

**SNF Working Paper No. 60/05**

**Access price regulation facilitates  
strategic transfer pricing**

**by**

**Kenneth Fjell  
Øystein Foros**

**SNF project No. 7476, 7477  
Teleforskning**

THE ECONOMICS OF TELECOMMUNICATIONS

This report is one of a series of papers and reports on telecommunication economics published by the Institute for Research in Economics and Business Administration (SNF) as part of its telecommunication economics program. The main focus of the research program is to study the deregulation process of the telecommunication industry, and the economic and organizational consequences of changes in markets, technology and regulation. Being started in 1992, the program is now in its fourth period ending in 2005/2006. The program is financed by Telenor AS

INSTITUTE FOR RESEARCH IN ECONOMICS AND BUSINESS ADMINISTRATION  
BERGEN, OCTOBER 2005

ISSN 1503-2140

© Dette eksemplar er fremstilt etter avtale med KOPINOR, Stenergate 1, 0050 Oslo. Ytterligere eksemplarfremstilling uten avtale og i strid med åndsverkloven er straffbart og kan medføre erstatningsansvar.

# Access price regulation facilitates strategic transfer pricing<sup>1</sup>

**Kenneth Fjell**

Norwegian School of Economics and Business Administration

kenneth.fjell@nhh.no

**Øystein Foros**

Norwegian School of Economics and Business Administration

oystein.foros@nhh.no

**JEL classification:** L11, L13, L96

**Keywords:** Telecommunications, competition, access pricing

**Abstract:** Access price regulation is used in telecommunications to prevent that a vertically integrated firm, that controls an essential input, raises the rivals' costs. When the authorities remove the access price as a strategic tool, they at the same time make it optimal for the vertically integrated firm to reorganize from centralized pricing to decentralized pricing in order to use the transfer price as an alternative strategic device. To implement access price regulation, authorities use accounting separation and transparent transfer prices as complementary remedies. However, these remedies facilitate the transfer price as a strategic device used to soften competition. Consequently, the regulation may protect the rivals (and the incumbent) from competition to the detriment of consumers.

---

<sup>1</sup>We are grateful to Kåre Petter Hagen, Bjørn Hansen, Kurt Jørnsten, Christian Riegler, and seminar participants at FIBE, Bergen, January 2005, NORIO, Reykjavik, June 2005, ARW, Bern, June 2005, International Conference on Industrial Organization, Economics and Law, Athens, June 2005, and at NHH-staff seminar, Bergen, September 2005 for valuable comments and discussions. We also recognize the Institute for Research in Economics and Business Administration (SNF) and Telenor for funding.

# 1 Introduction

When vertically integrated firms control essential inputs, such as in the telecommunications industry, a policy concern is that these firms will abuse their market power and discriminate against downstream competitors. Sector-specific obligations are imposed on firms that are defined to have Significant Market Power (SMP). Both in the United States and in the EU a light regulation with unregulated retail prices combined with ex ante regulation of the upstream access component has become dominant.<sup>2</sup> In practice the access price regulation used worldwide is typically cost-based access charges with common costs markups. Moreover, all regulatory cost allocation methods used to compute the access price are based on average costs, such that the access price is above the short-run marginal cost also with regulation (Laffont and Tirole, 2000, and Vogelsang, 2003).

The present paper is motivated by the striking discrepancy between policy applications and the theoretical literature on access price regulation with respect to the view on the strategic impact of transfer prices. Policy makers almost without exception assume that the transfer prices the vertically integrated firm charges its downstream subsidiaries have an impact on the downstream competition.<sup>3</sup> The theoretical literature on access pricing instead assumes complete vertical integration (centralized pricing), such that the transfer prices have no strategic impact on

---

<sup>2</sup>In the new European framework on electronic communications services The Access Directive (2002, Article 9-13) and the Universal Service Directive (Article 17-19) contain a list of available remedies that may be imposed on SMP-operators in the wholesale and retail markets, respectively.

<sup>3</sup>The Commission stresses the role of transfer prices in the Access Directive (2002): "The principle of non-discrimination ensures that undertakings with market power do not distort competition, in particular where they are vertically integrated undertakings that supply services to undertakings with whom they compete on downstream markets. Obligations of non-discrimination shall ensure, in particular, that the operator applies similar conditions in similar circumstances to other undertakings providing similar services, and provides services and information to others under the same conditions and the same quality as it provides for its own services, or those of its subsidiaries or partners."

downstream competition since internal payments cancel each other out.

In the present paper we show that the common view among policy makers may be true. By regulating the access price, the regulator removes the access price as a strategic tool that may be used to increase the rival's costs. When the authorities do that, they at the same time make it optimal for the integrated firm to reorganize the company from complete vertical integration (centralized pricing) to decentralized pricing. Hence, the regulation increases the *incentives* to use strategic transfer pricing.

We show that if the headquarters of the vertically integrated firm chooses decentralized retail pricing, and furthermore, has the ability to commit to the transfer price before retail competition, then the headquarters sets the transfer price above the marginal cost to soften downstream competition. Furthermore, if the government regulated access price is sufficiently low, the headquarters will compensate by setting the transfer price above the access price to soften competition. This will not be subject to protests by the rival firm as it too stands to gain - only consumers lose. Hence, the incumbent might wish to discriminate against its own subsidiary rather than against its rival which the regulation is intended to protect.

Surprisingly, the regulation also increases the *ability* to use strategic transfer pricing. Necessary conditions to ensure that the transfer price is a credible strategic device is that it is irreversible, observable and chosen before the price competition takes place (Katz, 1991, and Bagwell, 1995). It is a common assumption in the literature on access pricing that the access price, both with and without regulation, is decided on prior to retail competition. However, the headquarters of the vertically integrated firm may not have the ability to credibly commit to an observable transfer price. An interesting feature in the present context is that the obligation of cost-based access pricing (Access Directive, Article 13) will usually be supported by obligations on transparency (Article 9) and accounting separation (Article 11).<sup>4</sup>

---

<sup>4</sup>The list of remedies in the Access Directive (2002) includes a transparency obligation (Article 9), a non-discrimination obligation (Article 10), an accounting separation obligation (Article 11),

More specifically, the obligation on transparency means that the regulator may require "operators to make public specified information, such as accounting information, technical specifications, network characteristics, terms and conditions for supply and use, and prices" (Article 9). Furthermore, "to facilitate the verification of compliance with obligations of transparency and non-discrimination, national regulatory authorities shall have the power to require that accounting records, including data on revenues received from third parties, are provided on request. National regulatory authorities may publish such information as would contribute to an open and competitive market, while respecting national and Community rules on commercial confidentiality" (Article 11).

Even if obligations on transparency and accounting separation are usually considered as complementary obligations needed to implement a cost-based access price (see discussion in ERG, 2003)<sup>5</sup>, these obligations may help to solve the headquarter's commitment problem.<sup>6</sup> Specifically, the regulator's supervision of the vertically integrated firm to ensure non-discrimination will result in transfer prices that are binding and therefore credible. As stated, the regulator may also publish the information, thereby making it observable. However, should the regulator choose not to do so, the integrated firm may publish the transfer price itself.

Although we frame our analysis within the European telecommunications regulation, we believe the problem of strategic transfer pricing by vertically integrated an access obligation (Article 12), and a price control and cost accounting obligation (Article 13). See ERG (2003). Although not directly comparable, for certain competitive activities, the US Telecommunications Act of 1996 does have similar obligations on structural (and accounting) separation (section 272 (b)), non-discrimination (section 272 (c)) and transparency (section 272 (b) (5)).

<sup>5</sup>The European Regulators Group (ERG) was established by the European Commission in 2002. The ERG is advising and assisting the Commission in the electronic communications field.

<sup>6</sup>ERG (2003) gives a comprehensive discussion of the appropriate use of remedies in the new European regulatory framework for electronic communications. Cave (2003), Koboldt (2003) and Valletti (2003) evaluate remedies within the new framework for broadband services, narrowband services and mobile services, respectively.

firms controlling essential inputs sold to rivals, to have a much wider application. The US regulation related to the entry of regional Bell operating companies into the long distance voice market which is parallel. Bell companies have been required to provide non-regulated services through independent subsidiaries, and access cannot be charged higher to downstream rivals than to the subsidiary (see e.g. Biglaiser and DeGraba, 2001). Postal services are another common example where deregulation implies competition on some services while central network components remain subject to sector specific access regulation.<sup>7</sup> Our problem is also highly relevant to the railways in many countries where access to the infrastructure may be controlled by a vertically integrated firm (Pittman, 2004). The same is true for access to databases (national statistics, directory information, meteorological data, etc.) which also may be controlled by a vertically integrated firm competing in a downstream information services market. Typically, such firms are recommended or required to adopt some measure of vertical separation (e.g. accounting separation) and transparency to ensure non-discrimination of downstream rivals (see e.g. Pittman, 2004, Richards, 2004)<sup>8</sup>

In addition to such sector specific regulations, analogous obligations are often also imposed on dominant upstream firms within the general competition law such as is the case for EU competition law. Motta (2004) criticizes the EU competition rules and argues that by ensuring transparent prices between vertically related firms, the authorities solve the commitment problem for the upstream firm. Moreover, similar to the sector-specific regulation, the European competition law identifies the non-discrimination principle as a key instrument to regulate vertically integrated firms.<sup>9</sup> Consequently, also the competition authorities seem to assume that the

---

<sup>7</sup>For a recent discussion of current postal regulation, see de Bijl, van Damme and Larouche (2005).

<sup>8</sup>As an example, such a reorganization was recently recommended for the Norwegian Meteorological Institute to distinguish its public responsibilities from its commercial activities (Statskonsult, 2003).

<sup>9</sup>See for example Case IV/34.174 B&I Line plc v Sealink Harbours Ltd and Sealink Stena Ltd

transfer prices have strategic impact, and by their obligations these expectations are fulfilled. It is a cautionary tale for the authorities that such a regulation regime facilitates strategic transfer pricing used to soften competition.

We emphasize that we in the present paper do not analyze how to regulate this market, but rather implications of the current regime. We do this by combining elements from the literature on access price regulation and the literature on strategic transfer pricing.

There is an extensive literature on access price regulation of the telecommunications industry.<sup>10</sup> In contrast to the present paper, the focus is typically on either complete vertical separation or complete vertical integration. With vertical separation an independent upstream access provider is supplying access to the downstream firms, but does not itself compete in the downstream market. Hence, there is only an access price, but no transfer price as there is no internal trade of the input. With complete vertical integration the input is sold internally at a transfer price and an externally at an access price. However, the transfer price has no impact on the competition outcome, and the headquarters instead sets retail price to maximize total profit. In this case the focus is typically on the incentive for the integrated firm to engage in a predatory margin squeeze by closing the margin between the

---

(1992) 5 C.M.L.R 255, discussed in Bishop and Walker (2002). The European Commission stated that access should be offered on "non-discriminatory and reasonable" terms. Sealink was a ferry operator that also was the owner of a harbour, while B&I was a ferry company that used the harbour to compete with Sealink. The Commission stated that Sealink used its monopoly position in the supply of access to the harbour to strengthen its position in the downstream market, and "... in particular, by granting its competitor access to a related market on less favorable terms than those of its own service".

<sup>10</sup>Recent surveys of the access pricing literature are given by Laffont and Tirole (2000), Armstrong (2002) and Vogelsang (2003). Laffont and Tirole (2000) and Armstrong (2002) offer formal theoretical approaches, while Vogelsang (2003) also connects the theoretical results to the policy practice. Cave (2002) discusses the interplay between access price regulation and non-discrimination obligations within the new European framework on electronic communications services.

retail price and the access price to weaken or drive its rivals from the market. If the integrated firm cannot raise the access price, then it may cause a margin squeeze by lowering the retail price.<sup>11</sup> Biglaiser and DeGraba (2001) find that the higher the regulated access price is above marginal cost, the lower is the incentive to set such predatory retail prices. Like in this paper, they consider the access price to be exogenous, and the access is sold to a rival in the retail market. They also consider vertical separation with a transfer price equal to the regulated access price and find that this will raise retail prices and reduce welfare if the access price exceeds long run incremental cost. However, unlike in this paper and in the strategic transfer pricing literature, their transfer price is exogenous.

While strategic transfer pricing has not been given attention within the access pricing literature, there are several papers on strategic transfer pricing focusing on accounting, management, and tax issues. Alles and Datar (1998), Narayanan and Smith (2000), and Göx (2000) consider price competition between two firms where each headquarters just offers the intermediate good to their own subsidiary. However, there is no external market for these intermediate goods. The headquarters simultaneously choose transfer prices above the marginal costs in order to soften price competition.<sup>12</sup> Baldenius et al. (2004) analyze transfer pricing in multinational firms.<sup>13</sup> They include an external market for the intermediate good. This provides a comparable uncontrolled price (arm's length price) which typically serves as a benchmark for the transfer price. They find that if the supplying division has market

---

<sup>11</sup>Alternatively, the integrated firm may have an incentive to degrade the quality of access to the rivals (Economides, 1998).

<sup>12</sup>Göx (2000) show that this also holds when transfer prices are unobservable when choice of accounting system can serve as a signal. Similarly, Narayanan and Smith (2000) show that when tax rates vary, this will also make strategic transfer pricing credible in the absence of observability.

<sup>13</sup>Schjelderup and Sörgard (1997) analyze tax effects in a multinational setting. They find that taxes will either reinforce or dampen the pricing strategies. Gabrielsen and Schjelderup (1998 and 1999) also find that introduction of taxes (and tariffs) may improve performance when two producers jointly own a foreign distributor.



power in the intermediate market, a double marginalization problem arises from the arm's length principle in which too little will be supplied internally. Thus, the transfer price should be discounted.<sup>14</sup>

In Baldenius et al. (2004) the external buyers of the intermediate good do not compete against the input provider in the retail market. However, an idiosyncratic feature of the telecommunications industry is that the external buyers of the access component (the input) also compete towards the input provider in the downstream market. We expand on previous literature on strategic transfer pricing by assuming that the access input is sold to a downstream rival.<sup>15</sup>

The rest of the paper is organized as follows. In Section 2 we present the model where we assume Bertrand competition with differentiated services downstream. In Section 3 we analyze the outcome with Cournot competition downstream. The headquarters then commits to a more aggressive behavior and will set the transfer price below the marginal cost if the access price is sufficiently low. In Section 4 we have a policy discussion and concluding remarks.

## 2 The model

We analyze a market structure where two components are needed to provide the final service; a network component and a retail component. A vertically integrated firm controls the network component needed by its retail subsidiary and a retail rival. The retail rival and the subsidiary produce their own retail components.

---

<sup>14</sup>Absent an arm's length price, Geris and Osmundsen (2004) find that transfer price tests by authorities may cause tacit collusion.

<sup>15</sup>Strategic transfer pricing is also related to the literature on strategic delegation where Fershtman and Judd (1987), Sklives (1987), Vickers (1985) and Fershtman (1985) are pioneering papers. By using this framework Foros, Kind and Sørsgard (2004) show that if the authorities through ex ante obligations force the incumbent to perceive the transfer price as the real marginal cost, the incumbent firm can circumvent such obligations by hiring a retail manager who emphasizes market share at the expense of profitability.

We assume that one unit of the network component and one unit of the retail component are needed in order to produce one unit of the downstream good. For the sake of simplicity, we assume that both firms have the same marginal cost,  $c$ , of producing one unit of the retail component. The total cost of the network component, necessary for both downstream firms is  $C(q_d, q_c) = v(q_d, q_c) + F$ , which is assumed to be twice differentiable and (weakly) convex. Subscripts  $d$  and  $c$  indicate downstream subsidiary and retail rival, respectively. Furthermore, costs are the same whether a network component is produced for the subsidiary or the rival, such that  $\partial v / \partial q_d = \partial v / \partial q_c$ .<sup>16</sup>

The access price (or wholesale price) that the upstream monopolist charges the retail rival for the network component is equal to  $w$ . As Biglaiser and DeGraba (2001), we assume that the access price is exogenously fixed through an ex ante sector-specific regulation. As alluded to earlier, the access price is cost-oriented and includes fixed costs. We assume that these costs are ultimately allocated based on estimated volumes resulting in an average cost. Further, we assume that although marginal cost may be increasing, it will still be sufficiently low such that the marginal cost never exceeds the access price, i.e.  $w \geq \partial v / \partial q_d$ .

The retail subsidiary of the integrated firm is charged the transfer price,  $t$ , for the network component. We assume that the transfer price is set by the headquarters (HQ) of the vertically integrated firm. It may be argued that this assumption is too liberal and that the transfer price should be linked to the regulated access price. However, we believe our assumption is realistic for two reasons. First, the regulation itself suggests a certain flexibility based on how similar the services are.<sup>17</sup> Second,

---

<sup>16</sup>To focus strictly on the effects of the non-discrimination intent in the access regulation on transfer pricing, we make the firms as symmetric as possible. Hence, we rule out any economies of scope between the production of the network and retail components. For a discussion of this, see e.g. Hagen, Hansen, and Vagstad (2005). Also, we do not include any network effects to avoid strategic behavior related to network effects from over shadowing those related to transfer pricing.

<sup>17</sup>The Commission states that (Access Directive, 2002): “Obligations of non-discrimination shall ensure, in particular, that the operator applies similar conditions in similar circumstances to other

even if the transfer price is required to equal the access price, the integrated firm may still retain control if there is also at least one less regulated input. The relevant transfer price to the subsidiary would then be  $t + t_u = w + t_u$  where  $t_u$  is the transfer price of the less regulated input which can be set by the HQ.<sup>18</sup> However, for simplicity, we only consider one network component in the model and assume that its transfer price,  $t$ , is set by the HQ.

We assume price competition and differentiated services in the retail market where the subsidiary's price is  $p_d$  and the rival's price is  $p_c$ . An assumption of unregulated retail prices is consistent with the new regulatory framework.<sup>19</sup> The demand function  $q_i(p_i, p_j)$  is assumed to satisfy the usual properties in partial equilibrium analysis:

$$\frac{\partial q_i}{\partial p_i} < 0, \quad \frac{\partial q_i}{\partial p_j} > 0, \quad \frac{\partial^2 q_i}{\partial p_i \partial p_j} \geq 0 \quad i, j \in d, c \quad i \neq j \quad (1)$$

The products are (weak) substitutes, and the marginal demand effect of a price change by firm  $i$  is (weakly) increasing in the price of firm  $j$ . Together with the cost assumptions, (1) ensures that the firms consider their products strategic complements as in Bulow et al. (1985), i.e. that  $\frac{\partial^2 \pi_i}{\partial p_i \partial p_j} > 0$ . We also assume that:

$$\frac{\partial q_i}{\partial p_j} = \frac{\partial q_j}{\partial p_i} \quad \text{and} \quad \frac{\partial q_j}{\partial p_i} < -\frac{\partial q_i}{\partial p_i} \quad (2)$$

---

undertakings providing similar services, and provides services and information to others under the same conditions and the same quality as it provides for its own services, or those of its subsidiaries or partners." This suggests that the transfer price will not be forced to equal the access price except when retail services are identical. Such an interpretation seems logical since the regulation otherwise would require the access price and the transfer price to be equal even if the services are dissimilar.

<sup>18</sup>Even in the absence of unregulated network components, the integrated firm may move some non-bottleneck service component which is unregulated and typically performed downstream, from the subsidiary to the HQ. In our case, this might be the retail component,  $c$ , mentioned above. The relevant transfer price to the subsidiary would then be  $t + c$ .

<sup>19</sup>The new framework emphasizes that retail remedies are only justified if wholesale remedies cannot be used (The Universal Service Directive, 2002, Article 17).

where the first condition implies symmetry of cross-price effects on demand, whereas the second ensures that the products are imperfect substitutes. Downstream profits to the integrated subsidiary and the rival are thus, respectively:

$$\pi_d = (p_d - t - c) q_d(p_d, p_c) \quad (3)$$

and

$$\pi_c = (p_c - w - c) q_c(p_d, p_c) \quad (4)$$

To ensure the existence of a Nash equilibrium, the profit functions are assumed to be strictly concave in each downstream firm's own price. This requires that demand is not too convex.<sup>20</sup> The Nash equilibrium will be unique if the following condition holds:

$$\frac{\partial^2 \pi_i}{\partial p_i^2} \frac{\partial^2 \pi_j}{\partial p_j^2} - \frac{\partial^2 \pi_j}{\partial p_j \partial p_i} \frac{\partial^2 \pi_i}{\partial p_i \partial p_j} > 0 \quad (5)$$

Total profit of the vertically integrated firm can be written as:

$$\Pi_I = \pi_d + t q_d(p_d, p_c) + w q_c(p_d, p_c) - C(q_d, q_c) \quad (6)$$

which is independent of the transfer price, and thus in line with theoretical literature on vertical integration as mentioned in the Introduction.

We compare two market structures. First, we analyze the outcome with centralized pricing (CP) in the vertically integrated firm (complete vertical integration). The vertically integrated firm's HQ decides the retail price to maximize the vertically integrated firm's total profit. Second, we analyze decentralized pricing (DP) where the HQ has delegated the responsibility of retail pricing to the manager of the retail subsidiary while the HQ retains the control of the transfer price. In the latter case, the HQ evaluates the retail manager according to the retail subsidiary's profit, and the subsidiary manager then perceives the transfer price as the real marginal cost of the network component.

---

<sup>20</sup>The second order condition is  $\frac{\partial^2 \pi_i}{\partial p_i^2} = 2 \frac{\partial q_i}{\partial p_i} + (p_i - mc_i) \frac{\partial^2 q_i}{\partial p_i^2} < 0$  where  $mc_i$  is constant and equal to either  $(c + t)$  or  $(c + w)$ .

We have the following timing structure: With DP, the vertically integrated firm sets the transfer price,  $t$ , at stage 1. Then, at stage 2, the two retailers compete a la Bertrand. We will measure the results of DP against the results with CP. In either case, the access price is given prior to this game.

## 2.1 Centralized pricing (CP)

The HQ of the vertically integrated firm and the rival maximize the profit functions (6) and (4), respectively. For the HQ, we have the following first order condition:

$$\frac{\partial \Pi_I^{CP}}{\partial p_d} = q_d(p_d, p_c) + (p_d - c) \frac{\partial q_d}{\partial p_d} + w \frac{\partial q_c}{\partial p_d} - \left( \frac{\partial v}{\partial q_d} \frac{\partial q_d}{\partial p_d} + \frac{\partial v}{\partial q_c} \frac{\partial q_c}{\partial p_d} \right) = 0 \quad (7)$$

We rewrite the equilibrium condition as follows:

$$p_d^{CP} = \frac{\varepsilon_d}{1 + \varepsilon_d} \left[ \frac{\partial v}{\partial q_d} + c - \left( w - \frac{\partial v}{\partial q_c} \right) \frac{\partial q_c / \partial p_d}{\partial q_d / \partial p_d} \right] \quad (8)$$

Similarly, for the rival:

$$\frac{\partial \pi_c}{\partial p_c} = q_c(p_d, p_c) + (p_c - w - c) \frac{\partial q_c}{\partial p_c} = 0 \quad (9)$$

$$p_c^{CP} = \frac{\varepsilon_c}{1 + \varepsilon_c} (w + c) \quad (10)$$

where  $\varepsilon_i = (\partial q_i / \partial p_i) (p_i / q_i) < -1$ . The rival's equilibrium price (10) is the familiar inverse markup over its marginal cost,  $w + c$ . The vertically integrated firm (eq. 8) adjusts the marginal cost base of its markup for the net effect of access revenues. Provided the regulated access price exceeds marginal cost, retail prices are higher with access revenues to the vertically integrated firm than without. The reason is that the HQ behaves less aggressively since it has less incentive to steal customers from the rival when it captures a part of the rival's margin through the access price.

Put differently, from the regulator's point of view there are two effects from reducing  $w$ . First, the rival's perceived marginal cost,  $w$ , is closer to the real marginal

cost. Hence, there is a direct effect on the rival's pricing. Second, when  $w$  is reduced, the HQ of the vertically integrated firm becomes more aggressive since the wholesale margin is reduced. This supports Biglaiser and DeGraba (2001) who find that increased access price reduces the incentive for predation by the integrated firm (through margin squeeze).

## 2.2 Decentralized pricing (DP)

In contrast to the former case where the HQ determines the retail price, the retail price is now decided by the subsidiary's manager. Hence, at stage 2 the integrated firm's subsidiary and the rival maximize the profit functions (3) and (4), respectively. The rival's first order condition is still given by (9), whereas the first order condition for the vertically integrated firm's subsidiary is:

$$\frac{\partial \pi_d}{\partial p_d} = q_d(p_d, p_c) + (p_d - t - c) \frac{\partial q_d}{\partial p_d} = 0 \quad (11)$$

The equilibrium condition can be rewritten as:

$$p_d^{DP} = \frac{\varepsilon_d}{1 + \varepsilon_d} (t + c) \quad (12)$$

which, analogously to (10) is an inverse markup of the perceived marginal costs  $(t + c)$ .

From (8) and (12) we have that the equilibrium prices are lower under DP than under CP if transfer price is set equal to marginal cost. The intuition is that the subsidiary manager behaves more aggressively than the HQ with respect to retail pricing, since the subsidiary's manager does not take into the account the upstream profit. When the transfer price equals marginal cost, the HQ and the subsidiary's manager perceive the same marginal cost. Consequently, when they perceive the same marginal cost, but only the HQ perceives the access revenues from the rival, the manager of the subsidiary behaves more aggressively and the retail prices are lower with DP than with CP. Hence, as long as the transfer price mirrors the true costs, a regulation that changes the organizational structure of the vertically integrated firm

from CP to DP may be positive from the regulator's point of view. However, as we show below, the HQ will choose to set the transfer price above the true marginal cost both when it can and cannot credibly commit to a transfer price before retail prices are decided.

From (8) and (12) it follows that also under DP, the HQ can achieve the CP-outcome by setting:

$$\tilde{t} = \frac{\partial v}{\partial q_d} - \left( w - \frac{\partial v}{\partial q_c} \right) \frac{\partial q_c / \partial p_d}{\partial q_d / \partial p_d} \quad (13)$$

Specifically, to replicate the centralized outcome, the HQ should set transfer price equal to marginal cost plus an adjustment based on degree of substitutability between the retail services. Indeed,  $\tilde{t}$  is the optimal transfer price if the HQ cannot credibly commit to the transfer price. Although the HQ may set a different transfer price, if it is not credible, then it cannot be used strategically and hence we essentially are back in the centralized pricing case where any other transfer price than  $\tilde{t}$  will be suboptimal. The opportunity to replicate the centralized pricing outcome provides the integrated firm with greater strategic flexibility under DP and gives rise to the following result:

**Proposition 1:** *(i) If the HQ is forced to set transfer prices that mirrors the true marginal costs, then the equilibrium retail prices are lower under DP than under CP. (ii) When the HQ can set the transfer price freely, the HQ will always (weakly) prefer DP when the access price is exogenous.*

This is not very surprising, and the result resembles the standard outcome from strategic delegation when we have price competition with differentiated services (Fershtman and Judd, 1987). If the HQ can credibly commit to the transfer price, the HQ becomes a Stackelberg leader by using decentralized pricing.

As discussed in the Introduction, obligations that impose transparency of transfer prices are used to implement the access price remedies. But then the regulator provides the HQ of the vertically integrated firm with the transfer price as a credible and observable strategic device. Hence, we now concentrate on the case where the

HQ credibly can commit to an observable transfer price prior to the retail price competition.

The equations (9) and (11) implicitly define the Nash equilibrium of the second stage game in the retail market. The equilibrium solution  $p^* = (p_d^*, p_c^*)$  for a given demand system is uniquely determined by the HQ's transfer price, and the equilibrium strategies can be expressed as:

$$p_d^*(t) = \arg \max_{p_d} \pi_d(p_d, p_c^*, t), \quad p_c^*(t) = \arg \max_{p_c} \pi_c(p_d^*, p_c) \quad (14)$$

As can be seen from (14), the HQ considers both downstream firms' equilibrium strategies to be functions of its transfer price. The difference is that the transfer price affects the subsidiary directly, whereas it affects the rival only indirectly through the changed price of the subsidiary. Proposition 2 states how a change in the transfer price affects the downstream equilibrium strategies.

**Proposition 2:** *Under DP the equilibrium prices chosen by the downstream firms are strictly increasing in the transfer price:*

$$\frac{\partial p_d^*}{\partial t} > 0, \quad \frac{\partial p_c^*}{\partial t} > 0 \quad (15)$$

Proof: See the Appendix.  $\square$

This result is analogous to what is found under price competition when the intermediate good is *not* sold to a rival (Alles and Datar, 1998, Narayanan and Smith, 2000, and Göx, 2000). The intuition behind Proposition 2 is that the transfer price will directly affect the subsidiary of the vertically integrated firm by raising its marginal cost, making it profitable for the subsidiary to raise its price for a given rival price. In turn, the best response of the rival is to also raise its price as the products are strategic complements.<sup>21</sup>

---

<sup>21</sup>Göx (2000) find the same relation between the transfer price and the retail prices, but he assumes that the headquarters just offer their upstream inputs to their own subsidiary.



Before we analyze the outcome of stage 1, from Proposition 2 we have the following policy implication:

**Corollary 1:** *Remedies that directly or indirectly increase the transfer price protect competitors rather than competition.*

As we discuss below, this is a cautionary tale for regulators that seemingly are more worried about too low than too high transfer prices.

In stage one, the vertically integrated firm sets transfer price to maximize:

$$\Pi_I = \pi_d^* + tq_d(p_d^*(t), p_c^*(t)) + wq_c(p_d^*(t), p_c^*(t)) - C(q_d(p_d^*(t), p_c^*(t)), q_c(p_d^*(t), p_c^*(t))) \quad (16)$$

where  $\pi_d^*$  is given by

$$\pi_d^* = (p_d^*(t) - t - c)q_d(p_d^*(t), p_c^*(t)) \quad (17)$$

By maximizing (16) with respect to  $t$  we get:

$$\frac{\partial \Pi_I(t)}{\partial t} = \frac{\partial \pi_d^*}{\partial t} + q_d^* + \left(t - \frac{\partial v}{\partial q_d}\right) \left(\frac{dq_d}{dt}\right) + \left(w - \frac{\partial v}{\partial q_c}\right) \left(\frac{dq_c}{dt}\right) = 0 \quad (18)$$

where

$$\frac{dq_d}{dt} = \frac{\partial q_d}{\partial p_d} \frac{\partial p_d^*}{\partial t} + \frac{\partial q_d}{\partial p_c} \frac{\partial p_c^*}{\partial t} \quad \text{and} \quad \frac{dq_c}{dt} = \frac{\partial q_c}{\partial p_c} \frac{\partial p_c^*}{\partial t} + \frac{\partial q_c}{\partial p_d} \frac{\partial p_d^*}{\partial t}$$

and

$$\frac{\partial \pi_d^*}{\partial t} = (p_d^* - t - c) \frac{\partial q_d}{\partial p_c} \frac{\partial p_c^*}{\partial t} - q_d^* \quad (19)$$

From (18) and (19) we have that the direct effect on the HQ obviously will cancel against the direct effect on the subsidiary.

Let us now define the following:

$$\alpha \equiv \frac{\partial q_d}{\partial p_c} \frac{\partial p_c^*}{\partial t} > 0, \quad \beta \equiv \frac{\partial q_d}{\partial p_d} \frac{\partial p_d^*}{\partial t} < 0, \quad \gamma \equiv \frac{\partial q_c}{\partial p_d} \frac{\partial p_d^*}{\partial t} > 0, \quad \lambda \equiv \frac{\partial q_c}{\partial p_c} \frac{\partial p_c^*}{\partial t} < 0$$

Then, (18) may be rewritten as:

$$\frac{\partial \Pi_I(t)}{\partial t} = (p_d^* - t - c) \alpha + \left( t - \frac{\partial v}{\partial q_d} \right) (\beta + \alpha) + \left( w - \frac{\partial v}{\partial q_c} \right) (\gamma + \lambda) = 0 \quad (20)$$

The first term in (20) is the positive strategic effect of the transfer price on subsidiary profit. The second term in (20) is the strategic effect of the transfer price on transfer profit. The third term is the strategic effects of the transfer price on access profit. Solving (20) with respect to  $t$  yields the equilibrium transfer price:

$$t^* = \frac{\partial v}{\partial q_d} - \frac{\alpha}{\beta} \left( p_d^* - \frac{\partial v}{\partial q_d} - c \right) - \frac{\gamma + \lambda}{\beta} \left( w - \frac{\partial v}{\partial q_c} \right) \quad (21)$$

The signs of each term in (21) is straightforward except for the last term. Since  $dq_c/dt = \gamma + \lambda$ , we may derive the following lemma to determine the sign of the last term:

**Lemma 1:**  $dq_c/dt > 0$  provided that the rival's demand is not too convex.

Proof is in the Appendix, where we also show that this always holds for linear demand.  $\square$

We now summarize the following results:

**Proposition 3:** *Given that the rival's demand is not too convex (Lemma 1),*

*(i) the transfer price will be increasing in the access price ( $\partial t^*/\partial w > 0$ ),*

*(ii) the HQ sets the transfer price above the marginal cost to soften competition when services are imperfect substitutes,*

*(iii) the HQ sets the transfer price close to the marginal cost when the final services are almost independent, and*

*(iv) the HQ is indifferent between selling through its own subsidiary and the rival when final services are identical.*

Proof for (i) is seen directly from (21). Proof for (ii) is in the Appendix. Proof for (iii): When the retail services are independent, we have  $\alpha = \gamma = \lambda = 0$  such that  $t^* = \frac{\partial v}{\partial q_d}$ . Proof for (iv), see below.  $\square$

The intuition for (i) in Proposition 3 is straightforward. An increase in the regulated access price will make selling through the rival more profitable for the HQ, *ceteris paribus*. Hence, the HQ will increase the transfer price provided this will also increase the volume sold through the rival.

The intuition for (ii) and (iii) in Proposition 3 is simply that when the final services are related, the HQ will utilize the strategic advantage of the transfer price to soften competition downstream. As final services become less dependent, competition softens for this reason and the transfer price loses its strategic value. Avoiding double marginalization becomes a greater concern to the HQ and, hence, the transfer price is set closer to marginal cost. As expected, if the retail services are unrelated, i.e.  $\partial q_d/\partial p_c = \partial q_c/\partial p_d = 0$  and thus  $dp_c/dt = 0$ , we get the standard monopoly result that the optimal transfer price is equal to marginal cost (Hirshleifer, 1956).

At the other extreme, as the final services become close substitutes, this limits the possible price differential for the subsidiary and the rival. Competition will reduce the possible second stage markups in (10) and (12) and drive prices towards the highest marginal cost. Based on the Bertrand paradox, we conjecture that when the final products are identical, the HQ will set the transfer price equal to the access price. If the transfer price exceeds the access price, the HQ will not receive a price greater than  $w$  as the rival will steal the market at a price marginally below the transfer price. In this case,  $t > w$  will simply reduce the total volume, and therefore the access profits, for the HQ. Provided  $w \geq \partial v/\partial q$  the HQ will maximize profit by maximizing volume and hence set the transfer price equal to  $w$ . Also, there is no gain in setting transfer price lower and foreclose the rival as long as  $w$  does not exceed the monopoly price in the final services market.

As mentioned in the Introduction, all regulatory cost allocation methods used to compute the access price are based on average costs (Laffont and Tirole, 2000, and Vogelsang, 2003). The level of the access price can thus be expected to depend on the level of the fixed costs. Next we analyze the relationship between the access price and the retail prices given that the HQ sets transfer price strategically.

**Proposition 4:** *If the access price is sufficiently low,  $w < \partial v / \partial q_c - \frac{\partial q_d / \partial p_c}{\partial q_c / \partial p_c} \left( p_d^* - \frac{\partial v}{\partial q_d} - c \right)$ , then the equilibrium prices will be higher with DP than with CP.*

Proof: From Proposition 2 we know that the equilibrium retail prices are increasing in the transfer price. By using (21) and (13) to solve  $t^* > \tilde{t}$  for  $w$  it follows readily that equilibrium prices are higher under DP if  $w < \partial v / \partial q_c - \frac{\partial q_d / \partial p_c}{\partial q_c / \partial p_c} \left( p_d^* - \frac{\partial v}{\partial q_d} - c \right)$ .  $\square$

An interpretation of this result is that a lower access price leads to tougher retail competition, and the HQ then relies on transfer price to compensate and soften competition through its subsidiary. With CP, the HQ does not have this opportunity to use transfer price strategically.

Recall from Proposition 1 that the HQ always prefers DP when the access price is exogenously given, since the HQ always can replicate the CP outcome by manipulating the transfer price under DP. However, what is more surprising is that when the access price is low, then even the rival firm prefers DP as it makes the integrated downstream firm a softer competitor and thereby raises the retail price level. In that case, the rival would not complain to the authorities when the HQ chooses DP. However, had the vertically integrated firm had the ability to raise access price (which we assume to be exogenously determined by the authorities) instead of raising transfer price, the rival would certainly object to this and call upon the authorities to intervene. Thus, the authorities can only rely on rivals to bring excessive access pricing to their attention, but not excessive transfer pricing. However, in our regulatory context, policy makers are usually concerned that the vertically integrated firm will set a low transfer price to provide an advantage to its own subsidiary rather than being concerned with excessive transfer prices:

*"The general nondiscrimination obligation requires that third party access seekers are treated no less favorably than the operator's internal divisions." (ERG, 2003, p. 49).<sup>22</sup>*

---

<sup>22</sup>A similar concern seems to be reflected in the Telecommunications Act of 1996: "A Bell

In contrast, in the present model, the opposite may be the problem:

**Proposition 5:** *If the access price is sufficiently low,  $w < \partial v / \partial q - \frac{\alpha}{\beta + \gamma + \lambda} \left( p_d^* - \frac{\partial v}{\partial q_d} - c \right)$ , then the HQ will set a transfer price which is higher than the access price and thus discriminate against its own subsidiary, and vice versa.*

Proof: By (1) and (2) we have that  $(\beta + \gamma + \lambda) < 0$ . Using (21) and  $\partial v / \partial q_d = \partial v / \partial q_c = \partial v / \partial q$  to solve for  $t^* > w$  we get  $w < \partial v / \partial q - \frac{\alpha}{\beta + \gamma + \lambda} \left( p_d^* - \frac{\partial v}{\partial q_d} - c \right)$ .  $\square$

As discussed above, the motivation behind the non-discrimination obligation is to prevent that the transfer price does not favor the subsidiary, e.g. by being lower than the access price.<sup>23</sup> However, as shown above, the implementation of the regulation enables the HQ to use the transfer price strategically to soften competition. Indeed, it turns out that if the access price is sufficiently low, resulting in tougher competition from the rival, then the HQ will compensate by setting a transfer price which exceeds the access price. Thus it can be profitable for the HQ to discriminate *against* its own subsidiary rather than favorizing it. Furthermore, this may be the case even though the access price is above the marginal cost. Hence, to ensure low retail prices, the authorities should probably be more concerned about a high transfer price than a low transfer price. Note that interpreting the statement by the ERG above as a price floor on transfer prices will still open for such excessive transfer pricing resulting in softer competition. Referring to access regulation, Hausman (2004) cautions that "The goal of such regulation should not be a competitor welfare goal, as regulators often seem to believe, but a consumer welfare goal." (p. 15).<sup>24</sup> Our conclusion is indeed that the regulation is protecting the rival rather than the consumers who ultimately should be the policy makers' concern.

---

operating company ... shall charge the affiliate ... or impute to itself .. an amount for access to its telephone exchange service and exchange access that is *no less* than the amount charged to any unaffiliated interexchange carrierers for such service..." (section 272 (e) (3)) [italics added].

<sup>23</sup>Biglaiser and DeGraba (2001) refer to this as "artificial cost advantage strategies" (p. 303).

<sup>24</sup>See also Hausman (1997, 2002).

The impact on the rival's profit from an increase in the transfer price is very different from the impact of an increase in the access price. Indeed, unlike the case with an access price increase, the rival's profit increases when the transfer price increases. This should have implications on the reliance the authorities place on information and complaints they receive from the competitors. Consumers have incentives to complain when the transfer price increases and thereby increases retail prices for both the subsidiary and the rival. However, the opposite will be true for the rival's incentive to complain (as mentioned above). This is a message of caution to those regulators that in practice only investigate transfer prices (and access prices) if rivals are complaining. Silent rivals cannot be taken as a verification that the transfer price is in line with the intent of the regulation.

Comparing Propositions 4 and 5 we see that retail prices may be higher under DP even though the transfer price is lower than the access price. Put differently, the condition on  $w$  in Proposition 4 is less restrictive than in Proposition 5. Hence, even if the regulator intervenes against excessive transfer pricing, there may still be a welfare loss to consumers from retail prices which are higher than what would have been the case under CP.

### 3 Cournot competition

In this section, we briefly explore the consequences of quantity competition in the downstream market, i.e. the retailers compete a la Cournot at stage 2 under decentralized decision making. Moreover, we assume that they offer identical services to end-users such that inverse downstream demand is  $p(q_d, q_c)$  where

$$\frac{\partial p}{\partial q_d} = \frac{\partial p}{\partial q_c} < 0, \quad \frac{\partial^2 p}{\partial q_i \partial q_j} \leq 0 \quad i, j \in d, c \quad (22)$$

Together with the cost assumptions, this is sufficient to satisfy the second order conditions of the profit functions and to ensure that the services are strategic substitutes. For simplicity, we assume that the marginal cost of the retail component

is zero,  $c = 0$ . The transfer price,  $t$ , is still set by the HQ at stage 1, and the game is solved by backward induction. Under centralized determination of retail output, the equilibrium conditions are:

$$q_d^* = \frac{p - \frac{\partial v}{\partial q}}{-\frac{\partial p}{\partial q}}, \quad q_c^* = \frac{p - w}{-\frac{\partial p}{\partial q}} \quad (23)$$

Under decentralized determination of retail output, the stage 2 equilibrium condition for the rival is the same, whereas for the subsidiary it is:

$$q_d^* = \frac{p - t}{-\frac{\partial p}{\partial q}} \quad (24)$$

As under Bertrand competition, the HQ can imitate the outcome under the centralized regime by choosing the appropriate level for transfer price. In the Bertrand case the transfer price would have to exceed marginal cost to compensate for the more aggressive subsidiary behavior to imitate the centralized outcome. However, in Cournot, the centralized outcome would be imitated by using marginal cost-based transfer price, i.e. by setting  $t = \frac{\partial v}{\partial q}$  at stage 1.

As expected, under decentralized decision making the equilibrium quantity of the subsidiary is strictly decreasing in the vertically integrated firm's transfer price whereas the rival's quantity is strictly increasing. This is due to quantities being strategic substitutes.

$$\frac{\partial q_d^*}{\partial t} < 0, \quad \frac{\partial q_c^*}{\partial t} > 0 \quad (25)$$

Profit to the integrated firm is given by:

$$\Pi_I(t) = \pi_d^*(t) + tq_d^*(t) + wq_c^*(t) - C(q_d^*(t), q_c^*(t))$$

and the stage 1 equilibrium transfer price is found by solving  $\partial \Pi_I / \partial t = 0$ :

$$t^* = \frac{\partial v}{\partial q} - \left( w - \frac{\partial v}{\partial q} + \frac{\partial p}{\partial q} q_d^* \right) \frac{\frac{\partial q_c^*}{\partial t}}{\frac{\partial q_d^*}{\partial t}} \quad (26)$$

Like in Bertrand, the optimal transfer price is also always increasing in the access price under Cournot. The intuition is straightforward. The vertically integrated firm

sets a relatively low transfer price to strategically commit the downstream subsidiary to a greater output at the expense of the rival's output. However, as the regulated access price increases, this will in itself reduce the rival's optimal output. Hence, there is less need for a low transfer price, and it will increase too.

Further, we find that whether the optimal transfer price is lower than the marginal cost depends on how sensitive price is to changes in output.

**Proposition 6:** *With decentralized decision making and Cournot competition, the HQ sets the transfer price below the marginal cost only if the access price is sufficiently low,  $w < \partial v / \partial q - (\partial p / \partial q) q_d^*$ .*

Proof follows from (26), solving  $t^* < \partial v / \partial q$ .  $\square$

As with price competition, the credible commitment to a transfer price allows the vertically integrated firm to achieve a first mover advantage a la Stackelberg. In Cournot, this typically leads to a transfer price lower than marginal cost to increase the subsidiary's output at expense of the rival's output (see e.g. Schjelderup and Sørsgard, 1997). However, in the presence of access revenues from the rival, as in telecommunications, this moderates the use of the transfer price. A reduction in the transfer price will increase the subsidiary's output and profit, but now at the expense of wholesale revenues. Thus only if the access price is sufficiently low, specifically  $w < \partial v / \partial q - (\partial p / \partial q) q_d^*$ , will the transfer price still be set lower than marginal cost. Hence, we have:

**Proposition 7:** *(i) If the access price equals the marginal cost, then the transfer price will be set lower than marginal cost. (ii) If the access price is sufficiently low, then the retail price is lower with decentralized decision making than with centralized decision making.*

Proof of the former follows from (26), and of the latter from Proposition 6, (23), and (24).  $\square$



## 4 Policy discussion and concluding remarks

In the present paper we are focusing on the striking discrepancy on the view on transfer prices in policy applications and in the theoretical literature on access price regulation. When the access price is regulated, and removed as a strategic tool, the vertically integrated firm may prefer decentralized pricing in order to achieve an alternative strategic tool – the transfer price. By assuming complete vertical integration (centralized pricing), the transfer prices have no strategic impact in the theoretical literature. At the other extreme, policy makers implicitly assume that the transfer price a headquarters charges its downstream subsidiary has a direct impact on the downstream competition. One example is the European sector-specific regulation on electronic communications services where the Commission states the following (the Access Directive 2002): “Obligations of non-discrimination shall ensure, in particular, that the operator applies similar conditions in similar circumstances to other undertakings providing similar services, and provides services and information to others under the same conditions and the same quality as it provides for its own services, or those of its subsidiaries or partners.”

We argue that the key features of the present regulatory regime facilitate the transfer price as an observable and credible strategic device that can be used by the vertically integrated firm to soften competition. First, all regulation methods calculate an average-cost based access price. For this type of industry, this means that the regulated access price will be above the true marginal cost. Second, in order to implement this average-cost based access regulation, complementary remedies like accounting separation and transparent transfer pricing are used. These remedies will to some degree force the headquarters of the vertically integrated firm to consider its retail subsidiary as an independent firm. More important, however, is it that these remedies make it profitable for the vertically integrated firm to use decentralized pricing (i.e. by organizing its retail subsidiary as an independent profit center) by making the transfer price observable and credible. Only then do the transfer prices

have strategic impact on retail competition consistent with the common view among policy makers. However, the policy makers' expectation is fulfilled through their own obligations, and will not generally be true.

By choosing decentralized pricing we have shown that the headquarters of the vertically integrated firm can soften competition by setting the transfer price above the true marginal cost. It may even be optimal to set the transfer price above the regulated access price. While the authorities can expect rivals to bring excessive access prices to their attention, the same is not true for excessive transfer prices. This is a cautionary tale for reactive regulators who only investigate subsequent to receiving complaints, and moreover may be more concerned with too low rather than too high transfer prices. Indeed, their regulation may be too successful in protecting the rival from margin squeeze to the detriment of consumers.

Our results suggest that the above problems are most relevant when access price is relatively low (although still exceeding marginal cost). Two main regimes for cost based access prices are fully distributed (historic) costs (FDC) and long run incremental cost (LRIC). The latter is forward looking and (mainly) since equipment prices are falling, it typically results in lower access prices. Thus, our results should be of more concern for regulators applying LRIC than for those applying FDC.

We have assumed that the transfer price is set by the headquarters of the vertically integrated firm. It may be argued that this assumption is too liberal. An alternative interpretation is that the transfer price could be linked to the access price by a price floor, such that it should be at least as high as the access price. This seems to be in line with the main concern of the European Regulators Group that "third party access seekers are treated no less favorably than the operator's internal divisions." However, such a price floor will not be binding if the optimal transfer price is above the access price. Moreover, we have shown that if retail services are identical, the optimal transfer price is equal to the access price, and such a price floor would not be necessary. However, if the retail services are (almost) independent, such a floor may have a considerable, negative impact. The obligation

will then link otherwise unrelated services, and the headquarters will be forced to set a higher transfer price (resulting in higher retail prices) than what is profitable. Thus, it would be unreasonable to enforce such a price floor without regard to how different (or similar) the services are. Indeed, the term “similar conditions in similar circumstances to other undertakings providing similar services” from the Access Directive, suggests that the transfer price will not be linked directly to the access price except when retail services are identical.

Even if the transfer price is required to equal the access price, the integrated firm may still treat the regulation as a price floor if there are also other inputs that are subject to lighter regulatory measures than cost-based regulation. Typically, for some inputs, only transparency and non-discrimination obligations are imposed. The headquarters then controls the sum of the cost-based and less regulated transfer prices. Consequently, we believe the transfer price will probably *de facto* be set by the headquarters of the vertically integrated firm as assumed in the present paper.

Finally, although we have used telecommunications regulations as a framework for our analysis, we believe the results to be relevant for other industries with sector specific regulation as well as for anti-trust cases where the dominant firm is vertically integrated and in control of an upstream bottleneck resource.

## 5 References

The Access Directive. 2002. Directive 2002/19/EC on access to, interconnection of, electronic communications networks and services.

Alles, M. and S. Datar 1998. Strategic transfer pricing, *Management Science*, 44, 451-461.

Armstrong, M. 2002. The theory of access pricing and interconnection, in *Handbook of Telecommunications Economics*, M. Cave, S. Majumdar, and I. Vogelsang (eds.), Amsterdam, Elsevier Publishers.

Bagwell, K. 1995. Commitment and observability in games, *Games and Eco-*

conomic Behaviour, 8, 271-280.

Baldenius, T, N. Melumad, and S. Reichelstein, 2004, Integrating managerial and tax objectives in transfer pricing, *Accounting Review*, Vol. 79, No. 3, 591-615.

Biglaiser, G. and P. DeGraba. 2001. Downstream integration by a bottleneck input supplier whose regulated wholesale prices are above costs, *RAND Journal of Economics*, Vol. 32, No. 2, 302-315.

de Bijl, P., E. van Damme, and P. Larouche, 2005. "Light is Right." Conditions for Competition and Regulation in the Postal Market, Tilburg Law and Economics Center.

Bishop, S. and M. Walker. 2002. The economics of EC competition law. Sweet & Maxwell, London.

Bulow, J.I., J.D. Geanakoplos and P.D. Klemperer. 1985. Multimarket oligopoly: strategic substitutes and complements, *Journal of Political Economy*, 93, 488-511.

Cave, M. 2002. Can regulators be smart about discrimination?, Discussion Paper, Centre for management under regulation, Warwick Business School.

Cave, M. 2003. Remedies for broadband services. Prepared for DG InfoSoc.

Dixit, A. 1980. The role of investment in entry deterrence, *The Economic Journal*, 90, 96-106.

Economides, N. 1998. The incentive for non-price discrimination by an input monopolist, *International Journal of Industrial Organization*, Vol. 16, 271-284.

ERG, 2003. "ERG Common Position on the approach to Appropriate remedies in the new regulatory framework"

Foros, Ø., H.J. Kind and L. Sjørgard, 2004. Managerial incentives and access price regulation, working paper.

Fershtman, C. 1985. Managerial incentives as a strategic variable in duopolistic environment, *International Journal of Industrial Organization*, 3, 245-253.

Fershtman, C. and K.L. Judd. 1987. Equilibrium incentives in oligopoly, *American Economic Review*, 77, 927-940.

Gabrielsen, T.S. and Schjelderup, G., 1998. "Joint Ventures and Transfer Pricing

Rivalry," Papers 10/98, Norwegian School of Economics and Business Administration.

Gabrielsen, T.S. and Schjelderup, G., 1999. "Transfer Pricing and Ownership Structure," *Scandinavian Journal of Economics*, 101(4), 673-688.

Göx, R. F. 2000. Strategic transfer pricing, absorption costing, and observability, *Management Accounting Research*, 11, 327-348.

Hagen, KP., B. Hansen and S. Vagstad. 2005. Synergies and non-discriminatory access pricing, mimeo.

Hausman, J. A. 1997. Valuing the Effects of Regulation on New Services in Telecommunications, *Brookings Papers on Economic Activity, Microeconomics*, 1-38.

Hausman, J. A. 2002. Mobile Telephone. In Cave, M., S. Majumdar, and I. Vogelsang, *Handbook of Telecommunications Economics*, Vol. 1, North-Holland.

Hausman, J. 2004. "Cellular 3G Broadband and WiFi", in R. Cooper and G. Madden (eds.) *Frontiers of Broadband, Electronic and Mobile Commerce*, Physica-Verlag, New York.

Hirshleifer, J. 1956. On economics of transfer pricing, *Journal of Business*, Vol. 29, 172-184.

Katz, M. 1991. Game-playing agents: unobservable contracts as precommitments, *Rand Journal of Economics*, 22, 201-228.

Koboldt, C. 2003. Regulatory obligations to be imposed on operators with significant market power: Narrowband services. Prepared for DG InfoSoc.

Laffont, J.J. and J. Tirole. 2000. *Competition in Telecommunication*, The MIT Press.

Motta, M. 2004. *Competition Policy: Theory and Practice*, Cambridge University Press.

Narayanan, VG and M Smith 2000. "Impact of Competition and Taxes on Responsibility Center Organization and Transfer Prices," *Contemporary Accounting Research* Vol. 17 No. 3 (Fall 2000) pp. 497-529.

Pittman, R. 2004. "Russian Railways Reform and the Problem of Non-Discriminatory Access to Infrastructure", *Annals of Public and Cooperative Economics* 75:2, 167-192.

Richards, P. 2003. "Competition issues on access to databases for the provision of directory information services in the EU", *Telecommunications Policy* 27, 563-583.

Schjelderup, G. and L. Sjørgard 1997. Transfer Pricing as a Strategic Device for Decentralized Multinationals, *International Tax and Public Finance*, 4, 277-290.

Statskonsult 2003. Organiseringen av Meteorologisk Institutt, rapport 2003:16.

Sklivas, S.D. 1987. The strategic choice of managerial incentives, *RAND Journal of Economics*, 18, 452-458.

Telecommunications Act of 1996, Pub. LA. No. 104-104, 110 Stat. 56 (1996).

The Universal Service Directive. 2002. Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services.

Valletti, T. 2003. Obligations that can be imposed on operators with significant market power under the new regulatory framework for electronic communications: Access services to public mobile networks. Prepared for DG InfoSoc.

Vickers, J. 1985. Delegation and theory of the firm, *Economic Journal* 95, 138-147.

Vogelsang, I. 2003. Price regulation of access to telecommunications networks, *Journal of Economic Literature*, XLI, 830-862.

## 6 Appendix

**Proposition 2:** Proof: Totally differentiating the system of implicit reaction functions in (9) and (11) yields:

$$\begin{aligned} \frac{\partial^2 \pi_d}{\partial p_d^2} dp_d + \frac{\partial^2 \pi_d}{\partial p_d \partial p_c} dp_c + \frac{\partial^2 \pi_d}{\partial p_d \partial t_d} dt &= 0 \\ \frac{\partial^2 \pi_c}{\partial p_c \partial p_d} dp_d + \frac{\partial^2 \pi_c}{\partial p_c^2} dp_c &= 0 \end{aligned}$$

By Cramer's rule we get:

$$\begin{aligned} dp_d &= \frac{1}{k} \left( -\frac{\partial^2 \pi_d}{\partial p_d \partial t_d} \frac{\partial^2 \pi_c}{\partial p_c^2} dt \right) \\ dp_c &= \frac{1}{k} \left[ -\frac{\partial^2 \pi_c}{\partial p_c \partial p_d} \left( -\frac{\partial^2 \pi_d}{\partial p_d \partial t_d} dt \right) \right] \end{aligned}$$

where

$$k = \frac{\partial^2 \pi_d}{\partial p_d^2} \frac{\partial^2 \pi_c}{\partial p_c^2} - \frac{\partial^2 \pi_c}{\partial p_c \partial p_d} \frac{\partial^2 \pi_d}{\partial p_d \partial p_c} > 0$$

by assumption in (5). Since

$$\frac{\partial^2 \pi_i}{\partial p_i \partial p_j} > 0, \quad \frac{\partial^2 \pi_i}{\partial p_i \partial t_i} = -\frac{\partial q_i}{\partial p_i} > 0 \quad \text{and} \quad \frac{\partial^2 \pi_i}{\partial p_i^2} < 0$$

and

$$dp_d = \frac{\partial p_d^*(t)}{\partial t} dt \quad \text{and} \quad dp_c = \frac{\partial p_c^*(t)}{\partial t} dt$$

the signs of the strategic effects are:

$$\begin{aligned} \frac{\partial p_d^*(t)}{\partial t} &= \frac{dp_d}{dt} = -\frac{1}{k} \frac{\partial^2 \pi_d}{\partial p_d \partial t} \frac{\partial^2 \pi_c}{\partial p_c^2} > 0 \\ \frac{\partial p_c^*(t)}{\partial t} &= \frac{dp_c}{dt} = \frac{1}{k} \frac{\partial^2 \pi_c}{\partial p_c \partial p_d} \frac{\partial^2 \pi_d}{\partial p_d \partial t} > 0 \end{aligned}$$

**Lemma 1:** Proof:

$$\gamma + \lambda > 0$$

↓

$$\frac{\frac{\partial p_d^*(t)}{\partial t}}{\frac{\partial p_c^*(t)}{\partial t}} > -\frac{\frac{\partial q_c}{\partial p_c}}{\frac{\partial q_c}{\partial p_d}}$$

From the proof of Proposition 1 above we get:

$$\begin{aligned} -\frac{1}{k} \frac{\partial^2 \pi_d}{\partial p_d \partial t} \frac{\partial^2 \pi_c}{\partial p_c^2} &> -\frac{\frac{\partial q_c}{\partial p_c}}{\frac{\partial q_c}{\partial p_d}} \\ \frac{1}{k} \frac{\partial^2 \pi_c}{\partial p_c \partial p_d} \frac{\partial^2 \pi_d}{\partial p_d \partial t} &> -\frac{\frac{\partial q_c}{\partial p_c}}{\frac{\partial q_c}{\partial p_d}} \\ \frac{\partial^2 \pi_c}{\partial p_c^2} &< \frac{\frac{\partial q_c}{\partial p_c}}{\frac{\partial q_c}{\partial p_d}} \frac{\partial^2 \pi_c}{\partial p_c \partial p_d} \end{aligned}$$

By (1), the right-hand-side (RHS) is negative. Hence this condition is stricter than the second order condition for which the RHS is zero, and which is satisfied provided that the rival's demand is not too convex. Expanding and reorganizing the above, we get:

$$\frac{\partial^2 q_c}{\partial p_c^2} < \frac{-\frac{\partial q_c}{\partial p_c}}{(p_c - w - c)} + \frac{\frac{\partial q_c}{\partial p_c}}{\frac{\partial q_c}{\partial p_d}} \frac{\partial^2 q_c}{\partial p_c \partial p_d}$$

For linear demand,  $\frac{\partial^2 q_c}{\partial p_c \partial p_d} = \frac{\partial^2 q_c}{\partial p_c^2} = 0$ , and the condition always holds by (1) and assuming  $\left(p_d^* - \frac{\partial v}{\partial q} - c\right) \geq 0$ . If demand is not linear, we that the first term on the RHS is positive and the second is negative. Hence, provided  $\frac{\partial^2 q_c}{\partial p_c^2}$  is not too large, i.e. that the rival's demand is not too convex, the condition will still hold for non-linear demand.

**Proposition 3:** (ii) Proof:

$$\begin{aligned} t^* &> \partial v / \partial q \\ &\Downarrow \\ \frac{-(\gamma + \lambda)}{\beta} \left( w - \frac{\partial v}{\partial q} \right) &> \frac{\alpha}{\beta} \left( p_d^* - \frac{\partial v}{\partial q} - c \right) \\ \frac{-(\gamma + \lambda)}{\alpha} &< \frac{\left( p_d^* - \frac{\partial v}{\partial q} - c \right)}{\left( w - \frac{\partial v}{\partial q} \right)} \end{aligned}$$

From previous assumption,  $w \geq \partial v / \partial q_i$  and  $\left(p_d^* - \frac{\partial v}{\partial q} - c\right) \geq 0$ . Thus the RHS is non-negative. By (1), (15), and Lemma 1 we have that the left hand side is strictly negative, and the condition always holds.