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Incentives for Discrimination when Upstream Monopolists Participate in Downstream Markets*

DENNIS L. WEISMAN
Kansas State University,
Department of Economics, Waters Hall, Manhattan, KS 66506-4001
E-mail: weisman@ksu.edu

JAESUNG KANG
Kansas State University,
Department of Economics, Waters Hall, Manhattan, KS 66506-4001
E-mail: jsk5068@ksu.edu

Abstract
A regulated upstream monopolist supplies an essential input to firms in a downstream market. If an upstream monopolist vertically integrates downstream, non-price discrimination becomes a concern. Discrimination always arises in equilibrium when the vertically integrated provider (VIP) is no less efficient than its rivals in the downstream market, but it does not always arise when the VIP is less efficient than its rivals. Numerical simulations that parameterize the regulator's ability to monitor discrimination in the case of long-distance telephone service in the U.S. reveal that pronounced efficiency differentials are required for the incentive to discriminate not to arise in equilibrium.

1. Introduction

In network industries such as telecommunications, electric power, and natural gas, 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*.[1] 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

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1 There is a voluminous literature on access pricing. See, for example, Laffont et al. (1998), Laffont and Tirole (1996), Armstrong et al. (1996), Baumol and Sidak (1994) and Kahn and Taylor (1994).

termination of long-distance messages. In electricity markets, competition in generation requires access to the transmission and distribution networks of regional power companies.

There is growing interest among policymakers in substituting competition for regulation in traditional utility-like industries. This process entails *network unbundling* and the prospective relaxation of prohibitions that may restrict upstream suppliers of essential access services from competing in downstream competitive markets.[2] The 1996 Telecommunications Act and The Energy Policy Act of 1992 are legislative initiatives along these lines.

The degree to which efficiency gains can be realized from vertical integration in network industries is the subject of considerable debate. While there is some evidence of vertical-integration economies in electric power (Kwoka 1996), the evidence in telecommunications is decidedly mixed (Nadiri and Nandi 1997; Evans and Heckman 1988; Charnes et al. 1988). A potential downside to vertical integration is the prospect that the vertically-integrated provider (VIP) will engage in non-price discrimination or sabotage against independent downstream rivals. Discrimination occurs when the VIP raises its rivals' costs through illicit acts of sabotage or ''foot-dragging'' in the provision of essential access services (Krattenmaker and Salop 1986; Salop and Scheffman 1983).

The possibility that VIPs will engage in discriminatory behavior is of genuine concern to policymakers and has contributed to highly contentious regulatory proceedings.[3] In point of fact, with the exception of Verizon (formerly Bell Atlantic) in New York and SBC in Texas, Oklahoma and Kansas, the FCC has summarily rejected the petitions of the Regional Bell Operating Companies (RBOCs) to enter the interLATA long-distance market under the provisions of the 1996 Telecommunications Act,[4] albeit on grounds not directly related to the discrimination issue.[5] Similar concerns in the electric power industry have triggered a comprehensive review of codes of business conduct (Kahn 1998).

It is well known that when the VIP is no less efficient than the independent rivals in a

2 Network unbundling refers generally to the practice of partitioning retail services into individual network elements and leasing these elements to would-be entrants at prices determined by the regulatory authority. In theory, this practice encourages competition by substantially reducing the sunk costs of entry.

3 In a related context, Microsoft and Intel are alleged to have engaged in exclusionary behavior in downstream markets (Internet browsers and graphic subsystems) through their monopoly control over an input essential to downstream production (operating systems and microprocessors). See *U.S. v. Microsoft* (1998) and *Intergraph Corp. v. Intel Corp.* (1998).

4 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 not between LATAs in their own territories. The regulatory debate has focused, in part, on whether RBOC entry would contribute to or detract from the competitiveness of this market segment. See Weisman (1995) and Sibley and Weisman (1998A) for an historical account of the discrimination issue in the telecommunications industry.

5 The RBOCs may petition for entry into the (in-region) interLATA long-distance market under section 271 of the 1996 Telecommunications Act once they have satisfied a 14-point competitive checklist and their entry is deemed to satisfy a *public interest* standard. The discrimination issue is one of a myriad of issues that policy makers must examine in determining the conditions under which this public interest standard is satisfied. In addition, regulators may have held up the RBOCs from entering the interLATA long-

Cournot model, the incentive to discriminate always exists in equilibrium. Moreover, Economides (1998) claims that the incentive to discriminate is independent of the relative efficiency of the VIP and the independent rivals. We refute this claim in the analysis that follows.[6]

We construct a simple Cournot model using linear market demand to investigate the incentives of a VIP with a monopoly in the upstream access market to engage in discriminatory behavior downstream. The analysis reveals that the efficiency superiority of the independent rivals must be pronounced in order for the VIP's incentive to discriminate not to arise in equilibrium. These findings suggest that concerns about discriminatory behavior in network industries may well be justified.

The format for the remainder of this paper is as follows. Section 2 introduces the notation and presents the basic structure of the model. The primary findings concerning the VIP's incentive to discriminate are provided in section 3. These findings are then applied in section 4 to conduct numerical simulations to evaluate incentives for discrimination in the interLATA long-distance market. The conclusions and policy implications are contained in the final section.

2. Structure of the Model

There is assumed to be a single VIP of both the essential upstream access service and the downstream service.[7] There are also assumed to be $n-1$ identical downstream independent rivals of the VIP, where the integer $n \geq 2$. Production of the downstream service is of the fixed-coefficient type. Each unit of downstream output requires one unit each of access and a complementary input that may be self-supplied by an independent rival. The regulated price and marginal cost of access are w and c, respectively. The per unit cost of the complementary input is s^i, where $s^i > 0$ and $i = V$ and I denotes the VIP and the representative independent downstream rival, respectively.

We assume throughout the analysis that inverse market demand is linear of the form $P(Q) = A - BQ$, where $Q = q^V + (n-1)q^I$ is market demand, q^V and q^I represent the output of the VIP and the independent rival, respectively. The profit function for the VIP is given by

$$\pi^V = (w-c)(n-1)q^I + [P(Q) - c - s^V]q^V. \tag{1}$$

The profit function for the representative independent rival is given by

distance market in order to provide them with the requisite incentives to "cooperate" with new entrants in local exchange markets. In other words, interLATA entry is the *quid pro quo* for the RBOCs' opening their local exchange networks to new entrants.

6 See Mandy (2000) for a comprehensive analysis of this issue. See also Sibley and Weisman (1998B), Weisman (1995, 1998) and Reiffen (1998).

7 For example, in many regions the RBOCs are monopoly providers of access services and would-be entrants in the market for interLATA long-distance telephone service.

$$\pi^I = [P(Q) - w - s^I]q^I. \tag{2}$$

The Cournot-Nash equilibrium output levels are given by

$$q^V = \frac{1}{(n+1)B}\left[A - n(c + s^V) + (n-1)(w + s^I)\right], \tag{3}$$

and

$$q^I = \frac{1}{(n+1)B}\left[A - 2s^I + s^V - 2w + c\right]. \tag{4}$$

3. Primary Findings

To determine whether the VIP has incentives to discriminate, we examine whether raising rivals' costs leads to increased profits for the VIP. The first proposition establishes the shape of the VIP's profit function. This provides the requisite foundation for the formal analysis that follows.

Proposition 1: *When inverse market demand is linear of the form, $P(Q) = A - BQ$, π^V is a convex function of s^I that takes on a global minimum at $s^I_n = \frac{ns^V - A - c + 2w}{n-1}$.*

Proof: Substituting (3) and (4) into the expression for inverse market demand, we obtain

$$P(Q) = \frac{1}{(n+1)}\left[A + (n-1)(w + s^I) + (c + s^V)\right]. \tag{5}$$

The VIP's profit function is thus given by

$$\pi^V(s^I) = \frac{[n-1][w-c][A - 2(w + s^I) + (c + s^V)]}{B(n+1)} + \frac{1}{B}\left[\frac{A + (n-1)(w + s^I) - n(c + s^V)}{n+1}\right]^2.[8] \tag{6}$$

The first and second derivatives of the VIP's profit function with respect to s^I are given, respectively, by

$$\frac{\partial \pi^V}{\partial s^I} = \frac{2(n-1)}{(n+1)^2 B}\left[A + c - ns^V - 2w + (n-1)s^I\right], \tag{7}$$

8 Strictly speaking, π^V is a function of w, c, n, s^V and s^I. For notational simplicity, we suppress all other variables except for s^I.

and

$$\frac{\partial^2 \pi^V}{\partial s^{I^2}} = \frac{2}{B}\left(\frac{n-1}{n+1}\right)^2 > 0. \tag{8}$$

The result follows immediately from (7) and (8). ■

Proposition 1 indicates that, holding s^V fixed for given values of $w > c$ and $n \geq 2$ and assuming $s_n^I > 0$, the VIP's profit function can be illustrated as shown in figure 1.[9] It is immediate from figure 1 that for $s^I > s_n^I$ the profit function is increasing in s^I. Conversely, for $s^I < s_n^I$, the profit function is decreasing in s^I.

Let δ denote the maximum percentage distortion in the independent rival's complementary cost that the VIP can affect without certain detection by the regulator.[10,11] It follows that the VIP is indifferent between discrimination and non-discrimination when $\pi^V(s^I) = \pi^V((1+\delta)s^I)$. This profit equivalence across non-discrimination and discrimination outcomes occurs only when $s^I < s_n^I$ since any small amount of discrimination enhances the VIP's profit when $s^I \geq s_n^I$. Define the critical value of s^I for any $\delta > 0$ by $s_c^I(\delta)$, where $s_c^I(\delta)$ is the implicit function that satisfies

$$\pi^V(s_c^I(\delta)) \equiv \pi^V((1+\delta)s_c^I(\delta)). \tag{9}$$

It is immediate that if $s_c^I(\delta)$ exists, then $s_c^I(\delta) < s_n^I$.[12] Given that the VIP's profit function is strictly convex in s^I, the VIP's optimum is determined by a simple comparison of the VIP's profits at s^I and $(1+\delta)s^I$. In other words, given the rival's complementary cost (s^I) and discrimination threshold (δ), the VIP discriminates iff

$$\pi^V(s^I) < \pi^V((1+\delta)s^I). \tag{10}$$

9 The sign of s_n^I depends on specific parameter values. It is assumed here solely for purposes of illustration that $s_n^I > 0$ and thus $ns^V - A - c + 2w > 0$. If $s_n^I \leq 0$, the incentive to discriminate always exists in equilibrium. See note 20 for an example.

10 For example, when $s^I = 1$ and $\delta = 0.2$, the VIP can increase the independent rivals' complementary input costs by at most 20% to $s^I = 1.2$ without detection by the regulator.

11 The VIP is assumed to face the ''death penalty'' if discrimination is detected. This implies that the ''regulatory costs'' of discrimination are identically zero for any level of discrimination less than or equal to δ and equal to the VIP's downstream profit for any level of discrimination greater than δ. For example, under section 271(d)(6)(A) of the 1996 Telecommunications Act, the regulator can ''suspend or revoke'' the RBOC's authority to provide interLATA long-distance service if the RBOC ''has ceased to meet any of the conditions required for'' interLATA entry. It is straightforward to show that this penalty is sufficient to deter discrimination. To wit, if the RBOC is not allowed to participate downstream, its profits are comprised exclusively of access profits since $q^V = 0$. Discrimination against rivals under these conditions would serve only to reduce q^I and hence access profits. Consequently, the RBOC has no incentive to discriminate when it does not participate in the downstream market. We are grateful to an anonymous referee for this observation.

12 It is straightforward to show that $s_c^I > 0$ when $s_n^I > 0$. See (12) and note 9.

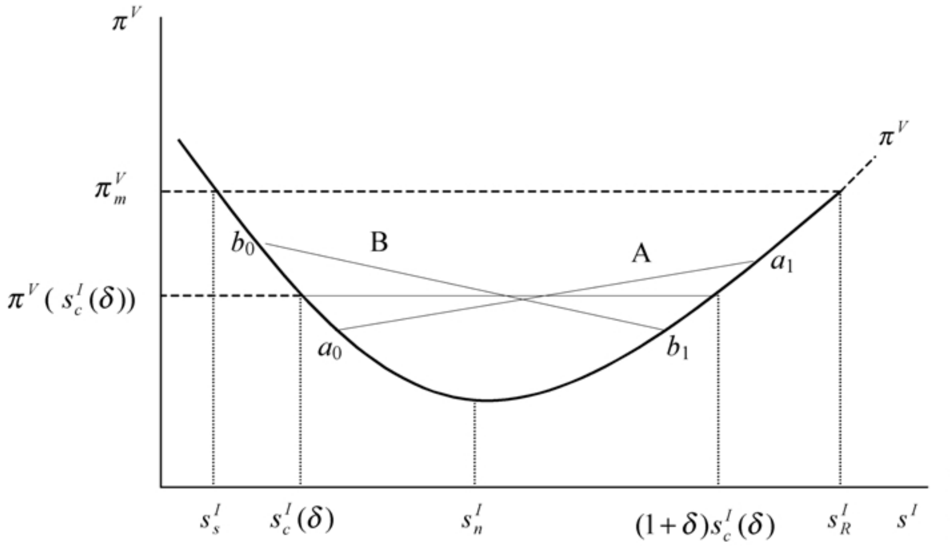

Figure 1. Conditions for non-discrimination under convex profit function.

Proposition 2: *For linear market demand and* $\delta > 0$, *the VIP has no incentive to discriminate against its rivals iff* $s^I \leq s^I_c(\delta)$.

Proof: If $s^I \leq s^I_c(\delta)$, then $(1+\delta)s^I \leq (1+\delta)s^I_c$. Proposition 1 implies that $(1+\delta)s^I$ lies on either the non-increasing or increasing segment of π^V. If $(1+\delta)s^I$ lies on the non-increasing segment of π^V, it is immediate that $\pi^V(s^I) \geq \pi^V((1+\delta)s^I)$ and hence there is no incentive to discriminate. If $(1+\delta)s^I$ lies on the increasing segment of π^V, then $(1+\delta)s^I \leq (1+\delta)s^I_c$ implies that (i) $\pi^V((1+\delta)s^I) \leq \pi^V((1+\delta)s^I_c)$. Also, $s^I \leq s^I_c(\delta)$ implies that (ii) $\pi^V(s^I) \geq \pi^V(s^I_c)$. It follows from (i) and (ii) that $\pi^V(s^I) \geq \pi^V((1+\delta)s^I)$ since $\pi^V(s^I_c) = \pi^V((1+\delta)s^I_c)$ by the definition of s^I_c and hence there is no incentive to discriminate. Similar arguments establish necessity. ■

This result can be seen with the aid of figure 1. The secant line A illustrates a representative case where $s^I > s^I_c(\delta)$. Moving from left to right in figure 1, the VIP is able to conceal a level of discrimination sufficient to move it down and then back up the profit hill above $\pi^V(s^I_c(\delta))$ to $\pi^V((1+\delta)s^I)$. The VIP's profit with no distortion in the rival's cost (at point a_0) is lower than the profit with distortion (at point a_1). The secant line B illustrates a representative case where $s^I \leq s^I_c(\delta)$. The VIP's profit with no distortion (at point b_0) is greater than the profit with distortion (at point b_1). Consequently, the VIP will not find discrimination to be profitable whenever $s^I \leq s^I_c(\delta)$. In other words, when the secant line is upward sloping, the VIP has an incentive to discriminate. Conversely, when the secant line is not upward sloping, the VIP has no incentive to discriminate.

The result in Proposition 2 is intuitive and suggests that the experience of the independent rivals in the downstream market may confer an efficiency advantage (learning by doing) that the VIP (and access supplier) will not wish to distort. In other words, the more efficient the independent rival, the larger its output and hence the greater its demand for upstream access services, *ceteris paribus*. For the ''sufficiently-inept'' VIP, the efficient independent rival represents the proverbial goose that lays the golden egg, where the ''golden egg'' refers to access volumes.

Recognize that when either δ or s^I is sufficiently large that $(1+\delta)s^I$ is greater than the minimum value of s^I that forecloses the independent rivals, $\pi^V((1+\delta)s^I)$ is no longer the relevant benchmark for the profit comparison. In this case, the VIP's maximum feasible level of discrimination is restricted to $s_R^I/s^I - 1$ where $s_R^I = \min\{s^I : q^I = 0 | w, c, n, s^V\}$ and monopoly profit $(\pi_m^V(s_R^I))$ is the highest possible profit with discrimination.[13] Hence, the maximum feasible level of discrimination for the VIP is given by $\min\{\delta, s_R^I/s^I - 1\}$.

The limiting case of a ''large'' δ corresponds to one in which the regulator has no ability to detect the VIP's discrimination behavior. As shown in figure 1, there exist two values of s^I that yield monopoly profit for the VIP, one of which is s_R^I. Let s_s^I denote the critical value of s^I that yields the same profit for the VIP that it would realize if it were a monopolist. The formal definition of s_s^I is given by

$$s_s^I = \min\{s^I : \pi^V(s^I) = \pi_m^V | w, c, n, s^V\}.^{14} \tag{11}$$

As δ becomes larger, the critical value, s_c^I, decreases and approaches s_s^I. When $\delta \geq (s_R^I/s_s^I - 1)$,[15] $s_c^I \leq s_s^I$ and the VIP's profit for $s_c^I < s^I \leq s_s^I$ is greater than its monopoly profit (π_m^V). In this case, s_c^I no longer functions as a critical value to delineate non-discrimination and discrimination outcomes. Instead, s_s^I plays the role of the critical value. Note that s_s^I is identical to s_c^I defined for a given δ that yields $s_R^I/s_s^I - 1$. Hence, the case of non-detection by the regulator is just a special case where δ is sufficiently large.

For the purpose of simulating the critical value of s_c^I in the next section, we define the critical value explicitly in terms of parameters for linear market demand. This is provided in the following proposition.

Proposition 3: *For inverse linear market demand of the form $P(Q) = A - BQ$, the critical value of s_c^I that delineates the VIP's incentive for non-discrimination is defined by*

$$s_c^I = \frac{2(ns^V - A - c + 2w)}{(n-1)(2+\delta)}. \tag{12}$$

Proof: The VIP's profit function without discrimination is given by (6). The VIP's profit function with the maximum concealable level of discrimination (δ) is given by

13 We assume that s_R^I lies on the increasing portion of the VIP's profit function. If s_R^I lies on the decreasing portion of the VIP's profit function, the VIP would never have an incentive to discriminate because the VIP's profit is monotonically decreasing in the relevant range of s^I. See section 4 for an example.

14 The sign of s_s^I depends on specific parameter values. In figure 1, s_s^I is assumed to be positive for purposes of illustration.

15 The expression, $s_R^I/s_s^I - 1$, represents the level of discrimination that satisfies $(1+\delta)s_s^I = s_R^I$. This is the maximum level of discrimination that equalizes the VIP's profit with and without discrimination for a given parameter set.

$$\pi^V((1+\delta)s^I) = \frac{[n-1][w-c][A-2[w+(1+\delta)s^I]+(c+s^V)]}{B(n+1)} + \frac{1}{B}\left[\frac{A+(n-1)[w+(1+\delta)s^I]-n(c+s^V)}{n+1}\right]^2. \tag{13}$$

Appealing to the definition of s_c^I in (9) and solving for s^I yields the result in (12). ■

Propositions 2 and 3 provide simple criteria to determine whether the VIP has an incentive to discriminate (respectively, not discriminate) by comparing the rival's actual level of complementary cost with the value, $s_c^I(\delta)$, once the discrimination threshold (δ) and the other parameters are specified.

The final issue to address in this section concerns whether there exists an efficiency differential sufficiently large such that (i) the VIP participates in the downstream market; and (ii) the VIP has no incentive to discriminate against its independent rivals in equilibrium. Setting $q^V > 0$ in (3) yields the VIP's market participation condition, or

$$s^I > \frac{n(c+s^V)+w(1-n)-A}{n-1} = s_f^I. \tag{14}$$

Hence, s_f^I represents the value of the independent rivals' complementary cost that just chokes off the VIP's participation in the downstream market.

In order to show that the VIP participates in the downstream market and yet has no incentive to discriminate, we must establish that there exists an s^I, such that $\max\{0, s_f^I\} < s^I \leq s_c^I$. This condition has an intuitive economic interpretation. The VIP must be sufficiently inept to foster a dependence on the independent rivals (for generating access volumes), but not so inept that it voluntarily retreats from the downstream market altogether. The sign of $(s_c^I - s_f^I)$ is ambiguous in general. The following example demonstrates the existence of an s^I such that $\max\{0, s_f^I\} < s^I \leq s_c^I$.

Example 1: *Let* $A = 18, B = 2, n = 10, w = 5, c = 1, s^V = 7, s^I = 3.5$ *and* $\delta = 0.1$. *For this set of parameters, it is straightforward to show using (12) and (14) that* $s_c^I = 6.5$ *and* $s_f^I = 1.9$. *Hence, this example satisfies* $\max\{0, s_f^I\} < s^I \leq s_c^I$. *This result can be verified directly by using (3)–(6) and (13). These imply that* $q^V = 0.66$, $q^I = 0.41$, $P = 9.32$, *and* $\pi^V(s^I) = 15.6 > 14.9 = \pi^V((1+\delta)s^I)$. *Hence, the VIP participates in the downstream market and yet has no incentive to discriminate in equilibrium.*

4. Numerical Simulations

In this section, we apply the theoretical results derived in section 3 to construct numerical simulations to critically evaluate the incentives for the RBOC to engage in discrimination should it be allowed to enter the interLATA long-distance market.[16] These simulations are

16 See Hinton (1998) for an analysis of the welfare effects of RBOC entry into the interLATA market.

based on current market data and plausible input parameters. Nonetheless, as with any highly stylized model, these results should be regarded as suggestive rather than conclusive.

We begin by calibrating linear inverse demand functions of the form, $P(Q) = A - BQ$, for interLATA long-distance telephone service, where Q is measured in billions of minutes, and P is measured in cents per minute.[17] Also, $c = 1¢$,[18] and $s^V = 2¢$, 4.5¢, and 7¢, respectively.[19] We use equation (12) in Proposition 3 to compute the critical values of the rivals' complementary costs (s_c^I) that delineate non-discrimination and discrimination outcomes. Tables 1–3 provide the ratio of s_c^I to s^V that corresponds to maximum concealable levels of discrimination of 10%, 25% and 50%, respectively.[20]

To illustrate the mechanics, consider table 2B which corresponds to $\delta = 0.25$, and

Table 1. The Critical Ratios of s_c^I to s^V for Non-Discrimination Outcomes ($\delta = 0.1$)

$\varepsilon = -0.7$	A											
s^V	2				4.5				7			
w *n*	3	5	7	9	3	5	7	9	3	5	7	9
2	—	—	—	—	—	—	0.27	0.44	—	0.38	0.57	0.67
4	—	—	—	—	—	0.15	0.42	0.55	0.09	0.52	0.66	0.74
6	—	—	—	0.14	—	0.36	0.56	0.66	0.36	0.66	0.75	0.80
8	—	—	0.18	0.37	0.19	0.57	0.70	0.76	0.63	0.79	0.85	0.87
10	—	0.27	0.50	0.61	0.61	0.78	0.84	0.87	0.90	0.93	0.94	0.94
$\varepsilon = -0.89$	B											
s^V	2				4.5				7			
w *n*	3	5	7	9	3	5	7	9	3	5	7	9
2	—	—	—	—	—	0.11	0.39	0.53	0.04	0.50	0.65	0.73
4	—	—	—	0.10	—	0.32	0.53	0.64	0.32	0.63	0.74	0.79
6	—	—	0.13	0.34	0.12	0.54	0.68	0.74	0.59	0.77	0.83	0.86
8	—	0.20	0.45	0.57	0.54	0.75	0.82	0.85	0.86	0.91	0.92	0.93
10	0.39	0.67	0.77	0.81	0.98	0.98	0.98	0.98	0.81	0.81	0.81	0.81

17 The demand function specification assumes that the price elasticity (ε) is equal to -0.7 (Taylor 1994, p. 143) and -0.89 (Ward 1999, p. 664) when $P = 11¢$ (FCC, 1999, table 14.5) and $Q = 344.5$ (FCC, 1999, table 2.6).

18 Kahn and Tardiff (1998, p. 13 and note 11).

19 Hubbard and Lehr (1998, p. 129) suggest a range of 5¢ to 8¢. Kahn and Tardiff (1998, pp. 14–16 and note 12) suggest a range of between 1¢ and 2¢ at the low end and between 6¢ and 7¢ at the high end.

20 For some parameter sets in tables 1–3, $s_n^I < 0$ (consequently $s_c^I < 0$) and thus the critical values for non-discrimination do not exist. In other words, for these parameter sets, the RBOC always has an incentive to discriminate.

Table 2. The Critical Ratios of s_c^I to s^V for Non-Discrimination Outcomes ($\delta = 0.25$)

$\varepsilon = -0.7$	A											
s^V	2				4.5				7			
w \ n	3	5	7	9	3	5	7	9	3	5	7	9
2	—	—	—	—	—	—	0.26	0.41	—	0.36	0.54	0.62
4	—	—	—	—	—	0.14	0.39	0.51	0.08	0.49	0.62	0.69
6	—	—	—	0.13	—	0.34	0.52	0.61	0.34	0.61	0.70	0.75
8	—	—	0.17	0.35	0.18	0.53	0.65	0.71	0.59	0.74	0.79	0.81
10	—	0.25	0.47	0.57	0.57	0.73	0.78	0.81	0.85	0.90	0.91	0.92

$\varepsilon = -0.89$	B											
s^V	2				4.5				7			
w \ n	3	5	7	9	3	5	7	9	3	5	7	9
2	—	—	—	—	—	0.11	0.37	0.50	0.04	0.46	0.61	0.68
4	—	—	—	0.09	—	0.30	0.50	0.60	0.29	0.59	0.69	0.74
6	—	—	0.12	0.31	0.11	0.50	0.63	0.69	0.55	0.72	0.78	0.80
8	—	0.18	0.42	0.54	0.51	0.70	0.76	0.79	0.80	0.85	0.86	0.87
10	0.36	0.63	0.71	0.76	0.98	0.98	0.98	0.98	0.81	0.81	0.81	0.81

Table 3. The Critical Ratios of s_c^I to s^V for Non-Discrimination Outcomes ($\delta = 0.5$)

$\varepsilon = -0.7$	A											
s^V	2				4.5				7			
w \ n	3	5	7	9	3	5	7	9	3	5	7	9
2	—	—	—	—	—	—	0.23	0.37	—	0.32	0.48	0.56
4	—	—	—	—	—	0.12	0.35	0.46	0.07	0.44	0.56	0.62
6	—	—	—	0.11	—	0.30	0.47	0.55	0.30	0.55	0.63	0.68
8	—	—	0.15	0.31	0.16	0.48	0.59	0.64	0.53	0.67	0.71	0.73
10	—	0.23	0.42	0.51	0.51	0.66	0.70	0.73	0.85	0.90	0.91	0.92

$\varepsilon = -0.89$	B											
s^V	2				4.5				7			
w \ n	3	5	7	9	3	5	7	9	3	5	7	9
2	—	—	—	—	—	0.10	0.33	0.45	0.04	0.42	0.55	0.61
4	—	—	—	0.08	—	0.27	0.45	0.54	0.27	0.53	0.62	0.67
6	—	—	0.11	0.28	0.10	0.45	0.57	0.63	0.49	0.65	0.70	0.72
8	—	0.16	0.38	0.48	0.46	0.63	0.69	0.71	0.72	0.76	0.77	0.78
10	0.33	0.56	0.64	0.68	0.98	0.98	0.98	0.98	0.81	0.81	0.81	0.81

$\varepsilon = -0.89$. Identify the cell that corresponds to $s^V = 4.5¢$, $w = 6¢$ and $n = 7$. For this parameter set, the value for s_c^I is $2.84¢$ and the ratio of s_c^I to s^V is 0.63. This ratio indicates that the independent rivals must have complementary input costs at least 37% lower than those of the RBOC in order for the incentive to discriminate not to arise in equilibrium when the RBOC can raise its rivals' cost by no more than 25% without being detected by the regulator.[21,22] For $s^I = 2.84¢$, the RBOC can raise its rivals' costs to $s^I = 3.55¢$ without detection by the regulator. This level of discrimination is insufficient to generate a level of profit greater than that which the RBOC realizes when it does not discriminate. Hence, for $s^I \leq 2.84¢$ the RBOC will not have an incentive to discriminate in equilibrium. The corresponding critical ratios of s_c^I to s^V for $\delta = 0.1$ and $\delta = 0.5$ are provided in tables 1B and 3B and are given by 0.68 and 0.57, respectively.

Four key observations follow directly from these simulations. First, the incentive to discriminate is decreasing with the regulator's ability to detect discrimination (i.e., a smaller δ), *ceteris paribus*. Second, the incentive to discriminate is decreasing in the market elasticity, *ceteris paribus*. This occurs because a higher market elasticity, *ceteris paribus*, gives rise to a lower equilibrium downstream price which, in turn, reduces the profitability of the downstream market relative to the upstream market. Third, the incentive to discriminate is decreasing in the level of the access charge, *ceteris paribus*. This occurs because higher access charges raise the opportunity cost of discrimination for the VIP. This finding suggests that a policy of reducing access charges when the regulator's ability to detect discrimination is highly imperfect may well have adverse welfare consequences. Fourth, the incentive to discriminate is decreasing in *n, ceteris paribus*. This occurs because higher values of *n, ceteris paribus*, imply a lower equilibrium downstream price which, in turn, reduces the profitability of the downstream market relative to the upstream market. This finding suggests that the acquisition of an independent rival by an RBOC can be expected to exacerbate the incentive for discrimination, *ceteris paribus*. This is particularly noteworthy given the recent consolidation trend in the telecommunications industry.

The shaded cells in tables 1B, 2B and 3B represent the parameter sets for which the rivals' foreclosure occurs on the decreasing portion of π^V, specifically at $s_R^I = s_s^I$. For these parameter sets, the rivals retreat from the downstream market when their complementary costs become greater than $s_s^I (= s_R^I)$. The only relevant range of s^I for the rivals to participate in the downstream market is $0 < s^I \leq s_s^I$ in figure 1. In this range, the RBOC's profit is monotonically decreasing with the rivals' cost. Hence, the RBOC's incentive to discriminate does not arise in these cases.[23]

21 Alternatively, suppose the RBOC is forced to purchase the complementary input (e.g., interLATA transport) from a rival (interexchange carrier). The incentive to discriminate will not arise in equilibrium when the market power for interLATA transport is sufficiently pronounced—a mark-up greater than 58% in this example.

22 Depending on the particular parameter set, the VIP will retreat from the downstream market when the independent rivals' efficiency superiority is sufficiently large.

23 The values in these shaded cells are the ratios of s_R^I to s^V. By letting $q^I = 0$, we obtain $s_R^I = \frac{1}{2}(A + c + s^V - 2w)$ which is independent of the size of n. Hence, the critical ratios for these parameter sets do not vary with n.

Table 4. The Critical Ratios of s_c^I to s^V for Non-Discrimination Outcomes Under No Regulator Detection ($\delta = s_R^I/s_s^I - 1$)

$\varepsilon = -0.7$					A							
s^V	2				4.5				7			
w n	3	5	7	9	3	5	7	9	3	5	7	9
2	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	0.07
8	—	—	—	—	—	—	—	—	—	0.33	0.44	0.49
10	—	—	—	—	—	0.29	0.40	0.46	0.85	0.90	0.91	0.92
$\varepsilon = -0.89$					B							
s^V	2				4.5				7			
w n	3	5	7	9	3	5	7	9	3	5	7	9
2	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	0.23	0.36	0.43
8	—	—	—	—	—	0.14	0.29	0.36	0.71	0.81	0.84	0.85
10	—	—	0.02	0.12	0.98	0.98	0.98	0.98	0.81	0.81	0.81	0.81

The shaded cells in tables 2A and 3A represent parameter sets for which $s_c^I < s_s^I$. In these cases, s_c^I no longer functions as a critical value to delineate the RBOC's non-discriminatory behavior. Recall that s_s^I serves as the critical value for discrimination when $\delta \geq (s_R^I/s_s^I - 1)$ as discussed in section 3. As an example, consider table 2A with $s^V = 7¢$, $w = 10¢$ and $n = 7$. For this parameter set, $s_R^I = 7.36¢$, $s_s^I = 6.4¢$ and $s_c^I = 6.12¢$. The ratio of s_s^I to s^V is 0.91 as shown in the table. The maximum feasible amount of discrimination that equalizes the RBOC's profit with and without discrimination is computed to be 0.15, which is less than the assumed maximum amount of concealable discrimination of $\delta = 0.25$. This implies that when $\delta \geq (s_R^I/s_s^I - 1)$, s_c^I is not well-defined and the critical value for non-discrimination reduces to s_s^I for all $\delta \geq (s_R^I/s_s^I - 1)$. The values in these shaded cells are identical to the ratios of s_c^I to s^V when evaluated at $\delta = (s_R^I/s_s^I - 1)$.[24] To summarize, when w and s^V are ''large'', a relatively modest degree of efficiency superiority on the part of independent rivals is sufficient to generate a non-discrimination outcome.

The case where $\delta \geq (s_R^I/s_s^I - 1)$ corresponds to a regulatory environment in which the regulator's ability to detect discrimination is so weak that δ is non-binding. In other words, foreclosure of the rival occurs before the regulator detects discrimination. Table 4 provides

24 For example, if we set $\delta = 0.15$ in this example, the critical value of s_c^I would be 6.4¢ which is identical to s_s^I.

the critical ratios of s_s^I to s^V for each parameter set in the limiting case of non-detection by the regulator.[25]

In the case of non-detection, the critical values for non-discrimination do not exist for the vast majority of parameter sets simulated. In other words, depending on the parameter sets, there does not exist a non-negative value of s^I for which $\pi^V(s^I) \geq \pi_m^V$. This is illustrated in figure 1 by moving the location of s_s^I to the left of the vertical axis where $s^I \leq 0$. Thus, for any $s^I > 0$, the RBOC can raise its maximal profit to the monopoly profit level through discrimination. This implies that, in the absence of any explicit costs of discrimination, the RBOC will have an incentive to discriminate against its downstream rivals for relatively low access charges. Notably, this includes the current level of access charges.[26]

5. Conclusions and Policy Implications

It is common in network industries for an upstream monopolist to supply an essential input to firms operating in the downstream market. Should the upstream monopolist vertically integrate downstream, the prospect of discriminatory behavior becomes a real concern. This paper derives necessary and sufficient conditions for non-discrimination.

The discrimination issue has received considerable attention in the course of introducing competition in network industries. In the telecommunications industry, for example, the discrimination issue has figured prominently in the ongoing regulatory debate over the merits of RBOC entry into the interLATA long-distance market. A primary concern is that the RBOCs have both the ability and incentive to discriminate against their downstream rivals. This analysis suggests that while the incentives to discriminate are not unequivocal, such concerns are clearly warranted.

More specifically, these findings reveal that when downstream incumbency confers little or no efficiency advantage, the VIP has incentive to discriminate against its rivals. Yet, when independent rivals enjoy a pronounced efficiency advantage, the incentive to discriminate need not arise in equilibrium. The likely source of such a cost advantage is a combination of market experience, weak vertical-integration economies, and market power for the complementary input. Numerical simulations that parameterize the VIP's ability to conceal discrimination from the regulator identify the magnitude of the efficiency differentials required to generate a non-discrimination outcome in the case of interLATA long-distance telephone service in the United States.

These findings present policymakers with something of a dilemma: The incentives to discriminate are most pronounced precisely when the efficiency gains from vertically-integrated supply are likely to be quite large. Prohibiting the VIP from serving the downstream market solves the discrimination problem but runs the risk of foreclosing an efficient provider. Permitting the VIP to serve the downstream market may lead to gains in

25 As shown in note 24, these ratios are identical to the ratios of s_c^I to s^V at the maximum feasible amount of discrimination (i.e., $\delta = s_R^I/s_s^I - 1$).

26 The current level of the interstate access charge is 1.91 cents per minute (FCC, 2000, table 1.2).

productive efficiency but risks allocative efficiency losses from discrimination and exclusion.

As a final observation, we note that these findings give rise to an interesting paradox concerning the incentive to discriminate in that when each side claims superior efficiency it is (actually) pleading the other side's case. In other words, claiming to be a relatively inefficient provider is a dominant strategy!

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