bid auction with no reserve price than in the case of no reselling. The effect of reselling with lump sum fees is to (weakly) increase the rights seller's profits, even though firm A still always wins the rights.

2.2.3. Reselling premium programming for per subscriber fees

The preceding section considered what happens when the downstream firm which acquires the exclusive premium programming rights is restricted to reselling the programming to its competitor for a lump sum fee. The result was that firm A always acquired the rights

[21] We could allow for bargaining to determine firm B's selling price, however it is easy to see that this makes no essential difference to the analysis.

[22] If firm B could resell to firm A by granting A the exclusive rights to the premium programming (so that firm B no longer retains the rights for itself), then under a take or leave it offer B could obtain $b_A + l_A$ from A for the rights. Clearly B would then always choose to resell since $b_A + l_A > b_B + l_B$, and the value of the rights would be the same to both downstream firms. This form of resale is typically not allowed under rights contracts in the UK pay TV market.

and withheld the programming from firm B. This assumption is restrictive, however, as rights are typically resold in this market (e.g. by BSkyB) for a per subscriber charge.

Recall that when programming is resold on a lump sum fee basis, competition downstream dissipates any potential profit from selling premium programming and consumers capture all the benefits. When the downstream firms resell premium programming for a per subscriber fee however, this reduction in downstream profits is mitigated. Reselling for a per subscriber fee of q increases the marginal costs of the firm purchasing the programming by q, while at the same time increasing the marginal (opportunity) costs of the reselling firm. The reselling firm however receives additional revenue of qx_j where x_j is the market share of the purchasing firm. This makes reselling more profitable for the firm which acquires the rights, and hence more likely to occur.

To see the effects of reselling for a per subscriber fee, observe that when firm i acquires the rights and resells for a per subscriber fee of q to firm j, each firms' profits are then

$$\begin{aligned}\pi_i &= (p_i - c_i)\, x_i + qx_j \\ \pi_j &= (p_j - c_j - q)\, x_j.\end{aligned}$$

Denoting the total demand served by $x = x_i + x_j$ it is convenient to rewrite firm i's profits as

$$\pi_i = (p_i - c_i - q)\, x_i + qx. \tag{2.3}$$

When the market is covered (e.g. in the competitive regime), total demand is fixed at $x = 1$. Hence both firms compete as if their marginal cost had increased to $q + c_i, i = A, B$, while the firm which resells the rights receives additional revenues equal to q. This means that when firm i acquires the rights and resells to j it will want to raise the value of q as high as possible, while firm j is indifferent over all values of q for which these profit functions remain valid. One implication of this is that determination of the value of q does not depend upon the relative bargaining positions of firms i and j. So long as q remains within the range in which this analysis is valid, the firms will agree on its value.

Note that whenever rights are resold for a per subscriber charge the benefits and losses, net of any revenues from resale, are zero for both firms, while the firm which acquires the rights obtains a net profit increment of q. Firm i will therefore be willing to resell the rights for a variable charge of q if and only if $q \geq b_i$ where

$$b_i = \frac{1}{2t}\left(\frac{2}{3}\alpha\left(t + \frac{s_i - s_j}{3}\right) + \frac{\alpha^2}{9}\right) < \alpha$$

by (2.2), i.e. the assumption that we remain in the competitive regime once firm i acquires the premium programming rights. We conclude that either firm will be willing to resell the programming rights for a per subscriber price of $q = \alpha$. Lemma 1 below shows that the per subscriber charge q cannot exceed this amount.

Lemma 1 *The per-subscriber resale charge cannot be larger than the value of the programming to consumers, i.e.* $q \leq \alpha$.

Proof. Consider any putative equilibrium in which firm i resells to firm j for a per subscriber charge of $q > \alpha$. It is not required that the equilibrium be in the competitive regime.[23] In any such equilibrium firm j's profits are $\pi_j = (p_j - c_j - q)\, x_j$ while firm j's marginal consumer receives a net utility of $u_j + \alpha - p_j - tx_j$. Now consider a deviation by firm j in which the it offers to sell the basic product alone for a price equal to $p_j - \alpha$ and the premium product for a price of $p_j + \varepsilon$. Firm j's marginal consumer now receives a net utility of $u_j - (p_j - \alpha) - tx_j$ from the basic product, and $u_j + \alpha - p_j - \varepsilon - tx_j$ from the premium product. Hence all of firm j's customers will switch to consuming the basic product alone. Firm j's profits will then be $\pi_j = (p_j - \alpha - c_j)\, x_j > (p_j - c_j - q)\, x_j$ when $q > \alpha$. Hence this is a profitable deviation for j. □

Since firm j's equilibrium profits are invariant in the level of q so long as $q \leq \alpha$, while firm i's profits are strictly increasing in q, the firms will clearly "agree" to set $q = \alpha$, the highest value consistent with equilibrium. Since for $q \leq \alpha$ we are guaranteed to remain in the competitive regime, the assumption underlying this analysis is verified.

We may therefore conclude that when either firm A or firm B acquires the rights it will resell the rights to its rival for a per subscriber charge equal to α, which leaves the rival firm in precisely the same position it would have been if the premium programming rights were not available. This means that the profits of the firm which acquires the exclusive rights from the upstream rights seller are also the same as they would have been if the premium programming rights had not been made available, except that it now receives the per subscriber charge α.

When rights are resold for a per subscriber fee of α, each firm's willingness' to pay for the rights is then

$$\Gamma_i = \pi_i (s_i, s_j) + \alpha - \pi_i (s_i, s_j) = \alpha$$

$i = A, B$, so *resale for per subscriber fees equalizes the value of the rights to each firm.* The upstream rights seller will now obtain $R_S = \alpha$ for the rights under either a take it or leave it offer *or* in a second price auction with no reserve price. Hence, although consumers in aggregate receive an additional gross utility of α, all of this surplus is captured by the firm which acquires the rights via the per subscriber charge $q = \alpha$, which is then passed on to the upstream rights seller.[24] Aggregate consumer surplus is thus the same as in the case

[23] Analysis of the Hotelling model is complicated by the existence of a kinked demand curve at the point where the marginal consumer is indifferent between consuming and not consuming. Typically this issue is avoided by making appropriate assumptions on parameters (see e.g Laffont, Rey and Tirole, 1998a; Gilbert and Matutes, 1993). We cannot do so here because the reselling firm may wish to set q so as to implement an equilibrium at the kink. The lemma, however, shows that this cannot occur.

[24] Notice that both firms' equilibrium prices increase by exactly α.

when the premium programming is not available. In summary, we have

$$\begin{aligned}\delta\Pi &= 0\\ R_S &= \alpha\\ \delta V &= 0\\ \delta W &= \alpha.\end{aligned}$$

Resale for a per subscriber fee of α means that consumers receive no benefit from the availability of the premium programming, and the upstream rights seller captures the entire social surplus created by its product.

Resale of premium programming for per subscriber fees thus unequivocally reduces consumer welfare compared to the case of no resale. It has an ambiguous effect on total welfare, however, due to the different allocations of the premium and basic programming which arise in equilibrium in the two cases. When programming rights are resold for a per subscriber fee, all consumers in the market will efficiently purchase the premium product. In the absence of resale, on the other hand, some consumers are excluded from consuming the premium product, but a larger fraction of consumers will purchase from firm A. Because the *ex ante* market share of firm A is inefficiently low (due to the usual monopoly distortion), the latter effect tends to increase total welfare. Resale will then be welfare improving if the net utilities, $u_i - c_i$, offered by the two firms in supplying the basic product are not too asymmetric. More precisely, a necessary condition for reselling to reduce total welfare it is that the *ex ante* market share of firm A be at least 60%; if α is small then firm A's market share must be at least 80%. When this occurs, resale for a per subscriber fee will be privately profitable, but not socially optimal.

2.2.4. More general resale contracts

Reselling with two part tariffs We now briefly consider the effects of allowing firms to resell premium programming under simple, or 'noncontingent,' two part tariffs of the form $\langle q_i, Q_i\rangle$, $i = A, B$, where q_i is the variable or per subscriber fee and Q_i is the fixed payment from the buyer to the reseller. Under any such tariff the deviation argument (Lemma 1) will continue to remain valid, therefore we must still have $q_i \leq \alpha$. This implies that the equilibrium market shares and prices of each firm are also unchanged. Hence a two part tariff of this form merely redistributes rent between the two firms, without effecting the downstream market outcome.

The optimal tariff for firm i when reselling to j will clearly extract firm j's rent $l_j = \pi_j(s_j, s_i) - \pi_j(s_j, s_i + \alpha)$, equal to the difference in the profits achieved by firm j when firm i alone sells the premium product to that achieved when firm i resells to firm j. Hence if firm i can make a take it or leave it offer we will have $\langle q_i, Q_i\rangle = \langle \alpha, l_j\rangle$. Firm i's willingness to pay for the rights to the premium programming is then

$$\Gamma_i = \alpha + l_j + l_i,\ i = A, B,$$

so the value of the rights is again the same to both firms. The upstream rights seller will then obtain $R_S = l_i + l_j + \alpha$ under either take it or leave it offers or in a second price auction with no reserve price.

If the reselling firm does not have all of the bargaining power (i.e. an ability to make a take it or leave it offer), then all resale contracts of the form $\langle q_i, Q_i \rangle$ which result from efficient bargaining will still have $q_i = \alpha$. However under the Nash bargaining solution, for instance, we will typically have $Q_i < 0$. Hence reselling under simple two part tariffs has the effect of reducing the upstream rights seller's profits, since the willingness to pay of each firm will then be[25]

$$\Gamma_i = \alpha + Q_i + Q_j < \alpha, \; i = A, B.$$

Contingent contracts Simple (or linear) two part tariffs cannot increase the firms' joint profits in equilibrium because they do not effect the incentive of the buying firm to deviate whenever $q > \alpha$, as described in Lemma 1. However, since increasing the resale price q induces *both* firms to increase their retail prices, if the reselling firm could implement a resale price $q > \alpha$ still more collusive market outcomes could be achieved, in which retail prices are increased by *more* than the value of the premium product to consumers. Allowing more general contractual arrangements for reselling the premium product to prevent the buyer from deviating whenever $q > \alpha$ would therefore allow the reselling firm to increase joint profits at the expense of consumers.

As explained above, any resale contract requiring $q > \alpha$ is subject to a deviation from the buyer which consists in selling the basic product at a price which induces all of its customers to purchase only the basic product. To prevent this deviation the reselling firm could compensate the buyer with the bonus contingent upon the buyer not deviating from the desired price offer.[26] The reselling firm would then choose the variable fee q at the level which maximizes the total equilibrium profits $\Pi(s_i + \alpha - q, s_j + \alpha - q) + q$ and this price always exceeds α. It could also extract the buyer's rent by demanding an up front payment of $Q = \pi_j(s_j + \alpha - q, s_i + \alpha - q) - \pi_j(s_j, s_i + \alpha) + F$ for offering the resale contract.[27]

In order to increase equilibrium prices under this scheme it is necessary to "bribe" the buyer into accepting $q > \alpha$, or alternatively to punish him for not accepting. It is easy to see that the buyer will agree to a contract specifying a penalty for a deviation from the desired behavior. (Since the buyer would never deviate under such a contract, no penalty

[25] Note that this implies that if the firms could commit themselves to paying a negative fixed fee Q *ex ante*, they would then pay less for the rights, and each firm's profit *ex post* would increase by Q.

[26] The contingent contract would need to specify that the buyer cannot offer to sell the basic product alone at a price less than $p_j^{collusion} - \alpha$.

[27] Typically the optimal value of q takes firms out of the competitive regime into the kinked demand curve region, but cannot implement the joint monopoly outcome. The latter requires a net transfer of output from the smaller firm to the industry leader which a symmetric increase in marginal costs is not sufficient to induce in equilibrium. In simple cases however, e.g. when $s_i = s_j$, it can be shown that the optimal q implements the joint monopoly outcome within the competitive regime.

would ever be paid). Such a contract could then specify an up front fixed payment Q, variable charge $q > \alpha$, and a penalty for deviating sufficient to induce compliance.

Quantity forcing contracts or quantity discounts The contracts described above make the buyer's bonus or penalty contingent upon not deviating from the prices specified by the seller, and as such are likely to violate competition laws, and hence be unenforceable. Since such contracts are not self-enforcing (i.e. ex post the seller would not pay (receive) the required bonus (penalty)), they may therefore be impossible for firms to implement. It might be conjectured that a simple "quantity forcing" contract could achieve the same outcome by specifying a bonus or penalty if the buyer sells less than a pre-specified quantity of the premium product. For example, the contract could specify payment of a bonus if the buyer sells $x_j = \frac{1}{2} + \frac{s_j - s_i}{6t}$ units of premium programming for a resale price of q (or a penalty for selling fewer units than this). Given this incentive, the buyer would charge consumers $p_j^{collude}$ for x_j units, hence implementing the seller's desired outcome.

A problem arises with this type of contract, however, because the *reselling firm* now has an incentive to deviate to a lower price and higher quantity, thus forcing the buyer below the critical quantity. The seller's payoff from such a deviation will be its profits from sales to consumers, plus the penalty or (saved) bonus, plus or minus any up front transfer Q, and this may exceed the seller's payoff from not deviating. Depending upon the precise formulation of the contract, and the profitable deviations for both the buyer and seller which this entails, one can show that it is always possible to sustain $q > \alpha$ with a quantity forcing contract. However the seller's incentive to deviate places an additional upper limit on q. In typical cases the seller will no longer be able to implement the value of $q > \alpha$ which maximizes joint profits.

Discussion To summarize the above discussion, noncontingent two part tariffs cannot increase the firms' joint downstream profits in equilibrium because they do not effect the incentive of the buying firm to deviate whenever $q > \alpha$. Hence a two part tariff of this type merely redistributes rent between the two firms, without effecting the downstream market equilibrium. The upstream rights seller's payoff may increase or decrease depending upon whether the reseller can make take it or leave offers to the buyer, or the fixed component Q is determined by bargaining.

Under unrestricted contingent contracts, the reselling firm can implement the value of $q > \alpha$ which maximizes the firms' joint profits, and this value can then be shared between the firms by using a noncontingent fixed payment Q. In simple (e.g. symmetric) cases, such contracts can be used to implement the joint monopoly (i.e. perfectly collusive) outcome. When only simple forms of contingent contracts are considered (e.g. quantity forcing contracts) this places an additional restriction on what firms can achieve, however it is always possible to implement a resale price $q > \alpha$. Such contingent contracts induce firms to set retail prices for the premium product which leaves consumers worse off than they were in the absence of the premium programming being available. In other words the resale of premium programming becomes a mechanism for altering the pricing incentives of firms so as to achieve even more collusive outcomes at the expense of consumers.

2.3. Conclusion

In Section 3 below we show that the upstream rights seller can do no better, and will usually do worse, by selling the rights to downstream firms for: (i) a per subscriber fee, (ii) under a two part tariff $\langle r_S, R_S \rangle$ with $r_S > 0$, or (iii) nonexclusively. We may therefore assume without loss of generality that the rights are sold exclusively for a lump sum fee, as postulated in this section.

In the absence of contingent two part tariffs, the analysis of the Hotelling model thus predicts that rights will be sold originally under exclusive contracts for a lump sum payment, and then resold for a per subscriber fee equal to α. Reselling for per subscriber fee allows the downstream firm which acquires the exclusive broadcasting rights to prevent the dissipation of downstream profits by *raising its rival's costs,* while simultaneously increasing the *opportunity cost* of serving its own customers. The opportunity cost effect reflects the fact that (when the market is covered), any revenues earned by the reselling firm from reducing its price and serving additional customers, are at the expense of resale revenue that would otherwise have been received from its rival. This reduction in resale revenue has exactly the same effect as an increase in the reselling firm's marginal costs, giving both firms an incentive to increase their retail prices in equilibrium.[28]

3. Incentives of the Upstream Rights Seller

The preceding section analyzed the resale subgame in which one downstream firm had acquired the exclusive premium programming rights for a lump sum fee from the upstream seller. The conclusion was that in the absence of contingent contracts, resale for a per subscriber fee of $q = \alpha$ would always occur. In this section we consider the incentives of the upstream rights seller. In particular, the upstream seller has a choice between selling the rights exclusively or nonexclusively for lump sum or per subscriber fees. We will show that selling the rights exclusively for a lump sum fee is always revenue maximizing and weakly dominates the alternative selling schemes, hence validating the assumption made in the previous section.

[28] The finding that resale for per subscriber fees can be used to sustain more monopolistic market outcomes than resale for lump sum fees is common to both the Cournot model of Katz and Shapiro (1985) and the Hotelling model. See the Appendix, Section 6.1, for an analysis.

3.1. Selling premium program rights for lump sum fees

We suppose first that the upstream rights seller can sell rights for a lump sum payment either exclusively to firm A or B, or nonexclusively to both firms.

3.1.1. Exclusive selling

No resale If reselling is not allowed, then firm A outbids firm B and pays $l_A + b_A$ under take it or leave it offers, or $l_B + b_B$ in an ascending bid auction with no reserve price.[29]

Resale When rights are sold exclusively, the firm which acquires the rights will resell for per subscriber fee of $q = \alpha$. The willingness to pay of each firm is then

$$\Gamma_i = \pi_i^{resell} - \pi_i^{purchase} = \pi_i (s_i, s_j) + \alpha - \pi_i (s_i, s_j) = \alpha.$$

Both firms are therefore willing to pay α for the exclusive rights, since acquiring the rights allows them to increase their profits by α without affecting their equilibrium market shares. Since firms' valuations of the premium product rights are equal, clearly under either take it or leave it offers or an ascending bid auction, the upstream rights seller will obtain a lump sum of α for the rights.

3.1.2. Nonexclusive selling

If the rights seller sells the rights nonexclusively for a lump sum fee,[30] the benefit b_i from acquiring the nonexclusive rights to either firm is zero. The highest price which the rights seller can charge firm i is then l_i in any credible equilibrium.[31] The rights seller's maximum payoff is therefore

$$l_A + l_B = \frac{2\alpha}{3}\left(1 - \frac{\alpha}{6t}\right) < \alpha.$$

Hence selling rights exclusively for lump sum fees earns greater profits for the upstream rights seller.

3.2. Selling premium program rights for per subscriber fees

We now suppose that the upstream rights seller makes premium programming available to downstream firms for a per subscriber fee rather than on a lump sum fee basis.

[29] $l_A + b_A$ can exceed α when the intial asymmetry between the firms is large enough, i.e. when the industry leader's market share exceeds 75% in the basic market equilibrium. In this case an upstream rights seller would have an incentive to prohibit resale. We assume that this case does not apply in what follows.

[30] We assume that nonexclusive rights cannot be resold.

[31] I.e. the seller could ask firm i for b_i under an implicit promise not to sell to j for a lower price; however once i has purchased the seller can offer j any price weakly less than l_j which j will accept. Given this, firm i will not pay more than l_i.

3.2.1. Exclusive selling

If we assume that the upstream rights seller sells premium programming exclusively to one firm for a per subscriber fee of $r_i, i = A, B$, if firm i acquires the rights and resells to firm j at a price of q, its profits are

$$\begin{aligned} \pi_i &= (p_i - c_i - r_i)x_i + (q - r_i)(1 - x_i) \\ &= (p_i - c_i - q)x_i + (q - r_i). \end{aligned}$$

So we have

$$\begin{aligned} \pi_i &= \pi_i(s_i, s_j) + q - r_i \\ \pi_j &= \pi_j(s_j, s_i). \end{aligned}$$

Clearly we may set $q = \alpha$ as before. If $r_i \leq \alpha$ then resale will take place, and the rights seller will receive $R_S = r_i$ for the rights. Hence $r_i = \alpha$ is optimal for the rights seller, and both firms will be willing to pay up to this price. Reselling will always occur since we may define $\alpha'_i = \alpha - r_i$. Then the reselling condition is

$$2t \geq \frac{s_i - s_j}{3} + \frac{\alpha'_i}{6}.$$

Since this is satisfied for α by assumption (2.2), it is also true for α'_i.

At $r_i = \alpha$ firm i is indifferent between acquiring or not acquiring the rights. For any $r_i < \alpha$ firm i makes positive profits from acquiring the rights. Hence in an ascending bid auction with no reserve price the price will be bid up to α.

3.2.2. Nonexclusive selling

If the rights are sold nonexclusively (i.e. offered to both firms), then it is easy to see that both firms will purchase the premium programming if and only if $r_i \leq \alpha$.[32] Hence if the upstream rights seller can make a take it or leave it offer to downstream firms, he will offer $r_i = \alpha$, $i = A, B$, and earn revenues of $R_S = \alpha$. If the upstream rights seller does not have all of the bargaining power however, he will only obtain a fraction of this amount, given by the relevant bargaining solution.

3.3. Selling premium program rights under two part tariffs

We denote a two part tariff for the upstream rights seller by $\langle r, R \rangle$, where r is the variable (per subscriber) fee and R the lump sum component . A two part tariff for resale is denoted by $\langle q, Q \rangle$. Before analyzing the incentives of the upstream rights seller we must first consider the downstream resale subgame when the rights are purchased and then resold under a two part tariff.

[32] See Armstrong (1999), p. 277.

3.3.1. Resale subgame

Recall that when firm i acquires the exclusive rights for a lump sum fee of R (i.e. $r = 0$), it will resell to firm j for a tariff $\langle q, Q\rangle = \langle \alpha, l_j\rangle$ under a take it or leave it offer.[33] Willingness to pay for the rights is then

$$\Gamma_i = \alpha + l_j + l_i$$

for $i = A, B$.

Assume now that firm i has purchased the exclusive rights under a two part tariff $\langle r, R\rangle$. Its profits from resale under $\langle q, Q\rangle$ are

$$\begin{aligned}\pi_i &= (p_i - c_i - r)x_i + (q - r)(1 - x_i) + (Q - R) \\ &= (p_i - c_i - q)x_i + (q - r) + (Q - R).\end{aligned}$$

Hence

$$\begin{aligned}\pi_i &= \pi_i(s_i, s_j) + (q - r) + (Q - R) \\ \pi_j &= \pi_j(s_j, s_i) - Q.\end{aligned}$$

Clearly when firm i can make a take it or leave it offer to firm j he will set $q = \alpha$ and $Q = l_j(r)$, where

$$l_j(r) = \pi_j(s_j, s_i) - \pi_j(s_j, s_i + \alpha - r).$$

Hence the firms' payoffs can be written

$$\begin{aligned}\pi_i &= \pi_i(s_i, s_j) + (\alpha - r) + l_j(r) - R \\ \pi_j &= \pi_j(s_j, s_i) - l_j(r).\end{aligned}$$

Given the variable fee r, each firm is willing to pay a fixed fee of $R = (\alpha - r) + l_j(r) + l_i(r)$ for the exclusive rights. If $r = \alpha$ then $R = l_j(\alpha) + l_i(\alpha) = 0$ and the upstream seller will obtain at most $R_S = r + R = \alpha$. If $r = 0$ then he will obtain up to $R_S = R = \alpha + l_j + l_i$.

3.3.2. Exclusive selling

Each firm is willing to pay $r \leq \alpha$ and $R = (\alpha - r) + l_j(r) + l_i(r)$ for the exclusive rights. Clearly $r = 0$ and $R = \alpha + l_j + l_i$ is the rights seller's optimal policy.

3.3.3. Nonexclusive selling

The upstream seller offers tariffs $\langle r_i, R_i\rangle$, $i = A, B$. If firm i purchases then firm j is willing to pay $r_j \leq \alpha$ and $R = b_j(r_j, r_i) + l_i(r_i)$ to purchase the rights from the upstream seller, where

[33] We assume that the reseller can make take it or leave offers in this subsection. Extension of the results to the case of bargaining is immediate.

$$b_j(r_j, r_i) = \pi_j(s_j + \alpha - r_j, s_i + \alpha - r_i) - \pi_j(s_j, s_i).$$

So

$$b_j(r_j, r_i) + l_j(r_i) = \pi_j(s_j + \alpha - r_j, s_i + \alpha - r_i) - \pi_j(s_j, s_i + \alpha - r_i).$$

Lemma 2 *The seller maximizes revenue by setting $r_i = r_j = \alpha$ thereby obtaining $R_S = \alpha$.*

Proof. From

$$R_S^j = r_j + \pi_j(s_j + \alpha - r_j, s_i + \alpha - r_i) - \pi_j(s_j, s_i + \alpha - r_i).$$

we have

$$\frac{\partial R_S^j}{\partial r_j} = 1 - \frac{2}{3}\left(\frac{1}{2} + \frac{s_j - s_i - r_j + r_i}{6t}\right) > 0.$$

Hence $r_j = \alpha$. Similarly

$$\frac{\partial R_S^i}{\partial r_i} = 1 - \frac{2}{3}\left(\frac{1}{2} + \frac{s_i - s_j - \alpha + r_i}{6t}\right) > 0,$$

so that $r_i = \alpha$.

3.4. Concluding comment

Selling exclusively for a lump sum fee weakly dominates other selling schemes for the rights seller. Under exclusive selling for a lump sum fee the rights seller can obtain α for the rights when they are resold for a variable fee. He can obtain up to $R = R_S = \alpha + l_j + l_i$ when rights are sold exclusively for a lump sum fee and resold under a two part tariff.

4. Remedies

The key competition problem identified in the model is that premium programming endows monopoly power upon upstream rights owners and downstream broadcasters who purchase the exclusive rights to this programming. Exclusive vertical contracts allow this monopoly power to be transferred downstream, resulting in higher prices and lower consumer welfare. Indeed, when rights are resold for per subscriber fees, consumers are worse off in aggregate than they would be in the absence of any reselling.

A number of possible remedies are considered here, including: a price squeeze test, regulating the relationship between the resale price q and P_i; direct regulation of the resale price q; forced divestiture of premium programming rights, or forced 'rights splitting'; forced rights sharing, or reselling for lump sum fees; and a ban on exclusive vertical contracts. We shall show that neither a price-squeeze test nor forced rights 'splitting' (equivalent to forced rights divestiture) have any effect on pricing, profits or consumer welfare, at least in our simple model. A ban on exclusive vertical contracts, on the other hand, would intensify downstream competition and transfer the social benefits of premium programming from firms to consumers.

4.1. Price squeeze test

The UK's Office of Fair Trading currently loosely regulates BSkyB's resale prices, which involves application of a margin, or price, squeeze test. A price squeeze test in our model requires that the reselling firm should earn positive profits on the bundle of basic and premium programming at price q, i.e. $p_i - c_i - q > 0$. This says that at the price at which programming is resold to firm j, firm i's bundle should be profitable given its costs c_i. This condition is always satisfied in equilibrium however, so imposes no additional constraint upon resale prices.

4.2. Regulation of the resale price

Another alternative is to regulate the price at which firms resell premium programming to each other. For any resale price $0 \leq q \leq \alpha$, the consequences of small changes in q are given by

$$\begin{aligned}
\frac{\partial \Pi}{\partial q} &= 1 - \frac{\partial R_S}{\partial q} \\
\frac{\partial R_S}{\partial q} &= 1 \\
\frac{\partial V}{\partial q} &= -1 \\
\frac{\partial W}{\partial q} &= 0.
\end{aligned}$$

As q is lowered from α surplus is transferred on a one for one basis from firms to consumers.

4.3. Forced rights splitting or divestiture of premium programming rights

The UK regulatory authorities have sometimes evinced a preference for upstream rights sellers making exclusive packages of rights available to different downstream firms. For example, Premier League broadcasting rights were recently split into a package of pay per view rights and a package of non pay per view rights[34] after an intervention by the Office or Fair Trading, with no pay TV company permitted to win the auctions for both packages. Cave and Crandall (2001) also suggest that the rationale behind the OFT's 1999 challenge of Premier League collective selling practices in the Restrictive Trade Practices Court, was that the Premier League should make more rights packages available:

[34] i.e. the rights to broadcast the matches as part of a subscription channel.

> "In his argument before the Court, the Director General made it plain that he had no objection per se to collective sale of matches by the Premier League. Indeed he suggested that two or more packages of rights could be sold to separate broadcasters, each granting exclusivity over the matches in question...."

The issue then is whether the splitting of broadcasting rights into separate exclusive packages can be expected to have a procompetitive effect. There are two ways in rights could be separated into packages - first, by requiring the rights seller to split the rights and sell them to different firms, or secondly by forcing the downstream firm which has acquired the exclusive rights to divest itself of a fraction of the rights by selling them for a lump sum fee to a competitor. We consider each of these in turn.

4.3.1. Forced rights splitting

We suppose that the rights seller splits the rights to α into two packages $\alpha_1$and $\alpha_2$such that $\alpha_1 + \alpha_2 = \alpha$. Assume initially, and without loss of generality, that firm A acquires the rights to α_1 and firm B acquires the rights to α_2. Each will then resell the rights for a per subscriber charge of $q_i \leq \alpha_i$, $i = A, B$. Firm i's profits are then

$$\begin{aligned} \pi_i &= (p_i - c_i - q_j)x_i + q_i(1 - x_i) \\ &= (p_i - c_i - q_j - q_i)x_i + q_i \end{aligned}$$

$i, j = A, B, i \neq j$. Hence with resale

$$\begin{aligned} \pi_i &= \pi_i(u_i - c_i, u_j - c_j) + q_i \\ \pi_j &= \pi_j(u_j - c_j, u_i - c_i) + q_j, \end{aligned}$$

and firms will agree that $q_i = \alpha_i, i = A, B$. The total surplus extracted from selling the premium programming is therefore $\alpha_1 + \alpha_2 = \alpha$. How much will downstream firms be willing to pay for the split rights?

Suppose that the rights to α_1 are sold first. In the second stage each firm's willingness to pay for the rights to α_2, given that the other firm has acquired the rights to α_1, is then just $V_i^{\alpha_2} = \alpha_2$. If this is the price paid for α_2 at the second stage (i.e. under a take it or leave it offer), willingness to pay for α_1 is then $V_i^1 = \alpha_1$. Hence when the rights seller can make take it or leave it offers

$$\begin{aligned} \delta\Pi &= \alpha - R_S \\ R_S &= \alpha \\ \delta V &= 0 \\ \delta W &= \alpha. \end{aligned}$$

So this case does not differ from the case in which the rights are all sold to a single firm.[35]

[35]When the rights seller does not have all of the bargaining power, and we impose the symmetric Nash

4.3.2. Forced rights divestiture

Forced rights divestiture amounts to requiring firm i to give up a fraction of the rights to firm j. This could be implemented by requiring firm i to divest itself of α_2 to firm j, while retaining α_1. It is natural to assume that $\alpha_1 \geq \alpha_2$ and $\alpha_1 + \alpha_2 = \alpha$. Again, firms will resell the rights for per subscriber charges $q_i \leq \alpha_i$, $i = A, B$. Firm i's profits are then

$$\begin{aligned} \pi_i &= (p_i - c_i - q_j)x_i + q_i(1 - x_i) \\ &= (p_i - c_i - q_j - q_i)x_i + q_i \end{aligned}$$

$i, j = A, B, i \neq j$. Hence with resale

$$\begin{aligned} \pi_i &= \pi_i(u_i - c_i, u_j - c_j) + q_i \\ \pi_j &= \pi_j(u_j - c_j, u_i - c_i) + q_j. \end{aligned}$$

and firms will agree that $q_i = \alpha_i, i = A, B$. The total surplus extracted from selling the premium programming is therefore $\alpha_1 + \alpha_2 = \alpha$.

How much either firm be willing to pay to acquire the rights depends upon the transfer price for α_2 which we denote by $z_{2i}, i = A, B$. If firm i acquires the rights, its net gain is just $\alpha_1 + z_{2j}$. If firm i doesn't acquire the rights its net gain(loss) is $\alpha_2 - z_{2i}$. Hence $V_i = (\alpha_1 - \alpha_2) + z_{2j} + z_{2i}$. The maximum transfer either firm would pay is α_2 hence the maximum value of Γ_i is just α. Hence again, under take it or leave it offers

$$\begin{aligned} \delta\Pi &= \alpha - R_S \\ R_S &= \alpha \\ \delta V &= 0 \\ \delta W &= \alpha \end{aligned}$$

The conclusion again is that forced rights divestiture has no effect on competition, consumer surplus or welfare.[36]

4.4. Forced rights sharing or resale for lump sum fees

Resale of exclusive rights for per subscriber fees (or a two part tariff) results in both firms charging a price increment of $\delta P_i = \alpha$ for the premium good, and consumers receive no benefit from the availability of the premium product. In the absence of resale, when firm i owns the rights, its price increases by $\delta P_i = \frac{\alpha}{3}$,so each of firm i's customers receives a surplus of $\frac{2\alpha}{3}$,while firm j's customers benefit from a decrease in firm j's price of $\frac{\alpha}{3}$. Hence consumers would be strictly better off with a ban on per subscriber resale contracts.

bargaining solution we find that forced rights splitting still has no effect on competition, consumer surplus or total welfare, but may effect how much the upstream rights seller receives for the rights.

[36] Allowing for bargaining between the downstream firms does not effect this result.

If the rights are acquired by both firms for a lump sum fee, on the other hand, then each downstream firms' price increment is $\delta P_i = 0$. Hence downstream firms make no additional profits from the premium good, and consumer surplus increases by α. One remedy for the monopolistic pricing of the premium product implemented via high per subscriber fees would therefore be to force firms to resell for lump sum fees.

4.4.1. Resale for lump sum fees

If firm A acquires the exclusive premium programming rights and is forced to sell to B for a lump sum fee, B will accept any transfer price z_B less than l_B. Similarly when B acquires the rights, A will accept any price z_A less than l_A. Assuming that the regulator knows l_A and l_B, then he can impose transfer prices z_A and z_B satisfying these restrictions $(z_i \leq l_i)$ upon the firms. Each firms' willingness to pay for the rights is then $\Gamma_i(z_i, z_j)$ where

$$\begin{aligned} \Gamma_A &= z_B + z_A \\ \Gamma_B &= z_A + z_B. \end{aligned}$$

Suppose the seller makes a take it or leave it offer of R to each firm. If both firms accept we assume that each is equally likely to win the rights. For $\max(z_A, z_B) < R \leq z_A + z_B$ there are two equilibria - $\langle Accept, Accept \rangle$ and $\langle Reject, Reject \rangle$. If $R < \max(z_A, z_B)$ then $\langle Accept, Accept \rangle$ is a dominant strategy equilibrium.

	Firm B accepts	Firm B rejects
Firm A accepts	$\pi_A + \frac{1}{2}[z_B - R - z_A]$, $\pi_B + \frac{1}{2}[z_A - R - z_B]$	$\pi_A + z_B - R$, $\pi_B - z_B$
Firm A rejects	$\pi_A - z_A$, $\pi_B + z_A - R$	π_A, π_B

If the seller holds an ascending bid auction then it easy to show that B will bid up to $z_B + z_A$ before dropping out. Note that whenever B drops out its payoff is $\pi_B - z_B$. Whenever B wins the auction its payoff is $\pi_B + z_A - R$, where R is the auction price. B is willing to stay in so long as $R \leq z_B + z_A$. The same is true for A, hence the seller gets $z_B + z_A$ from an ascending bid auction.

Hence under take it or leave it offers $(z_i = l_i)$

$$\begin{aligned} \delta\Pi &= -(l_B + l_A) \\ R_S &= (l_B + l_A) \\ \delta V &= \alpha \\ \delta W &= \alpha \end{aligned}$$

while under symmetric bargaining ($z_i = \frac{l_i}{2}$)

$$\begin{aligned}
\delta\Pi &= -\frac{(l_B + l_A)}{2} \\
R_S &= \frac{(l_B + l_A)}{2} \\
\delta V &= \alpha \\
\delta W &= \alpha.
\end{aligned}$$

4.4.2. Regulatory rights sharing rule

Since the regulator will not typically know the values of l_A and l_B an obvious solution is to base a regulatory rights sharing formula on observables. If rights are shared according to a regulatory formula whereby each firm pays a fraction of their cost in proportion to their market shares, then if A pays R_A and B pays R_B to acquire the exclusive rights from the rights seller

$$\Gamma_A(R_A, R_B) = R_A x_B(s_A, s_B) + R_B x_A(s_A, s_B)$$
$$\Gamma_B(R_A, R_B) = R_A x_B(s_A, s_B) + R_B x_A(s_A, s_B),$$

with

$$R_A x_B(s_A, s_B) \leq \ l_B \text{ and } R_B x_A(s_A, s_B) \leq \ l_A.$$

which implies that $R_A = R_B = R$, so the value of the rights are equalized. It is easy to see that the maximum value of R is $l_B/x_B(s_A, s_B)$.

If the upstream rights seller makes a take it or leave it offer of l_B/x_B , then assuming that firm i will accept, firm j can do no better than to accept. But $\langle Reject, Reject\rangle$ is a dominant strategy equilibrium.

	Firm B accepts	Firm B rejects
Firm A accepts	$\pi_A - x_A\frac{l_B}{x_B}$, $\pi_B - l_B$	$\pi_A - x_A\frac{l_B}{x_B}$, $\pi_B - l_B$
Firm A rejects	$\pi_A - x_A\frac{l_B}{x_B}$, $\pi_B - l_B$	π_A, π_B

Since this is true for any take it or leave or offer R, the seller will get nothing for the rights.

	Firm B accepts	Firm B rejects
Firm A accepts	$\pi_A - Rx_A$, $\pi_B - Rx_B$	$\pi_A - Rx_A$, $\pi_B - Rx_B$
Firm A rejects	$\pi_A - Rx_A$, $\pi_B - Rx_B$	π_A, π_B

What if the seller holds an ascending bid auction for the rights? When will A or B drop out? Suppose the current bid is R and it is B's turn to either improve on R or drop out immediately. If B drops out then his payoff will be $\pi_B(s_A, s_B)$ $-Rx_B(s_A, s_B)$, so long as $Rx_B \leq l_B$. If B stays in his payoff is at most $\pi_B(s_A, s_B) + Rx_B(s_A, s_B) - R$. Hence B's payoff from dropping out immediately always (weakly) exceeds the payoff from staying in. Hence it is a (weakly) dominant strategy for B to drop out at 0 (i.e. not enter the auction). Likewise it is optimal for A not to enter the auction. The seller will again get zero for the rights.

Discussion The conclusion that a market share based rule will result in neither firm bidding a price above zero for the rights means that this rule probably cannot be used without modification. One solution is to interpret this remedy as an interim measure to be applied to rights held by downstream firms, while existing vertical contracts with upstream rights sellers remain in place. As such contracts expire, remedies could then be imposed upon the form of future vertical contacts, such as in the immediately following subsection. An alternative would be to adapt the rule to make the transfer prices proportionate to (e.g. historic) market shares, plus a regulatory mark-up. Any mark-up larger than the bid increment in an ascending bid auction would mean that it is no longer a dominant strategy to drop out of the auction immediately.

4.5. Nonexclusive rights selling

A final alternative is to force the upstream rights seller to sell the rights nonexclusively for a lump sum fee. If the rights are sold to both firms, then in the unique equilibrium each firm will purchase the rights so long as the price does not exceed $l_i, i = A, B$. Hence, as before, under take it or leave it offers the maximum the seller can get is $l_A + l_B$. If the upstream rights seller does not have all of the bargaining power we assume again that the outcome will be the Nash-Rubinstein bargaining solution, $\frac{1}{2}(l_A + l_B)$. Hence under take it or leave it offers

$$\begin{aligned} \delta\Pi &= -(l_B + l_A) \\ R_S &= (l_B + l_A) \\ \delta V &= \alpha \\ \delta W &= \alpha. \end{aligned}$$

And under symmetric bargaining

$$\begin{aligned} \delta\Pi &= -\frac{(l_B + l_A)}{2} \\ R_S &= \frac{(l_B + l_A)}{2} \\ \delta V &= \alpha \\ \delta W &= \alpha. \end{aligned}$$

Note that in this case the value of rights is not reduced to zero. This is because the consequences of rejecting an offer are no longer the same as accepting. Indeed it is now a (weakly) dominant strategy for each firm to accept any offer $R_i \leq l_i$.

	Firm B accepts	Firm B rejects
Firm A accepts	$-R_A$, $-R_B$	$b_A - R_A$, $-l_B$
Firm A rejects	$-l_A$, $b_B - R_B$	$0, 0$

Hence from the seller's point of view a rule which enforces nonexclusive selling upstream for lump sum fees may be preferable to a rule which imposes downstream reselling for lump sum fees under a regulatory market share rule.[37]

4.6. Concluding comment

The conclusions from our analysis of remedies in the Hotelling model are the following:

- a price squeeze test has no effect on pricing, profits or consumer welfare in the model
- reducing the wholesale price q divides the surplus from premium programming between firms and consumers
- rights splitting, or forced rights divestiture, has no effect on prices, total profits or welfare
- forced rights reselling for lump sum fees (or under a market share based formula) reallocates all of the gains from the premium programming to consumers, as does nonexclusive sale of rights for lump sum fees

The two regulatory remedies so far imposed by the competition authorities in the UK therefore appear to be ineffective, at least in this model. On the other hand, remedies which alter the way in which rights are sold or resold can have a large effect on both competition and consumer welfare. In the version of the Hotelling model adopted in this paper, these remedies transfer surplus from producers to consumers. In more realistic versions of the model, described in a companion paper, they would also increase social welfare.

[37] Following the Premier League's auctions in June 2000, the cable company NTL returned the exclusive pay per view rights, which it had won for a bid of £328 million. As a consequence the Premier League has resold these rights nonexclusively to each downstream pay TV company for a single fixed payment. The total paid for the rights is not known, but it is clear that it is much less than NTL's original bid for the exclusive rights.

5. Conclusion

Our analysis implies that premium programming rights will be sold originally under exclusive contracts for a lump sum payment, and then resold for per subscriber fees. Resale of premium programming for per subscriber fees relaxes downstream price competition and provides incentives for both downstream firms to increase their prices. The profits created are initially captured by the reselling firm, and then transferred upstream to the rights monopolist.

The model thus predicts a number of the key features of competition in the UK pay TV market, and in particular the form of the rights selling and resale contracts. A key conclusion for competition policy purposes is that these vertical and horizontal contracts may actually harm consumers compared to the case of no resale, in which some consumers do not get served.

In a companion paper we analyze resale contracts in a model which allows for both horizontal and vertical differentiation in the tastes of consumers and the products offered by the firms (see for example Gilbert and Matutes, 1993 and Rochet and Stole, 2001for analyses of price discrimination in the Hotelling model). This more realistic model allows for a more complete analysis of welfare effects from monopolistic pricing, and hence remedies.

References

[1] Armstrong, Mark (1999) "Competition in the Pay-TV Market," *Journal of the Japanese and International Economies*, 13, 257-280.

[2] Armstrong, Mark (2000) "Converging Communications: Implications for Regulation," Beesley Lecture on Regulation, 14 November, London Business School.

[3] Bulow, Jeremy, John Geanakoplos and Paul Klemperer (1985) "Multimarket Oligopoly: Strategic Substitutes and Complements " *Journal of Political Economy*, 93(3), 488-511.

[4] Cave, Martin and Robert W. Crandall (2001) "Sports Rights and the Broadcast Industry," *Economic Journal*, 111, F4-F26.

[5] Fudenberg, Drew and Jean Tirole (1984) "The Fat Cat Effect, the Puppy Dog Ploy and the Lean and Hungry Look," *American Economic Review Papers and Proceedings*, 74(2), 361-366.

[6] Gilbert, Richard and Carmen Matutes (1993), "Product Line Rivalry with Brand Differentiation," *Journal of Industrial Economics*, 41(3), 223-240.

[7] Harbord, David and Ken Binmore (2000) "Toeholds, Takeovers and Football," *European Competition Law Review*, 21 (2), March.

[8] Harbord, David, Angel Hernando and George von Graevenitz (2000) "Market Definition in European Sports Broadcasting and Competition for Sports Broadcasting Rights," A Study for DGIV of the European Commission, October (available from authors).

[9] Jehiel, Philippe and Benny Moldovanu (2000) "Auctions with Downstream Interaction Among Buyers," *Rand Journal of Economics*, 31(4), 768-791.

[10] Kamien, Morton and Yair Tauman (1986) "The Private Value of a Patent: A Game-Theoretic Analysis," *Quarterly Journal of Economics,* 101, 471-491.

[11] Katz, Michael and Carl Shapiro (1985) "On the Licensing of Innovations," *Rand Journal of Economics*, 16(4), 504-520.

[12] Klemperer, Paul (2000) "What Really Matters in Auction Design," mimeo, Nuffield College, Oxford.

[13] Krattenmaker, Thomas and Steven Salop (1986) "Anticompetitive Exclusion: Raising Rivals' Costs to Achieve Power over Price," *Yale Law Journal*, 96(2), 209-293.

[14] Laffont, Jean-Jacques, Patrick Rey and Jean Tirole (1998a) "Network Competition: Overview and Nondiscriminatory Pricing," *Rand Journal of Economics*, 29(1), 1-37.

[15] Laffont, Jean-Jacques, Patrick Rey and Jean Tirole (1998b) "Network Competition: Price Discrimination," *Rand Journal of Economics*, 29(1), 38-56.

[16] Monopolies and Mergers Commission (1999) "BSkyB and Manchester United: Report on Proposed Merger," HMSO, London.

[17] Riordan, Michael and Steven Salop (1995) "Evaluating Vertical Mergers: A Post-Chicago Approach," *Antitrust Bulletin* 63, 513-568.

[18] Rochet, Jean-Charles and Lars A. Stole (2001) "Nonlinear Pricing with Random Participation," *Review of Economic Studies*, forthcoming.

[19] Salop, Steven and David Scheffman (1983) "Raising Rivals' Costs," *American Economic Review, Papers and Proceedings*, 73(2), 267-271.

[20] Salop, Steven and David Scheffman (1987) "Cost-Raising Strategies," *Journal of Industrial Economics*, 41(3), 223-240.

[21] Shapiro, Carl (1995) "Patent Licensing and R&D Rivalry," *American Economic Review Papers and Proceedings*, 75(2), 25-30.

[22] Shapiro, Carl (2001) "Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting," mimeo, Department of Economics, University of California at Berkeley.

[23] Vickers, John (1996) "Market Power and Inefficiency: A Contracts Perspective," *Oxford Review of Economic Policy*, 12(4), 11-26.

6. Appendix: The Strategy of Reselling

Section 6.1 of this annex compares the effects of reselling for per subscriber fees to rivals in Bertrand, Hotelling and Cournot models. We show that the strategic price effects of variable resale pricing are most pronounced in the Hotelling model, and least pronounced in Cournot models. Differentiated product Bertrand competition lies between these two extremes. We also illustrate the aggregate welfare effects of per subscriber resale pricing in linear Cournot and Bertrand models, which were absent in the Hotelling model. In the linear Cournot model, resale for a per subscriber fee results in higher retail prices and lower consumer surplus than does resale for lump sum fees. The affect on total welfare is ambiguous in general, but always negative with symmetric firms.

In the Bertrand model, a variable resale price results in higher retail prices, lower aggregate output, lower consumer surplus and *an unambiguous reduction in total welfare* compared to resale for lump sum fees. The competitive regime of the Hotelling model is a limiting case of the Bertrand model in which an increase in the per subscriber price q does not effect aggregate welfare.

Section 6.2 contains an analysis of BSkyB's actual reselling scheme in which wholesale prices are proportional to retail prices, and compares this to wholesale pricing for a fixed resale price q. We show that when the reselling firm is able to commit itself to a proportional pricing scheme this results in higher equilibrium profits and prices, and hence lower consumer surplus, than under independent (i.e. fixed) resale pricing. Hence proportional resale pricing, as practised by BSkyB, would appear to be an even more effective mechanism for extracting consumer surplus *from both premium and basic programming* than independent resale pricing, as assumed in the paper.

6.1. Strategic Interaction and Raising Rival's Costs in Bertrand, Hotelling and Cournot Models

In Section 2 of the paper we showed that when either downstream firm acquires the exclusive rights to premium programming for a fixed (i.e. lump sum) payment, it will resell to its rival for a per subscriber fee $q = \alpha$. In Section 3 we showed that the upstream rights seller maximizes profits by selling rights exclusively for a lump sum payment. Our analysis of the Hotelling model thus "predicts" that rights will be sold originally under exclusive contracts for a lump sum fee, and then resold for a per subscriber fee equal to α.

Resale for per subscriber fee allows the downstream firm which acquires the exclusive broadcasting rights to prevent the dissipation of downstream profits by *raising its rival's costs,* while simultaneously increasing the *opportunity cost* of serving its own customers. The opportunity cost effect reflects the fact that (when the market is covered), any revenues earned by the reselling firm from reducing its price and serving additional customers are at the expense of resale revenue that would otherwise have been received from its rival. This reduction in resale revenue has exactly the same effect as an increase in the reselling firm's marginal costs, giving both firms an incentive to increase their retail prices in equilibrium.

The finding that resale for per subscriber fees can be used to sustain more monopolistic market outcomes than resale for lump sum fees is common to both the Cournot model of Katz and Shapiro (1985) and the Hotelling model. The main difference is that in the Hotelling model, an increase in the per subscriber resale fee shifts the reaction functions of both firms outwards in exactly the same way, inducing both firms to increase their prices by q. In the Cournot model, the per subscriber fee shifts the reaction function of the buying firm only, and firms produce exactly the same outputs they would have in the absence of a resale agreement. Given the importance of this difference to our analysis, in this annex we develop the intuition for it further.

Recall that when firm A acquires the rights and resells to firm B at a resale price of q, firms' profits may be written as

$$\begin{aligned}
\pi_A &= (p_A - c_A)\, x_A + q x_B = (p_A - c'_A)\, x_A + qX \\
\pi_B &= (p_B - c_B - q)\, x_B = (p_B - c'_B)\, x_B
\end{aligned}$$

where the total demand is $X \equiv x_A + x_B$ and the new cost $c'_i = c_i + q$.

The reselling firm A chooses strategically the variable q taking into account the impact on the outcome of competition. Following the analysis of Bulow, Geanakopolos and Klemperer (1985) and Fudenberg and Tirole (1984), the effect of an increase in the reselling price on the reseller's profits is

$$\begin{aligned}
\frac{d\pi_A}{dq} &= \left(x_A + (p_A - c'_A)\frac{\partial x_A}{\partial p_A}\right)\frac{dp_A}{dq} + (p_A - c'_A)\frac{\partial x_A}{\partial p_B}\frac{dp_B}{dq} - x_A\frac{\partial c'_A}{\partial q} \\
&\quad + q\left(\left(\frac{\partial x_A}{\partial p_A} + \frac{\partial x_B}{\partial p_A}\right)\frac{dp_A}{\partial q} + \left(\frac{\partial x_A}{\partial p_B} + \frac{\partial x_B}{\partial p_B}\right)\frac{dp_B}{dq}\right) + X
\end{aligned}$$

After substitution of the first order condition (or by the envelope theorem)

$$\frac{\partial \pi_A}{\partial p_A} = x_A + \frac{\partial x_A}{\partial p_A}(p_A - c'_A) + q\left(\frac{\partial x_A}{\partial p_A} + \frac{\partial x_B}{\partial p_A}\right) = 0$$

and the decomposition

$$\frac{dp_B}{dq} = \frac{\partial p_B}{\partial c'_B}\frac{\partial c'_B}{\partial q} + \frac{\partial p_B}{\partial c'_A}\frac{\partial c'_A}{\partial q} + \frac{\partial p_B}{\partial q}$$

we have

$$\frac{d\pi_A}{dq} = (p_A - c'_A)\frac{\partial x_A}{\partial p_B}\frac{dp_B}{dq} - x_A\frac{\partial c'_A}{\partial q} + q\left(\frac{\partial x_A}{\partial p_B} + \frac{\partial x_B}{\partial p_B}\right)\frac{dp_B}{dq} + X.$$

In addition $\frac{\partial c'_A}{\partial q} = \frac{\partial c'_B}{\partial q} = 1$, so we may write

$$\frac{d\pi_A}{dq} = \underbrace{(p_A - c'_A)\frac{\partial x_A}{\partial p_B}\frac{\partial p_B}{\partial c'_B}}_{\text{strategic raising rival's cost effect}} + \underbrace{(p_A - c'_A)\frac{\partial x_A}{\partial p_B}\left(\frac{\partial p_B}{\partial c'_A} + \frac{\partial p_B}{\partial q}\right)}_{\text{strategic opportunity cost effect}} + \underbrace{x_A}_{\text{direct opportunity cost effect}} + \underbrace{q\left(\frac{\partial x_A}{\partial p_B} + \frac{\partial x_B}{\partial p_B}\right)\left(\frac{\partial p_B}{\partial c'_A} + \frac{\partial p_B}{\partial c'_B} + \frac{\partial p_B}{\partial q}\right) + X}_{\text{resale revenue effect}} \tag{6.1}$$

The first addend is the *strategic raising rivals' cost effect* on A's profits through a change in B's price brought about by a change in B's costs. The second addend is the *strategic opportunity cost effect* on A's profits through a change in B's price brought about by a change in A's opportunity costs. The third addend is the *direct opportunity cost effect.* The fourth addend is the *resale revenue effect,* reflecting the increase in the reselling firm's revenues from sales of the premium product to its own customers, and to those of its rival.

Equation (6.1) is generally valid for Bertrand price competition. In the competitive regime of the Hotelling model the total output is fixed, i.e.

$$\frac{\partial x_A}{\partial p_B} = -\frac{\partial x_B}{\partial p_B},$$

$$\frac{dp_A}{dq} = \frac{2}{3} + \frac{1}{3} = 1 = \frac{dp_B}{dq}$$

and

$$\frac{\partial x_A}{\partial p_B}(p_A - c'_A) = x_A.$$

The sum of the two strategic effects exactly offsets the opportunity cost effect, so that the total effect of a marginal increase in the per subscriber fee is an increase in the reseller's profits equal to total output:

$$\frac{d\pi_A}{dq} = X.$$

Similar analysis shows that the buyer's profits are unaffected: $\frac{d\pi_B}{dq} = 0$. It can be shown that under Bertrand price competition with differentiated products the strategic effects are weaker than in Hotelling model, so that the total effect on the seller's profits is then $\frac{d\pi_A}{dq} \leq X$ and on the buyer $\frac{d\pi_B}{dq} \leq 0$.

In the Cournot model of Katz and Shapiro (1995) we may write the reselling firm's profits as

$$\pi_A = (p_A(x_A, x_B) - c'_A)\, x_A + qX$$

for a given resale price q, where again $X = x_A + x_B$ and $c'_i = c_i + q$. After application of the envelope theorem we have

$$\frac{d\pi_A}{dq} = \underbrace{x_A\frac{\partial p_A}{\partial x_B}\frac{dx_B}{dq}}_{\text{strategic raising rival's cost effect}} + \underbrace{q\frac{dx_B}{dq} + x_B}_{\text{resale revenue effect}}.$$

The first addend is the *strategic raising rivals' cost effect* on A's profits from a decrease in B's output due to an increase in B's costs; the last addend is the *resale revenue effect*. Note that there is no strategic opportunity cost effect nor a direct opportunity cost effect. The resale price q appears as an addition to marginal cost for firm B only in the Cournot model, and does not affect the reaction function of firm A.

To summarize the above analysis in words, the Hotelling and Cournot models are both special cases in which the reselling firm's opportunity cost from serving an additional customer (unit of demand) are equal to q and zero respectively. In differentiated product Bertrand competition models this opportunity cost always exceeds zero, but is less than q. The effect of setting $q = \alpha$ on equilibrium prices and profits is thus greatest in the Hotelling model (where equilibrium prices increase by α) and smallest in the Cournot model (where the equilibrium price is unchanged).

6.1.1. Resale in differentiated product duopoly with linear demands

We now illustrate the mechanics of resale for lump sum and per subscriber fees in Cournot and Bertrand models with differentiated products and linear demands. Apart from explaining the comparison made immediately above in greater detail, we also derive the aggregate welfare effects of per subscriber resale pricing in linear Cournot and Bertrand models, which were absent in the Hotelling model.

Cournot competition Following the usual approach, the inverse demand system

$$\begin{aligned} p_i &= a_i - b_i x_i - d x_j \\ p_j &= a_j - b_j x_j - d x_i \end{aligned}$$

can be generated from a quadratic aggregate consumer utility function

$$U(x_i, x_j) = a_i x_i + a_j x_j - \frac{1}{2}\left(b_i x_i^2 + 2d x_i x_j + b_j x_j^2\right).$$

When $a_i = a_j$, the substitutability between the two products is parametrized by $\frac{d^2}{b_i b_j} \leq 1$, with the inequality required for concavity of $U(x_i, x_j)$. The parameters are assumed to satisfy $a_i, b_i > 0$ and $b_i > d$.

Resale for lump sum fees We assume that firm i has acquired the premium programming rights and resells to firm j for a lump sum fee. Hence we abuse notation throughout the remainder of this section and let $a_i = a_i + \alpha$ and $a_j = a_j + \alpha$. The two firms' profits are then

$$\begin{aligned} \pi_i &= (a_i - b_i x_i - d x_j - c_i)\, x_i + Q \\ \pi_j &= (a_j - b_j x_j - d x_i - c_j)\, x_j - Q \end{aligned}$$

where Q is the lump sum transfer paid by firm i to firm j. The best replies are given by

$$
\begin{aligned}
x_i &= \frac{a_i - dx_j - c_i}{2b_i} \\
x_j &= \frac{a_j - dx_i - c_j}{2b_j},
\end{aligned}
$$

so that equilibrium quantities are

$$
\begin{aligned}
x_i &= \frac{2(a_i - c_i) b_j - d(a_j - c_j)}{4b_i b_j - d^2} \\
x_j &= \frac{2(a_j - c_j) b_i - d(a_i - c_i)}{4b_i b_j - d^2} \\
&.
\end{aligned}
$$

and prices are

$$
\begin{aligned}
p_i &= b_i \frac{2(a_i - c_i) b_j - d(a_j - c_j)}{4b_i b_j - d^2} \\
p_i &= b_j \frac{2(a_j - c_j) b_i - d(a_i - c_i)}{4b_i b_j - d^2}.
\end{aligned}
$$

Resale for per subscriber fees When firm i resells premium programming to firm j for a per subscriber fee of q, the firms' profits are

$$
\begin{aligned}
\pi_i &= (a_i - b_i x_i - dx_j - c_i) x_i + qx_j \\
\pi_j &= (a_j - b_j x_j - dx_i - c_j - q) x_j,
\end{aligned}
$$

and the best replies are

$$
\begin{aligned}
x_i &= \frac{a_i - dx_j - c_i}{2b_i} \\
x_j &= \frac{a_j - dx_i - c_j - q}{2b_j}.
\end{aligned}
$$

Under Cournot competition the only effect of resale for a per subscriber fee is the direct effect on firm j's marginal cost, which increases from c_j to $c_j + q$. Equilibrium quantities are given by

$$
x_i = \frac{2(a_i - c_i) b_j - d(a_j - c_j - q)}{4b_j b_i - d^2} \tag{6.2}
$$

$$
x_j = \frac{2(a_j - c_j - q) b_i - d(a_i - c_i)}{4b_j b_i - d^2}. \tag{6.3}
$$

We then have

$$\frac{\partial x_i}{\partial q} = \frac{d}{4b_j b_i - d^2} > 0 \tag{6.4}$$

$$\frac{\partial x_j}{\partial q} = -\frac{2b_i}{4b_j b_i - d^2} < 0. \tag{6.5}$$

and,

$$\begin{aligned}
\frac{\partial p_i}{\partial q} &= -b_i \frac{\partial x_i}{\partial q} - d\frac{\partial x_j}{\partial q} = \frac{b_i d}{4b_j b_i - d^2} > 0 \\
\frac{\partial p_j}{\partial q} &= -b_j \frac{\partial x_j}{\partial q} - d\frac{\partial x_i}{\partial q} = \frac{2b_j b_i - d^2}{4b_j b_i - d^2} > 0.
\end{aligned}$$

Both firm's equilibrium prices increase under variable resale pricing, while firm i's output increases and firm j's output decreases (aggregate output decreases however).

The effect of a small increase in the resale price q on the buying firm's profits is

$$\frac{\partial \pi_j}{\partial q} = -dx_i \left(\frac{d}{4b_j b_i - d^2} \right) - x_j < 0.$$

and on the seller's profits

$$\frac{\partial \pi_i}{\partial q} = -dx_i \left(-\frac{2b_i}{4b_j b_i - d^2} \right) + x_j > 0.$$

We summarise the key results in the following proposition.

Proposition 1 *In the Cournot model a higher q results in an increase in the prices of both goods, thereby unambiguously reducing output and consumer surplus. The effect on total welfare $W(x_i, x_j) = U(x_i, x_j) - c_i x_i - c_j x_j$ is ambiguous in general, but always negative with symmetric firms.*

Proof. Using (6.4),(6.5), and

$$\frac{\partial W}{\partial x_i} = (a_i - c_i) - b_i x_i - dx_j,$$

we have

$$\begin{aligned}
\frac{\partial W}{\partial q} &= \frac{\partial W}{\partial x_i}\frac{\partial x_i}{\partial q} + \frac{\partial W}{\partial x_j}\frac{\partial x_j}{\partial q} \\
&= \frac{d(a_i - c_i) + db_i x_i - 2b_i(a_j - c_j) + (2b_i b_j - d^2)x_j}{4b_j b_i - d^2}
\end{aligned}$$

After substitution of the equilibrium quantities (6.2) and (6.3) we obtain

$$\frac{\partial W}{\partial q} = b_i \frac{4db_j(a_i - c_i) - (a_j - (c_j + 3q))d^2 - 4b_j b_i(a_j - (c_j + q))}{(4b_j b_i - d^2)^2}$$

A sufficient condition for welfare to decrease in q is

$$4db_j(a_i - c_i) - \left(d^2 + 4b_j b_i\right)(a_j - c_j) < 0,$$

which is always satisfied under symmetry ($a_i - c_i = a_j - c_j$ and $b_i = b_j$). ■

Bertrand competition Under Bertrand competition it is convenient to work with the direct demand system which may be written as

$$x_i = \widehat{a}_i - \widehat{b}_i p_i + \widehat{d} p_j$$
$$x_j = \widehat{a}_j - \widehat{b}_j p_j + \widehat{d} p_i,$$

where

$$\widehat{a}_i = \frac{a_i b_j + a_j d}{b_i b_j - d^2}, \widehat{b}_i = \frac{b_j}{b_i b_j - d^2}, \widehat{d} = \frac{d}{b_i b_j - d^2}.$$

Again product substitutability is measured by $\frac{\widehat{d}^2}{\widehat{b}_i \widehat{b}_j} = \frac{d^2}{b_i b_j} \leq 1$.

Resale for lump sum fees Still abusing notation so that $\widehat{a}_i = \widehat{a}_i + \alpha$ and $\widehat{a}_j = \widehat{a}_j + \alpha$, firms' profits may be written

$$\begin{aligned} \pi_i &= (p_i - c_i)\left(\widehat{a}_i - \widehat{b}_i p_i + \widehat{d} p_j\right) + Q \\ \pi_j &= (p_j - c_j)\left(\widehat{a}_j - \widehat{b}_j p_j + \widehat{d} p_i\right) - Q \end{aligned}$$

where Q is again the lump sum transfer paid by firm j for access to the premium content. From the best replies

$$\begin{aligned} p_i(p_j) &= \frac{\widehat{a}_i + \widehat{b}_i c_i + \widehat{d} p_j}{2\widehat{b}_i} \\ p_j(p_i) &= \frac{\widehat{a}_j + \widehat{b}_j c_j + \widehat{d} p_i}{2\widehat{b}_j}, \end{aligned}$$

the equilibrium prices are given by

$$\begin{aligned} p_i &= \frac{2\widehat{b}_j\left(\widehat{a}_i + \widehat{b}_i c_i\right) + \widehat{d}\left(\widehat{a}_j + \widehat{b}_j c_j\right)}{4\widehat{b}_j \widehat{b}_i - \widehat{d}^2} \\ p_j &= \frac{2\widehat{b}_i\left(\widehat{a}_j + \widehat{b}_j c_j\right) + \widehat{d}\left(\widehat{a}_i + \widehat{b}_i c_i\right)}{4\widehat{b}_j \widehat{b}_i - \widehat{d}^2} \end{aligned}$$

with equilibrium quantities

$$\begin{aligned} x_i &= \widehat{b}_i(p_i - c_i) \\ x_j &= \widehat{b}_j(p_j - c_j) \end{aligned}$$

Resale for per subscriber fees When firm i resells premium programming to firm j for a per subscriber fee of q under Bertrand competition, firms' profits can be written

$$\begin{aligned} \pi_i &= (p_i - c_i)\left(\widehat{a}_i - \widehat{b}_i p_i + \widehat{d} p_j\right) + q\left(\widehat{a}_j - \widehat{b}_j p_j + \widehat{d} p_i\right) \\ \pi_j &= (p_j - c_j - q)\left(\widehat{a}_j - \widehat{b}_j p_j + \widehat{d} p_i\right) \end{aligned}$$

The first order condition for firm i, given a price chosen by firm j is

$$\left(\widehat{a}_i - \widehat{b}_i p_i + \widehat{d} p_j\right) - (p_i - c_i)\,\widehat{b}_i + q\widehat{d} = 0,$$

so the effect on i's best reply is equivalent to the increase in i's own cost by $q\widehat{d}/\widehat{b}_i$, i.e.

$$p_i\left(p_j\right) = \frac{\widehat{a}_i + \widehat{b}_i\left(c_i + \frac{\widehat{d}}{\widehat{b}_i}q\right) + \widehat{d}p_j}{2\widehat{b}_i}$$

Firm $j's$ best reply is

$$p_j\left(p_i\right) = \frac{\widehat{a}_j + \widehat{b}_j\left(c_j + q\right) + \widehat{d}p_i}{2\widehat{b}_j},$$

since clearly the resale price q results in a one for one increase in firm j's marginal cost.

Redefining the firms' *effective* marginal costs by $c_i' = c_i + \frac{\widehat{d}}{\widehat{b}_i}q$ and $c_j' = c_j + q$, we may write equilibrium prices as

$$\begin{aligned}
p_i &= \frac{2\widehat{b}_j\widehat{a}_i + \widehat{b}_i c_i' + \widehat{d}\left(\widehat{a}_j + \widehat{b}_j c_j'\right)}{4\widehat{b}_i\widehat{b}_j - \widehat{d}^2} \\
p_j &= \frac{2\widehat{b}_i\left(\widehat{a}_j + \widehat{b}_j c_j'\right) + \widehat{d}\left(\widehat{a}_i + \widehat{b}_i c_i'\right)}{4\widehat{b}_i\widehat{b}_j - \widehat{d}^2}
\end{aligned}$$

with corresponding quantities

$$x_i = \widehat{a}_i - \widehat{b}_i p_i + \widehat{d}p_j = \left(p_i - c_i'\right)\widehat{b}_i \tag{6.6}$$

$$x_j = \widehat{a}_j - \widehat{b}_j p_j + \widehat{d}p_i = \left(p_j - c_j'\right)\widehat{b}_j. \tag{6.7}$$

The resulting profits for each firm are

$$\begin{aligned}
\pi_i &= \widehat{b}_i\left(\frac{2\widehat{b}_i\left(\widehat{a}_i - \widehat{b}_i c_i' + \widehat{d}c_j'\right) + \widehat{d}\left(\widehat{a}_j - \widehat{b}_j c_j' + \widehat{d}c_i'\right)}{4\widehat{b}_i\widehat{b}_j - \widehat{d}^2}\right)^2 \\
&\quad + q\widehat{b}_j\left(\frac{2\widehat{b}_i\left(\widehat{a}_j - \widehat{b}_j c_j' + \widehat{d}c_i'\right) + \widehat{d}\left(\widehat{a}_j - \widehat{b}_j c_j' + \widehat{d}c_i'\right)}{4\widehat{b}_i\widehat{b}_j - \widehat{d}^2}\right) \\
\pi_j &= \widehat{b}_j\left(\frac{2\widehat{b}_i\left(\widehat{a}_j - \widehat{b}_j c_j' + \widehat{d}c_i'\right) + \widehat{d}\left(\widehat{a}_j - \widehat{b}_j c_j' + \widehat{d}c_i'\right)}{4\widehat{b}_i\widehat{b}_j - \widehat{d}^2}\right)^2
\end{aligned}$$

Notice that

$$\begin{aligned}
\frac{\partial p_i}{\partial q} &= \frac{\partial p_i}{\partial c_i}\frac{dc_i'}{dq} + \frac{\partial p_i}{\partial c_j}\frac{dc_j'}{dq} = \frac{3\widehat{\widehat{d}b}_j}{4\widehat{b}_i\widehat{b}_j - \widehat{d}^2} > 0 \\
\frac{\partial p_j}{\partial q} &= \frac{\partial p_j}{\partial c_i}\frac{dc_i'}{dq} + \frac{\partial p_j}{\partial c_j}\frac{dc_j'}{dq} = \frac{\widehat{d}^2 + 2\widehat{b}_i\widehat{b}_j}{4\widehat{b}_i\widehat{b}_j - \widehat{d}^2} > 0
\end{aligned}$$

and

$$\frac{\partial x_i}{\partial q} = \widehat{b}_i \left(-\frac{\widehat{d}}{\widehat{b}_i} \frac{\widehat{b}_i \widehat{b}_j - \widehat{d}^2}{4\widehat{b}_i \widehat{b}_j - \widehat{d}^2} \right) < 0$$

$$\frac{\partial x_j}{\partial q} = \widehat{b}_j \left(-2 \frac{\widehat{b}_i \widehat{b}_j - \widehat{d}^2}{4\widehat{b}_i \widehat{b}_j - \widehat{d}^2} \right) < 0$$

So both firm's prices are increasing in the value of the resale price q while both firm's quantities decrease.

The effect on the seller's payoff from a small change in q is given by

$$\frac{d\pi_i}{dq} = \widehat{d} \left(p_i - \left(c_i + \frac{\widehat{b}_i}{\widehat{d}} q \right) \right) \left(\frac{2\widehat{b}_i \widehat{b}_j + \widehat{d}^2}{4\widehat{b}_i \widehat{b}_j - \widehat{d}^2} \right) + x_j = \frac{\widehat{d}}{\widehat{b}_i} \left(\frac{2\widehat{b}_i \widehat{b}_j + \widehat{d}^2}{4\widehat{b}_i \widehat{b}_j - \widehat{d}^2} \right) x_i + x_j \in (0,1)$$

where the second equality uses (6.7) and the coefficient on x_i is less than one since

$$\frac{2\widehat{b}_i \widehat{b}_j + \widehat{d}^2}{4\widehat{b}_i \widehat{b}_j - \widehat{d}^2} < 1 < \frac{\widehat{b}_i}{\widehat{d}},$$

by the assumption that $\widehat{b}_i > \widehat{d}$.

Similarly, the effect on the buyer's payoff is

$$\frac{\widehat{d\pi_j}}{\widehat{dq}} = \widehat{d} \left(p_j - (c_j + q) \right) \frac{3\widehat{d}\widehat{b}_j}{4\widehat{b}_i \widehat{b}_j - \widehat{d}^2} - x_j = \widehat{d} \left(\frac{x_j}{\widehat{b}_j} \right) \frac{3\widehat{d}\widehat{b}_j}{4\widehat{b}_i \widehat{b}_j - \widehat{d}^2} - x_j = \left(\frac{3\widehat{d}^2}{4\widehat{b}_i \widehat{b}_j - \widehat{d}^2} - 1 \right) x_j \leq 0,$$

where the second equality uses (6.7) and the final inequality follows from $\widehat{b}_i \widehat{b}_j - \widehat{d}^2 \geq 0$.

We conclude:

Proposition 2 *Under Bertrand competition, the effect of an increase of q on consumer surplus and total welfare is unambiguously negative, as both firms' prices increase and their quantities decrease. The change in total welfare is given by $dW = [p_i - c_i]\, dx_i + [p_j - c_j]\, dx_j < 0$.*

The Hotelling model is a special case of the differentiated Bertrand model. Demands in the competitive regime of the Hotelling model are linear with $\widehat{b}_i = \widehat{b}_j = \widehat{d}$. Nonetheless, $\widehat{a}_i \neq \widehat{a}_j$ guarantees that products are not perfectly substitutable. The effect of resale for q is an equal increase in the marginal cost of both firms. Both equilibrium prices then increase one for one with the resale price, and equilibrium quantities are unaffected by q. The seller's profits increase one for one with q, while the buyer's profits are unaffected.

6.2. Sky Resale Scheme: Proportional Resale Pricing

The analysis in our paper assumed that the downstream firm which acquires the rights to premium content will resell to its competitor for a per subscriber fee of q which is *independent of its own retail price.* BSkyB, however, resells premium programming to its competitors under the "rate card," which since 1996 has been subject to informal regulatory oversight by the Office of Fair Trading. The rate card makes BSkyB's wholesale prices equal to a *percentage* of its retail prices to consumers. Under the current rate card, BSkyB charges its downstream competitors (the cable operators and ONdigital) a fixed percentage of 57% or 59% of its total package retail price for each subscriber on a competitor's network who subscribes to one or more of its premium channels. That is, the wholesale price per subscriber for a single premium channel is 57% or 59% of BSkyB's retail price for the BSkyB package which includes its largest basic package and that premium channel. Similarly the wholesale price per subscriber for all four of BSkyB's premium channels is 57% or 59% of the retail price for the BSkyB package which includes the largest basic package and all four premium channels.

In the basic Hotelling model with only one type of premium programming available this means that instead of allowing the resale price q to be set independently, we should set q equal to a proportion $0 \leq \mu \leq 1$ of the reselling firm's retail price, i.e. $q = \mu p_i$. Doing so obviously changes the nature of the problem facing the firms, and in this section we provide a (partial) analysis of this wholesale pricing scheme.

As discussed in Section 6.1 of this annex, when the resale price q is set independently, reselling for a per subscriber fee has two effects: it *raises rival's costs* and increases the *opportunity cost* of the reselling firm, giving both firms an incentive to increase their retail prices in equilibrium. Making the resale price a proportion of the reselling firm's retail price introduces a third strategic effect. Now a small reduction in the reselling firm's retail price not only results in a reduction in the resale revenues from the rival firm's marginal customers, but it also results in *a reduction in the resale price*, and hence a reduction in the resale revenue received from all of its rival's *inframarginal* customers. This makes a reduction in price to attract the rival's customers even less profitable for the reselling firm, and allows the firms to sustain higher equilibrium prices.

We show that any given level of the resale price $q \leq \alpha$ can be implemented under the proportional pricing scheme by choosing the appropriate value of μ, and results in both downstream firms charging higher prices and earning greater profits than they would if q were set independently. Consumer welfare is thus further reduced by proportional resale pricing, and when $q = \mu p_i$ consumers are worse off than they would be if the premium product were not available. The resale of premium programming thus becomes a mechanism for altering the pricing incentives of firms so as to achieve even more collusive outcomes at the expense of consumers.

6.2.1. Comparison of proportional and independent resale pricing

To see the effects of proportional resale pricing in the basic Hotelling model we consider what happens when firm i resells to firm j for a per subscriber fee of $q = \mu p_i$. We consider a three stage pricing game. In the first stage the firm which has acquired the exclusive rights to premium content chooses between proportional and independent resale pricing. In the second stage the independent resale price q or the proportional resale parameter μ is chosen by the reselling firm. In the third stage equilibrium retail prices and payoffs are determined.

We will show that independent resale pricing is dominated by proportional resale pricing so long as the reselling firm is not too inefficient compared with its rival. Then any value of the resale price q which the reselling firm wishes to implement in the first stage can be implemented more profitably by choosing a proportional resale price over an independent resale price.

We begin by characterizing payoffs in the third stage pricing game when proportional resale pricing is chosen. For any value of μ chosen in the second stage, assuming that firm j purchases, the two firms' downstream profits in the third stage can be written as

$$\begin{aligned}\pi_i &= (p_i - c_i)x_i + \mu p_i(1 - x_i) = ((1-\mu)p_i - c_i)x_i + \mu p_i \\ \pi_j &= (p_j - c_j - \mu p_i)x_j.\end{aligned}$$

The maximization problem of firm i for given prices by firm j is then

$$\max_{p_i} ((1-\mu)p_i - c_i)\frac{1}{2t}(t + u_i - p_i - u_j + p_j) + \mu p_i$$

and firm j's problem is

$$\max_{p_j} (p_j - \mu p_i - c_j)\frac{1}{2t}(t + u_j - p_j - u_i + p_i).$$

The best replies are given by

$$\begin{aligned}p_i(p_j) &= \frac{(1+\mu)t + (u_i - u_j + p_j)(1-\mu) + c_i}{2(1-\mu)} \\ p_j(p_i) &= \frac{t + u_j - u_i + (1+\mu)p_i + c_j}{2}.\end{aligned}$$

It is immediate that an increase in μ shifts upward the best replies of both firms, so higher values of μ result in higher equilibrium prices. The equilibrium prices are given by[38]

$$\begin{aligned} p_i^\mu &= \frac{(3+\mu)\,t + (s_i - s_j)\,(1-\mu) + (3-\mu)c_i}{(1-\mu)\,(3-\mu)} \\ p_j^\mu &= \frac{(3+\mu^2)t - (1-\mu)^2(s_i - s_j) + (3-\mu)\,(c_i\mu + c_j\,(1-\mu))}{(1-\mu)\,(3-\mu)}. \end{aligned} \tag{6.8}$$

Substitution of these prices into the firms' profit functions then gives

$$\begin{aligned} \pi_i^\mu &= \frac{1}{2t}\left(\frac{(3+\mu)t + (1-\mu)(s_i - s_j)}{(3-\mu)}\right)\left(\frac{(3-2\mu)t + (s_i - s_j)}{(3-\mu)}\right) \\ &\quad + \mu\frac{(3+\mu)t + (1-\mu)(s_i - s_j) + (3-\mu)c_i}{(3-\mu)(1-\mu)} \\ \pi_j^\mu &= \frac{1}{2t}\left(\frac{3t + s_j - s_i}{(3-\mu)}\right)^2, \end{aligned} \tag{6.9}$$

and equilibrium market shares are given by

$$\begin{aligned} x_i^\mu &= \frac{1}{2t}\left(t + \frac{s_i - s_j - \mu t}{3-\mu}\right) \\ x_j^\mu &= \frac{1}{2t}\left(t + \frac{s_j - s_i + \mu t}{3-\mu}\right). \end{aligned}$$

Recall that under independent resale pricing, for any per subscriber fee of $q \leq \alpha$ chosen in the second stage, the firms' equilibrium profits and market shares were given by

$$\begin{aligned} \pi_i^q\,(s_i, s_j) &= \frac{1}{2t}\left(\frac{3t + s_i - s_j}{3}\right)^2 + q \\ \pi_j^q\,(s_j, s_i) &= \frac{1}{2t}\left(\frac{3t + s_j - s_i}{3}\right)^2 \end{aligned}$$

and

$$\begin{aligned} x_i^q &= \frac{1}{2t}\left(t + \frac{s_i - s_j}{3}\right) \\ x_j^q &= \frac{1}{2t}\left(t + \frac{s_j - s_i}{3}\right). \end{aligned}$$

We first observe that $x_i^\mu < x_i^q$ and $x_j^\mu > x_j^q$, for all $\mu \in [0,1]$. This follows from the fact that $3t > \alpha + s_i - s_j$ (i.e. the competitive regime condition). That is, the market share of

[38] Notice that p_i^μ and p_j^μ go to infinity as μ goes to 1. In order to remain in the competitive regime it is necessary that $p_i^\mu + p_j^\mu \leq u_i + u_j - t$. This condition is satisfied at $\mu = 0$ and violated at $\mu = 1$. Following Laffont, Rey and Tirole (1998a) and Gilbert and Matutes (1993) we will assume that $u_i + u_j$ is always sufficiently large to guarantee that we remain in the competitive regime for values of μ not exceeding $\overline{\mu}$ to be defined below.

the selling firm is reduced, and that of the buyer increased, compared to the independent resale pricing scheme.

It is also clear that $\pi_j^\mu \geq \pi_j^q$ with the inequality strict for $\mu > 0$, so the buying firm's profits are higher under proportional resale pricing, and strictly increasing in μ. Comparing profits under the two schemes for equivalent resale prices, so that $q = \mu p_i$, the same is true of π_i^μ so long as the asymmetry between the firms is not too large when the reseller is the inefficient firm. To see this note that

$$\pi_i^\mu \geq \pi_i^q \Leftrightarrow 27t^2\mu(1-\mu) + 12t(s_i - s_j)\mu^2 - \mu(3+\mu)(s_i - s_j)^2 \geq 0. \tag{6.10}$$

The right hand side of (6.10) is always positive when $(s_i - s_j) = 0$ (i..e for symmetric firms). For $(s_i - s_j) > 0$ it is increasing in t, and hence if it is satisfied when we let $3t = s_i - s_j$, it will be satisfied for all higher values of t. Making this substitution yields $\pi_i^\mu = \pi_i^q$, implying that $\pi_i^\mu > \pi_i^q$ for all values of t such that $3t > s_i - s_j$.

Hence firm A always prefers proportional resale pricing over independent resale pricing $(s_A \geq s_B)$, and firm B prefers proportional resale pricing whenever (6.10) is satisfied. In either case we have shown that for a given value of the resale price q at which firm j purchases, the equilibrium profits of both firms are higher under proportional resale pricing. Since $\pi_i^\mu > \pi_i^q$ for $q = \mu p_i$, i.e. for any given level of the resale price, this implies that $p_i^\mu > p_i^q$ since $x_i^\mu < x_i^q$ (firm i's market share is smaller). This in turn implies that $p_j^\mu > p_j^q$ in equilibrium since

$$p_j^\mu\left(p_i^\mu\right) = \frac{t + u_j - u_i + p_i^\mu + \mu p_i^\mu + c_j}{2} > p_j^q\left(p_i^q\right) = \frac{t + u_j - u_i + p_i^q + q + c_j}{2}$$

whenever $p_i^\mu > p_i^q$ and $\mu p_i^\mu = q$.

We conclude that prices and profits for both firms are higher under proportional resale pricing when $\mu p_i = q \leq \alpha$. Intuitively, less competitive prices are supported in equilibrium because by reducing its retail price the reselling firm automatically reduces the resale price charged to its rival. Hence proportional resale pricing is an effective way for the reselling firm to credibly commit not to undercut its rival's price. Given strategic complementarity, the equilibrium prices of both firms are higher than under independent resale pricing. This implies that consumer surplus is lower, and indeed lower than it would be in the absence of the premium product being available.

6.2.2. The optimal value of μ

From Lemma 1 in Section 2 we know that when the resale price q is set independently, the buying firm will deviate to selling only the basic product if q exceeds α. This deviation argument is independent of the form of the per subscriber resale pricing scheme, however, so it also determines the set of self-enforcing agreements over μ which result in the buying firm purchasing with certainty. It is straightforward, but tedious, to establish in this case that $\frac{\partial \pi_i}{\partial \mu} > 0$, i.e. the reselling firm's equilibrium profits are strictly increasing in μ. Since firm j's profits are also increasing in μ, the firms will clearly "agree" in the second stage on the highest value of μ consistent with the buying firm purchasing with probability one in equilibrium. Hence we will have $\mu = \frac{\alpha}{p_i^{\overline{\mu}}} = \overline{\mu}$.[39]

For $\mu > \overline{\mu}$, by Lemma 1, firm j can profitably deviate to offering the basic product at a price of $p_j^{\mu} - \alpha$, so none of firm j's subscribers will purchase the premium product, and resale revenues are reduced to zero. Hence firm j purchasing at a price $\mu p_i^{\mu} > \alpha$ cannot be a pure strategy equilibrium. However both firms offering prices contingent upon firm j not purchasing cannot be a pure strategy equilibrium either, at least for values of μ not too much larger than $\overline{\mu}$, since in such an equilibrium the reseller will offer a price strictly less than p_i^{μ} resulting in $\mu p_i^{noresale} \leq \alpha$. Given this the buyer will wish to purchase, and the seller wish to increase its price to p_i^{μ}, and so on. For values of μ such that $\mu p_i^{\mu} > \alpha$, Lemma 1 guarantees that there is no pure strategy equilibrium. The only equilibrium for $\mu \in [\overline{\mu}, \widehat{\mu}]$ is then a mixed strategy equilibrium in which the buying firm randomizes over purchasing and not purchasing.[40]

Under the assumption that the expected payoff of the reselling firm in the best mixed strategy equilibrium does not exceed the most profitable pure strategy equilibrium payoff, the reselling firm will wish to set $\mu = \overline{\mu}$ as in the previous analysis. Retail prices increase by more than α compared to the basic product equilibrium, and hence consumers suffer a reduction in consumer surplus.

[39] Note that $\overline{\mu}$ is uniquely determined by the equation $\overline{\mu} p_i^{\overline{\mu}} = \alpha$, since for any value of μ chosen in the first stage, equilibrium prices in the second stage are unique.

[40] For $\mu > \widehat{\mu}$ there is a unique pure strategy equilibrium in which the buyer does not purchase, where $\widehat{\mu}$ is defined by $\widehat{\mu} p_i^{noresale} = \alpha$. It is immediate that the seller will never wish to set μ so that resale does not occur with probability one.