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by

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Endogenous Average Cost Based Access Pricing[1]

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Abstract: We analyze an endogenous average cost based access pricing rule, where both the regulated firm and its rivals realize the interdependence among their output and the regulated access price. In contrast, the existing literature on access pricing has always assumed the access price to be exogenously fixed ex-ante. We show that endogenous access pricing fully neutralizes the dominance enjoyed by the incumbent firm, and that the consumer surplus is equal to or larger than under exogenous access pricing. If the entrants are more efficient than the incumbent, then the welfare under endogenous access pricing is higher than under exogenous access pricing.

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1. Introduction

In many regulated industries, such as the telecommunications industry, downstream competitors require access to an upstream essential facility controlled by a vertically integrated incumbent. Usually the essential facility is some costly infrastructure, such as the local loop in telecommunications or the power distribution network in electricity. Typically, *ex ante* regulatory directives are used to ensure downstream competitors' access to the upstream facility.[2] For telecommunications in the European Union (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).[3] In the United States, the Telecommunications Act of 1996 authorizes new entrants to lease parts of the incumbent firm's communications network.

To achieve the first best welfare outcome, the regulated access price should typically equal marginal cost of providing the infrastructure (see, for example, Laffont and Tirole, 1994). However, given the cost structure of most regulated sectors, this pricing rule would not lead to full recovery of fixed costs. Hence, much of the economic literature departs for some variation of marginal cost based pricing (see Armstrong, 2002, for a review). For example, in the access literature, the recovery

[2]This is often referred to as one way access, as opposed to two way access (interconnect), where each firm is in a position of granting access to its rivals (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.

[3]See European Regulatory Group. ERG, 2003.

of fixed costs is typically advocated to take place through a Ramsey markup of marginal cost.

More common in practice, and also in the regulation of access in telecommunications, however, is an allocation based on service volume, where the access price is based an average total cost rather than marginal cost. In Norway, for instance, the current interpretation of cost orientation of access prices is one of fully distributed cost (FDC), where historic common costs are allocated primarily on the basis of volume. Long Run Average Incremental Costs (LRAIC) is currently being considered as an alternative. This may change the common cost measure, but not the principle that the access price is based on average costs. In practice, almost all regulatory cost allocation methods, including FDC and LRAIC, are based on average costs, such that the access price is set above the short-run marginal cost (Laffont and Tirole, 2000, and Vogelsang, 2003). Thus, the average costs based access pricing rules remain 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 (see, e.g. Baumol and Sidak, 1994, and Armstrong, Doyle, and Vickers, 1996).

In general, an exogenously set average cost based access price gives rise to conflicts among the incumbent firm that owns the infrastructure and the entrants that lease the infrastructure from the incumbent. The incumbent prefers a higher, whereas the entrant prefer a lower access price. The consequences of an exogenous access price in excess of marginal cost in an oligopolistic market have been studied by several authors. For example, Damania (1996) shows that in a homogeneous

product Cournot duopoly where only one firm is vertically integrated, an exogenous access price exceeding marginal cost results in the integrated firm dominating the market. 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.

To eliminate the advantage that would otherwise be enjoyed by the incumbent, regulations often require access price to be non-discriminatory with accounting separation and transparency used to ensure "that third party access seekers are treated no less favorably than the operator's internal divisions" (ERG, 2003, p. 49). Such an array of regulations (e.g, Articles 9 - 13 in the EU Access Directives), however, give rise to monitoring and enforcing costs, and therefore, create a significant source of welfare loss.

In this paper, we propose and analyze an **endogenous average cost based access pricing rule**, where both the regulated firm and its rivals realize the interdependence among their output and the regulated access price. In contrast, the existing literature on access pricing has always assumed the access price to be exogenously fixed *ex-ante*. Under an endogenous average cost based access pricing, the access price is determined by dividing the incumbent's fixed cost by the actual aggregate quantities of the firms. It seems reasonable to assume that firms will realize the impact of their own output decisions on an FDC based access price, i.e. on the share of fixed costs each firm will end up covering.

An endogenous average cost based access price can be easily implemented in practice. The access price determination mechanism and a tentative access price can be announced *ex-ante*, with the understanding that the firms may have to pay more (or they receive money back) *ex-post* according to the access price determination mechanism. A simple option of adjusting the access price *ex-post* transforms an exogenous access pricing regime to an endogenous access pricing regime. Furthermore, under complete information, the *ex-ante* tentative access price can easily be computed, such that it would be identical to the *ex-post* access price, and therefore, the firms would pay or receive nothing *ex-post*.

Furthermore, we demonstrate that endogenous access pricing has several advantages over an exogenous access pricing. We establish that: (*i*) Endogenous access pricing fully neutralizes the dominance that is otherwise enjoyed by the incumbent firm, making it unnecessary to promote decentralized decision making as opposed to complete vertical integration. (*ii*) The aggregate quantity and the consumer surplus under endogenous access pricing are equal to or larger than those under exogenous access pricing. (*iii*) If the entrants are no less efficient than the incumbent, then the welfare under endogenous access pricing is equal to or larger than the welfare under exogenous access pricing.

Our work is distinct from, but closely related to Sappington (2005). Sappington (2005) considers a similar framework (but with price competition, as opposed to quantity competition downstream) and analyzes whether an entrant would build its own infrastructure or lease it from the incumbent. Sappington (2005) demonstrates that the entrant's make or buy decision is independent of the access price set by the regulators. Our work is distinct from Sappington (2005), since we do not allow

the entrant to build its own infrastructure and concentrate on designing a superior access pricing mechanism. On the other hand, our findings are alike, since they both demonstrate redundancy of costly regulations in similar contexts.

The paper is organized as follows. Section 2 describes the model. Sections 3 and 4 present the findings under centralized and decentralized decision making by the incumbent firm. Section 5 demonstrates the advantages of endogenous access pricing, and Section 6 concludes the paper.

2. Model

A vertically integrated incumbent firm provides an upstream component, network access, to its own downstream subsidiary and to N downstream rivals. Without loss of generality, we assume $N = 1$. Our results hold for $N \geq 2$. One unit of network access is required per unit of retail service provided. The inverse demand for downstream retail service is given by $p(Q)$, where $Q = q_1 + q_2$ is the sum of the incumbent and its rival's output, q_1 and q_2 are the downstream quantities sold by the incumbent and its rival, respectively. We assume $p'(Q) < 0$ and $p''(Q) \leq 0$. Quantities and the market price are unregulated. The profit functions of the vertically integrated incumbent and its rival are, respectively:

$$\pi_1 = p(Q)q_1 + wq_2 - c_1q_1 - F \tag{2.1}$$

$$\pi_2 = p(Q)q_2 - wq_2 - c_2q_2$$

where w is the regulated access price paid by the rival, c_1 and c_2 are per unit retail costs of the incumbent owned downstream firm and its rival. We assume that c_1 and c_2 are independent of the output produced. F is total fixed cost of

providing network access. The variable cost of providing access is normalized to zero as we wish to rule out economies of scope effects for the incumbent. As we are not interested in entry issues, we ignore downstream fixed costs.[4] Furthermore, we assume that the retail services are symmetrical from a customer point of view. This seems reasonable since we are looking towards what an 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). Welfare is defined as the sum of the producer surplus and the consumer surplus.

The structure of the game is as follows. In Stage 1, the regulator announces the access price or the process of determining the access price. In Stage 2, the firms simultaneously compete in quantities (a lá Cournot) to maximize profit.[5]

We assume that the regulator enforces an average cost based access price. Specifically, the regulator is successful when the fixed network cost is covered based on total downstream sales in equilibrium. We consider two different circumstances (regimes) in which this objective can be achieved; an exogenous access pricing regime and an endogenous access pricing regime.

In the exogenous access price regime, the regulator sets $w = \overline{w}$, which is perceived as exogenous by the firms. $\overline{w} = \frac{F}{\widehat{Q}}$ is based on the regulator's estimate of market volume, $\widehat{Q}$, which can be accurately calculated by solving the model.

[4]For a thorough discussion of entry in telecommunications, see Spulber and Sidak (1997).
[5]Mitchell and Vogelsang (1998) argue that the rival and the integrated incumbent compete "in capacity and pricing, so that Cournot pricing is most likely to result."(p. 38).

In the endogenous access price regime, the regulator announces at Stage 1 that $w = \frac{F}{Q}$, where the access price is based on realized total output Q in the second stage. In practice, a tentative access price can be announced *ex-ante*, with the understanding that the firms may have to pay more (or they receive money back) *ex-post* according to the access price determination mechanism. Hence, w becomes endogenous to both firms. After the announcement of the access price determination mechanism, the firms compete in quantities in Stage 2. The firms' costs and objectives are common knowledge.

In the next sections, we analyze the outcomes under exogenous and endogenous access pricing regimes. For each scenario, we also study the outcomes under both centralized and decentralized decision making by the incumbent. Under the centralized decision making process, the incumbent acts as a fully integrated firm. As a result, the marginal cost of the upstream input (which is access) faced by the incumbent owned downstream firm is identical to the true marginal cost of access as incurred by the upstream firm. In contrast, under the decentralized decision making process, the upstream firm and the incumbent owned downstream firm must act as two separate firms. As a result, the marginal cost of the upstream input (which is access) faced by the incumbent owned downstream firm is identical to the marginal cost of access that is faced by its downstream rival. Note that the 2002 EU Access Directives calls for a decentralized decision making process. Several ancillary obligations on accounting separation, transparency and non-discrimination should ensure that the incumbent's subsidiary perceives the regulated access price as the marginal cost.

3. Centralized Decision Making by the Incumbent Firm

3.1. **Exogenous Access Price.** Taking access price $w = \overline{w}$ as given, both firms simultaneously maximize profit. The first order conditions for the incumbent and the rival are, respectively:

$$p'(Q)q_1 + p(Q) - c_1 = 0 \tag{3.1}$$

$$p'(Q)q_2 + p(Q) - \overline{w} - c_2 = 0$$

Rearranging (3.1) we get the following equilibrium quantities:

$$q_1^* = \frac{p - c_1}{p'(Q)} \tag{3.2}$$

$$q_2^* = \frac{p - \overline{w} - c_2}{p'(Q)}$$

Proposition 1. *Under centralized decision making, the output and profit of the integrated incumbent firm exceed those of the rival when access price is exogenous and exceeds the difference in marginal cost between the incumbent and its rival.*

Proposition 1 confirms the findings by Damania (1996) and Biglaiser and DeGraba (2001). Furthermore, we show that the result holds as long as the exogenous access price exceeds any marginal cost disadvantage the incumbent might have in the retail market, that is, $\overline{w} > (c_1 - c_2)$. The intuition behind the result in Proposition 1 is that the access price becomes part of the rival's total marginal cost, $(\overline{w} + c_2)$, and that the incumbent is dominant as long as this total exceeds the incumbent's own marginal cost. Hence, the incumbent owned downstream firm enjoys an 'advantage', since it does not face a 'double marginalization' problem

that is faced by its rival. In particular, if the incumbent owned downstream firm and its rival are equally efficient, the output and profit of the incumbent owned downstream firm exceed those of its rival.

Note that the regulator sets the access price at Stage 1 such that in equilibrium in Stage 2 we get $\overline{w} = \frac{F}{q_1^* + q_2^*}$. Inserting $\overline{w} = \frac{F}{q_1^* + q_2^*}$ into the equilibrium quantities in (3.1), and solving the following two equations, we get q_1^*, q_2^* and $\overline{w} = \frac{F}{q_1^* + q_2^*}$.

$$p'(Q)q_1 + p\,(Q) - c_1 = 0 \tag{3.3}$$

$$p'(Q)q_2 + p\,(Q) - \frac{F}{Q} - c_2 = 0$$

Note that equations (3.3) result in two average cost 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 the regulator, firms and consumers. Here and in the rest of the paper, whenever multiple equilibria arise, we consider the equilibrium with the lowest access price.

3.2. **Endogenous Access Price.** Next, we turn to the case where in Stage 1, the regulator announces the mechanism to determine the access price. Here, the regulator announces that the access price w will be set at $\frac{F}{q_1 + q_2}$. Hence, the access price becomes endogenous to the firms when they compete at Stage 2. Rewriting the firms' profit functions in (3.1) in terms of the endogenous access price, we get:

$$\pi_1 = p(Q)q_1 + w\,(Q)\,q_2 - c_1 - F \tag{3.4}$$

$$\pi_2 = p(Q)q_2 - w\,(Q)\,q_2 - c_2$$

The corresponding first order conditions are:

$$p'(Q)q_1 + p(Q) + w'(Q)\,q_2 - c_1 = 0 \tag{3.5}$$

$$p'(Q)q_2 + p(Q) - w'(Q)\,q_2 - w(Q) - c_2 = 0$$

Substituting for $w(Q)$ and $w'(Q)$, and rearranging terms, we get:

$$p'(Q)q_1 + p(Q) - \frac{F}{(q_1+q_2)}(q_2) - c_1 = 0 \tag{3.6}$$

$$p'(Q)q_2 + p(Q) - \frac{F}{(q_1+q_2)}(q_1) - c_2 = 0$$

Proposition 2 below follows directly from equation (3.6) :

Proposition 2. *Under centralized decision making and endogenous access pricing, the equilibrium will be one of non-dominance, where the output and the profit of the incumbent owned downstream firm and those of its rival firm are based on their respective downstream marginal costs. In particular,if* $c_1 = c_2$*, then the output and the profit of the incumbent owned downstream firm and those of its rival firm are identical.*

The intuition behind Proposition 2 is as follows. An increase in output by the incumbent owned downstream firm lowers the access price and hence, reduces the amount it collects from its rival for each unit of the rival's output. An increase in output by the rival firm, on the other hand, also lowers the access price, but reduces the amount it pays to the incumbent for each unit of its output. Since the effect of an increase in output by either firm is perfectly symmetric, the incumbent firm loses its 'advantage' under endogenous access pricing. The argument is similar to

the one made by Sappington (2005) in the context of the irrelevance of input prices for make or buy access decisions by an entrant.

3.3. **Comparisons of outcomes under exogenous and endogenous access prices.** We now compare the equilibrium outcomes under endogenous and exogenous access pricing. Summation of the first order conditions in equation (3.6) yields the following equilibrium condition when access price is considered endogenous:

$$p'(\widetilde{Q})\widetilde{Q} + 2p\left(\widetilde{Q}\right) - \frac{F}{\widetilde{Q}} = c_1 + c_2 \tag{3.7}$$

where $\widetilde{Q}$ denotes the aggregate output under endogenous access pricing.

Similarly, substituting $\overline{w} = \frac{F}{\widehat{Q}}$ into the exogenous access pricing equilibrium conditions in (3.1) and summing the first order conditions, we get:

$$p'(\widehat{Q})\widehat{Q} + 2p\left(\widehat{Q}\right) - \frac{F}{\widehat{Q}} = c_1 + c_2 \tag{3.8}$$

where $\widehat{Q}$ denotes the aggregate output under exogenous access pricing.

Note that equations (3.7) and (3.8) are identical, giving rise to the following proposition:

Proposition 3. *With centralized decision making by the incumbent firm, the total quantity and the market price under endogenous access pricing are identical to those under exogenous access pricing.*

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 termination charges, imputation and unbundling – they find that all three tend to neutralize dominance and profit differences in a network duopoly.

We now compare welfare under endogenous and exogenous access pricing. Since the total quantity under endogenous access pricing are identical to that under exogenous access pricing, the welfare is larger in the scenario in which more output is produced by the more efficient firm. The following proposition follows by noting that when the access price is exogenous, the incumbent owned downstream firm produces relatively more.

Proposition 4. *With centralized decision making by the incumbent firm, if* $c_1 < c_2$*, then the welfare under endogenous access pricing is smaller than that under exogenous access pricing. If* $c_1 = c_2$*, then the welfare is identical under both access pricing regimes. If* $c_1 > c_2$*, the welfare under endogenous access pricing is higher than that under exogenous access pricing.*

4. Decentralized Decision Making by the Incumbent Firm

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. 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 both downstream firms. The downstream subsidiary maximizes profit while treating w as its marginal cost just like the rival does. The role of the HQ is trivial in our case as it simply passes on the access price to the downstream firms.

When decision making by the downstream firm is decentralized, we get symmetrical downstream profit functions:

$$\pi_i = p(Q)q_i - wq_i - c_i \text{ where } i = 1, 2 \tag{4.1}$$

4.1. **Exogenous Access Price.** Next, we consider the case where access price is perceived as exogenous by the firms. It can be verified that the first order conditions for profit maximization are:

$$\begin{aligned} p'(Q)q_1 + p\,(Q) - \frac{F}{Q} - c_1 = 0 \\ p'(Q)q_2 + p\,(Q) - \frac{F}{Q} - c_2 = 0 \end{aligned} \tag{4.2}$$

Adding the first order conditions in equation (4.2) , we obtain:

$$p'(Q)Q + 2p\,(Q) - \frac{2F}{Q} - (c_1 + c_2) = 0 \tag{4.3}$$

Next, we investigate the impact of decentralized decision making, given that access price is perceived as exogenous by the firms. When decision making by the incumbent firm is centralized, the equilibrium output are given by equation (3.1) . Adding the two first order conditions in equation (3.1) , we obtain:

$$p'(Q)Q + 2p\,(Q) - \frac{F}{Q} - (c_1 + c_2) = 0 \tag{4.4}$$

Comparing equations (4.3) and (4.4) , we obtain the following proposition:

Proposition 5. *Under exogenous access pricing, decentralized decision making by the incumbent firm results in a higher access price, a lower quantity and a higher*

market price, relative to those under centralized decision making by the incumbent firm.

In the proposition below, we compare welfare under endogenous and exogenous access pricing by noting that the total quantity is larger under centralized decision making, and the firm that does not own the infrastructure produces relatively more under decentralized decision making.

Proposition 6. *Under exogenous access pricing and $c_1 \leq c_2$, then decentralized decision making by the incumbent firm results in a lower welfare, relative to that under centralized decision making by the incumbent firm.*

Propositions 5 and 6 are a caution that decentralized decision making may actually reduce consumer surplus and welfare. Regulations 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 DeGraba (2003).

4.2. **Endogenous Access Price.** As in the previous section, the regulator announces at Stage 1 that the access price w will be set at $\frac{F}{q_1+q_2}$. Hence, the access price becomes endogenous to the firms when they compete in Stage 2. Therefore, the first order conditions for profit maximization are:

$$p'(Q)q_i + p(Q) + \frac{F}{(q_1+q_2)^2}q_i - \frac{F}{(q_1+q_2)} - c_i = 0 \tag{4.5}$$

$$\implies p'(Q)q_i + p(Q) - \frac{F}{(q_1+q_2)}q_j - c_i = 0 \text{ where } i \neq j = 1, 2$$

Comparing equations (3.6) and (4.5), we establish that with endogenous access pricing, outcomes under decentralized decision making are identical to those under centralized decision making.

Proposition 7. *With endogenous access pricing, individual firm quantities, total output, market price and welfare under decentralized decision making are identical to those under centralized decision making.*

4.3. **Comparisons of outcomes under exogenous and endogenous access prices.** The task requires a comparison between equations (4.2) and (4.5). A direct comparison between the equations, however, turns out to be problematic. We, therefore, use Propositions (3), (5) and (7) for the comparison.

Let Q_{end}^{cen} denote the aggregate quantity under centralized decision making by the incumbent firm and endogenous access pricing. We similarly define Q_{exo}^{cen}, Q_{end}^{dec}, and Q_{exo}^{dec}. Now, Proposition 3 states that $Q_{end}^{cen} = Q_{exo}^{cen}$. Proposition 5 states that $Q_{exo}^{cen} \geq Q_{exo}^{dec}$, and Proposition 7 states that $Q_{end}^{dec} = Q_{end}^{cen}$. Therefore, $Q_{end}^{dec} = Q_{end}^{cen} = Q_{exo}^{cen} \geq Q_{exo}^{dec}$, giving rise to the following proposition.

Proposition 8. *With decentralized decision making by the incumbent firm, the total quantity under endogenous access pricing is higher and the market price is lower than those under exogenous access pricing.*

We now compare the welfare under exogenous and endogenous access pricing. The following proposition follows from Proposition 8 and from the fact that with decentralized decision making by the incumbent firm, the incumbent owned downstream firm and its rival produce equal quantities.

Proposition 9. *With decentralized decision making by the incumbent firm and* $c_2 \leq c_1$*, endogenous access pricing gives rise to a larger welfare than exogenous access pricing.*

5. Advantages of Endogenous Access Pricing

In this section, we present the advantages of endogenous access pricing. As stated in Proposition (2), endogenous access pricing neutralizes the advantage enjoyed by an incumbent firm making centralized decisions. With endogenous access pricing, the market shares and the profits of the firms are identical. Therefore, with endogenous access pricing, the regulators do not need to worry about enforcing a non-discrimination obligation and an accounting separation obligation, as stated in Articles 10 and 11 of 2002 European Union Access Directives. Also, Propositions (3) and (8) state that the aggregate quantity under endogenous access pricing is at least as large as the aggregate quantity under exogenous access pricing. Hence, the consumer surplus is equal or higher under endogenous access pricing. Furthermore, from Propositions (4) and (9), it follows that if $c_2 \leq c_1$, then the welfare under endogenous access pricing is at least as large as the welfare under exogenous access pricing. Diffusion of technology and/or higher likelihood of adaptation of superior technology by the later entrant justify the condition $c_2 \leq c_1$.

Proposition (10) below summarizes the above discussions and highlights the advantages of an endogenous access pricing:

Proposition 10. *Irrespective of centralized or decentralized decision making by the incumbent firm, (i) the aggregate quantity and the consumer surplus under endogenous access pricing are equal to or larger than those under exogenous access pricing. (ii) endogenous access pricing neutralizes the dominance that is otherwise*

enjoyed by the incumbent firm, (*iii*) *if* $c_2 \leq c_1$*, then the welfare under endogenous access pricing is equal to or larger than the welfare under exogenous access pricing.*

6. Conclusion

In this paper, we propose and analyze an **endogenous average cost based access pricing rule**. The existing literature on access pricing has always used exogenous access pricing, where the access price is fixed *ex-ante*. Despite the presence of more sophisticated rules such as Ramsey pricing or the Efficient Component Pricing Rule (ECPR), the average cost based rules dominate in practice. For instance, fully distributed cost (FDC) based exogenous access pricing is currently used in the Norwegian telecommunications industry. Long run average incremental cost (LRAIC) is being considered as an alternative. However, both result in an access price based on some *ex ante* average cost.

We argue that an *endogenous* access pricing rule can be easily implemented in practice. A simple option of adjusting the access price *ex-post* transforms an exogenous access pricing regime to an endogenous access pricing regime. A tentative access price can be announced *ex-ante*, with the understanding that a firm may have to pay more (or it receives money back) *ex-post* according to the access price determination mechanism. Under complete information, a tentative access price can easily be computed *ex-ante*, such that it would be identical to the *ex-post* access price, and therefore, the firms would pay or receive nothing *ex-post*.

We demonstrate that an endogenous access pricing has significant advantages over an exogenous access pricing: (*i*) the aggregate quantity and the consumer surplus under endogenous access pricing are equal to or larger than those under exogenous access pricing. (*ii*) endogenous access pricing neutralizes the dominance

that is otherwise enjoyed by the incumbent firm. (*iii*) if the entrant is as efficient as the incumbent firm, then the welfare under endogenous access pricing is equal to or larger than the welfare under exogenous access pricing. Furthermore, we show that costly ancillary obligations, such as accounting separation, transparency, and non-discrimination, can be avoided by adopting an endogenous access pricing rule.

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