AVERAGE COST BASED ACCESS PRICING AND THE NON-DISCRIMINATION PRINCIPLE: A LEVEL PLAYINGFIELD?*

KENNETH FJELL

and

ØYSTEIN FOROS

Norwegian School of Economics and Business Administration

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ABSTRACT

Essential network infrastructure in telecommunications typically exhibit natural monopoly characteristics resulting in significant market power for the operator. Ex ante regulation is used to ensure rival downstream service providers access to the network in competition with the vertically integrated network operator. Cost orientation is frequently used for regulating the access price. To recover fixed cost, existing rules inevitably tend to result in an access price based on average cost. We compare the effects on market equilibrium in a duopoly where the firms perceive that access price is based on average cost as opposed to when they consider it exogenous. When access price is considered exogenous, the output and contribution of the vertically integrated network operator exceeds that of its rival. On the other hand, when both firms perceive fixed cost to be allocated according to traffic volumes, output and profits are the same for both vertically integrated incumbent and the rival resulting in non-discrimination. If the vertically integrated operator has decentralized decision making, then there are multiple equilibriums when access price is considered exogenous. Welfare will regardless be reduced relative to centralized decision making. Finally, if the firms consider access price as endogenous, then the structure of decision making makes no difference.

Keywords: regulated industries, telecommunications, cost orientation, non-discrimination.
1. Introduction

In many regulated industries, like the telecommunications industry, downstream competitors are dependent on access to an upstream essential facility controlled by a vertically integrated incumbent. Usually the essential facility is some large infrastructure, like the local loop in telecommunications. *Ex ante* based regulation is used to ensure downstream competitors access to the upstream facility.\(^1\) For telecommunications in the EU, this is set forth in the Access Directive (2002) which provides National Regulating Authorities with a set of remedies including a transparency obligation (Article 9), a non-discrimination obligation (Article 10), an accounting separation obligation (Article 11), an access obligation (Article 12), and a price control and cost accounting obligation (Article 13) (see ERG, 2003).

To achieve the first best welfare outcome, access price should typically equal marginal cost (see e.g. Laffont and Tirole, 1994). However, given the cost structure of regulated telecommunications services, this would normally not lead to full recovery of fixed costs. Hence, much of the economic literature departs for some version of marginal cost based pricing (see Armstrong, 2002, for a review). For example, in the access literature, the recovery of fixed costs is typically advocated to take place through a Ramsey markup of marginal cost. In this case, fixed costs are allocated based on the demand elasticities of the respective services. More common in practice, and also in the regulation of access in telecommunications, however, is the more arbitrary allocation based on service volume. In Norway, for instance, the current interpretation of cost orientation of access prices is one of fully distributed cost (FDC) where common costs are allocated primarily on the basis of

\(^{1}\) This is often referred to as one way access, as opposed to two way access (interconnect) where both firms are in a position of granting access to their rival (e.g. both own infrastructure, or have an installed base of customers which other firms may desire access to). See Armstrong (2002) for an overview.
volume.\(^2\) Hence, the access price is based an average total cost rather than marginal cost. Although there are several approaches to cost based access pricing, all regulatory cost allocation methods 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). Of these, FDC has been the most popular (Laffont and Tirole, 1994) and remains popular despite economists’ critique (see e.g. Laffont and Tirole, 1996, 2000) and the availability of more sophisticated methods such as Ramsey pricing (see e.g. Laffont and Tirole, 1994 and 2000) and the efficient component pricing rule (Baumol, 1993, and Armstrong, Doyle, and Vickers 1996).

The consequences of an exogenous access price in excess of marginal cost in an oligopolistic market have been studied by several authors. Damania (1996) shows that in a homogeneous product Cournot duopoly where one firm is vertically integrated, an exogenous access price exceeding marginal cost results in the integrated firm dominating the market. Further, a reduction in the access price is unambiguously beneficial to consumers, and causes volumes to become more equal. Welfare effects are ambiguous, but under unit elastic demand, an increase in access price from marginal cost will increase total welfare. In a later paper, Biglaiser and DeGraba (2001) assume product differentiation a la Hotelling (1929) in a downstream duopoly setting two-part tariffs. They show that allowing the upstream monopolist to integrate downstream improves consumer welfare as well as overall welfare relative to when both downstream firms are independent. Like in Damania (1996), the vertically integrated firm attains a larger market share than its rival as it sets per-unit price

\(^2\) Also referred to as fully allocated cost (FAC) or “additive markup”. For a recent discussion of cost concepts in telecommunications, see Parsons (2002).
equal to the exogenous access price, and not the lower true marginal cost like the integrated firm.\(^3\)

Unlike these previous studies, we ask what the consequences are of an endogenous access price. In a duopoly, it seems reasonable to assume that firms will realize the impact of own output decisions on an FDC-based access price, i.e. on the share of fixed costs each firm will end up covering. However, assuming that price and quantity are dependent, this leads to circularity; the FDC-based access price is dependent on volumes which in turn are dependent the access price.\(^4\) Laffont and Tirole (1994) mention that such an “access price must be the outcome of a dynamic tatonnement whose path ought to be studied in more detail” (p. 1697).

We do not attempt to study such a path, but rather attempt to shed some light on the equilibrium using a static simultaneous-move game as it is considerably more usable and yet may offer valuable insight (Dixit, 1985).\(^5\)

Secondarily, we are interested in how decentralized decision making influences the above results. Usually when analyzing the pricing of access to bottlenecks, it is assumed that decision making is centralized (e.g. Armstrong et al. 1996, Baumol and Sidak 1994, Biglaiser and Degraba 2001, Damania 1996, Laffont and Tirole 1994 and 2000, Willig 1979). However, telecommunications regulation also requires access price to be non-discriminatory with accounting separation and transparency used to ensure “that third party access seekers are treated no less favourably than the operator's internal divisions” (ERG, 03, 30rev1, p. 49).

Policy makers thus seem to believe that these measures are sufficient to result in decentralized decision making where the downstream incumbent firm takes the regulated

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\(^3\) Goel (1999) builds on Damania (1996) and shows that an increase in the exogenous (above marginal cost) access price causes a reduction in cost-reducing R&D by the integrated firm.

\(^4\) A different strand of literature explores allocation of joint costs according to the net-realizable-value (NRV) method which also poses a problem of circularity as NRV depends on the very prices it is meant to determine. Schneider (1986) and Schneider and Jeroslow (1988) solve this simultaneity problem assuming among other that price and quantity are independent.

\(^5\) Dixit (1986) mentions in passing that “it might be claimed that the myopic adjustment process assumed is no worse than the tatonnement of competitive models” (p. 107).
access price to be its marginal cost. Indeed, Motta (2004) criticizes the EU competition rules and argues that by ensuring transparent prices between vertically related firms, the regulator solves a commitment problem and enables the upstream firm to use transfer price strategically. This is analogous to the strategic transfer pricing literature which also assumes decentralized decision making (see e.g. Schjelderup and Sørgard 1997, Alles and Datar 1998, Narayanan and Smith 2000, and Göx 2000). However, unlike this literature, we assume that the transfer price is regulated based on the cost orientation principle and equal to the access price.6

In this paper, we study the effects of a cost based access price which both the regulated firm and its rival realize is based on their volumes. Contrary to the result of Damania (1996) and Biglaiser and DeGraba (2001) where an exogenous access price exceeding marginal cost promotes dominance by the vertically integrated firm, the equivalent endogenous access price results in a non-discriminatory equilibrium. The result is robust to whether the integrated firm adopts centralized or decentralized decision making. However, if firms consider access price to be exogenous, then decentralized decision making results in lower welfare than centralized decision making. Similar to Biglaiser and DeGraba (2001), our results thus indicate that regulators should be cautious about promoting decentralized decision making as opposed to complete vertical integration.

6 Some recent papers have begun to discuss pricing of access to bottlenecks assuming decentralized decision making (Fjell and Foros 2004, Foros, Kind and Sørgard 2004, and Hagen, Hansen and Vagstad 2005). Foros et al. (2004) show that the incumbent firm can circumvent the intention of the non-discrimination principle through the use of managerial incentives and indeed make the vertically separated incumbent more aggressive. The resulting equilibrium is asymmetric despite identical accounting costs downstream. In a similar setting, Fjell and Foros (2004), much like Motta (2004), argue that the access regulation can serve to solve a commitment problem for the incumbent headquarter by making the transfer price observable and credible. Thus, the headquarter may use it strategically to soften competition by setting a transfer price which exceeds marginal cost, and in certain cases even exceeds the regulated access price.
2. Model

A vertically integrated incumbent provides an upstream component, network access, to its own downstream subsidiary and to a downstream rival. One unit of network access is required per unit of retail service provided. The inverse demand for downstream retail service is given by $p = a - Q$ where $Q = q_1 + q_2$ is the sum of incumbent and rival output respectively. Quantities (and thus, indirectly the price) are unregulated. The profit functions of the vertically integrated incumbent and its rival are, respectively:

$$\pi_1 = pq_1 + wq_2 - F$$  \hspace{1cm} (1a)  

$$\pi_2 = pq_2 - wq_2$$  \hspace{1cm} (1b)  

were $w$ is the regulated access price paid by the rival and $F$ is total fixed cost of providing network access. As we are not specifically interested in entry issues, we ignore downstream fixed costs.\(^7\) Furthermore, we assume that the retail services are symmetrical from a customer point of view. This seems reasonable since we are looking towards what a stable equilibrium might look like when the newcomer has matured and reached a level of service comparable to that of the incumbent. As Peitz (2005), we argue that: “If the entrant stays long enough in the market such [consumer utility] asymmetries will finally disappear.” (p. 342, square brackets added). Similarly, we assume that the marginal cost of providing the retail component is identical and normalized to zero.\(^8\) Welfare is taken to be the sum of producer and consumer surpluses.

The structure of the game is as follows. At stage one the regulator announces the access price (regime). At stage two the firms simultaneously compete in quantities to maximize profit. Here we lean on Mitchell and Vogelsang (1998) who argue that the rival

\(^7\) For a thorough discussion of entry in telecommunications, see Spulber and Sidak (1997).
\(^8\) However, the issue of consumer utility or cost asymmetries may be very relevant upon entry or introduction of new services (see e.g. Peitz 2005 and Hansen 2005, respectively).
and the integrated incumbent compete “in capacity and pricing, so that Cournot pricing is most likely to result.” (p. 38).

We assume that the regulator is intent on achieving a cost oriented access price. Cost orientation is interpreted as an average cost based access price. Specifically, the regulator is successful when the fixed network cost is allocated based on volume in equilibrium. We consider two different circumstances (regimes) under in which this cost orientation can be achieved; when access price is considered exogenous or endogenous.

First the first regime, the regulator sets \( w = \overline{w} \) which is perceived as exogenous by the firms. \( \overline{w} \) may for example be based on the regulator’s private estimates of volumes, \( \overline{w} = F / (\hat{q}_1 + \hat{q}_2) \).

In the second regime, the regulator announces at Stage 1 that \( w = F / (q_1 + q_2) \) where the access price is based on realized output in the second stage. Hence, \( w \) becomes endogenous to both firms. Again, on the second stage the firms compete in quantities.

We look at these regulatory regimes under both centralized and decentralized decision making.

3. Centralized decision making

In this section, we consider a fully integrated incumbent, i.e. centralized decision making.

Exogenous access price

Taking access price \( w \) as given, both firms simultaneously maximize profit. The first order conditions for the incumbent and rival are, respectively:

\[
\begin{align*}
\frac{\partial \pi}{\partial q_i} &= a - 2q_i - q_2 = 0 \\
\frac{\partial \pi}{\partial q_2} &= a - q_1 - 2q_2 - \overline{w} = 0
\end{align*}
\]

Subtracting the latter from the former in (2) we get:
\[ q_1 = q_2 + \bar{w} \]  \hspace{1cm} (3)

Hence, the incumbent’s output will always exceed that of the rival for a positive access price, and the difference will be strictly increasing in \( \bar{w} \), as also shown by Damania (1996). The equilibrium in terms of the exogenous access price is:

\[ q_1 = \frac{a + \bar{w}}{3} \]  \hspace{1cm} (4)

\[ q_2 = \frac{a - 2\bar{w}}{3} \]

\[ p = \frac{a + \bar{w}}{3} \]

\[ \pi_1 = \frac{a^2 + 5a\bar{w} - 5\bar{w}^2}{9} - F \]

\[ \pi_2 = \frac{a^2 - 4a\bar{w} + 4\bar{w}^2}{9} \]

\[ W = \frac{8a^2 - 2a\bar{w} - \bar{w}^2}{18} - F \]

**Proposition 1:** Under centralized decision making, the output of the integrated incumbent will exceed that of the rival when access price is exogenous and greater than marginal cost. Price will be strictly increasing and welfare strictly decreasing in the access price.

This simply confirms the findings by Damania (1996) and Biglaiser and DeGraba (2001). The intuition behind the result in Proposition 1 is that the FDC based access price becomes the rival’s marginal cost which exceeds the marginal cost of the vertically integrated firm as it includes fixed costs.
If the regulator were to maximize welfare in (1) by setting $w$ freely without regard to cost orientation, it would choose $w = -a$ resulting in a price of zero and only the rival producing.

**Proposition 2:** Under imperfect competition, the welfare maximizing access price would be below marginal cost, resulting in the incumbent producing only access and being foreclosed from the retail market. The retail price would equal marginal cost.

Market power leads to a social loss as an unregulated price will exceed marginal cost. The intuition is that the regulator compensates for the imperfect competition by setting a lower access price. In particular, it sets access price below marginal cost, i.e. a negative access price.\(^9\) This subsidized access stimulates the rival’s production at the expense of the incumbent, so much so that the incumbent is foreclosed from the market. Retail price equals marginal cost (zero) in equilibrium.

However, this would not be a sustainable equilibrium as it results in a negative profit of $\pi_1(w = -a) = -a^2 - F$ for the incumbent which both would pay the entire fixed cost as well as subsidize the rival with $a$ per unit of access.\(^10\) From (4) we have that equilibrium welfare is strictly concave in access price and decreasing for $w > -a$. Hence, if the regulator maximizes welfare subject to an access price no lower than marginal cost, $w \geq 0$, then the optimal access price would simply be marginal cost. Still, the vertically integrated incumbent would carry the entire burden of the fixed cost, and might earn negative profits if the fixed cost is sufficiently large $(F > a^2/9)$.

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\(^9\) Laffont and Tirole (1994) show that if the rival’s profit is excluded from the welfare function and elasticities are constant, then the market power of the rival decreases the optimal access price (p. 1689).

\(^10\) The equilibrium would also make the rival a monopolist. However, as there is no subsequent stage, the rival would not be able to take advantage of its monopoly power. In a more dynamic setting, the equilibrium would have to be interpreted as a contestable market equilibrium (Baumol et al. 1982). That may not be totally unreasonable as long as the incumbent remains a provider of access and could re-enter the downstream market.
Rather than traditional welfare maximization, we assume that the regulator is committed to cost orientation. Furthermore, we assume that the cost orientation is interpreted, not as marginal cost which is often the case, but as FDC where the regulator attempts to set access price at Stage 1 such that in equilibrium at Stage 2 we get \( w = \frac{F}{q_1^* + q_2^*} \). We do not analyze a dynamic path to such an equilibrium, which Laffont and Tirole (1994) call for, but rather ask what would characterize such an equilibrium in a simple Cournot-Nash setting. Inserting \( w = \frac{F}{q_1 + q_2} \) into the equilibrium quantities in (4), and solving with respect to quantities, we get the following two solutions:

\[
q_1 = \frac{2a + \sqrt{a^2 - 3F}}{3} \quad \text{where } q_2 < 0 \quad \forall \quad F \in \left[0, \frac{a^2}{3}\right] \tag{5a}
\]
\[
q_2 = -a - 2\sqrt{a^2 - 3F} \quad \frac{3}{3}
\]

\[
q_1 = \frac{2a - \sqrt{a^2 - 3F}}{3} \quad \text{where } q_2 \geq 0 \quad \forall \quad F \in \left[0, \frac{a^2}{4}\right] \tag{5b}
\]
\[
q_2 = -a + 2\sqrt{a^2 - 3F} \quad \frac{3}{3}
\]

However, as (5a) violates the condition that output must be non-negative, the only remaining solution is (5b). From (5b) we note that a solution is only possible if fixed cost is sufficiently small, specifically \( F \leq a^2/4 \). Substituting (5b) into (4) gives us the following remaining equilibrium values where an FDC access price is achieved while the firms consider access price exogenous:
Endogenous access price

Next, we turn to the case where the regulator announces that \( w = F/(q_1 + q_2) \) at stage 1. Hence, the access price is endogenous to the firms when they compete at stage 2. Rewriting the firms’ profit functions in (1a) and (1b) in terms of the now endogenous access price, we get:

\[
\pi_i = (a - q_i - q_j)q_i - \frac{F}{q_i + q_j}q_i \quad \text{where } i, j \in 1, 2 \text{ and } i \neq j \quad (7)
\]

Note that the regulatory regime has made the fixed cost variable to the firms in a symmetric manner; each firm is allocated a share of fixed cost corresponding to its market share. Due to this symmetry, the two firms will choose identical outputs in equilibrium despite that the access price at face value still represents a revenue source to the integrated incumbent and a cost to its rival. This leads to two possible output levels which satisfy the regulation.

\[
q_1 = q_2 = \frac{a + \sqrt{a^2 - 3F}}{6} \quad \text{if } F \in \left[0, \frac{a^2}{3}\right], \emptyset \text{ otherwise} \quad (8a)
\]

\[
q_1 = q_2 = \frac{a - \sqrt{a^2 - 3F}}{6} \quad \text{if } F \in \left[0, \frac{a^2}{3}\right], \emptyset \text{ otherwise} \quad (8b)
\]
However, only the high volume alternative, (8a), satisfies the second order conditions for profit maximization.\textsuperscript{11} This in turn yields the following remaining equilibrium values:

\[ w = a - \sqrt{a^2 - 3F} \]
\[ p = \frac{2a - \sqrt{a^2 - 3F}}{3} \]
\[ \pi_1 = \pi_2 = \frac{a^2 + a\sqrt{a^2 - 3F} - 6F}{18} \]
\[ W = \frac{2a^2 + 2a\sqrt{a^2 - 3F}}{9} - \frac{5}{6} F \]  

(9)

Comparing the equilibrium in (9) with the previous equilibrium in (6) where access price also equals FDC, but where the firms take \(w\) as given, reveals that they result in the same access price, retail price, and welfare. However, in the former equilibrium, the integrated incumbent always produces more than its rival, whereas in the latter the firms’ quantities (and profits) are identical. In other words, when the firms consider the cost oriented access price to be endogenous, the result is a transfer of market share and revenues from the incumbent to the rival. It also results in a symmetric equilibrium and as such the one might argue that the cost orientation has non-discrimination as its outcome.

**Proposition 3:** When the incumbent is fully integrated, i.e. under centralized decision making, and the firms perceive the cost orientation based on FDC as endogenous, then the outcome is one of non-discrimination.

This result is similar to a two-way access result by Economides et al. (1996). Investigating the consequences of three different interconnect regulations – reciprocity of

\textsuperscript{11} The second order condition for firm \(i\) is satisfied if \( F < \left(\frac{q_i + q_j}{\sqrt{q_j}}\right) / q_j \) for \(i, j \in 1, 2\) and \(i \neq j\). Given symmetry, this implies \( F < 8q_i^2 \). It can be shown that for (8a) this translates to \( F < \left(\frac{8}{25}\right)a^2 \), and for (8b) to \( F < 0 \).
termination charges, imputation\textsuperscript{12} and unbundling – they find that all three tend to neutralize dominance and profit differences in a network duopoly.

The result also echoes a more familiar property that price and total output in Cournot equilibrium depends on the sum, but not the distribution of marginal costs. Bergstrom and Varian (1985) shows how this property formally holds for constant marginal costs. Although marginal cost is declining in our endogenous regime, the sum of marginal costs in equilibrium is equal to that in the exogenous regime. In the latter, marginal cost of the vertically integrated firm is zero, whereas the constant, exogenous marginal cost of the rival is $\bar{w} = F/Q$ in equilibrium. In the endogenous regime, taking the derivative of the last term in (7) and summing over the firms, we have that the sum of marginal costs is
\[
\sum_i \frac{F}{Q} \left(1 - \frac{q_i}{Q}\right) = \frac{F}{Q}.
\]

4. Decentralized decision making

As discussed in the Introduction, the cost oriented access regulation often includes additional regulatory measures to ensure non-discrimination, such as transparency and accounting separation. Motta (2004) and Fjell and Foros (2004) suggest that this regulation enables the integrated firm to decentralize decision making. In this section, we assume that the vertically integrated firm reorganizes into upstream headquarters (HQ) providing network access and a downstream subsidiary providing service in competition with the rival. Simultaneously, decision making is decentralized. Based on homogeneity downstream, the non-discrimination obligation implies that the HQ must offer access on identical terms to...

\textsuperscript{12}“An imputation rule restricts termination fees to be no larger than the implicit price for termination sold as part of internal calls” (Economides et al. 1996).
both downstream firms. The downstream subsidiary maximizes profit while treating $w$ as its marginal cost just like the rival does.

The structure of the game is now expanded by one stage. First, the regulator announces the access price (regime), second the HQ adopts the regime, and finally, the downstream subsidiary and rival compete in quantities. Note that unlike in Fjell and Foros (2004) where transfer price may deviate from the access price and is used strategically, the role of the HQ is trivial in our case as it simply passes on the access price (regime) to the downstream firms. As such, the setting more closely resembles that of Biglaiser and DeGraba (2001).

Given identical services and costs downstream, we get symmetrical downstream profit functions:

$$
\pi_i = (a - q_i - q_j)q_i - wq_i
$$

where $i, j \in \{1, 2\}$ and $i \neq j$ \hspace{1cm} (10)

Total profit of the vertically integrated firm is $\pi_i = pq_i + wq_j - F$.

For reasons which will become obvious, we change the order from the previous section and first consider the endogenous access price regime, then the exogenous access price regime.

*Endogenous access price*

As in the previous section, the regulator announces at Stage 1 that the access price regime is

$$
w = \frac{F}{q_1 + q_2}, \ \text{i.e. what we have called an endogenous access price. This access price regime is simply passed on by the HQ of the incumbent firm to its downstream subsidiary and the downstream rival. The HQ’ profit is zero under this regulation, and hence the downstream subsidiary faces the total profit function of the vertically integrated firm. Thus, the outcome will be the same as under centralized decision making.}
$$
Exogenous access price

Next, we consider the case where access price is perceived as exogenous by the firms, \( w = \bar{w} \), and solve by backward induction. Maximizing (10) with respect to quantity, we get following symmetrical equilibrium:

\[
q_1 = q_2 = \frac{a - \bar{w}}{3} \\
p = \frac{a + 2\bar{w}}{3} \\
\pi_1 = \frac{a^2 + 4a\bar{w} - 5\bar{w}^2}{9} - F \\
\pi_2 = \frac{a^2 - 2a\bar{w} + \bar{w}^2}{9} \\
W = \frac{4a^2 - 2a\bar{w} - 2\bar{w}^2}{9} - F
\]

(11)

As in the previous section, we next solve for the case where the regulator achieves a cost oriented access price in equilibrium. In this case, the profit of the HQ will be zero and the total profit of the integrated firm is thus equal to that of its downstream subsidiary. Solving \( \bar{w} = F/(q_1 + q_2) \) and (11) simultaneously for \( \bar{w} \), we get:

\[
\bar{w} = \frac{a + \sqrt{a^2 - 6F}}{2} \quad \text{if} \; F \in \left[0, \frac{a^2}{6}\right], \varnothing \; \text{otherwise} \quad (12a)
\]

\[
\bar{w} = \frac{a - \sqrt{a^2 - 6F}}{2} \quad \text{if} \; F \in \left[0, \frac{a^2}{6}\right], \varnothing \; \text{otherwise} \quad (12b)
\]

Comparing (12) with (6) we find that the range of fixed costs for which an equilibrium solution exists is narrower under decentralized decision making, \( F \in \left[0, \frac{a^2}{6}\right] \), than under centralized decision making, \( F \in \left[0, \frac{a^2}{4}\right] \). This can be summarized in the following proposition.
Proposition 4: Decentralized decision making reduces the likelihood that an equilibrium exists for an FDC based access price.

Inserting (12a) and (12b) back into (11) we get the following two possible equilibriums, respectively.

\[ q_1 = q_2 = \frac{a - \sqrt{a^2 - 6F}}{6} \]
\[ p = \frac{2a + \sqrt{a^2 - 6F}}{3} \]
\[ \pi_1 = \pi_2 = \frac{a^2 - a\sqrt{a^2 - 6F} - 3F}{18} \]
\[ W = \frac{2a^2 - 2a\sqrt{a^2 - 6F} - 6F}{9} \]

\[ q_1 = q_2 = \frac{a + \sqrt{a^2 - 6F}}{6} \]
\[ p = \frac{2a + \sqrt{a^2 - 6F}}{3} \]
\[ \pi_1 = \pi_2 = \frac{a^2 + a\sqrt{a^2 - 6F} - 3F}{18} \]
\[ W = \frac{2a^2 + 2a\sqrt{a^2 - 6F} - 6F}{9} \]

(13a,b)

From (13) we can show that welfare is strictly higher in the high volume alternative, (13b), for \( F \in \left[0, \frac{a^2}{6}\right] \). The equilibriums are identical for \( F = \frac{a^2}{6} \). Hence, the high volume alternative will be preferred by the regulator. Furthermore, profits are also higher in the high volume alternative, such that the firms would also prefer this alternative. However, both equilibriums are sustainable. As such, absent any explanation for the dynamic path towards the equilibrium, either equilibrium might be equally likely, although one is significantly poorer from the perspective of all parties – regulator, firms and consumers.

Proposition 5: Decentralized decision making results in two FDC-based access price equilibriums; one yielding a high and one yielding a low access price. The low access price equilibrium results in higher welfare, higher profits, and lower prices and would hence be preferred by regulator, firms and consumers.
Next, we investigate the impact of decentralized decision making, given that access price is perceived as exogenous by the firms. Comparing the low access price equilibrium under decentralized decision making (13b) with that under centralized decision making leads to the following proposition:

**Proposition 6:** Decentralized decision making results in a higher FDC-based access price, higher retail price and lower welfare.

Proof: Subtracting access price under decentralized decision making, (12b), from that under centralized decision making, (6), we get:

\[
F_a F_a F_a + \frac{1}{2} a^2 \left( -a + 2\sqrt{a^2 - 3F} - \sqrt{a^2 - 6F} \right)
\]

which is zero for \( F = 0 \), and \( \frac{a}{2} (\sqrt{2} - 1) > 0 \) for \( F = \frac{a^2}{6} \). Furthermore, the derivative of the difference with respect to \( F \) is

\[
\frac{3}{2} \left( \frac{1}{\sqrt{a^2 - 6F}} - \frac{1}{\sqrt{a^2 - 3F}} \right) > 0 \quad \forall F \in \left[ 0, \frac{a^2}{6} \right].
\]

Proof for price and welfare can be shown analogously. □

Propositions 4 and 6 are a caution that decentralized decision making may actually reduce welfare. Regulators that attempt to put distance between the monopoly and competitive activities by enforcing decentralized decision making on vertically integrated firms, may thus inadvertently reduce welfare. This supports earlier cautions about possible negative consequences from decentralized decision making put forth by Biglaiser and DeGraba (2001) and Fjell and Foros (2004).
5. Conclusion

In this paper, we discuss the possible equilibrium effects of an access price based on fully distributed cost (FDC) in a telecommunications duopoly. By FDC we mean the simplest form of allocation of common fixed cost based on quantity. This seems to be in line with practice which typically implies some average cost based access (Laffont and Tirole, 2000, and Vogelsang, 2003). Furthermore, we discuss the effects of decentralized decision making.

We find that under centralized decision making, the equilibrium price and welfare will be unaffected by whether the firms perceive the access price as exogenous (and equal to FDC) or they perceive it as endogenous in that their own quantity influences access price. However, when the firms perceive it as exogenous, the vertically integrated firm will always be dominant (have a greater market share). On the other hand, when the firms perceive that an increase output also increases their share of the common fixed costs, the result is one of equal market shares. Hence, our results indicate that, all else being equal, FDC will bring about a non-discriminatory equilibrium if the firms perceive access price as endogenous.

We also study the impact of decentralized decision making with an FDC based access price. Recent literature suggests that the regulatory push towards accounting separation and decentralized decision making may have adverse effects on consumer welfare (Biglaiser and DeGraba 2001, Fjell and Foros 2004). We find that decentralized decision making has no impact when firms consider access price to be endogenous. However, if they perceive it as exogenous, then decentralized decision making reduces the scope for an equilibrium, and also results in a higher access price, higher retail price, and lower welfare.

Some caveats are in order. Our results are based on a simple Cournot setting. The influence of price competition thus remains unexplored. Further, Laffont and Tirole’s (1994) call for a study of the dynamic path towards equilibrium is not addressed here.
6. References


