Asymmetric Regulation of Conditional Access Charges for Public Service Broadcasters

A Report Prepared for the BBC and ITV by Market Analysis Ltd*

24 January 2002

1 Introduction and Summary

OFTEL is currently reviewing the arrangements for public service broadcasters' (PSB's) access to conditional access (CA) services, and the principles for tariff construction. We argue in this paper that there are strong reasons for OFTEL to differentiate PSB's from other (commercial) broadcasters in setting the framework for determining conditional access charges. In summary form our arguments are:

1. OFTEL's conditional access framework envisages CA charges being determined by commercial negotiations, with OFTEL intervening only as a last resort. However the BBC is subject to a *de facto* universality requirement which means that it cannot effectively bargain with BSkyB over CA charges. This makes the OFTEL framework of commercial negotiation against the background of its broad charging principles particularly ineffective, and possibly explains why BSkyB is able to charge the BBC for carrying its channels, rather than the reverse.[1] OFTEL should therefore be more actively engaged in specifying reasonable charges for these services.

*4 Mill Street, Eynsham, Oxford OX29 4JS. Phone: +44-1865-883-176. Fax: +44-1865-731-250. E-mail: manalysis@aol.com

[1] OFTEL itself recognises that if the BBC were to obtain access to BSkyB's network by making its channels part of a BSkyB basic package (which the BBC is proscribed from doing), then it would be paid for its content, rather than be required to pay for conditional access.

2. The case of ITV demonstrates the above point particularly clearly. ITV *can* walk away from the negotiating table, but it has been unable to agree a CA price with BSkyB.[2] It is likely that ITV will be subject to a universality requirement in the near future, and hence will be in a similar position to the BBC in this respect.[3] Again, OFTEL will need to become more actively engaged in specifying reasonable charges for PSB conditional access in order to ensure that BSkyB does not simply abuse its unassailable bargaining position at the expense of PSB providers, and television licence fee payers.

3. OFTEL's conditional access pricing principles are extremely broad and cost-based. This may or may not be appropriate for the 'light-handed' regulation of purely commercial conditional access agreements, but it is clearly insufficient for PSBs. Cost-based principles are unable to take account of some important factors which distinguish PSB's from other broadcasters. The access pricing literature, briefly summarised below, provides useful insights into the factors which should be taken into account in determining specific conditional access charges. In particular:

    - as an unregulated commercial firm, BSkyB can be assumed to be recovering its network costs from its retail prices to subscribers, so access charges should be set so as to recover these costs *only if* (but not necessarily *if*) providing conditional access reduces BSkyB's revenue from subscriptions

    - PSB's provide (weakly) complementary rather than substitute programming to digital pay-TV companies, which makes these companies better able to recover their network costs from subscriptions (i.e. the opportunity cost to BSkyB and other platform providers of providing conditional access to BBC and ITV channels is zero or negative). Therefore PSB's should not be required to make additional contributions to network fixed or common costs via conditional access charges

[2] ITV has recently made a formal complaint to OFTEL concerning BSkyB's CA charges and has asked for a price determination.

[3] As recommended in the white paper concerning the new broadcasting act.

- the nature of downstream competition between pay-TV companies must be taken into account as this determines the relevant opportunity costs. If competition downstream is imperfect, optimal conditional access charges may be greater or less than marginal cost, depending upon the nature of the good or service being provided by the PSB

4. One problem with applying the access pricing literature to CA for public broadcasters is that the theory derives its conclusions by considering the *marginal* decisions made by access purchasers for given access prices. Since the BBC needs to obtain access to BSkyB's network to maintain universality, and produces digital channels independently of obtaining access at any particular price, it is arguable that the theory does not apply directly as no relevant economic decisions are affected by the level of the CA charge. However the BBC operates as a nonprofit company subject to a fixed budget constraint, so any reduction in the BBC's revenues will result in fewer, or lower quality, programs and channels being produced. Hence higher conditional access charges are likely to result in a reduced 'quality-adjusted' supply of programming.

5. The optimal access pricing literature also focuses on rather special market structures, typically a network monopolist, or dominant firm, providing access to a price-taking entrant or a competitive fringe. Hence the effects of different access pricing regimes on downstream competition are not fully accounted for. In the pay-TV market, on the other hand, conditional access is provided by competing oligopolists (BSkyB, the cable operators and ITV Digital) to "price-taking" PSBs. It is therefore important to consider the determination of conditional access charges in a model with oligopolistic (e.g. Bertrand) competition downstream.

6. To model these features of the TV market, we adopt Armstrong's (1999) formulation of duopoly competition in pay-TV broadcasting, as recently extended by Harbord and Ottaviani (2001). We consider optimal (i.e. welfare maximising) conditional access charges when two downstream firms are permitted to charge for conditional access, and when only one firm is, and assume that quality or quantity of the programming provided by the

PSB depends negatively on the total conditional access charges it incurs. Within this framework we show that:

- when both downstream firms charge *fixed* conditional access fees, optimal access fees will either be indeterminate (when PSB program quality does not depend on access fees), or negative. They are typically negative because although fixed access fees do not effect the downstream allocation of programming to consumers, they effect the total programming budget of the PSB. Transfers of profits from the downstream firms to the PSB therefore always improve welfare, and welfare-maximising access prices are determined by the downstream firms' maximum willingness to pay for the programming
- when both firms charge *variable*, or *per subscriber*, access fees, optimal access prices will again be indeterminate or negative, and for reasons similar to those given immediately above. In the Armstrong-Hotelling model, the downstream allocation of programming depends only on the *difference* in the firms' per subscriber charges, and not on their *absolute level*. The *difference* between the firms' conditional access charges should be set to remedy any downstream monopoly distortion, and the *absolute level* should be set to maximise the quality of programming provided by the PSB. Hence once again, welfare-maximising per subscriber access prices are typically negative, and determined by the downstream firms' maximum willingness to pay
- when only one firm is able to charge a *per subscriber fee* for conditional access, this distorts downstream competition in favour of the charging firm. The effect of the asymmetric regulation of conditional access charges is to reduce the charging firm's marginal (i.e. per subscriber) costs (or increase its marginal revenues) relative to its competitors, giving it a competitive advantage it would not otherwise have. This can be good for welfare if the charging firm is more efficient at *both* service provision *and* access, and is bad for welfare otherwise. When the firm with the ability to charge for CA is more efficient, the optimal per subscriber access charge must balance the correction to the monopoly distortion with the negative effect of positive conditional access charges on PSB product quality, and may

be positive or negative. When the charging firm is less or equally efficient, the optimal access charge is unambiguously negative.

7. Within the current regulatory and legislative framework BSkyB alone is able to (or indeed, needs to) charge public service broadcasters for conditional access services. Our model suggests that this asymmetric regulatory treatment of commercial pay-TV broadcasters has the effect of tilting the competitive playing field in BSkyB's favour, thus distorting downstream competition in the pay-TV market. The asymmetric regulation of CA charges gives BSkyB a competitive advantage it would not otherwise have.

8. Optimal regulation of conditional access charges implies that the regulator should use access charges to tilt the competitive playing field in favour of the more efficient firm, where efficiency includes the cost of providing services plus the costs of providing access. This requires that regulator be able to identify the more efficient firm, and more specifically, the degree of (marginal) cost asymmetry between the firms. This task is well beyond OFTEL's limited resources, and OFTEL's remit is in any event to ensure *competitive neutrality* in the application of regulatory instruments.

9. The evidence in any case suggests that cable, satellite and digital terrestrial pay-TV companies are probably - to a first approximation - equally efficient.[4] Given that only BSkyB charges PSB's for conditional access, the obvious remedy is for OFTEL to *re-level* the competitive playing field by setting BSkyB's conditional access charges at zero.

Balancing these various considerations leads to the conclusion that BSkyB's conditional access charges should probably be set at zero for PSBs, in line with other digital platform providers.

1.1 Outline of Report

Section 2 provides a brief overview of OFTEL's current framework for determining conditional access charges. Section 3 briefly reviews the access pricing

[4] One of BSkyB's justifications for charging PSBs for conditional access is that if faces additional (e.g. encryption) costs not incurred by other firms. However if Sky is a particularly high cost provider of access, its CA charges should be lower to encourage subscriptions to the more efficient networks.

literature and explains what factors should be taken into account in determining conditional access charges in any particular instance. Section 4 models downstream competition between pay-TV companies following the analyses of Armstrong (1999) and Harbord and Ottaviani (2001),[5] and argues that the current regulatory framework tilts the competitive playing field in favour of BSkyB at the expense of its competitors, consumers and public broadcasters. Annex A shows that the standard approach to optimal access pricing (Armstrong, Doyle and Vickers, 1996; Armstrong and Vickers, 1998) easily generalises to the case of complementary products or services, as claimed in Section 3.

2 OFTEL's Regulatory Framework

OFTEL has described its framework for determining fair, reasonable and non-discriminatory (FRND) conditional access charges for digital TV platforms in OFTEL (1999) and OFTEL (2001). It sets out a number of principles for the regulation of CA charges:

1. The overall level of prices should be consistent with those that would prevail in a *competitive market,* so that on average conditional access suppliers should be able to recover their costs and make a return on investment appropriate to the level of risk and uncertainty (i.e. prices should allow for cost recovery, but no more).

2. Prices for individual services or groups of services should lie between the *incremental cost* of providing the conditional access service (or group of services) and the *stand-alone cost* of providing these services.

3. A degree of price discrimination is allowed so long as:

- comparable services are charged comparable prices,
- vertically integrated suppliers of conditional access should not offer services in a way which restricts downstream competition by favouring their own downstream businesses more favorably than those of third parties;
- the terms of supply should be consistent with public policy objectives relating to universal access to public services; and

[5] See Harbord and Ottaviani (2002) for a nontechnical discussion.

- the terms of supply should maximise benefits to consumers in particular by not creating barriers to the entry of competitors

OFTEL's first two principles essentially treat CA as if it were being provided by a separate network business (e.g. SSSL) which is not vertically integrated with a downstream provider of pay-TV services. This network business connects consumers to the network (for a fee) and charges broadcasters for providing conditional access to customers. Connection and other network costs not recovered from subscribers are recovered from CA charges to broadcasters.

OFTEL's pricing principles for this vertically separated network business are the familiar Baumol-Willig conditions for multiproduct firms, i.e. prices greater than the incremental costs of providing network services and less than stand-alone costs. The Baumol-Willig conditions are designed to ensure that network prices:

- do not permit a network monopolist to earn more than a competitive rate of return - i.e. excessive profits - by ensuring that the firm does not recover more than its aggregate total costs (or those of an efficient operator);

- are not set so high as to induce the inefficient duplication of network provision - i.e. the inefficient entry of competing network operators - by ensuring that network charges for any service do not exceed stand-alone costs; and

- do not permit cross-subsidisation between services, and prevent a network monopolist from engaging in predatory pricing by placing a lower bound on access charges of avoidable or incremental costs.

The difference between the incremental cost and stand-alone cost price bounds is equal to the value of the scale and scope economies which arise from undertaking multiple activities. Where there are several services these conditions must be applied *combinatorially*, so that no service, or subset of services, is priced so that total purchase costs exceed stand-alone costs for that subset, and similarly for the incremental cost floors.

The Baumol-Willig conditions are aimed at the achievement of productive economic efficiency, or least-cost provision of services, by replicating the pricing constraints a monopolist would face in a "contestable" market. However, they are not in general either necessary or sufficient to achieve allocative efficiency at either the network or retail levels. There are two reasons for this:

- within the Baumol-Willig price bounds numerous different pricing structures are possible - each corresponding to a different allocation of common costs between services or users. These conditions leave open the question of the allocation of fixed and common costs, and this allocation may - and typically will - influence both network usage decisions and downstream competition and prices

- allocatively efficient access prices depend upon, amongst other things, downstream market structure. Where market power is being exerted downstream, access prices below incremental (or avoidable) costs may be optimal in order to offset downstream allocative inefficiency.

Optimal network access prices must balance these considerations. Access prices that are too low may result in over-use of the network by users whose willingness to pay is not sufficient to cover their avoidable or incremental costs, and hence require cross-subsidies between services. On the other hand, access prices below avoidable costs may be socially optimal if there are positive network externalities, barriers to entry, or if they improve allocative efficiency where market power is being exerted downstream. If access prices are too high, productive inefficiency may occur in the form of inefficient by-pass, or some users may be priced off the network, again worsening efficiency and leading to a social waste of resources.

OFTEL's regulatory framework recognises these issues to the extent that point 3 above implies that additional constraints will be placed on CA charges for vertically integrated operators with market power.[6] However BSkyB's conditional access charges - as set out in the SSSL rate card - would appear to already violate these guidelines. For example, BSkyB's practice of charging *per broadcaster* (rather than per channel, say) means that a network customer who subscribes to the services of more than one pay-TV retailer attracts much higher

[6] OFTEL appears to accept that it cannot treat BSkyB's network business as entirely separate from its retail pay-TV business when it suggests that the magnitude of the network "common costs" to be recovered from CA charges may depend upon BSkyB's retail pricing scheme, and in particular the extent to which a customer is locked in to purchasing a BSkyB retail package when connecting to the network. See OFTEL (1999), paras 2.7-2.10.

network charges than a customer who takes services from BSkyB alone, even though network costs are not driven by the number of companies providing services to a particular subscriber. This charging structure is evidently designed to discourage competition on Sky's pay-TV platform. In addition, as we shall show in Section 4 below, BSkyB's conditional access charges to PSB's are likely to have an adverse impact on downstream competition *between pay-TV platforms*.[7]

OFTEL's guidelines are not intended to determine conditional access charges in any particular instance, but rather to provide the background to commercial negotiations and indicate how OFTEL will deal with complaints and make determinations. However the framework may provide excessive latitude to a dominant network operator with little interest in providing access to its customer base at prices which other broadcasters find acceptable. In the case of the BBC, which is arguably proscribed from walking away from the bargaining table,[8] it must simply accept whatever terms it is offered by BSkyB, in the absence of intervention by OFTEL. ITV, on the other hand, has so far failed to reach an agreement with BSkyB over CA terms, despite years of protracted negotiations. Hence the 'light-handed' regulatory approach adopted by OFTEL appears not to have worked.

Since a more prescriptive regulatory approach may be required, in the following two sections we use analytical economic models to explain what factors should be taken into account in any OFTEL determination. In Section 3 we briefly review the access pricing literature and show how it can be adapted to deal with complementary (as opposed to substitute) services. In Section 4 we model downstream competition between (conditional) access providers, a feature largely absent from the access pricing literature.

3 Efficient Access Pricing

Purely 'cost-based' approaches to access pricing, such as that applied by OFTEL, have been heavily criticized by economists for being arbitrary and ignoring efficiency considerations (c.f. Laffont and Tirole, 2000, Ch. 4). On the other

[7] BSkyB's set-top box subsidy would also appear to violate the guidelines, in that it implies a price to subscribers less than OFTEL's incremental cost floor, and is arguably predatory.

[8] OFTEL (2001) notes that: "Whilst there is no legislative requirement on PSBs to make their channels universally available on all digital platforms, there is an expectation from consumers that they will be available and it is Government policy to ensure that they are so available in the future."

hand, the theory of efficient or optimal access pricing has received considerable development in recent years,[9] and provides a useful framework for considering particular access pricing problems. Indeed, one way to think of access pricing theory is that it provides the means for making a specific determination within the broad guidelines set out by OFTEL. The theory does not, however, guarantee that the access prices so derived will lie between the OFTEL floors and ceilings of incremental and stand alone costs.

The theoretical access pricing literature is now voluminous, and we have no intention of surveying it here. Both Armstrong (2001b) and Laffont and Tirole (2000) provide useful and detailed expositions. What follows relies heavily on Armstrong (2001b).

3.1 Access Pricing for a Regulated Firm

Much of the access pricing literature is concerned with deriving optimal access prices for a price-regulated network monopolist with a binding budget constraint, in which entry does not effect the retail price of services. Hence allocative efficiency is not a concern, and the focus is on efficient entry, bypass and longer term network investment decisions. The conclusions of the theory can be broadly summarised by the following heuristic formula,

$$\textit{Optimal Access Price} = \textit{Marginal Cost of Access} + \textit{Opportunity Cost of Access}$$

which is a version of the well-known Baumol-Willig formula, or the "efficient component pricing rule" (ECPR).

More formally, Armstrong, Doyle and Vickers (1996) (see Armstrong, 2001b, 25-26 for an exposition) consider a regulated network monopolist providing access to a 'competitive fringe' of price-taking firms. They derive the access pricing formula

$$A = C_2 + \sigma[P - C_1], \tag{1}$$

where $A =$ the access price, $C_2 =$ the monopolist's marginal cost of providing access, $P =$ the monopolist's price for the retail service, $C_1 =$ the monopolist's marginal cost of providing retail service, and $\sigma =$ the 'displacement ratio'.

[9] Especially Laffont and Tirole (1994) (1998) (2000), Armstrong, Doyle and Vickers (1996), Armstrong and Vickers (1998) and Armstrong (2001a). Armstrong (2001b) surveys the literature.

When $\sigma = 1$, (1) is simply the ECPR which states that (when allocative efficiency is not an issue), the access price should be set so that entry occurs if and only if the entrant is more efficient than the monopolist in providing the retail service. This occurs when the access charge is set so that the monopolist recovers its marginal costs of access, plus its *opportunity costs*, or foregone profits. That is, the monopolist loses $[P - C_1]$ units of revenue for each unit of access provided, so $[P - C_1]$ is the relevant measure of opportunity cost.

The version of the ECPR represented by (1) is Armstrong, Doyle and Vickers'(1996) generalisation of the Baumol-Willig formula to allow for product differentiation, network bypass and technological substitution. σ measures the rate at which the monopolist loses sales to the entrant as the access charge varies, and can be decomposed into three components:

$$\sigma = \sigma_d \times \sigma_b \times \sigma_t \tag{2}$$

where σ_d captures the effect of product differentiation, σ_b the effect of bypass, and σ_s the effect of technological substitution.

If price-taking entrants and network monopolist provide the same homogeneous product or service then providing a unit of access results in the monopolist forgoing revenues of $P - C_1$, its profit margin on the retail service. In this case $\sigma_d = 1$.[10] If the entrants and monopolist provide entirely different products, then providing a unit of access results in the monopolist forgoing no revenues at all, so $\sigma_d = \sigma = 0$ and $A = C_2$, i.e. an extra unit of the entrant's output does not reduce monopolist's profits. If the products are complements then $\sigma_d < 0$, so the $A < C_2$.[11] In the last case providing a unit of access actually *increases* demand for the monopolist's retail service, hence the entrant's service contributes directly to the monopolist's revenues.

Similarly, if the entrant can efficiently bypass the incumbent's network, then $\sigma_b = 0$ and $A = C_2$. Or if the entrant can substitute another input for access then $\sigma_s < 1$.

[10] The access price therefore leaves the incumbent indifferent between providing a unit of access or providing a unit of the retail service itself.

[11] This is demonstrated in Annex A.

3.2 Ramsey Access Pricing

As Laffont an Tirole (1994)(2000) point out, the regulator should be concerned with the (optimal) recovery of the regulated firm's fixed or common costs across all of the services it provides, including access services. Access should therefore be treated like any other service, and a mark-up to recover fixed costs added. The optimal access price can then be expressed as (see Armstrong, 2001b, p. 26)

$$A = C_2 + \sigma[P - C_1] + RMT, \tag{3}$$

where RMT = the Ramsey mark-up term, which is an inverse function of the entrant's price elasticity of demand. The access price in equation (3) is higher than ECPR prices because it reflects the social benefit generated from selling access to entrants. A higher access price allows the regulated monopolist to recover its fixed costs while *simultaneously* reducing its retail price P.

3.3 Unregulated Dominant Firm and Downstream Competition

For our current purposes we are concerned with conditional access to BSkyB's satellite network, so the theory of access pricing for a price regulated firm is not directly applicable. Armstrong and Vickers (1998) (see also Armstrong, 2001, Section 2.6) consider the problem of optimal access pricing for an unregulated dominant firm facing a price-taking competitive fringe. When the dominant firm's retail prices are unregulated, entry of competing services can intensify downstream competition and hence result in lower retail prices and increased allocative efficiency. Hence lower access prices may be optimal.

Note that in this case the regulator is not *directly* concerned with the dominant firm's ability to cover its costs. We may assume that an unregulated firm sets its retail prices so as to recover at least all of its relevant costs.[12] Armstrong (2001b) shows that in this case,

$$A = C_2 + \sigma[P - C_1] - MPMT \tag{4}$$

[12] The determination of the optimal access price takes this into account only in so far as providing access deprives the firm of revenue it would otherwise have earned had it not provided access.

where $MPMT$ = the market power mitigation term. If the dominant firm's retail price P is positively related to the access charge A, then access prices lower than the ECPR level may be optimal to reduce retail prices.[13] Note that $\sigma < 0$ or $MPMT > 0$ can both imply that $A < C_2$ i.e. *the optimal access charge is less than marginal cost of access.*

The framework represented by equation (4) is probably the most relevant for considering conditional access charges for public service broadcasters to BSkyB's network. In particular, BSkyB is an unregulated firm and the PSB's effectively act as "price takers" in the pay TV market in that they must set their prices for each of their channels equal to zero. Applying this formula to setting PSB charges for conditional access would likely imply access prices below marginal cost, since PSB's provide (weakly) complementary services to BSkyB. The market power mitigation term would also change sign, however, as in this case *the monopolist's retail price will be decreasing, rather than increasing, in the access price.*[14] It is important to note that this is a consequence of assuming that downstream prices are set by a monopolist: when downstream competition is oligopolistic, and in the limit perfectly competitive, the $MPMT$ term is reduced or disappears, as we show in Section 4.

The major problem with applying this framework to conditional access charges for public service broadcasters is that downstream competition is modelled in a particularly restrictive fashion, i.e. a competitive, price-taking entrant or 'competitive fringe.' Thus it assumes that access is provided by only one firm, a network monopolist, whereas in the pay-TV market conditional access is provided by competing oligopolists to "price-taking" PSBs. In the next section we therefore consider the determination of conditional access charges in a model with oligopolistic (i.e. Bertrand) competition downstream.

[13] Laffont and Tirole (1994) show that if the entrant has market power downstream, then a lower access price may be optimal to reduce 'double mark-up' problems. With entry barriers lowering the access price may again be optimal to encourage entry (see Armstrong and Doyle, 1994, Economides and White, 1995). In all of these cases the $MPMT$ is positive so the access price is less than sum of first two terms. Lewis and Sappington (1999) reach similar conclusions, but also show that access prices should be lower or higher depending upon whether the entrant firm is more or less efficient than the incumbent monopolist (see further below).

[14] See Annex A for a demonstration of this.

4 Conditional Access Pricing and Competition

The preceding section briefly described the conditional access problem in terms of the optimal access pricing literature. One problem with applying this literature to public broadcasters, and perhaps the BBC especially, is that the theory derives its conclusions by considering the *marginal* decisions made by access purchasers for given access prices. Since the BBC must obtain access to BSkyB's network to maintain universality, and produces digital channels independently of obtaining access at any particular price, it is arguable that the theory does not apply directly. That is, it could be argued that no relevant economic decisions are affected by the level of the conditional access price.[15]

We would claim that the theory nevertheless provides guidance on the factors that should taken into account in making an access price determination (e.g. whether access is being provided for substitute or complementary products, the extent of market power mitigation, etc.). In addition, because the BBC operates as a nonprofit company subject to a fixed budget constraint, any reduction in the BBC's revenues will result in fewer, or lower quality, programs and channels being produced. Hence higher conditional access charges are likely to result in a reduced 'quality-adjusted' supply of programming.

As noted above, the optimal access pricing literature also assumes rather special market structures, typically a single large firm providing access to a competitive fringe.[16] Hence the effects of different access pricing regimes on downstream competition are not fully taken into account. In this section we take a different approach to that adopted above, and focus on how downstream competition and economic welfare are effected by differential access prices.

To model this we adopt Armstrong's (1999) formulation of competition in pay-TV broadcasting, as recently extended by Harbord and Ottaviani (2001). Competition is modelled in the context of a classic Hotelling model, with asymmetries in the value of firms' products to consumers and in the firms' costs.[17] We consider optimal conditional access charges when both downstream firms

[15] ITV's access decision is clearly effected by the level of the CA charge, but again this is a global, rather than a marginal, decision.

[16] There have been exceptions to this, in particular Armstrong and Doyle (1993)(1994) and Economides and White (1995). These early and tentative explorations aside, the theory has concentrated nearly exclusively on extremely asymmetric market structures.

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

are permitted to charge for conditional access, and when only one firm is. We also assume that quality or quantity of the programming provided by the PSB depends negatively on the total conditional access charges it incurs. Within this framework we show that:

1. When both firms charge *fixed* conditional access fees, optimal access fees will either be indeterminate (when PSB program quality does not depend on access fees), or negative. They are typically negative because although fixed access fees do not effect the downstream allocation of programming to consumers, they do effect the total programming budget of the PSB. Transfers of funds from the downstream firms to the PSB therefore always improve welfare, and welfare-maximising access prices are determined by the downstream firms' maximum willingness to pay for the programming.

2. When both firms charge *variable*, or *per subscriber*, access fees, optimal access prices will again be indeterminate or negative, and for reasons similar to those given immediately above. In the Armstrong-Hotelling model, the downstream allocation of programming depends only on the *difference* in the firms' per subscriber charges, and not on their *absolute level.* The *difference* between the firms' conditional access charges should optimally be set to remedy any downstream monopoly distortion, and the *absolute level* should be set to maximise the quality of programming provided by the PSB. Hence once again, welfare-maximising per subscriber access prices are typically determined by the downstream firms' maximum willingness to pay.

3. When only one firm is able to charge a *fixed fee* for conditional access (i.e. other firms' conditional access charges are set by regulation at zero), the optimal fixed access fee will again be indeterminate or negative, for reasons identical to those given in point (1) immediately above

4. When only one firm is able to charge a *per subscriber fee* for conditional access, this distorts downstream competition in favour of the charging firm. The effect of this asymmetric regulation of conditional access is to reduce the charging firm's marginal (i.e. per subscriber) costs (or increase its marginal revenues) relative to its competitors, giving it a competitive advantage it would not otherwise have. This can be good for welfare if the

charging firm is more efficient at both service provision and conditional access, and is bad for welfare otherwise. The optimal per subscriber access charge balances the correction to the monopoly distortion with the negative effect of positive conditional access charges on PSB product quality.

The following sections describe the model and our analysis in more detail.

4.1 The Model

In Armstrong (1999)'s model of competition between pay-TV broadcasters (see also Harbord and Ottaviani, 2001), two downstream firms 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 receive the PSB programming, PSB channels and the firms' basic products are offered by firms only as pure bundles. This feature accurately describes the way in which pay-TV companies offer PSB channels to their subscribers.

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. The two firms are located at the end points of the interval: firm A at 0 and firm B at 1, so that consumer x receives utility $u_A - tx - p_A$ from purchasing firm A's product at price p_A and utility $u_B - t(1-x) - p_B$ from purchasing firm B's product at price p_B. Firm i's production cost is denoted c_i. We 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 $s_A \geq s_B$. Firm i's profits are denoted by $\pi_i(s_i, s_j)$, and the quantity sold by firm i by $x_i(s_A, s_B), i = A, B$.

4.1.1 Equilibrium in the competitive regime

Following the literature[18] we focus on the "competitive" regime in which both firms are active and the market is "covered", i.e. all consumers derive positive utility from consuming the product of one of the firms. This requires that there is enough but not "too much" product differentiation.

In the competitive regime firm i's profits and market share are easily shown to be

$$\begin{aligned} \pi_i(s_i, s_j) &= \frac{1}{2t}\left(t + \frac{s_i - s_j}{3}\right)^2 \\ x_i(s_i, s_j) &= \frac{1}{2} + \frac{s_i - s_j}{6t} \end{aligned}$$

for $i = A, B$. The corresponding equilibrium prices are given by

$$p_i = t + \frac{1}{3}(u_i - u_j + c_j + 2c_i), \tag{5}$$

$i = A, B$.

The sum of firms' profits, denoted by Π, is given by

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

and equilibrium consumer surplus is

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

Total welfare may then be written as

$$W = V + \Pi = \frac{1}{2}(s_A + s_B) + \frac{5(s_A - s_B)^2}{36t} - \frac{1}{4}t. \tag{6}$$

We can now illustrate the effects of conditional access pricing on competition in the Hotelling model.

4.1.2 Conditional access to complementary programming

We now suppose that some type of complementary programming (e.g. PSB channels) becomes available to the downstream firms. For simplicity we assume that all consumers value this content equally, and receive a utility increment of $\alpha > 0$ for it. We let the value of α depend upon the revenues retained by the

[18] See Gilbert and Matutes (1993), Laffont, Rey and Tirole (1998) and Armstrong (1999).

PSB, to reflect the fact that the PSB expends all of its resources on programming. This dependence may be written as $\alpha = \Phi(R - \Gamma)$ where R represents the PSB's total resources (from, for example, licence fees or advertising), and Γ is the PSB's total expenditure on conditional access. The quality or quantity of the PSB's programming is therefore increasing in $R - \Gamma$, so $\Phi'(R - \Gamma) \geq 0$. To simplify notation we will rewrite the function $\Phi(R - \Gamma)$ as $\alpha = \alpha(\Gamma)$ with $\alpha'(\Gamma) \leq 0$.

We assume throughout that the two downstream firms take the quality or quantity of the programming provided by the PSB as exogenous, and ignore the dependence of α on Γ. The regulator, or social planner, however, takes this into account in deriving optimal access charges.[19]

We also assume that the PSB's marginal cost of supplying programming to downstream firms is zero. However each downstream firm incurs a *marginal (per subscriber) cost* of $0 \leq \varsigma_i < \alpha$, for providing conditional access, and a *fixed (or incremental) cost* of C_i, $i = A, B$.[20] Hence if firm j offers the programming, the net utility it offers *per subscriber* increases from $s_j = u_j - c_j$ to $s_j + \alpha - \varsigma_j = u_j + \alpha - c_j - \varsigma_j$.[21]

4.2 Monopoly Conditional Access and Bargaining

We first illustrate bargaining over conditional access fees between a monopolist pay-TV firm and a single PSB. We will assume here for simplicity that the PSB's programming quality or quantity is exogenous, so α is independent of Γ. Let firm A be a Hotelling monopolist located at point 0, and let $Q = \Lambda - C_A$ be the *net fixed access price*. Given its retail price p_A,and net access price Q, firm A's demand is then

$$x_A^m = \frac{u_A + \alpha - p_A}{t}.$$

[19] That is, the downstream pay-TV companies behave *myopically* with respect to the effects of access prices on PSB program quality or quantity. This matters when access prices are set on a per subscriber basis, since the firms' pricing decisions determine their market shares and hence total access payments.

[20] This does not imply that we believe these costs to be significant, or significantly different between the firms.

[21] We also impose the assumption that

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

so that both firms remain active when one of them offers the programming, i.e. the firms remain in the competitive regime.

Firm A's profits from selling conditional access *and* programming are

$$\pi_A^m(Q) = (p_A - c_A - \varsigma_A)\left(\frac{u_A + \alpha - p_A}{t}\right) + Q. \tag{7}$$

Firm A maximises profit by choosing the monopoly price p_A^m. Differentiating $\pi_A^m(Q)$ with respect to p_A gives the first order condition

$$\frac{\partial \pi_A^m(Q)}{\partial p_A} = \left(\frac{u_A + \alpha - p_A}{t}\right) - \left(\frac{p_A - c_A - \varsigma_A}{t}\right)$$

Hence

$$p_A^m = \frac{u_A + \alpha + c_A + \varsigma_A}{2}$$

The monopolist's profits from providing conditional access are then

$$\pi_A^m(Q) = \frac{(u_A + \alpha - c_A + \varsigma_A)^2}{4t} + Q. \tag{8}$$

When conditional access is not provided its profits are

$$\pi_A^m = \frac{(u_A - c_A)^2}{4t}$$

Since the monopolist's profits are strictly increasing in Q, if the PSB has no bargaining power, firm A will obviously ask for access prices as high as the regulator will accept.

4.2.1 Bargaining over fixed access prices

We now follow the standard procedure and consider the Nash-Rubinstein bargaining solution to the CA pricing problem between a monopolist access provider and a single PSB. The disagreement payoff for the monopolist is simply π_A^m, i.e. the payoff the monopolist would receive if no CA agreement is reached. The disagreement payoff for the PSB is taken to be zero. The Nash bargaining payoffs are then,

$$\begin{aligned}
\Pi_A^{NBS} &= \pi_A^m + \frac{1}{2}\left[\pi_A(s_A + \alpha - \varsigma_A) - C_A - \pi_A^m\right] \\
\Pi_{PSB}^{NBS} &= 0 + \frac{1}{2}\left[\pi_A(s_A + \alpha - \varsigma_A) - C_A - \pi_A^m\right].
\end{aligned}$$

Hence,

$$Q^{NBS} = -\frac{1}{2}\left[\pi_A(s_A + \alpha - \varsigma_A) - \pi_A^m + C_A\right] = -\frac{1}{2}\left(\frac{2(\alpha - \varsigma_A)(u_A - c_A) + (\alpha - \varsigma_A)^2}{4t}\right) - \frac{C_A}{2}$$

That is, under Nash bargaining the *net fixed access price* would be negative. The *gross fixed conditional access price* is

$$\Gamma^{NBS} = \frac{C_A}{2} - \frac{1}{2}\left(\frac{2\left(\alpha - \varsigma_A\right)\left(u_A - c_A\right) + \left(\alpha - \varsigma_A\right)^2}{4t}\right).$$

That is, half of the fixed costs of providing conditional access minus half the difference in variable profits. Hence for fixed α, if providing CA is efficient for the monopolist, i.e. if the additional variable profits exceeds the fixed costs, the CA price is negative. Otherwise the PSB splits the loss entailed by providing CA with firm A.[22]

4.3 Duopoly Competition and Conditional Access

We now consider the interaction between conditional access charges and downstream duopoly competition. Sections 4.3.2 and 4.3.3 derive optimal CA prices when *both* downstream firms are free to charge either fixed or variable (i.e. per subscriber) fees for CA. Section 4.3.4 considers optimal CA prices when only a single firm is able to charge for CA (i.e. the other firm's CA charges are set by regulation at zero), as is the case under the current regulatory framework. In section 4.3.1 we first demonstrate that the downstream firm's willingness to pay for complementary programming will typically be positive.

4.3.1 Willingness to pay for complementary programming

Suppose initially that only one downstream firm offers the PSB programming to its subscribers, *for a conditional access fee of zero.* So in this case the PSB pays no conditional access fees, hence $\alpha(\Gamma) = \alpha(0) = \alpha$ quality adjusted units programming are supplied by the PSB. If the firm offering the programming is firm j, its downstream profits increase by b_i where

$$b_j = \pi_j\left(s_j + \alpha - \varsigma_j, s_i\right) - C_j - \pi_j\left(s_j, s_i\right) > 0,$$

since $\varsigma_j < \alpha$ by assumption. If firm i does not offer the programming on the other hand (when firm j does), its downstream profits *decrease* by

$$l_i = \pi_i\left(s_i, s_j\right) - \pi_i\left(s_i, s_j + \alpha - \varsigma_j\right) > 0,$$

[22] CA can improve social welfare even when the total effect on monopoly profits is negative. The change in monopoly profits is given by $\frac{2(\alpha-\varsigma_A)(u_A-c_A)+(\alpha-\varsigma_A)^2}{4t} - C_A$ whereas the change in welfare is $\frac{3\left[2(\alpha-\varsigma_A)(u_A-c_A)+(\alpha-\varsigma_A)^2\right]}{8t} - C_A$.

where l_i is the *negative externality* suffered by firm i when it fails to provide access for the programming given that firm j does. That is, firm j's offer becomes more attractive to subscribers relative to firm i's when firm j alone provides CA to the PSB programming. Hence firm j gains market share at the expense of firm i while simultaneously *increasing* its price by $\frac{\alpha+2\varsigma_j}{3}$, and firm i loses market share while simultaneously *lowering* its price by $\frac{\alpha-\varsigma_j}{3}$.

Note that *each firm would be willing to pay a lump sum fee* of $l_i - C_i$ to acquire the programming, given that its competitor does. That is, since the firms' benefit from providing access to the (complementary) programming, and suffer a competitive disadvantage when they do not, they are willing to offer *negative* conditional access fees to the PSB. Hence if $l_i > C_i$ it is not clear that firms' should be paid for CA, rather than pay for the PSB programming.

4.3.2 Selling conditional access for lump sum fees

We suppose now that both firms offer CA for a lump sum fee *net of fixed costs* of $Q_i = \Lambda_i - C_i = A, B$, where Λ_i is the lump sum access charge of firm i. The quality or quantity of the product provided by the PSB depends upon its total access payments $\Gamma = \Lambda_A + \Lambda_B$ represented by the function $\alpha(\Gamma)$. When both firms provide conditional access for given access prices Q_A and Q_B, their profits are

$$\begin{aligned}
\pi_A\left(s_A + \alpha(\Gamma) - \varsigma_A, s_B + \alpha(\Gamma) - \varsigma_B\right) + Q_A &= \pi_A\left(s_A - \varsigma_A, s_B - \varsigma_B\right) + Q_A \\
\pi_B\left(s_B + \alpha(\Gamma) - \varsigma_B, s_A + \alpha(\Gamma) - \varsigma_A\right) + Q_B &= \pi_B\left(s_B - \varsigma_B, s_A - \varsigma_A\right) + Q_B
\end{aligned}$$

Hence both firms compete with marginal costs $c_i + \varsigma_i$ and receive the (possibly negative) fixed access payment Q_i, $i = A, B$. The effects of the fixed access prices on profits, consumer surplus and welfare are given by,

$$\begin{aligned}
\delta\Pi &= \frac{(\varsigma_A - \varsigma_B)^2 - 2(\varsigma_A - \varsigma_B)\left(s_A - s_B\right)}{9t} + Q_A + Q_B \\
\delta V &= \alpha(\Gamma) - \frac{(\varsigma_A + \varsigma_B)}{2} + \frac{(\varsigma_A - \varsigma_B)^2 - 2(\varsigma_A - \varsigma_B)\left(s_A - s_B\right)}{36t} \\
\delta W &= \alpha(\Gamma) - \frac{(\varsigma_A + \varsigma_B)}{2} + 5\frac{(\varsigma_A - \varsigma_B)^2 - 2(\varsigma_A - \varsigma_B)\left(s_A - s_B\right)}{36t} \\
&\quad -(C_A + C_B) + (1-\lambda)(\Lambda_A + \Lambda_B).
\end{aligned}$$

where we have assumed that the PSB revenues receive a welfare weight of $\lambda \in [0, \overline{\lambda}]$ with $\overline{\lambda} > 1$.[23] The fixed access fees which maximise social welfare are given by

$$\begin{aligned} \frac{\partial W}{\partial \Lambda_A} &= \alpha' + (1-\lambda) = 0 \\ \frac{\partial W}{\partial \Lambda_B} &= \alpha' + (1-\lambda) = 0 \end{aligned}$$

For λ small enough the solution is given by $\alpha' = \lambda - 1$. For $\lambda > \alpha' + 1$ (e.g. $\lambda \geq 1$), on the other hand, welfare can always be increased by reducing the fixed access charge of either firm, so negative access prices will be optimal. The optimal access prices are then determined by the constraint that each firm is better off supplying access to the PSB than not, given that the other firm will. That is,.

$$\Lambda_i \geq C_i - [\pi_i (s_i - \varsigma_i, s_j - \varsigma_j) - \pi_i (s_i, s_j + \alpha - \varsigma_j)]$$

$i = A, B$. Unless the fixed costs of providing access are quite large, this will frequently imply that negative fixed access charges are socially optimal.

4.3.3 Selling conditional access for per subscriber fees

We now suppose that each pay-TV broadcaster provides CA for a *net of marginal access costs* per subscriber fee of $q_i = a_i - \varsigma_i, i = A, B$, where a_i is the per subscriber access fee of firm i.. Firms' profits may then be written

$$\begin{aligned} \pi_A &= (p_A - c_A) x_A + q_A x_A - C_A = (p_A + q_A - c_A) x_A - C_A \\ \pi_B &= (p_B - c_B) x_B + q_B x_B - C_B = (p_B + q_B - c_B) x_B - C_B \end{aligned}$$

Hence the firms compete as if their marginal costs had been reduced, or their marginal revenues increased, by q_i, $i = A, B$. We then have

$$\begin{aligned} \pi_A &= \pi_A (s_A + \alpha(\Gamma) + q_A, s_j + \alpha(\Gamma) + q_j) - C_A \\ \pi_B &= \pi_B (s_B + \alpha(\Gamma) + q_B, s_i + \alpha(\Gamma) + q_i) - C_B \end{aligned}$$

[23] The function $\alpha(\Gamma)$ is intended to capture the effect of access payments on the PSB's program quality (or quantity) in the pay-TV market. However the PSB's revenues should receive additional weight because: (i) revenues taken from the PSB may require an increase in (costly) taxation, or licence fees and (ii) the quality effects are felt more broadly by the larger TV audience which does not subscribe to pay TV. The scalar λ reflects these considerations.

where the PSB's total CA payments $\Gamma = (q_A + \varsigma_A)x_A + (q_B + \varsigma_B)x_B$. Note that if $q_i = q_j$ (if the firms price CA at marginal cost, for instance), then $\alpha(q_i) + q_i = \alpha(q_j) + q_j$, and variable downstream profits are unchanged by CA.

The effects of these per subscriber access prices on profits, consumer surplus and welfare are given by,

$$\begin{aligned}
\delta\Pi &= \frac{(q_A - q_B)^2 + 2(q_A - q_B)(s_A - s_B)}{9t} - (C_A + C_B) \\
\delta V &= \alpha(\Gamma) + \frac{q_A + q_B}{2} + \frac{(q_A - q_B)^2}{36t} + \frac{2(q_A - q_B)(s_A - s_B)}{36t} \\
\delta W &= \alpha(\Gamma) + \frac{q_A + q_B}{2} + \frac{5(q_A - q_B)^2}{36t} + 10\frac{(q_A - q_B)(s_A - s_B)}{36t} \\
&\quad -(C_A + C_B) - \lambda\Gamma.
\end{aligned}$$

Consider the case of equal *net* conditional access charges, $q_A = q_B = q$. Downstream competition means that consumers capture all of the benefits from the CA charges, as both firms' decrease their prices by the net access charge q. Asymmetric access charges increase (reduce) total profits, consumer surplus and gross welfare (gross of BBC payments) further by transferring output to the more (less) efficient firm.

The welfare maximising per subscriber conditional access charges are given by:[24]

$$\begin{aligned}
q_A(q_B) &= \frac{9t[1 - \lambda + \alpha'] + [5 - 3\lambda + 3\alpha'](s_A - s_B) - 3(\lambda - \alpha')[\varsigma_A - \varsigma_B]}{6\lambda - 5 - 6\alpha'} + q_B \\
q_B(q_A) &= \frac{9t[1 - \lambda + \alpha'] + [5 - 3\lambda + 3\alpha'](s_A - s_B) - 3(\lambda - \alpha')[\varsigma_B - \varsigma_A]}{6\lambda - 5 - 6\alpha'} + q_A
\end{aligned}$$

or

$$\begin{aligned}
a_A(a_B) &= \frac{9t[1 - \lambda + \alpha'] + [5 - 3\lambda + 3\alpha'](s_A - s_B - \varsigma_A + \varsigma_B)}{6\lambda - 5 - 6\alpha'} + a_B \\
a_B(a_A) &= \frac{9t[1 - \lambda + \alpha'] + [5 - 3\lambda + 3\alpha'](s_B - s_A - \varsigma_B + \varsigma_A)}{6\lambda - 5 - 6\alpha'} + a_A.
\end{aligned}$$

When $\lambda = 1$,

$$\begin{aligned}
a_A(a_B) &= \frac{9t\alpha' + [2 + 3\alpha'](s_A - \varsigma_A - s_B + \varsigma_B)}{1 - 6\alpha'} + a_B \\
a_B(a_A) &= \frac{9t\alpha' + [2 + 3\alpha'](s_B - \varsigma_B - s_A + \varsigma_A)}{1 - 6\alpha'} + a_A.
\end{aligned}$$

[24] These equations are only valid when the denominator is positive, i.e. $\lambda > \frac{5}{6} + \alpha'$. Otherwise welfare can always be increased by increasing access prices.

In the special case in which $\alpha(\Gamma) \equiv \alpha$ we have

$$a_A = 2(s_A - \varsigma_A - s_B + \varsigma_B) + a_B \quad (9)$$

$$a_B = a_A - 2(s_A - \varsigma_A - s_B + \varsigma_B). \quad (10)$$

In the case of *ex post* symmetry any pair of *equal* conditional access prices satisfies these equations, as the access price is a pure transfer from the PSB to firms, and these are given equal weight. When firm A is *ex post* more efficient than firm B, then any pair of access prices such that $a_A = a_B +$ twice the ex post asymmetry maximises social welfare.

For $\alpha' < 0$ the equations do not yield a solution because welfare can always be increased by reducing access prices, while holding the difference $q_A - q_B$ fixed. This is because the downstream allocation depends only upon the difference $q_A - q_B$, while a reduction in access prices yields an increase in the quality of the product offered by the PSB. Thus transferring funds from firms to the PSB is always optimal, subject to the individual rationality constraints. The optimal access prices will in this case be determined by the constraints:

$$\pi_i(s_i + q_i, s_j + q_j) - \pi_i(s_i, s_j + \alpha + q_j) \geq C_i$$

$i = A, B$.

4.3.4 Asymmetric regulation in the UK market

The current regulatory regime in the UK means that only BSkyB is able to charge conditional access fees to public service broadcasters. Other digital pay-TV broadcasters are required to carry the content for free.[25] BSkyB's CA ratecard currently specifies a per subscriber charge of 30p per subscriber for each PSB requiring access to its network. However BSkyB has up the present charged the BBC a fixed, or lump sum, access fee, and apparently may do so in the future. We thus consider the effects of both fixed and per subscriber access charges here.

Given the asymmetry in the regulatory regime which allows only BSkyB to charge for conditional access, firms' profits may be written

$$\pi_i = (p_i + q_i - c_i)x_i + Q_i$$

$$\pi_j = (p_j - c_j - \varsigma_j)x_j - C_j$$

[25] Armstrong (2000) is critical of other asymmetric regulatory rules which he believes adversely affect BSkyB.

where we let firm i represent BSkyB, $q_i = a_i - \varsigma_i$ and $Q_i = \Lambda_i - C_i$. Hence for $q_i > 0$, BSkyB competes as if its marginal costs had been reduced, or its marginal revenues increased, by q_i. Firm j, on the other hand, competes as if its marginal costs are increased by ς_j (since $a_j = 0$). We then have

$$\begin{aligned}\pi_i &= \pi_i\left(s_i + \alpha(\Gamma_i) + q_i, s_j + \alpha(\Gamma_i) - \varsigma_j\right) + Q_i \\ \pi_j &= \pi_j\left(s_j + \alpha(\Gamma_i) - \varsigma_j, s_i + \alpha(\Gamma_i) + q_i\right) - C_j\end{aligned}$$

For $q_i \geq 0$, *firm i obtains a competitive advantage* and its (variable) profits increase, while *firm j suffers a competitive disadvantage* and its profits decrease. The overall effects are given by the following equations:

$$\begin{aligned}\delta\Pi &= \frac{(q_A + \varsigma_B)^2 + 2(q_A + \varsigma_B)(s_A - s_B)}{9t} + Q_A - C_B \\ \delta V &= \frac{2\alpha(\Gamma_A) + q_A - \varsigma_B}{2} + \frac{(q_A + \varsigma_B)^2 + 2(q_A + \varsigma_B)(s_A - s_B)}{36t} \\ \delta W &= \frac{2\alpha(\Gamma_A) + q_A - \varsigma_B}{2} + 5\frac{(q_A + \varsigma_B)^2 + 2(q_A + \varsigma_B)(s_A - s_B)}{36t} \\ &\quad -C_B - \lambda(q_A + \varsigma_A)x_A.\end{aligned}$$

if firm i (BSkyB) is the more efficient firm A, and

$$\begin{aligned}\delta\Pi &= \frac{(q_B + \varsigma_A)^2 - 2(q_B + \varsigma_A)(s_A - s_B)}{9t} - C_A + Q_B \\ \delta V &= \frac{2\alpha(\Gamma_B) + q_B - \varsigma_A}{2} + \frac{(q_B + \varsigma_A)^2 - 2(q_B + \varsigma_A)(s_A - s_B)}{36t} \\ \delta W &= \frac{2\alpha(\Gamma_B) + q_B - \varsigma_A}{2} + 5\frac{(q_B + \varsigma_A)^2 - 2(q_B + \varsigma_A)(s_A - s_B)}{36t} \\ &\quad -C_A - \lambda(q_B + \varsigma_B)x_B.\end{aligned}$$

if firm i (BSkyB) is the less efficient firm B.

Fixed access prices The fixed access fee which maximise social welfare are

$$\frac{\partial W}{\partial \Lambda_i} = \alpha' + (1 - \lambda)$$

When $\lambda = 1$ and $\alpha(\Gamma_i) \equiv \alpha$ a fixed access charge is a pure transfer with no other effects on either the PSB product quality or the downstream allocation. Hence any access price Λ_i maximises social welfare. Otherwise, for λ small enough the solution is given by $\alpha' = \lambda - 1$. For $\lambda > \alpha' + 1$ (e.g. $\lambda \geq 1$),on the other hand, welfare can always be increased by reducing the fixed access charge, so a negative access price will be optimal. In this case Λ_i is determined by the individual rationality condition,

$$\Gamma_i \geq C_i - \left[\pi_i\left(s_i - \varsigma_i, s_j - \varsigma_j\right) - \pi_i\left(s_i, s_j + \alpha - \varsigma_j\right)\right],$$

and will often be negative.

Per subscriber access pricing Setting $Q_i = 0$ in the above equations, the welfare maximising per subscriber access charge for firm i is given by[26]

$$q_i^* = \frac{9t\left[1 - \lambda + \alpha'\right] + \left[5 - 3\lambda + 3\alpha'\right]\left(s_i - s_j + \varsigma_j\right) - 3\left(\lambda - \alpha'\right)\varsigma_i}{6\lambda - 5 - 6\alpha'}$$

or

$$a_i^* = \frac{9t\left[1 - \lambda + \alpha'\right] + \left[5 - 3\lambda + 3\alpha'\right]\left(s_i - \varsigma_i - s_j + \varsigma_j\right)}{6\lambda - 5 - 6\alpha'}$$

Taking $\lambda = 1$,

$$a_i^* = \frac{9t\alpha' + \left[2 + 3\alpha'\right]\left(s_i - \varsigma_i - s_j + \varsigma_j\right)}{1 - 6\alpha'}.$$

Letting $\alpha(\Gamma_i) \equiv \alpha$, the optimal access charge is then $a_i^* = 2\left(s_i - \varsigma_i - s_j + \varsigma_j\right)$, i.e. twice the value of the *ex post* asymmetry (including CA costs) between the firms. Note that this may imply negative access charges if $s_i - \varsigma_i < s_j - \varsigma_j$. This is because the access charge corrects for the market inefficiency which allocates too much output to the less efficient firm and too little output to the more efficient firm.

$\alpha' < 0$ implies lower access charges, because the optimal access charge trades off the correction to the monopoly distortion with the reduction in the PSB's product quality. When firm i is more efficient *ex post*, these effects go in opposite directions. Otherwise both effects go in the same direction, implying a negative access price. For example in the *ex post* symmetric case $(s_i - \varsigma_i = s_j - \varsigma_j)$ we have

$$a_i^* = \frac{9t\alpha'}{1 - 6\alpha'}$$

so the access charge should be negative.

[26] Again, these equations are only valid for $\lambda > \frac{5}{6} + \alpha' > 0$, as otherwise welfare is increasing in the access price.

Assuming that pay-TV firms are roughly equally efficient, taking account of CA costs, which may be empirically accurate,[27] the effect of the asymmetric regulatory regime which allows BSkyB alone to charge for CA is to artificially grant a competitive advantage to BSkyB. Indeed, our model implies that in this situation the optimal access charge should be zero, or possibly negative.

It is also worth noting that firm i's optimal conditional access charge is decreasing in firm i's marginal cost of providing access, ς_i, but increasing in firm j's cost ς_j. This is again a consequence of using access charges to correct for the market inefficiency caused by the oligopoly market structure. The more efficient is firm j relative to firm i in providing conditional access, the lower should be firm i's per subscriber access charge.

4.4 Discussion

We have used a simple Hotelling model, with asymmetries in the value of firms' products to consumers and in firms' costs, to analyse how downstream competition and economic welfare are effected by differential conditional access charges. Although the model is special in some respects, the intuition derived from it is easily shown to be robust. Our analysis implies that unless BSkyB is considerably more efficient than its downstream competitors in pay-TV broadcasting, its conditional access charge should be close to zero, or possibly even negative. Allowing a positive per subscriber charge tilts the competitive playing field in favour of BSkyB at the expense of its competitors, consumers and public broadcasters.

The model also implies that allowing BSkyB to recover its marginal conditional access costs from PSB's is not optimal. Indeed, if these costs are significant this should result in a reduction in BSkyB's CA charges.

The conclusion that positive conditional access charges can be optimal when the charging firm is more efficient, or negative when it is less efficient, is of some interest, but probably irrelevant to the current regulatory inquiry. This is a natural consequence of using CA charges to tilt the competitive playing field in favour of the more efficient firm. Even if the more efficient firm could be

[27] BSkyB alone incurs any significant marginal cost of providing CA. Hence even if BSkyB were a little more efficient in providing basic programming to subscribers, this asymmettry might be overturned by the asymmetry in providing CA. We suspect the differences involved are small, or even neglible.

identified, however, doing so would imply a degree of regulatory fine tuning of the market not envisaged by the ostensibly 'light-handed' regulatory regime.

The conclusion that preventing all but one pay-TV company from charging for CA upsets the competitive balance in favour of the charging firm, is both robust and relevant however. Given that this is a result of primary legislation, an appropriate regulatory response would be to re-level the competitive playing field by setting access charges for PSB's equal to zero.

References

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

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

[3] Armstrong, Mark (2001a) "Access Pricing, Bypass and Universal Service," *American Economic Review Papers and Proceedings*, forthcoming.

[4] Armstrong, Mark (2001b) "The Theory of Access Pricing and Interconnection," *Handbook of Telecommunications Economics*, (Cave, Majumdar and Vogelsang eds.), forthcoming.

[5] Armstrong, Mark and Chris Doyle (1993) "Network Access Pricing, A Report Commissioned by HM Treasury," London.

[6] Armstrong, Mark and Chris Doyle (1994) "Access Pricing, Entry and the Baumol-Willig Rule," mimeo, University of Cambridge.

[7] Armstrong, Mark, Chris Doyle and John Vickers (1996) "The Access Pricing Problem: A Synthesis," *Journal of Industrial Economics*, XLIV, 131-150.

[8] Armstrong, Mark and John Vickers (1998) "The Access Pricing Problem with Deregulation: A Note," *Journal of Industrial Economics*, XLVI, 114-121.

[9] Economides, Nicholas and Lawrence White (1995) “Access Pricing and Interconnection: How Efficient is the Efficient Component Pricing Rule?” *The Antitrust Bulletin*, 40(3), 557-579.

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

[11] Harbord, David and Marco Ottaviani (2001) “Contracts and Competition in the Pay-TV Market,” DP 2001/5, Economics Subject Area, London Business School (www.lbs.ac.uk/economics/Discussion_Papers).

[12] Harbord, David and Marco Ottaviani (2002) “Anticompetitive Contracts in the UK Pay-TV Market,” forthcoming, *European Competition Law Review*, 2002 ECLR Issue 3, February.

[13] Laffont, Jean Jacques and Jean Tirole (1994) “Access Pricing and Competition,” *European Economic Review* 38: 1673-1710.

[14] Laffont, Jean Jacques and Jean Tirole (1996) “Creating Competition Through Interconnection: Theory and Practice,” *Journal of Regulatory Economics*, 10 (3), 227-256.

[15] Laffont, Jean Jacques and Jean Tirole (2000) *Competition in Telecommunications*, MIT Press.

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

[17] Lewis, Tracy and David Sappington (1999) “Access Pricing with Unregulated Downstream Competition,” *Information Economics and Policy*, 11, 73-100.

[18] OFTEL (1999) *The Pricing of Conditional Access and Access Control Services*, May, London.

[19] OFTEL (2001) *The Pricing of Conditional Access and Related Issues*, October, London

5 Annex A: Access Pricing for Complementary Products

We demonstrate in this annex that the Armstrong and Vickers (1998) formula for the optimal access price of an unregulated network monopolist generalises to the case of complementary products as described in Section 3 of the text. In particular the displacement ratio σ becomes negative, and the market power mitigation term also becomes negative. The latter point, as we have noted, is not particularly relevant to the conditional access problem in the pay-TV market, as downstream competition mitigates this term (and in the Hotelling model it is zero).

5.1 Model

Following Armstrong and Vickers (1998), we assume that the incumbent firm I sells quantity X at price P produced at marginal cost C_1 and provides access to a price-taking entrant, firm E, at marginal cost C_2 in exchange for a payment of an access charge of a. A complementary service is produced at constant marginal cost c by the entrant firm E, sold in quantity x at the competitive price $r = c + a$. Service I and E are complements, so an increase in the price of one service decreases the demand of the other: $\partial X(P,r)/\partial r = X_r < 0$ and $\partial x(r,P)/\partial P = x_P < 0$.

Firm I's profits are then given by

$$\Pi(P,a) = (P - C_1)\,X(P,a+c) + (a - C_2)\,x(P,a+c)$$

and aggregate welfare by

$$W(P,a) = v(P,a+c) + \Pi(P,a)\,.$$

Given the access price a, the profit maximizing retail price P solves

$$\Pi_P(P,a) = X(P,a+c) + (P - C_1)\,X_P(P,a+c) + (a - C_2)\,x_P(P,a+c) = 0.$$

We then have

$$P'(a) = -\frac{\Pi_{Pa}(P,a)}{\Pi_{PP}(P,a)} = -\frac{X_r + (P - C_1)\,X_{Pr} + x_P + (a - C_2)\,x_{Pr}}{2X_P + (P - C_1)\,X_{PP} + (a - C_2)\,x_{PP}} < 0$$

when the access price and the retail price are strategic substitutes, rather than complements, as in Armstrong and Vickers (1998), i.e. $\Pi_{Pa}(P,a) < 0$, since $\Pi_{PP}(P,a) < 0$ by the second order condition.

The choice of a which maximises social welfare is determined by the condition

$$\frac{\partial W}{\partial a} = \frac{\partial V(P, a+c)}{\partial a} + \frac{\partial V(P, a+c)}{\partial P}\frac{dP}{da} + \frac{\partial \Pi(P,a)}{\partial a} = 0$$

where we have used the monopolist's first-order condition. This yields

$$-x - X\frac{dP}{da} + x + (P - C_1) X_r + x + (a - C_2) x_r = 0.$$

Dividing by x_r we obtain

$$-\frac{X}{x_r}\frac{d\bar{p}_A}{da} + (P - c_1)\frac{X_r}{x_r} + (a - C_2) = 0,$$

which may be rearranged to give

$$a = C_2 - \frac{X_r}{x_r}(P - C_2) - \left(\frac{X}{-x_r}\right)\frac{d\bar{p}_A}{da}.$$

Hence the Armstrong and Vickers' (1998) displacement ratio is $\sigma = -\frac{X_r}{x_r} < 0$. The access price for a complementary product is adjusted downwards to account for the fact that the monopolist's retail price is decreasing in the access price, i.e.:

$$-\left(\frac{X}{-x_r}\right)\frac{d\bar{p}_A}{da} > 0.$$

For the purposes of illustration, we consider the following example with linear demands, $X(P,r) = A - bP - dr$ and $x(r,P) = B - br - dP$. For a given access price a the monopolist sets the retail price at

$$P(a) = \frac{A - d((a+c) + (a - C_2)) + bC_1}{2b} \tag{11}$$

with $P'(a) = -d/b < 0$. The social planner then sets the access price at

$$a = \frac{dA + b(b+d)C_2 - d^2c - 2dbP}{b^2 + d^2}. \tag{12}$$

The solution of the system (11) and (12) gives

$$\begin{aligned} P^* &= \frac{A}{2b} - \frac{dc}{2b} + \frac{b\left(b^2 + d^2\right)C_1 - d\left(b^2 + 2db - d^2\right)C_2}{2\left(b^2 - d^2\right)b} \\ a^* &= \left(1 + \frac{db}{b^2 - d^2}\right)C_2 - \frac{db}{b^2 - d^2}C_1 \end{aligned}$$

Note that $a \gtreqless C_2 \Leftrightarrow C_2 \gtreqless C_1$.

5.2 Application to the Pay-TV Market.

Two modifications are needed in order to apply this model to the problem of access pricing for a PSB. First, the programming of the PSB is bundled with the programming of the pay-TV provider. Equivalently, the service sold by the PSB is a perfect complement, $X = x$. Second, the PSB is financed by TV licence fees and does not levy a charge on pay-TV subscribers. The retail price of its service is effectively set equal to zero $r = 0$, regardless of the access charge. However, a higher access charge reduces the budget of the PSB resulting in a reduction in the quality of service and therefore its demand, so that $X(P,a) = x(a,P)$, with $\partial x/\partial a < 0$.

Consider the case with linear demand $x = A - bP - d(ax)$, where the quality of PSB service depends on the total PSB's budget ax, so that

$$x(P,a) = \frac{A}{1+da} - \frac{b}{1+da}P$$

with $\frac{\partial x(P,a)}{\partial a} = -d\frac{A-bP}{(1+da)^2} < 0$ and $\frac{\partial x(P,a)}{\partial P} = -\frac{b}{1+da} < 0$. The monopolist's first-order condition gives

$$P = \frac{A + bC_1 + bC_2 - ba}{2b} \tag{13}$$

with $P'(a) = -1/2 < 0$.

The social planner sets

$$a = \frac{1}{3}\frac{4C_2 d - 2Pd - 1}{d} \tag{14}$$

The system (13) and (14) is solved by

$$\begin{aligned} a &= \frac{3dbC_2 - dbC_1 - b - dA}{2bd} \\ P &= \frac{3dA + b + 3dbC_1 - dbC_2}{4bd} \end{aligned}$$

Note that $a \gtreqless C_2 \Leftrightarrow C_2 \gtreqless C_1 + \left(\frac{1}{d} + \frac{A}{b}\right)$, so that the condition for the access charge to be lower than the cost of access is even more likely to be satisfied than in the linear example at the end of the subsection above.