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Partial forward ownership and upstream quality investment

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Abstract

Partial forward ownership has been observed in many industries. We consider a linear city in which upstream firms invest in quality. Partial forward ownership increases the quality investment of an owning upstream firm. Although partial forward ownership increases market concentration and consumer transportation costs, consumer surplus increases because of higher quality. In addition, partial forward ownership increases total surplus if the upstream investment technology is efficient. Conversely, partial forward ownership hurts total surplus if the investment technology of upstream firms is inefficient or if they cannot make the investment. Therefore, the desirability of partial forward ownership depends on the efficiency of upstream investment.

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1. Introduction

Partial forward ownership has been observed in many industries. For example, in the soft drink industry, Coca-Cola has acquired an 18% share of Coca-Cola European Partners (Fiocco, 2016).[1] Hence, researchers have long been interested in partial forward ownership (Fiocco, 2016; Flath, 1989; Levy et al., 2018).[2] Furthermore, in the soft drink industry, manufacturers (e.g., Coca-Cola and PepsiCo) exclusively distribute their products to specialized bottlers (Luco and Marshall, 2018).[3] Thus, in the soft drink industry, we can observe competing vertical chains with partial forward ownership.

We focus on the competitive effects of partial forward ownership. When partial forward ownership takes place, an upstream firm becomes more concerned about a downstream partner's profit, and thus lowers the wholesale price. Hence, partial forward ownership will be desirable for society because the downstream firm will increase its total output. However, in a market (e.g., telecommunications) where almost all consumers buy a product, the effect of partial forward ownership on total output is limited because there is no market expansion effect.[4] Hence, partial forward ownership may not be desirable in a full covered market.

We consider a model in which there are two upstream firms and two downstream firms competing in a Hotelling market. Each upstream firm exclusively trades with its downstream firm and simultaneously chooses the wholesale price and product quality.

We find that in a covered market with endogenous quality decisions, partial forward ownership may increase total surplus. We show that the total surplus increases with the degree of partial forward ownership if the upstream investment technology is efficient. Although partial forward ownership increases market concentration, it also increases the product quality for the owning upstream firm. Hence, partial forward ownership increases the number of consumers buying high-quality products, which leads to a larger total surplus. Our result contrasts with the well-known finding that vertical integration in a covered market reduces the total surplus.[5] In particular, with inefficient investment technology or without investment, the opposite results will occur.

This study is related to the literature on partial ownership or vertical integration. Brito et al. (2020) consider a market with overlapping ownership. In their model, each firm chooses its price and quality. While they discuss the effects of horizontal ownership, we focus on the effects of partial forward ownership. Papadopoulos et al. (2022) consider passive partial forward ownership in a market with an upstream firm and two downstream firms producing differentiated goods. While Papadopoulos et al. (2022) consider partial forward ownership, they do not consider endogenous quality choice, unlike this study. There is another paper that has similar intuition as ours. Matsushima (2009) discusses the effects of vertical integration in a Hotelling market with two upstream firms and two downstream firms. Matsushima (2009) does not employ endogenous quality choice, unlike this study.

[1] In another example, Harbin Pharmaceutical, China's second-largest drug maker, has announced an agreement to acquire a 40% share of the U.S. vitamin retailer, GNC (Papadopoulos et al., 2022).

[2] For empirical studies, see Allen and Phillips (2000), Gilo and Spiegel (2011), and Reiffen (1998).

[3] Luco and Marshall (2018) state that a given bottler cannot bottle two beverages of the same flavor from two separate upstream firms.

[4] Gilo and Spiegel (2011) state that partial ownership is more common than full integration in the telecommunication industry.

[5] Matsushima (2009) shows that vertical integration reduces total surplus in a Hotelling model.

Other studies that analyze partial forward ownership include Fiocco (2016), Flath (1989), Levy (2021), and Spiegel (2013). Fiocco (2016) shows that partial forward ownership may be preferred over full vertical integration, and that welfare increases with the degree of passive partial forward ownership. Flath (1989) shows that in Cournot oligopolies, output is larger when an upstream firm owns shares in a downstream firm. Levy (2021) considers a model with corporate control and shows that if the control level is not too large, partial forward ownership can promote investment and improve the joint surplus. Spiegel (2013) also shows that partial forward ownership can mitigate vertical foreclosure compared to full vertical integration.[6] Although none of these studies discuss the welfare-improving effects of partial forward ownership with upstream quality investments in a linear market, this paper analyzes them.

The remainder of this paper is organized as follows. In the next section, we describe our model. Section 3 calculates the equilibrium and shows the results of the comparative statics. Finally, Section 4 concludes the paper.

2. Model

We consider a market with two upstream firms and two downstream firms. The upstream firm U_i exclusively sells its product to downstream firm D_i at wholesale price w_i and cannot trade with downstream firm D_j ($i, j = 1, 2$ and $i \neq j$). U_i produces a product at no cost. We assume that U_1 has 100 θ percent, $0 \leq \theta < 1/2$, of the equity of D_1. Hence, we sometimes refer to U_1, D_1, U_2, and D_2 as "owning upstream," "owned downstream," "independent upstream," and "independent downstream" firms, respectively.

U_i can invest to increase the quality of its product. To increase its quality by q_i, U_i pays investment cost $kq_i^2/2$, where k denotes the inefficiency of investment. We call θ the rate of partial forward ownership. D_i purchases a product from U_i and sells it to consumers at the retail price p_i. We assume that consumers are uniformly distributed in the unit interval $[0, 1]$. D_1 is located at 0, and D_2 is located at 1. We denote the demand for D_i as d_i. Then, the operating profits of D_i and U_i are

$$\pi_{Di} = (p_i - w_i)d_i, \quad \pi_{Ui} = w_i d_i - kq_i^2/2.$$

The total values of U_1 and D_1 are $V_{U1} = \pi_{U1} + \theta\pi_{D1}$ and $V_{D1} = (1 - \theta)\pi_{D1}$, respectively.

If a consumer located at $y \in [0, 1]$ purchases the product from D_1, the utility is

$$u_1 = r + bq_1 - p_1 - ty,$$

where r represents the willingness to pay in the absence of quality investment by upstream firms, b represents the degree to which quality affects utility, and t is a parameter related to the transportation cost. If the consumer at y purchases from D_2, then the utility is

$$u_2 = r + bq_2 - p_2 - t(1 - y).$$

Each consumer purchases at most one unit of the product. To guarantee positive equilibrium outcomes, we assume that $k > b^2/(7t)$. We denote the consumer, producer, and total

[6] Spiegel (2013) uses a unit demand function without a double marginalization problem.

surpluses as $CS = \int_0^{x_{12}} u_1 dy + \int_{x_{12}}^1 u_2 dy$, $PS = V_{U1} + V_{D1} + \pi_{U2} + \pi_{D2}$, and $TS = CS + PS$, respectively, where a consumer located at $x_{12} = 1/2 + [b(q_1 - q_2) + p_2 - p_1]/(2t)$ is indifferent between buying from D_1 and D_2.

The timing of the game is as follows. In the first stage, each upstream firm U_i chooses a wholesale price w_i and quality q_i. In the second stage, each downstream firm D_i chooses a retail price p_i. We solve this model using backward induction.

3. Results

We have the maximization problems in the second stage as follows:

$$\max_{p_1}(1-\theta)(p_1 - w_1)d_1(p_1, p_2), \quad \max_{p_2}(p_2 - w_2)d_2(p_2, p_1),$$

where $d_i(p_i, p_j)$ is the demand of downstream firm D_i. Then, the first-order condition for p_i leads to the following price:

$$p_i(w_i, w_j; q_i, q_j) = \frac{3t + b(q_i - q_j) + 2w_i + w_j}{3}.$$

We consider the first stage. Substituting $p_i(w_i, w_j; q_i, q_j)$ into $d_i(p_i, p_j)$, we obtain upstream firm i's demand: $d_i(w_i, w_j; q_i, q_j) = d_i[p_i(w_i, w_j; q_i, q_j), p_j(w_j, w_i; q_j, q_i)]$. Using $d_i(w_i, w_j; q_i, q_j)$, we have the maximization problems in the first stage as follows.

$$\max_{w_1, q_1} \; w_1 d_1(w_1, w_2; q_1, q_2) - \frac{k}{2}q_1^2 + \theta[p_1(w_1, w_2; q_1, q_2) - w_1]d_1(w_1, w_2; q_1, q_2),$$

$$\max_{w_2, q_2} \; w_2 d_2(w_2, w_1; q_2, q_1) - \frac{k}{2}q_2^2.$$

From the first-order conditions for w_i and q_i, we obtain the following outcomes:

$$w_1^* = \frac{t(9tk - b^2)(3 - 2\theta)}{\Phi}, \quad w_2^* = \frac{3t(\Phi - 2\theta tk)}{\Phi}, \quad q_1^* = \frac{b\,(9tk - b^2)}{2k\Phi}, \quad q_2^* = \frac{b(\Phi - 2\theta tk)}{2k\Phi},$$

where we define $\Phi = (9 - 2\theta)tk - b^2$. Note that $\Phi > 0$ from the assumption: $k > b^2/(7t)$.

Using the above results, we obtain equilibrium outcomes as follows.

$$p_1^* = \frac{2t(9tk - b^2)(2 - \theta)}{\Phi}, \quad p_2^* = \frac{4t\,(\Phi - 2\theta tk)}{\Phi}, \quad V_{D1}^* = \frac{t(9tk - b^2)^2(1 - \theta)}{2\Phi^2},$$
$$\pi_{D2}^* = \frac{t\,(\Phi - 2\theta tk)^2}{2\Phi^2}, \quad V_{U1}^* = \frac{(9tk - b^2)^2\,[(12 - 4\theta)tk - b^2]}{8k\Phi^2}, \quad \pi_{U2}^* = \frac{(12tk - b^2)(\Phi - 2\theta tk)^2}{8k\Phi^2}.$$

Furthermore, the equilibrium consumer and total surpluses are as follows.

$$CS^* = r + \frac{2b^6 - b^4tk(53 - 12\theta) + 4b^2t^2k^2(117 - 53\theta + 4\theta^2) - t^3k^3(1377 - 936\theta + 136\theta^2)}{4k\Phi^2},$$
$$TS^* = r + \frac{(b^2 - tk)[b^4 - 2b^2tk(9 - 2\theta) + t^2k^2(81 - 36\theta + 8\theta^2)]}{4k\Phi^2}.$$

Using the above results, we can consider the case without upstream investment. When the investment technology is sufficiently inefficient, that is, k diverges to infinity, the equilibrium investment level converges to zero.

Now, we present the results of the comparative statics. Differentiating the equilibrium outcomes with respect to θ, we obtain Proposition 1.

Proposition 1 *Consider a case in which the rate of partial forward ownership increases. (i) Owning upstream firm U_1 always increases its quality q_1^* and raises its wholesale price w_1^* if $k < b^2/(6t)$; owned downstream firm D_1 increases its retail price p_1^* if $k < b^2/(5t)$. (ii) Independent upstream firm U_2 decreases its quality q_2^* and wholesale price w_2^*; independent downstream firm D_2 lowers its retail price p_2^*.*

Proof. First, we consider the signs of $\partial q_1^*/\partial\theta$ and $\partial w_1^*/\partial\theta$.

$$\frac{\partial q_1^*}{\partial\theta} = \frac{bt\,(9tk - b^2)}{\Phi^2}, \quad \frac{\partial w_1^*}{\partial\theta} = -\frac{2t(6tk - b^2)(9tk - b^2)}{\Phi^2}.$$

Note that $\partial\Phi/\partial\theta = -2tk$. Because we assume $k > b^2/(7t)$, we obtain $\partial q_1^*/\partial\theta > 0$. Also, from $k > b^2/(7t)$, we obtain $\partial w_1^*/\partial\theta > 0$ if $k < b^2/(6t)$.

Next, let us consider the signs of $\partial q_2^*/\partial\theta$ and $\partial w_2^*/\partial\theta$.

$$\frac{\partial q_2^*}{\partial\theta} = -\frac{bt\,(9tk - b^2)}{\Phi^2}, \quad \frac{\partial w_2^*}{\partial\theta} = -\frac{6t^2k\,(9tk - b^2)}{\Phi^2}.$$

The assumption that $k > b^2/(7t)$ gives us $\partial q_2^*/\partial\theta < 0$ and $\partial w_2^*/\partial\theta < 0$.

Finally, we consider the signs of $\partial p_1^*/\partial\theta$ and $\partial p_2^*/\partial\theta$.

$$\frac{\partial p_1^*}{\partial\theta} = -\frac{2t\,(5tk - b^2)\,(9tk - b^2)}{\Phi^2}, \quad \frac{\partial p_2^*}{\partial\theta} = -\frac{8t^2k\,(9tk - b^2)}{\Phi^2}.$$

From $k > b^2/(7t)$, we obtain $\partial p_1^*/\partial\theta > 0$ if $k < b^2/(5t)$. In addition, from $k > b^2/(7t)$, we obtain $\partial p_2^*/\partial\theta < 0$.□

The intuition behind Proposition 1 is as follows: When the rate of partial forward ownership, θ, increases, U_1 raises its quality q_1 because high product quality yields a large operating profit of owned downstream firm D_1. In addition, with small k (i.e., efficient investment technology), the increase in quality is large. U_1 and D_1 then face large demand, and they can choose high wholesale and retail prices. With large k, U_1 slightly increases its product quality. Then, to increase the operating profit of D_1, U_1 must decrease the wholesale price w_1, which leads to a low retail price p_1. Because q_1 increases with θ, demand for the independent upstream firm U_2 and independent downstream firm D_2 shrinks. Hence, U_2 chooses low q_2 and w_2; D_2 also reduces p_2.

Finally, we present the main result. Differentiating consumer and total surpluses with respect to θ, we obtain Proposition 2.

Proposition 2 *The consumer surplus always increases with the rate of partial forward ownership. For $k < b^2/t$, the total surplus increases with the rate of partial forward ownership; for $k > b^2/t$ or without upstream investment, the total surplus decreases with the rate of partial forward ownership.*

Proof. Differentiating CS^* with respect to θ leads to

$$\frac{\partial CS^*}{\partial \theta} = \frac{t(9tk - b^2)[(9tk - b^2)^2 - 2tk(8tk - b^2)\theta]}{\Phi^3}.$$

Solving $\partial CS^*/\partial\theta > 0$ for θ, we obtain $\theta < (9tk - b^2)^2/[2tk(8tk - b^2)] = \theta_{CS}$. θ_{CS} increases with k, and it takes the minimum value $\theta_{CS} = 2$ at $k = b^2/(7t)$. Hence, for any $\theta \in [0, 1/2)$, we have $\partial CS^*/\partial\theta > 0$.

Next, differentiating TS^* with respect to θ, we obtain

$$\frac{\partial TS^*}{\partial \theta} = -\frac{2t^2k(tk - b^2)(9tk - b^2)\theta}{\Phi^3}.$$

Solving $\partial TS^*/\partial\theta > 0$ for k, we have $k < b^2/t$.

We consider the case without upstream investment. As $k \to \infty$, we have $\partial TS^*/\partial\theta \to -18t\theta/(9 - 2\theta)^3 < 0$. Therefore, we obtain this Proposition.□

The intuition behind Proposition 2 is as follows: From Proposition 1, the owning upstream firm U_1 increases its quality q_1 and obtains a larger demand. Hence, the number of consumers purchasing higher-quality products increases, which leads to a larger consumer surplus. With efficient investment technology (i.e., small k), an increase in quality q_1 is large, and consumer surplus also rises significantly.[7]

In terms of the total surplus, when the degree of partial forward ownership increases, the demand for D_1 expands and the transportation costs of consumers increase. This effect lowers the total surplus. Since with large k, U_1 slightly increases q_1 and decreases w_1, the effect of increasing transportation costs dominates the effect of increasing quality. Hence, partial forward ownership is detrimental to the total surplus. Conversely, when k is small, partial forward ownership is beneficial to the total surplus because the quality-improvement effect dominates the transportation-cost-increase effect. Finally, an intuition behind the case without upstream investment is the same as that with significantly inefficient technology of upstream investment.

4. Conclusion

We evaluate the effects of partial forward ownership in a linear city with upstream quality investments. We show that partial forward ownership always increases the consumer surplus and also raises the total surplus if the investment technology is efficient. We also show that with inefficient investment technology or without investment, partial forward ownership decreases the total surplus. Therefore, the desirability of partial forward ownership depends on the efficiency of upstream investment.

[7]From Proposition 1, the owned downstream firm D_1 may raise the retail price p_1, but this effect is always dominated by the increasing effect of the quality q_1. Thus, consumer surplus always increases with the rate of partial forward ownership.

References

Allen, J.W. and Phillips, G.M. (2000) "Corporate equity ownership, strategic alliances, and product market relationships" *Journal of Finance* **55**, 2791–2815.

Brito, D., Ribeiro, R., and Vasconcelos, H. (2020) "Overlapping ownership, endogenous quality, and welfare" *Economics Letters* **190**, 109074.

Fiocco, R. (2016) "The strategic value of partial vertical integration" *European Economic Review* **89**, 284–302.

Flath, D. (1989) "Vertical integration by means of shareholding interlocks" *International Journal of Industrial Organization* **7**, 369–380.

Gilo, D. and Spiegel, Y. (2011) "Partial vertical integration in telecommunication and media markets in Israel" *Israel Economic Review* **9**, 29–51.

Levy, N. (2021) "Partial ownership, control, and investment in vertical relationships" Available at SSRN: `https://ssrn.com/abstract=3475158`

Levy, N., Spiegel, Y., and Gilo, D. (2018) "Partial vertical integration, ownership structure, and foreclosure" *American Economic Journal: Microeconomics* **10**, 132–180.

Luco, F. and Marshall, G. (2018) "Vertical integration with multiproduct firms: when eliminating double marginalization may hurt consumers"
Available at SSRN: `https://ssrn.com/abstract=3110038`

Matsushima, N. (2009) "Vertical merger and product differentiation" *Journal of Industrial Economics* **57**, 812–834.

Papadopoulos, K.G., Petrakis, E., and Skartados, P. (2022) "The ambiguous competitive effects of passive partial forward ownership" *Southern Economic Journal, In Press.*

Reiffen, D. (1998) "Partial ownership and foreclosure: an empirical analysis" *Journal of Regulatory Economics* **13**, 227–244.

Spiegel, Y. (2013) "Backward integration, forward integration, and vertical foreclosure" Available at SSRN: `https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2319963`