Endogenous Access Charge and Leadership by Vertically Integrated Firms

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Abstract

We investigate how competitive structure between a vertically integrated firm (dominant firm) and a non-integrated firm (new entrant) affects access charge. We consider the situation where access charge (input price) is regulated by the government but the dominant firm affects actual rate through lobbying activity or manipulation of accounting. We find that leadership by the integrated firm in product markets (resp. new entrant) reduces access charge when the integrated firm is as efficient as (resp. highly less efficient than) the new entrant. We also find that vertical separation increases (resp. reduces) access charge when the integrated firm is as efficient as (resp. highly less efficient than) the new entrant.

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1 Introduction

Competition between a firm holding essential facilities (and usually it is a dominant firm) and firms without them are widely observed. Typical examples are overnight delivery, telecommunication, electric power and natural gas distribution industries. Especially in Japanese markets, the dominant firms are not vertically separated in telecommunication, electric power and natural gas distribution industries. They were former legal monopolists and they compete against new entrants after liberalization of these markets.¹ New entrants pay access charge to the dominant firms. The rate of this charge affects the new entrants’ marginal costs; thus it significantly affects the performance of the markets.

The rate of the charge (input price) is usually regulated by the government. Huge literature on the desirable and/or existing rules of access charge such as ECPR (Efficient Component Pricing Rule), TELRIC (Total Element Long Run Incremental Cost), and historical cost approach exist,² and now the charges based on costs of essential facilities are prevailed all over the world. For example, in Japan, TELRIC is adopted in traditional local telecommunication network, and historical cost approach is adopted in optical fiber network, electric power, and natural gas distribution industries. In EU, although detailed rules are different among countries, cost based approach is adopted in most industries and in most countries. In principle, the rule is determined by the government and there is no room for manipulation. In practice, however, firms often affects the access charge through lobbying activity and/or manipulation of accounting costs.³ For example, in Japan integrated gas companies insisted that costs of vaporizers and pumps of LNG (liquidated natural gas) tanks should be included in the base of access charge of gas distribution pipeline.

¹ In Japan liberalization of telecommunication (natural gas distribution, electric power distribution) has begun to in 1985 (1995, 2000). Since then many major and minor changes in the rules of third party access to the essential facilities have been made continuously.


³ For the discussions of these activities in general context of regulation policies, see Viscusi et al (2005).
networks. They made substantial efforts for rationalizing it at the government committee (Gas Energy Committee in the Advisory Committee for Natural Resource and Energy at METI) which determines the rule of access charge accounting. Eventually, they has succeed in persuading the government to adopt it, and the current access charge includes these costs. Similar stories are widely observed in telecommunication and electric power distribution in Japan.

In this paper, we assume that access charge is affected by firms. We formulate a duopoly model where a dominant firm holding essential facility competes against a new entrant (Section 2). First, we consider a model where only a dominant firm engages in lobbying activity. We investigate under what market structure the dominant firm has strong incentives for manipulating it. We consider the following three structures, Cournot, Stackelberg with dominant firm’s leadership (followership). We find that the leadership by the dominant firm yields the lowest access charge (smallest manipulation of the charge) and largest welfare among three if the dominant firm is as efficient as the new entrant. We obtain the inverse result when the dominant firm is highly less efficient than the new entrant (Section 3). Second, we discuss the model where only a new entrant engages in lobbying activity. We find that new entrant’s leadership always yields the lowest access charge (Section 4). Third, we discuss vertical separation. We find that the vertical separation decreases the access charge if the dominant firm is highly less efficient than the new entrant (Section 5).

2 The model

We consider a duopoly model. Firm 1 is a vertically integrated firm holding essential facility, and firm 2 is a new entrant. Firm 2 accesses the essential facility held by firm 1 and pays access charge \( ry_2 \) to firm 1, where \( r \in [0, \bar{r}] \) is per unit access charge and \( y_i \) is firm \( i \)’s output\(^4\).

In the first stage, access charge (input price) \( r \) is determined. Let \( L(r) \) denote firm 1’s effort costs (costs of lobbying activity, manipulation of access charge accounting and so on). In the second

\(^4\) In many countries, the sales and productions departments in the vertically integrated firms pay access charges to their own network departments which hold essential facilities in accounting. However, this accounting system does not affect the optimal outputs in the integrated firms as long as they maximize their joint profits of both departments.
stage, firms produce perfectly homogeneous products for which the market demand function is given by \( p = a - Y \) (price as a function of quantity), where \( Y \) is the total output of duopolists. Firm 2’s production cost (except for access charge) is normalized to zero and firm 1’s marginal production cost is \( c \). If \( c \) is positive (negative), firm 1 is less (more) efficient than firm 1. Let \( y_i \) denote the output of firm \( i \). Firm 1’s profit is \( \pi_1 = (p(Y) - c)y_1 + ry_2 - L(r) \) and firm 2’s profit is \( \pi_2 = (p(Y) - r)y_2 \). We assume that \( L'(r) \geq 0 \) and that \( L''(r) \) is positive and sufficiently large so as to ensure the concavity of firm 1’s payoff function. We assume that \( L'(0) = 0 \) and that \( L'(\bar{r}) \) is sufficiently large so as to ensure the interior solution in the first stage (i.e., the equilibrium \( r \in (0, \bar{r}) \)). We also assume \(-2(a - 2\bar{r}) < c < a/2 \) so as to ensure interior solutions in the second stage (production stage) discussed below.

We consider the following three situations; both firms produce simultaneously (Cournot), firm 2 produces first (Stackelberg with independent firm’s leadership), and firm 1 produces first (Stackelberg with dominant firm’s leadership).

### 3 Second stage competition

#### 3.1 Cournot

Suppose that firms choose their outputs independently. The reaction functions of each firm at the second stage are respectively given by:

\[
R_1(y_2) = \frac{a - c - y_2}{2}, \quad R_2(y_1) = \frac{a - r - y_1}{2}.
\]

The resulting equilibrium outputs and profits are respectively:

\[
y_1^C = \frac{a - 2c + r}{3}, \quad y_2^C = \frac{a - 2r + c}{3}, \quad Y^C = y_1^C + y_2^C = \frac{2a - r - c}{3},
\]

\[
\pi_1^C = \frac{(a - 2c + r)^2}{9} + \frac{r(a - 2r + c)}{3} - L(r), \quad \pi_2^C = \frac{(a - 2r + c)^2}{9}.
\]
where superscript ‘C’ denote the equilibrium outcomes in the Cournot game. The resulting total social surplus (consumer surplus plus profits of firms) is:

\[ W^C = \frac{8a^2 - 2a(r + c) - (r + c)^2}{18} - \frac{c(a - 2c + r)}{3} - L(r). \]  

(4)

3.2 Stackelberg with independent firm’s leadership

Suppose that firm 2 produces and then firm 1 produces after observing firm 2’s output. Given \( y_2 \), \( y_1 \) is given by (1). Firm 2 maximizes its own profit considering that \( y_2 \) affects \( y_1 \). It maximizes \( \pi_2 = (p(R_1(y_2) + y_2) - r)y_2 \) with respect to \( y_2 \). The resulting equilibrium outputs and profits are respectively:

\[
\begin{align*}
  y_1^I &= \frac{a - 3c + 2r}{4}, \\
  y_2^I &= \frac{a - 2r + c}{2}, \\
  Y^I &= \frac{3a - 2r - c}{4}
\end{align*}
\]

(5)

\[
\begin{align*}
  \pi_1^I &= \frac{(a - 3c + 2r)^2}{16} + \frac{r(a - 2r + c)}{2} - L(r), \\
  \pi_2^I &= \frac{(a - 2r + c)^2}{8}
\end{align*}
\]

(6)

where superscript ‘I’ denote the equilibrium outcomes in the Stackelberg game with independent firm’s (firm 2’s) leadership. The resulting total social surplus is:

\[ W^I = \frac{15a^2 - 2a(2r + c) - (2r + c)^2}{32} - \frac{c(a - 3c + 2r)}{4} - L(r). \]

(7)

3.3 Stackelberg with dominant firm’s leadership

Suppose that firm 1 produces and then firm 2 produces after observing firm 1’s output. Given \( y_1 \), \( y_2 \) is given by (1). Firm 1 maximizes its own profit considering that \( y_1 \) affects \( y_2 \). It maximizes \( \pi_1 = p(R_2(y_1) + y_1)y_1 - cy_1 + rR_2(y_1) - L(r) \) with respect to \( y_1 \). The resulting equilibrium outputs and profits are respectively:

\[
\begin{align*}
  y_1^D &= \frac{a - 2c}{2}, \\
  y_2^D &= \frac{a - 2r + 2c}{4}, \\
  Y^D &= \frac{3a - 2r - 2c}{4}
\end{align*}
\]

(8)

\[ ^5 \text{If the lobbying costs are not real social costs but just income transfers from the firm to regulators or lawyers, it might be better not to subtract } L(r) \text{ in (4). All of our results hold true if we do not subtract } L(r) \text{ from (4), (7), (10), (14), (18), and (22), too.} \]
\[ \pi_1^D = \frac{(a-2c)^2}{8} + \frac{r(a-r)}{2} - L(r), \quad \pi_2^D = \frac{(a-2r+c)^2}{16}, \]  

where superscript ‘D’ denote the equilibrium outcomes in the Stackelberg game with dominant firm’s (firm 1’s) leadership. The resulting total social surplus is:

\[ W^D = \frac{15a^2 - 4a(r + c) - 4(r + c)^2}{32} - \frac{c(a - 2c)}{2} - L(r). \]

We note some remarkable points among three games. In the Cournot and the Stackelberg with firm 2’s leadership, the equilibrium outputs are the same as the standard models (without access charge) in which the marginal cost of firm 1 (resp. firm 2) is \( c \) (resp. \( r \)). However, in the Stackelberg with firm 1’s leadership, the equilibrium output is different from the standard model (without access charge). In the standard model without access charge revenue, the equilibrium output of firm 1 is \( \frac{a - 2c + r}{2} \), which is larger than \( y_1^D = \frac{a - 2c}{2} \). We explain the reason. Considering the effect on the access charge revenue, firm 1 chooses \( y_1 \). An increase in \( y_1 \) induces the decrease in \( y_2 \) which is positively related to the access charge revenue of firm 1. Thus firm 1 has a weaker incentive for expanding its output. This is why our model yields the smaller equilibrium output of firm 1 than that in the standard model. In other two models, since \( y_1 \) does not directly affect \( y_2 \), the strategic effect discussed above disappears and then our models yield the same equilibrium outputs as the standard models.\(^6\)

4 Equilibrium access charge

We discuss the first stage action and equilibrium level of access charge in the above three games. Let \( r^C \), \( r^I \), and \( r^D \) respectively denote the equilibrium rate of access charge in the Cournot, in the Stackelberg with firm 2’s leadership, and in the Stackelberg with firm 1’s leadership, respectively.

First, we investigate the relationship between \( c \) and \( r \).

**Proposition 1** (i) \( r^C \) and \( r^I \) are decreasing in \( c \); (ii) \( r^D \) is independent of \( c \).

\(^6\) If we consider price competition model, this kind of strategic effect appears in simultaneous-move game. See Sappington (2005).
We explain the intuition. On the one hand, as the marginal cost of firm 1 (\(c\)) increases, firm 1’s profit from its own production decreases. Given that \(c\) is larger, an increase in \(r\) is less effective on the increase in firm 1’s profit from its own production (strategic effect). That is, when \(c\) is large (resp. small), the strategic effect is weak (resp. strong). The strategic effect is related to the first term of \(\pi_j^1 (j = C, I, D)\) in (3), (6), and (9). On the other hand, as the marginal cost of firm 1 (\(c\)) increases, the output of firm 2 increases. Given that \(c\) is larger, an increase in \(r\) is more effective on the increase in the access charge revenue of firm 1 (input market effect). That is, when \(c\) is large (resp. small), the input market effect is strong (resp. weak). The input market effect is related to the second term of \(\pi_j^1 (j = C, I, D)\) in (3), (6), and (9).

When firm 1 is the leader, it can use its output level as a strategic commitment for controlling firm 2’s output, thus the strategic incentive for manipulating \(r\) does not exist (see the first term of \(\pi_1^D\) in (9)). On the contrary, in the Cournot and the Stackelberg with firm 2’s leadership, firm 1 cannot use its output level as a strategic commitment, thus the strategic value of \(r\) is relatively strong. This is why the strategic effect dominates the input market effect and thus \(r\) is decreasing in \(c\) in the Cournot and the Stackelberg with firm 2’s leadership.

We now present our main results. Since \(r_1^D\) is independent of \(c\) and \(r_1^C\) and \(r_1^I\) are decreasing in \(c\), we guess that \(r_1^D < \min\{r_1^C, r_1^I\}\) when \(c\) is small and \(r_1^D > \max\{r_1^C, r_1^I\}\) when \(c\) is large. Following proposition states that this is true.

**Proposition 2** (i) There exists a threshold value \(c_a\) such that Stackelberg with dominant firm’s leadership yields the lowest access charge if and only if \(c < c_a\), where \(c_a\) is strictly positive; (ii) There exists a threshold value \(c_b\) such that Stackelberg with dominant firm’s leadership yields the highest access charge if and only if \(c > c_b (> c_a)\).

**Proof:** See Appendix.

When \(c \leq 0\) (dominant firm is at least as efficient as the independent firm), the leadership of firm 1 (dominant firm) reduces access charge. On the contrary, when firm 1 is less efficient than
the independent firm, the dominant firm’s leadership increases access charge.

We explain the intuition. In Cournot and Stackelberg with independent firm’s leadership, firm 1 can commit to a larger output by raising the access charge. When firm 1 is highly less efficient than firm 2, firm 1 earns profits more efficiently from access charge than from its own production. Thus, firm 1 strategically reduces the access charge so as to commit to a smaller output, which induces a larger output of firm 2 and larger access charge. When firm 1 is the leader, it can directly commit to its output. Thus, there is no need for using access charge strategically. This is why the leadership by firm 1 yields the highest access charge when \( c \) is large.

Finally, we discuss welfare implications. We compare welfare among three games.

**Proposition 3** (i) Stackelberg with dominant firm’s leadership yields the largest total social surplus if \( c \leq 0 \); (ii) Suppose that \( r \) is given exogenously. Then Stackelberg with dominant firm’s leadership yields the smaller total social surplus than Stackelberg with the independent firm’s leadership if \( c > 0 \);

**Proof:** See Appendix.

The dominant firm’s leadership yields the largest total output if and only if \( c \leq 0 \). And it yields the largest dominant firm’s output and the lowest access charge when \( c \leq 0 \). All of three effects above yield a larger social surplus; thus the dominant firm’s leadership unambiguously yields the largest total surplus when \( c \leq 0 \).

When \( c \) is large, this does not hold true. Suppose that \( r \) is endogenous and \( c \) is sufficiently large. Proposition 3(ii) states that the dominant firm’s leadership is not best when \( r \) is given exogenously. Proposition 2 (ii) states that the dominant firm’s leadership yields the highest access charge, resulting in the loss of social welfare. Thus, the dominant firm’s leadership is not best when \( r \) is endogenously determined.

Welfare implication under small and positive \( c \) is ambiguous. When \( c \) is positive but small, the dominant firm’s leadership yield the smaller total social surplus given \( r \), but it yields a lower access charge. It is ambiguous which effect on welfare is stronger.
5 Manipulation by the independent firm

In this section, we briefly discuss the model where independent firm (firm 2) rather than dominant firm (firm 1) makes lobbying activities. In the Japanese natural gas distribution case mentioned in Introduction, electric power companies (which are new entrants in the gas distribution markets) insisted that vaporizers costs should not be included in the base of access charge of gas distribution pipelines. New entrants failed to persuade it, but this example indicates that new entrants might have a chance for affecting the access charge.\footnote{In Japanese electric power distribution, the rule of access charge has been changed and the rate has been reduced reflecting new entrants’ pressures to the government. The similar event takes place in Japanese telecommunication, too.}

We change the model as follows: In the first stage, access charge $r$ for firm 2 is determined. In the second stage, firms compete in terms of outputs. Firm 1’s profit is $\pi_1 = (p(Y) - c)y_1 + ry_2$ and firm 2’s profit is $\pi_2 = (p(Y) - r)y_2 - L_2(r)$, where $L_2(r)$ is firm 2’s lobbying cost. We assume that $L'_2(r) \leq 0$, $L'_2(\bar{r}) = 0$, $L'_2(0)$ is sufficiently large and $L''_2(r)$ is positive and sufficiently large.

Let $r^{C2}$, $r^{I2}$, and $r^{D2}$ respectively denote the equilibrium rate of access charge in the Cournot, in the Stackelberg with firm 2’s leadership, and in the Stackelberg with firm 1’s leadership when firm 2 manipulates $r$.

**Proposition 4** When firm 2 determines $r$ by lobbying activity, $r^{I2} < r^{C2} < r^{D2}$.

**Proof:** See Appendix.

Proposition 4 states that the independent firm’s leadership yields the lowest access charge and the dominant firm’s leadership yields the highest access charge. The larger firm 2’s output is, the more firm 2 has an incentive for reducing $r$. Thus, firm 2 has the strongest incentive for lobbying when it is the leader.

Suppose that both firms make lobbying activities. If $c$ is large enough, firm 1 (resp. firm 2) has the smallest (resp. the largest) incentive for lobbying when firm 2 is the leader. Thus, unambiguously, independent firm’s leadership yields the lowest access charge. When $c$ is small, we
can say nothing what competition structure yields the lowest access charge. However, it is clear that dominant firm’s leadership yields the smallest total lobbying activities when $c$ is small.

6 Vertical separation

In the previous sections we assume that the dominant firm (firm 1) holds essential facilities and it also competes against the new entrant (firm 2) in the product market. However, ownership unbundling (or structural vertical separation) in such dominant firms is also an important policy issue. In fact, in EU (as well as in many countries except for Japan), such a separation policy is widely adopted in network industries. In this section, we discuss how vertical separation affects the level of equilibrium access charge.

We consider the situation where vertical separation is made. Firm 0 holds the essential facility and firm 1 and firm 2 pay access charge to firm 0. In the first stage firm 0 chooses $r$ with cost $L(r)$. After observing $r$, firm 1 and firm 2 compete in terms of outputs. Firm 0’s profit is $\pi_0 = r(y_1 + y_2) - L(r)$, firm 1’s profit is $\pi_1 = (p(Y) - c - r)y_1 + ry_2$, and firm 2’s profit is $\pi_2 = (p(Y) - r)y_2$. We again consider three games in the second stage.

We discuss the second stage subgame where $r$ is given exogenously. Consider the Cournot game. The equilibrium outputs are:

\[
y_1^{SC} = \frac{a - 2c - r}{3}, \quad y_2^{SC} = \frac{a - r + c}{3}, \quad Y^{SC} = \frac{2a - 2r - c}{3},
\]

where superscript ‘SC’ denote the equilibrium outcome in the Cournot game under vertical separation. The resulting profits of firms 1 and 2 are respectively:

\[
\pi_1^{SC} = \frac{(a - 2c - r)^2}{9}, \quad \pi_2^{SC} = \frac{(a - r + c)^2}{9}.
\]

The equilibrium profit of firm 0 is:

\[
\pi_0^{SC} = \frac{r(2a - 2r - c)}{3} - L(r).
\]

The resulting total social surplus is:

\[
W^{SC} = \frac{8a^2 - 2a(2r + c) - (2r + c)^2}{18} - \frac{c(a - 2c - r)}{3} - L(r).
\]
Consider the Stackelberg game with firm 2’s leadership. The equilibrium outputs are:

\[ y_{1}^{SI} = \frac{a - r - 3c}{4}, \quad y_{2}^{SI} = \frac{a - r + c}{2}, \quad Y^{SI} = \frac{3a - 3r - c}{4}, \]  

where superscript ‘SI’ denote the equilibrium outcome in the Stackelberg game under vertical separation. The resulting profits of firms 1 and 2 are respectively:

\[ \pi_{1}^{SI} = \frac{(a - r - 3c)^{2}}{16}, \quad \pi_{2}^{SI} = \frac{(a - r + c)^{2}}{8}. \]  

The equilibrium profit of firm 0 is:

\[ \pi_{0}^{SI} = \frac{r(3a - 3r - c)}{4} - L(r). \]  

The resulting total social surplus is:

\[ W^{SI} = \frac{15a^{2} - 2a(3r + c) - (3r + c)^{2}}{32} - \frac{c(a - r - 3c)}{4} - L(r). \]  

Consider the Stackelberg game with firm 1’s leadership. The equilibrium outputs are:

\[ y_{1}^{SD} = \frac{a - 2c - r}{2}, \quad y_{2}^{SD} = \frac{a - r + 2c}{4}, \quad Y^{SD} = \frac{3a - 3r - 2c}{4}, \]  

where superscript ‘SI’ denote the equilibrium outcome in the Stackelberg game under vertical separation. The resulting profits of firms 1 and 2 are respectively:

\[ \pi_{1}^{SD} = \frac{(a - 2c - r)^{2}}{8}, \quad \pi_{2}^{SD} = \frac{(a - r + 2c)^{2}}{16}. \]  

The equilibrium profit of firm 0 is:

\[ \pi_{0}^{SD} = \frac{r(3a - 3r - 2c)}{4} - L(r). \]  

The resulting total social surplus is:

\[ W^{SD} = \frac{15a^{2} - 2a(3r + 2c) - (3r + 2c)^{2}}{32} - \frac{c(a - 2c - r)}{2} - L(r). \]  

In the first stage, firm 0 maximizes its profit with respect to \( r \). The first order condition is

\[ \frac{\partial \pi_{0}^{j}}{\partial r} = 0 \quad (j \in \{SC, SI, SD\}). \]
Let $r^{SC}, r^{SI}, \text{ and } r^{SD}$ respectively denote the equilibrium rate of access charge in the Cournot, in the Stackelberg with firm 2’s leadership, and in the Stackelberg with firm 1’s leadership under vertical separation.

**Proposition 5** $r^{SC}, r^{SI}, \text{ and } r^{SD}$ is decreasing in $c$; (ii) $r^{SI} = r^I$ regardless of $c$; (iii) If $c \leq 0$, then $r^{Sj} \geq r^j$ for $j \in \{C, D\}$; (iv) If $c$ is sufficiently large, then $r^{Sj} < r^j$ for $j \in \{C, D\}$.

**Proof:** See Appendix.

Firm 0 obtains access charge revenue from two firms.\(^8\) Vertical separation increases the size of input market. This is why vertical separation increases $r$ when $c \leq 0$.\(^9\)

An increase in $c$ reduces the size of the market for input (total output of firms 1 and 2); thus, it reduces firm 0’s incentive for costly manipulation of $r$ (market shrinking effect). This effect is so strong that $r$ becomes lower under vertical separation when $c$ is large. Note that under vertical integration, an increase in $c$ enhances the size of input market (firm 2’s output).

Finally, we briefly discuss welfare implication of vertical separation. Vertical separation yields a double margin problem in firm 1. Thus it reduces firm 1’s output. Although it increases firm 2’s output, it reduces the total output. Vertical separation also affects $r$.

Suppose that $c \leq 0$. A reduction in $y_1$ and in $Y$ caused by the vertical separation reduces welfare. And vertical separation increases $r$ when $c \leq 0$ (Proposition 5(iii)); resulting in a welfare loss. Both effects reduce welfare, so vertical separation unambiguously reduces welfare.

**Proposition 6** Vertical separation reduces welfare when $c \leq 0$.

**Proof:** See Appendix.

However, welfare implication is ambiguous when $c$ is positive. When $c$ is large, a reduction

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\(^8\) In the model of vertical integration, network department of firm 1 might obtain access charge revenue from retail department of firm 1. However this is just income transfer within the same firm, so firm 1 does not care about this transfer when it chooses $r$.

\(^9\) Strictly speaking, strategic purpose for raising $r$ discussed in Section 3 disappears under vertical separation. In the Stackelberg with firm 2’s leadership, firm 1’s output is smallest, and thus the market effect is smallest. This is why the market effect is cancelled out in the Stackelberg with firm 2’s leadership.
of firm 1’s output and an increase of firm 2’s output improves welfare because firm 2 is more efficient than firm 1 (so total production costs are economized). This effect is known as the welfare-improving production substitution effect.\textsuperscript{10} And vertical separation decreases \( r \) (Proposition 5(iv)) resulting in a welfare gain. These two effects improve welfare. And the vertical separation reduces total output and it reduces welfare. It is ambiguous whether welfare improving effect dominates welfare-reducing effect.

In our model, vertical separation reduces welfare when \( c \leq 0 \) (Proposition 6). However, we should not too much emphasize this result. We assume that firm 0 (under vertical separation) and firm 1 (under vertical integration) have the same manipulation cost function, \( L(r) \). This assumption might not be realistic. Under the vertical separation, the cost structure becomes more transparent and the firm faces more difficulty for manipulating accounting costs. In such situations, the access charge is lower than what our model predicts. Thus, our model might underestimate the gains of vertical separation.

\section{Concluding remarks}

We endogenize access charge and investigate how competitive structure between a vertically integrated firm (incumbent) and a non-integrated firm (new entrant) affects access charge. We also investigate how vertical separation affects equilibrium access charge. We find that the results crucially depend on the relative efficiency of the incumbent. When the incumbent is more efficient or at least as efficient as the new entrant, the leadership by the incumbent and vertical integration reduces access charge and improve welfare. On the contrary, if the incumbent is inefficient than the new entrant, these can yield a higher access charge and lower welfare.

In this paper, we assume that the essential facility has already installed and neglect the problem of investment for essential facility. In the long run, how to stimulate the efficient investments is an important problem. Investigating how lobbying activity in the short run affects the long-run

behavior of the dominant firm remains for a future research.

Regarding the long-run effect, there is another important extension. In this paper, the number of the firms in the product market is given exogenously. If we consider further entries of independent firms, the result must be changed. Under vertical separation, the firm holding essential facility (firm 0) has incentive to reduce \( r \) so as to stimulate new entries. On the contrary, the vertically integrated firm has the opposite strategic incentive. It strategically raise \( r \) so as to deter a further entries. Thus, if we consider a possible further new entry, vertical separation might reduces \( r \) even when the incumbent is as efficient as the new entrants. This topic also remains for future research.
Appendix

Proof of Proposition 1

In the first stage, firm 1 maximizes its profit with respect to $r$. The first order condition is

$$\frac{\partial \pi_1^j}{\partial r} = 0 \quad (j \in \{C, I, D\}) \quad (24)$$

From (3), (6) and (9) we have:

$$\frac{\partial \pi_1^C}{\partial r} = \frac{5(a - 2r)}{9} - \frac{c}{9} - L'(r), \quad (25)$$

$$\frac{\partial \pi_1^I}{\partial r} = \frac{3(a - 2r)}{4} - \frac{c}{4} - L'(r), \quad (26)$$

$$\frac{\partial \pi_1^D}{\partial r} = \frac{a - 2r}{2} - L'(r) \quad (27)$$

From (24) and (27) we have Proposition 1 (ii). From (24), (25), and (26) we have Proposition 1 (i). Note that $L'' > 0$. Q.E.D.

Proof of Proposition 2

From Proposition 1 (ii) we have that $r^D$ is independent of $c$. Substituting $r = r^D$ into (25) we have

$$\left. \frac{\partial \pi_1^C}{\partial r} \right|_{r=r^D} = \frac{a - 2r^D}{18} - \frac{c}{9}, \quad (28)$$

where $(a - 2r^D)/2 = L'(r^D)$. From (28), we have that $r^D > r^C$ if and only if $(a - 2r^D)/2 > c$. Substituting $r = r^D$ into (26) we have

$$\left. \frac{\partial \pi_1^I}{\partial r} \right|_{r=r^D} = \frac{a - 2r^D}{4} - \frac{c}{4}, \quad (29)$$

where $(a - 2r^D)/2 = L'(r^D)$. From (28), we have that $r^D > r^I$ if and only if $(a - 2r^D) > c$. These implies that $r^D < \min\{r^C, r^I\}$ if $c < c_a \equiv (a - 2r^D)/2$ and that $r^D > \max\{r^C, r^I\}$ if $c > c_b \equiv (a - 2r^D)$. Q.E.D.

Proof of Proposition 3
Suppose that \( r \) is given exogenously. Let \( W^C, W^I \) and \( W^D \) respectively denote the equilibrium total social surplus in the Cournot, in the Stackelberg with firm 2’s leadership, and in the Stackelberg with firm 1’s leadership, given \( r \). Since the price is positive and larger than \( c \), \( W \) is increasing in \( y \) (total output). Fix \( y(= y_1 + y_2) \), \( W \) is non-decreasing in \( y_1 \) if \( c \leq 0 \), and decreasing in \( y_1 \) if \( c > 0 \).

Suppose that \( c \leq 0 \). From (2), (5), and (8), we have \( Y^D \geq Y^I \), \( Y^D > Y^C \), \( Y^D_1 \geq Y^I_1 \), and \( Y^D_1 > Y^C_1 \) (note that, we have assumed \( r < \bar{r} < a/2 \)). Thus, \( W^D \geq W^I \) and \( W^D > W^C \). This implies Proposition 3 (i).

Suppose that \( c > 0 \). We have \( W^D - W^I = -c(10a - 5c - 12r)/32 < 0 \) because \( c \leq a/2 \) and \( r < \bar{r} \leq a/2 \). This implies Proposition 3 (ii). Q.E.D.

**Proof of Proposition 4**

In the first stage, firm 2 maximizes its profit with respect to \( r \). The first order condition is

\[
\frac{\partial \pi^j_2}{\partial r} - L'_2(r) = 0 \quad (j \in \{C, I, D\}).
\]  
(30)

We have:

\[
\frac{\partial \pi^C_2}{\partial r} - L'_2(r) = -\frac{4(a - 2r + c)}{9} - L'_2(r),
\]  
(31)

\[
\frac{\partial \pi^I_2}{\partial r} - L'_2(r) = -\frac{a - 2r + c}{2} - L'_2(r),
\]  
(32)

\[
\frac{\partial \pi^D_2}{\partial r} - L'_2(r) = -\frac{a - 2r + c}{4} - L'_2(r)
\]  
(33)

Since (32) \(< (31) < (33)\), we have that \( r^I_2 < r^C_2 < r^D_2 \). Q.E.D.

**Proof of Proposition 5**

From (13), (17) and (21) we have:

\[
\frac{\partial \pi^{SC}_0}{\partial r} = \frac{2(a - 2r)}{3} - \frac{c}{3} - L'(r),
\]  
(34)

\[
\frac{\partial \pi^{SI}_0}{\partial r} = \frac{3(a - 2r)}{4} - \frac{c}{4} - L'(r),
\]  
(35)
\[
\frac{\partial \pi_{0}^{SD}}{\partial r} = \frac{3(a - 2r)}{4} - \frac{c}{2} - L'(r). 
\] 

(36)

Comparing (34), (35), and (36) with (25), (26), and (27), we obtain \( r^{SI} = r^{I} \) for all \( c, r^{SC} > r^{C} \) and \( r^{SD} > r^{D} \) when \( c \leq 0 \), and \( r^{SC} < r^{C} \) and \( r^{SD} < r^{D} \) for large \( c \). 

Q.E.D.

Proof of Proposition 6

First, we suppose that \( r \) is given exogenously. Since \( Y^j > Y^{Sj} \) and \( y^j_1 > y^{Sj} \) for \( j \in \{C, I, D\} \), vertical separation yields smaller total social surplus than vertical integration if \( c \leq 0 \). Next, we consider the effect of change in \( r \). When \( c \leq 0 \), vertical separation yields a larger \( r \) (Proposition 5(ii)); resulting in a reduction of total social surplus. The above two effects unambiguously reduce total social surplus. 

Q.E.D.
References


