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Welfare-improving vertical separation with network externality[☆]

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HIGHLIGHTS

- We compare the outcomes of vertical integration and vertical separation with network externalities.
- Integration has the advantage of avoiding double-margin distortion.
- Separation has the advantage of increasing network externalities.
- When both products are sufficiently close substitutes, vertical separation is more efficient than vertical integration.

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ABSTRACT

Considering the interplay between network externalities and the degree of product substitutability in a vertical structure, we compare the outcomes of vertical integration and vertical separation. In contrast to previous results, we show that when both products are sufficiently close substitutes, there is a threshold level of the network externality parameter, beyond which vertical separation is more efficient than vertical integration. This is due to the internalization of the network externality by a multiproduct monopolist, which, in the balance between the extensive and intensive margin, leads to higher output prices.

1. Introduction

Firms that sell products usually require inputs produced by other firms in an upstream industry, leading to a vertical structure. A conventional result is that pricing inefficiency in a vertical market stems from double-margin distortion.[2] There are two streams of solutions to such distortion in a monopolistic market. The first is vertical mergers between upstream and downstream firms. The second includes vertical constraints, such as franchise fees, resale price maintenance, and exclusive territories, among others.[3]

Network externalities are evident in the smartphone industry, in which the utilities of smartphone users subscribed to one telecommunication firm increase as the number of subscribers in the other telecommunication firm increases. A motivating example for our analysis is as follows. Qualcomm, a representative

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2 Sprengler (1950) firstly addressed the double margin distortion.

3 Resale price maintenance has been initially examined by Telser (1960). See, for a differentiated market, Mathewson and Winter (1984, 1998) and Bernheim and Whinston (1985).

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firm in the smartphone industry, uses specialized chips in its smartphones. Qualcomm provides the same agreements (either 3G or 4G) to its customers. This study analyzes welfare comparisons between vertical integration and separation with network goods in order to revisit whether conventional results that vertical integration is more efficient than vertical separation with a linear pricing are correct or not.[4]

While the above studies all examine the outcomes of vertical separation and integration without network externalities, few have conducted welfare comparisons between vertical integration and separation with network externalities. This study differs sharply from previous welfare comparison research in a two-tier market when comparing vertical separation with vertical integration.

2. The model

Consider a market in which an upstream firm sells an input to its downstream firms, which produce the final network goods. Following Hoernig (2012), we consider that the utility function of the representative consumer is as follows.[5]

$$U = a(x_i + x_j) - \frac{x_i^2 + x_j^2 + 2bx_ix_j}{2} + n\left[(y_i + by_j)x_i + (y_j + by_i)x_j - \frac{y_i^2 + 2by_jy_i + y_j^2}{2}\right] + m; \quad i, j = 1, 2, i \neq j,$$

where m denotes the consumption of all other goods, measured in terms of money; x_i denotes the quantity of final product i; y_i denotes consumers' expectations about final product i's quantity; $b \in (0, 1)$ represents the degree of product differentiation; and $n \in (0, 1)$ measures the strength of the network externalities. Note that the marginal utility of product i increases in y_i and y_j: $\partial^2 U/\partial x_i \partial y_i = n > 0$ and $\partial^2 U/\partial x_i \partial y_j = bn > 0$, respectively.[6] This implies that there are positive consumption externalities. It is evident that for given consumption bundle (x_i, x_j), utilities reach their highest level, if consumers' expectations are correct (i.e., if $y_i = x_i$ and $y_j = x_j$).

The direct demand function for product i can be derived as follows (see also Ghosh and Pal, 2014).

$$x_i = \frac{a(1-b) - p_i + bp_j + ny_i\left(1-b^2\right)}{1-b^2}; \quad i, j = 1, 2, \ i \neq j, \tag{1}$$

where p_i and p_j are, respectively, the final price charged for product i and j. Note that network externalities enter additively in demand functions and shift demand curves outward without changing their slopes, as in Hoernig (2012).

[4] The issue of firm boundaries has become an important topic, as originally discussed in Coase (1937). Early contributions include those of Williamson (1975, 1985), Grossman and Hart (1986), and Hart and Moore (1990). Many studies have focused on firm boundaries in a horizontal and vertical oligopolistic market, following two separate streams. The first stream focuses on a single channel, and is associated with transaction and influence costs, both within and across firms. The second stream focuses on competitive channels. From the viewpoint of competition, see Bonanno and Vickers (1988), Rey and Stiglitz (1988), Bettignies (2006), and Buchler and Schmutzler (2008), among others. For network externalities, see Katz and Shapiro (1985), Economides (1996), Chou and Shy (1993), Shy (2001), Hermalin and Katz (2006), Hoernig (2012), Chirco and Scrimitore (2013), and Bhattacharjee and Pal (2014), and so on.

[5] Note that, from the utility function, the inverse demand function for product i can be derived as follow: $p_i = a - x_i - bx_j + n(y_i + by_j)$.

[6] Note that, since two products are imperfect substitutes, the effect of y_j on marginal utility of product i is smaller than that of y_i.

The marginal cost for the upstream firm is c. We assume that $0 < c < a$, which ensures that equilibrium quantities and prices are always positive. For simplicity, one unit of the final product needs exactly one unit of the input and the cost of transforming the input into the final product is normalized to zero.

The timing of vertical integration is as follows. The monopolistic firm sets the prices (p_i, p_j). On the other hand, the timing of vertical separation is as follows. At stage one, the upstream firm sets the input price (w). At stage two, each downstream firm simultaneously chooses the price (p_i, p_j).

3. Vertical integration

We first consider a simple vertical integration. Suppose a firm who produces two differentiated products with a constant marginal cost (c). The integrated firm's maximization problem is defined as follows:

$$\max_{p_i, p_j} \Pi = \sum_{i=1, i\neq j}^{2} (p_i - c)\, x_i = \sum_{i=1, i\neq j}^{2} \frac{(p_i - c)\left[a(1-b) - p_i + bp_j + (1-b^2)ny_i\right]}{1-b^2}.$$

The integrated firm chooses its prices in order to maximize its profit. We state the solution to the optimization as two first-order conditions (Eqs. (2a) and (2b)) that are to hold under the equilibrium-restrictions of satisfied expectations (Eqs. (2c) and (2d)) as follows:

$$p_i(p_j) = \frac{(a+c)(1-b) + ny_i\left(1-b^2\right) + 2bp_j}{2}, \tag{2a}$$

$$p_j(p_i) = \frac{(a+c)(1-b) + ny_j\left(1-b^2\right) + 2bp_i}{2}, \tag{2b}$$

$$x_i = y_i, \tag{2c}$$

$$x_j = y_j. \tag{2d}$$

Note that, from the utility function, for any given consumption bundle (x_i, x_j) the representative consumer enjoys the highest utility level if his expectations are correct, i.e., if $x_i = y_i$ and $x_j = y_j$. Following Katz and Shapiro (1985) and Hoernig (2012), we consider that consumers' expectations satisfy 'rational expectations' conditions. Therefore, we assume that $x_i = y_i$ and $x_j = y_j$ hold true in equilibrium.

Solving Eqs. (2a)–(2d) with symmetry, we obtain the equilibrium prices as follows:

$$p_i^{VI} = c + \frac{a-c}{2-n}, \tag{3a}$$

where the superscript '*VI*' denotes vertical integration under Bertrand competition.

Finally, inserting p_i^{VI} into each equilibrium outcome, we obtain the equilibrium output, profit, consumer surplus, and social welfare as follows:

$$x_i^{VI} = \frac{a-c}{(1+b)(2-n)}, \qquad \Pi^{VI} = \frac{2(a-c)^2}{(1+b)(2-n)^2}, \tag{3b}$$

$$CS^{VI} = \frac{(a-c)^2(1-n)}{(1+b)(2-n)^2}, \qquad SW^{VI} = \frac{(a-c)^2(3-n)}{(1+b)(2-n)^2}. \tag{3c}$$

Note that total network effects have the following effect on price, output, profit, consumer surplus and social welfare:

$$\frac{\partial p_i^{VI}}{\partial n} > 0, \quad \frac{\partial x_i^{VI}}{\partial n} > 0, \quad \frac{\partial \Pi^{VI}}{\partial n} > 0, \quad \frac{\partial CS^{VI}}{\partial n} < 0, \quad \text{and} \quad \frac{\partial SW^{VI}}{\partial n} > 0.$$