The Efficient Component Pricing Rule:

Friend or Foe?

By

Dennis L. Weisman*

Department of Economics
Kansas State University
Waters Hall
Manhattan KS, 66506-4001
785-532-4588 (V)
785-539-7225 (F)
weisman@ksu.edu

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Abstract
The efficient component pricing rule (ECPR) is at the center of the access pricing controversy. The ECPR is generally favored by vertically-integrated providers and opposed by independent rivals. This analysis reveals that the vertically-integrated provider earns either monopoly or competitive profits in equilibrium under the ECPR depending upon its relative efficiency downstream. A strict preference for the ECPR is therefore somewhat puzzling given that the vertically-integrated provider can earn positive profits in equilibrium under marginal cost access pricing even when it is relatively inefficient. It follows that the vertically-integrated provider bears greater risk under the ECPR *vis-à-vis* marginal cost access pricing.

1. Introduction
In network industries, such as telecommunications, electric power and railroads, it is common for an upstream monopolist to supply an input essential to the production of the downstream service. This essential input is generally referred to as *access*. For example, long-distance carriers such as AT&T, MCI and Sprint are dependent in many regions on the access services supplied by local telephone companies for the origination and termination of long-distance messages. In electricity markets, competition in generation requires access to the transmission and distribution networks of regional power companies. Competition in rail markets requires that rivals be able to secure trackage rights from incumbent railroads in regions where they do not own their own facilities.

The so-called access pricing problem is a principal focus of the recent regulatory economics literature (Lewis and Sappington, 1999; Laffont, Rey and Tirole, 1998a, 1998b; Armstrong, Doyle and Vickers, 1996; and Laffont and Tirole, 1994, 1996). The efficient component pricing rule (ECPR) in particular has generated considerable controversy. The ECPR requires that the price of access be set equal to the direct incremental cost of providing the upstream access service plus the net contribution foregone (opportunity cost) in not providing the downstream retail service. This
particular statement of the ECPR is sometimes referred to as the M-ECPR, where the “M” indicates a market-determined measure of opportunity cost (Sibley, Doane, Williams and Tsai, 2002; Sibley, Doane and Williams, 1999; Sidak and Spulber, 1997a, 1997b).

The traditional conception of the ECPR measures the opportunity cost component with respect to the pre-entry (monopoly) price of the incumbent provider that is assumed to be set by the regulatory authority (Baumol, 1999; Kahn and Taylor, 1994; and Baumol and Sidak, 1994a, 1994b). The ECPR is generally supported by incumbent vertically-integrated providers and opposed by independent rivals (FCC, 1996, ¶ 660-661). Independent rivals generally reject the ECPR in favor of marginal cost access pricing. A common criticism is that the ECPR has no claim to efficiency when retail prices are not set at “efficient” levels (Baumol, Ordover and Willig, 1996; and Tye, 1994). It is argued further that the ECPR embodies a “make whole property” that insulates the incumbent provider from competitive losses (FCC, 1996, ¶ 710).

The analysis of the efficiency properties of the ECPR and the myriad other access pricing rules has spawned a voluminous literature (Sibley, Doane, Williams and Tsai, 2002; Weisman, 2001; Sibley, Doane and Williams, 1999; Baumol, 1999; Economides and White, 1995, 1998; Larson, 1998; Larson and Lehman, 1997; Baumol, Ordover and Willig, 1997; Armstrong, Doyle, and Vickers, 1996; Laffont and Tirole, 1994, 1996; Willig, 1979). The primary question to be examined here concerns whether incumbent, vertically-integrated providers should necessarily prefer the ECPR to marginal cost access pricing when opportunity costs are “market-determined.”

Ameritech, GTE, and SBC among others have publicly endorsed the ECPR for the pricing of unbundled network elements in regulatory proceedings to implement the 1996 Telecommunications Act. See Sibley, Doane, Williams and Tsai (2002), Sidak and Spulber (1997b) and FCC (1996). See Kahn, Tardiff and
The primary findings of this analysis are three. First, when the vertically-integrated provider and its independent rivals are not of equal efficiency, there is no market equilibrium in which both participate downstream under the ECPR. Second, the incumbent provider should strictly prefer the ECPR over marginal cost access pricing only if it is more efficient than its independent rivals downstream. Under the ECPR, the vertically-integrated provider earns either monopoly or competitive profits in equilibrium depending upon its relative efficiency downstream. Consequently, a relatively efficient (respectively, inefficient) vertically-integrated provider earns higher (respectively, lower) profits under the ECPR in comparison with marginal cost access pricing. Third, when there is uncertainty over relative efficiency, the vertically-integrated provider bears greater risk under the ECPR vis-à-vis marginal cost access pricing. The magnitude of this risk is shown to be decreasing in the number of independent, downstream rivals.

The format for the remainder of this paper is as follows. In section 2, we introduce the notation and the basic structure of the model. The main findings are provided in Section 3. Conditions under which the ECPR is a rational choice for the vertically-integrated provider are derived in Section 4. Section 5 summarizes the key findings and concludes.

2. The Model

We construct a highly-stylized model in which there is a single vertically-integrated provider that serves as a monopolist in the upstream access market. There are assumed to be $n-1$ identical, independent downstream rivals of the vertically-integrated provider where, except as otherwise noted, the integer $n \geq 2$ is finite. The downstream output of

Weisman for a discussion of the economic issues associated with the implementation of the 1996
the vertically-integrated provider and each of its independent rivals is given by \( q^V \) and \( q^I \), respectively. Market output is therefore given by \( Q = q^V + (n-1)q^I \). The inverse market demand function is denoted by \( P(Q) \), with \( P'(Q) < 0 \) assumed to be bounded. The regulated price of access is denoted by \( w \) and the corresponding marginal cost of access is denoted by \( c \). Production is of the fixed-coefficient type: Each unit of the downstream output requires one unit of access and one unit of a complementary input that may be self-supplied by an independent rival. The cost of each unit of the complementary input is denoted by \( s^i \), \( i = V \) and \( I \).

The profit function for the vertically-integrated provider is given by

1. \( \Pi^V = (w - c)(n - 1)q^I + \left[ P(Q) - c - s^V \right] q^V \).

The profit function for the representative independent rival is given by

2. \( \Pi^I = \left[ P(Q) - w - s^I \right] q^I \).

The vertically-integrated provider and the independent rivals are assumed to play a Cournot game. For an exogenous access price, \( w \neq w(P) \), the equilibrium is characterized by the solution to the following first-order conditions:

3. \( q^V : q^V P'(Q) + P(Q) - c - s^V \leq 0; \) and \( q^V [\cdot] = 0; \)

4. \( q^I : q^I P'(Q) + P(Q) - w - s^I \leq 0; \) and \( q^I [\cdot] = 0. \)

To rule out degenerate cases, we assume that neither the vertically-integrated provider nor the independent rivals are “grossly inefficient.” In other words, all firms produce strictly positive levels of output under marginal cost access pricing.

We specify a general access pricing rule as follows:

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Telecommunications Act.
(5) \( w = c + \alpha \max\{0, P - c - s^V\} \), \( \alpha = 0, 1 \).

Equation (5) embodies the two access pricing rules of interest. When \( \forall = 0 \), \( w = c \), which is marginal cost access pricing. When \( \forall = 1 \), \( w = c + (P - c - s^V) \), which is the ECPR. Also, recognize from (3) that when \( P - c - s^V \neq 0 \), the vertically-integrated provider does not participate in the downstream market \( (q^V = 0) \) and \( w = c \) in equilibrium. Nonetheless, we show formally that these two access pricing rules are not equivalent when the vertically-integrated provider is foreclosed from the downstream market in equilibrium. In fact, it is precisely the differences in the behavior of the independent rivals under the two access pricing rules that call into question the vertically-integrated provider’s strict preference for the ECPR. To wit, a relatively inefficient vertically-integrated provider that realizes positive profits in equilibrium under marginal cost access pricing earns zero profits in equilibrium under the ECPR.

3. Primary Findings

In this section, we record our primary findings concerning the ECPR. The first finding reveals a “knife-edge” property of the ECPR.

**Proposition 1.** When \( \forall = 1 \) and \( s^V < s^I \), there exists no equilibrium in which both the vertically-integrated provider and the independent rivals simultaneously participate in the downstream market.

**Proof:** When \( \forall = 1 \), \( w = c + (P - c - s^V) = P - s^V \). Substituting into (2) upon recognizing that \( w = w(P) \) yields the following first-order conditions:

(6) \( q^V : q^V P'(Q) + P(Q) - c - s^V \leq 0 \); and \( q^V[\cdot] = 0 \);

(7) \( q^I : s^V - s^I \leq 0 \); and \( q^I[\cdot] = 0 \); \( \forall P(Q) - c - s^V > 0 \).
For $s^V < s^l$, (7) implies that $q^l = 0$ by complementary slackness. For $s^V > s^l$, $q^l > 0$ with the equilibrium level of output, $(n-1)q^{l*} = Q^*$, defined implicitly by the solution to $P(Q^*) = c + s^V$. This further implies that $q^V = 0$ in (6) by complementary slackness since $P'(Q) < 0$.

The intuition for Proposition 1 is immediate upon examining the profit function for the independent rivals at $\forall = 1$ when $P > c + s^V$. The independent rivals earn a margin on each unit of output of $P - s^l - w = P - s^l - (P - s^V) = s^V - s^l$ so that $A^l = [s^V - s^l]q^l$. Hence, the independent rivals maximize profit by shutting down when $s^V < s^l$ and producing until the vertically-integrated provider exits the retail market when $s^V > s^l$.

Proposition 2. The relatively inefficient vertically-integrated provider strictly prefers $\forall = 0$ to $\forall = 1$.

Proof: Proposition 1 implies that $A^V = 0$ for $s^V > s^l$ when $\forall = 1$. Hence, it is sufficient to show that $A^V > 0$ for $s^V > s^l$ when $\forall = 0$. The vertically-integrated provider is not grossly inefficient by assumption. Hence, $q^V > 0$ which implies that $P - c - s^V > 0$ from (6) and $A^V > 0$ from (1).

It is significant that when $s^V > s^l$, marginal cost access pricing arises in equilibrium under both access pricing rules, $\forall = 0$ and $\forall = 1$. In the former, marginal cost access pricing is exogenously imposed. Whereas, in the latter marginal cost access pricing arises endogenously as a result of the expansion of output by the independent rivals and the subsequent foreclosure of the vertically-integrated provider from the downstream market.

To examine this output expansion more formally, observe from (6) that when $q^V > 0$ in equilibrium at $\forall = 0$, $P^* > c + s^V$. Conversely, when $\forall = 1$, $P^* = c + s^V$ in (6) and
\( q^V = 0 \) by complementary slackness.\(^2\) It follows that the collective output of the independent rivals (and hence total output) must be greater in this case since \( P'(Q) < 0 \) and \( Q = (n-1)q^I \). This output expansion occurs under the ECPR because an increase in output on the margin reduces the price of access (\( w \)) on all infra-marginal units of output.

**Proposition 3.** The relatively efficient vertically-integrated provider strictly prefers \( \forall = 1 \) to \( \forall = 0 \).

**Proof:** The proof is immediate from the fact that when \( s^I > s^V \) and \( \forall = 1 \) the vertically-integrated provider is a monopolist in the downstream market from Proposition 1. Moreover, when \( s^I > s^V \), the monopoly profit realized by the vertically-integrated provider dominates any alternative level of profit (upstream and downstream) that could be realized by the vertically-integrated provider when the independent rivals participate in the downstream market (\( q^I > 0 \)).

Propositions 2 and 3 collectively explain why the vertically-integrated provider should not strictly prefer the ECPR to marginal cost pricing of access. Under the ECPR, the vertically integrated provider avoids the “bad” (competitive or zero-profit) outcome iff it is both relatively efficient and not grossly inefficient. Conversely, avoiding the “bad” outcome under marginal cost access pricing requires only that the vertically-integrated provider not be grossly inefficient. A strict preference for the ECPR in this setting thus presents something of a paradox.

**Example**
Consider the case of entry into the interLATA long-distance market on the part of the Regional Bell Operating Companies (RBOCs).\(^3\) In this case, the bottleneck, monopoly

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\(^2\) It is this property of the ECPR that leads Sibley, Doane, Williams and Tsai to conclude that the ECPR dominates marginal cost access pricing in terms of allocative efficiency when the independent rivals are more efficient than the vertically-integrated provider in the downstream market.

\(^3\) As part of the AT&T divestiture in 1984, the United States was divided into 161 local access transport areas (LATAs). The RBOCs are permitted to provide long-distance telephone service within LATAs but
Each minute of long-distance service requires one unit of carrier access and one unit of interLATA transport. There are 3-plus backbone long-distance networks in the United States and each of them is owned or affiliated with one of the interexchange carriers—the RBOCs’ rivals in the downstream long-distance market. Hence, the RBOCs must secure interLATA transport from one of these rivals in order to produce long-distance telephone service. The market for interLATA transport is competitive, but not perfectly competitive.\(^4\) Hence, there is a mark-up above marginal cost for interLATA transport which implies that \(s^V > s^I\). Under these conditions, the RBOC should strictly prefer marginal cost access pricing (\(\forall = 0\)) to the ECPR (\(\forall = 1\)) consistent with Proposition 2.

### 4. Rationality Reexamined

In the previous section, we demonstrated that, in general, the vertically-integrated provider should not strictly prefer the ECPR to marginal cost pricing of access. In this section, we derive the conditions under which the ECPR is, in fact, a rational choice for the vertically-integrated provider.

We assume that market demand is linear of the form \(P(Q) = A - BQ\), where \(A > 0\) and \(B > 0\). Straightforward computations based on (3) and (4) reveal that when demand is linear the downstream outputs of the vertically-integrated provider and the independent rivals are given respectively by

\[
q^V = \frac{1}{(n + 1)B} [A - nx + (n - 1)y],
\]

\[n \neq \text{LATAs}.\] The 1996 Telecommunications Act allows the RBOCs to petition for entry into the (in-region) interLATA market once they have satisfied a 14 point checklist that specifies the manner in which they must open their local networks to competition. See Kahn, Tardiff and Weisman (1999). At the time of this writing, the petitions of the RBOCs in thirteen states have been approved. See http://www.fcc.gov/Bureaus/Common_Carrier/in-region_applications/.

\(^4\) For example, Schmalensee and Taylor (1998) contend that the MCI-WorldCom merger will serve to reduce the number of separate long-distance networks and thereby increase the market power for network capacity. A similar concern was voiced when Sprint and MCI-Worldcom discussed a possible merger.
\[ q' = \frac{1}{(n+1)}[A - 2y + x], \]

where \( x = c + s^V \) and \( y = w + s' \) denote the marginal cost of downstream output for the vertically-integrated provider and the independent rivals, respectively. Substituting (8) and (9) into the expression for linear market demand, \( P(Q) = A - BQ \), yields

\[ P(Q) = \frac{1}{(n+1)}[A + (n - 1)y + x]. \]

Substituting (8), (9), and (10) into (1) and simplifying yields the reduced-form profit function for the vertically-integrated provider

\[ \Pi^V(s^V, s') = \frac{n-1}{B(n+1)}[A - 2y + x][w - c] + \frac{1}{B} \left[ \frac{A + (n - 1)y - nx}{n+1} \right]^2. \]

The objective is to derive conditions under which the vertically-integrated provider is indifferent between the ECPR and marginal cost pricing of access. Let \( \Delta = s' - s^V \) denote the relative efficiency of the vertically-integrated provider in the downstream market.

When \( \Delta < 0 \) the vertically-integrated provider earns the competitive (zero) level of profit in equilibrium under the ECPR from Proposition 2. Conversely, when \( \Delta > 0 \) the vertically-integrated provider is a monopolist in the downstream market under the ECPR from Proposition 3 and (11) reduces to

\[ \Pi^V_M = \frac{1}{B} \left[ \frac{A - x}{2} \right]^2. \]

Under marginal cost access pricing, \( w = c \), and (11) reduces to

\[ \Pi^V(s^V, s') = \frac{1}{B} \left[ \frac{A + (n - 1)y - nx}{n+1} \right]^2. \]
We assume that the vertically-integrated provider is risk-neutral. Let \( \phi \) denote the probability that the vertically-integrated provider is relatively efficient with marginal cost given by \( x = x^0 \), and \( 1 - \phi \) denote the probability that the vertically-integrated is relatively inefficient with marginal cost given by \( x = x^1 \), where \( x^0 < y < x^1 \). The vertically-integrated provider will be indifferent between the ECPR and marginal cost access pricing when

\[
\frac{\phi}{B} \left[ \frac{A - x^0}{2} \right]^2 + [1 - \phi][0] = \frac{\phi}{B} \left[ \frac{A + (n-1)y - nx^0}{(n+1)} \right]^2 + \frac{1 - \phi}{B} \left[ \frac{A + (n-1)y - nx^1}{(n+1)} \right]^2.
\]

Observe that in the limit as \( \Delta \to 0 \), \( x \approx y \) and the vertically-integrated provider’s profits are approximately the same under marginal cost access pricing in both states of nature (i.e., when it is relatively efficient or inefficient).\(^5\) Taking the limit as \( \Delta \to 0 \) in (14) yields

\[
\frac{\phi}{B} \left[ \frac{A - x}{2} \right]^2 = \frac{1}{B} \left[ \frac{A - x}{(n+1)} \right]^2.
\]

Simplifying and solving for the critical value of \( \phi \) in (15) yields

\[
(16) \quad \phi = \left[ \frac{2}{n + 1} \right]^2 = \left[ \frac{2}{(n-1) + 2} \right]^2.
\]

We record this result formally in the following proposition.

**Proposition 4.** When demand is linear of the form, \( P(Q) = A - BQ \), and \( \Delta \) is sufficiently “small,” the risk-neutral, vertically-integrated provider strictly prefers \( \forall = 1 \) to \( \forall = 0 \) when \( \phi > \phi \).

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\(^5\) This convention facilitates the comparison of profits levels across different market structures.
To provide some intuition for Proposition 4, it is instructive to evaluate (16) for different values of \((n-1)\). In the monopoly case, \((n-1) = 0\) and \(\phi = 1\). In the competitive case, \((n - 1) \to \infty\) and \(\phi = 0\). More generally, \(\frac{d\phi}{d(n-1)} < 0\). The profits of the vertically-integrated provider under marginal cost access pricing are inversely related to the number of independent rivals in the downstream market, \(ceteris paribus\). This implies that the profit increment realized by the relatively efficient vertically-integrated provider under the ECPR \(vis-\a-vis\) marginal cost access pricing is increasing in the number of independent rivals, \(ceteris paribus\). It follows that the critical probability of relative efficiency (\(\phi\)) is decreasing in the number of independent rivals, \(ceteris paribus\). In other words, the lower the vertically-integrated provider’s profits under marginal cost access pricing, the less risk it bears under the ECPR.

The above result has possible implications for the strategies of the various parties in the regulatory proceedings to implement the 1996 Telecommunications Act. Recall that a number of the incumbent local exchange carriers publicly endorsed the ECPR for the pricing of unbundled network elements. A revealed preference argument would suggest that these firms believe incumbency confers an efficiency advantage and/or that the number of entrants (independent rivals) in the market for local telephone service is likely to be “large” in equilibrium. Neither of these propositions is axiomatic.

5. Conclusion

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6 Recall that \((n-1)\) is the number of identical, independent rivals in the downstream market. Hence, varying \((n-1)\) allows for the examination of different market structures.

7 See note 1 infra.
This paper examines whether vertically-integrated providers with a monopoly in the upstream access market should necessarily prefer the ECPR to marginal cost pricing of access when opportunity costs are “market determined.” A relatively efficient (respectively, inefficient) vertically-integrated provider earns higher (respectively, lower) profits under the ECPR in comparison with marginal cost pricing of access. There is no reason to believe a priori that the vertically-integrated provider is necessarily more efficient than its rivals. It follows that when there is uncertainty over relative efficiency the vertically-integrated provider bears greater risk under the ECPR in comparison with marginal cost access pricing.

A strict preference for the ECPR is therefore somewhat puzzling given that depending on relative efficiency the vertically-integrated provider earns either monopoly profits or competitive profits in equilibrium. It is in this sense that the ECPR may be either “friend or foe.”

In closing, it is instructive to note the limitations of this analysis and possible directions for future research. One outstanding question concerns whether these findings would likely endure in a Bertrand game. A cursory analysis leads to the conjecture that they would not. Also, in the static game modeled here, the access price and retail price are set simultaneously. It would be interesting to explore the properties of a dynamic game in which access prices are set on the basis of retail prices in the prior period. This structure may more closely approximate the mechanics of the ECPR in a real-world setting.

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8 On May 13, 2002 in Verizon et al v. FCC et al, the U.S. Supreme Court ruled that the Federal Communications Commission was operating within the bounds of its statutory authority when it rejected the ECPR for the pricing of unbundled network elements.
References


www.fcc.gov/Bureaus/Common_Carrier/in-region_applications/.