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Welfare-Improving Vertical Mergers in the Presence of Downstream Product Differentiation

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ABSTRACT

This paper investigates the welfare effect of a vertical merger in a market with downstream product differentiation. Previous studies find that a merger in this setting tends to be welfare-reducing if the merged firm exits the upstream market and the downstream goods are highly differentiated. The reason is that a reduction in the number of upstream suppliers raises the input price and lowers downstream production. This paper departs from previous studies by considering the case in which the merged firm continues to trade in the upstream market. A vertical merger is always procompetitive with this assumption change because, in this case, the merged firm sells inputs in the upstream market if the downstream goods are sufficiently differentiated.

1. INTRODUCTION

Market shares are commonly used screening criteria to determine whether a proposed vertical merger will be cleared without further antitrust investigation. For example, one of the necessary conditions for the European Commission to adopt a simplified procedure for a vertical merger is as follows:

> the individual or combined market share of all the parties to the concentration that are engaged in business activities in a product market which is upstream or downstream from a product market in which any other party to the concentration is engaged (vertical relationships) are less than 30%.[1]

That is, when this condition, along with others, is met and provided that there are no special circumstances, the European Commission adopts a short-form clearance decision within 25 working days from the date of notification.[2] Similarly, in Taiwan, the Fair Trade Commission may adopt a simplified procedure if "[t]he aggregate market share of the parties to a vertical merger in each relevant market is less than 25% of the total market."[3]

Häckner (2003) argues that this type of rule of thumb is not efficient and suggests that whether a vertical merger is procompetitive depends on the relative market share between the upstream and downstream markets rather than the absolute market shares. He finds that a vertical merger is harmful if (i) the upstream market is more concentrated than the downstream market, and (ii) the downstream products are relatively differentiated. By assuming that the integrated firm exits the upstream market (as both a seller and a buyer), he argues that whether an instance of vertical integration is welfare-improving depends on two countervailing effects. First, a reduction in the number of upstream suppliers raises the input price, which he calls the market structure effect. Second, the mitigation of the double marginalization problem intensifies downstream competition, which he calls the cost effect. The cost effect is less pronounced when the downstream products are more differentiated.

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[1] European Commission (2013), point 5(c)(ii).

[2] European Commission (2013), point 2.

[3] Fair Trade Commission (2016), point 7(3).

In a related paper, Wang et al. (2004), maintaining the assumption that a vertically merged firm will exit the upstream market, use a successive duopoly model that also allows for complementarity of downstream goods and varying downstream market sizes to analyze the welfare effect of a vertical merger. They find that the adverse structure effect is augmented if the market size of the nonintegrated downstream firm is substantially greater than that of the integrated firm.

The assumption that the integrated firm exits the upstream market, however, is not innocuous. After all, an integrated firm should choose to trade in the upstream market if it is profitable to do so. Previous studies adopting this assumption are often subject to criticism. For example, Salinger (1988) illustrates how a vertical merger in a successive Cournot oligopoly raises the price of the final good by explicitly assuming that the merged firm will withdraw from the upstream market. This assumption is challenged by Gaudet and Long (1996), who consider vertically integrated firms' participation in both the upstream and the downstream markets.[4] They show that, depending on the market structure, an integrated firm may want to either buy or sell in the upstream market. By buying inputs, while incurring losses upstream, the integrated firm can raise its downstream rivals' costs and earn a larger profit downstream;[5] on the other hand, selling inputs brings in profits upstream at the cost of reduced profits downstream. It is this tradeoff between the upstream and downstream profits that determines the firm's trading pattern in the upstream market. In a follow-up study, Higgins (1999) finds that vertical mergers are always procompetitive as long as the merged firms are allowed to trade in the upstream market and the number of downstream firms equals or exceeds the number of upstream firms. Wang et al. (2005) further show that, irrespective of whether there are more firms downstream, an additional vertical merger is always welfare-improving provided that the merged firms continue to trade in the upstream market. In both of these studies, even with the vertically merged firms' buying upstream, the adverse input foreclosure effect is always more than offset by the gains from the elimination of double marginalization.

Because the aforementioned papers consider only the case in which homogeneous goods are traded in the downstream market, in this study, we specifically take into ac-

[4] Another notable example is Ordover et al. (1990), who consider price competition in a successive oligopoly. They show that higher downstream prices will result if a vertically integrated firm can commit not to undercut an upstream rival's price. This assumed ability to make price commitments is challenged by Reiffen (1992).

[5] Salop and Scheffman (1987) describe this situation as an "over-purchase" of inputs because it is more efficient to produce the input internally.

count downstream product differentiation and investigate whether a vertical merger is still procompetitive. A model of homogeneous inputs and differentiated outputs is not only a theoretical exercise but also one with empirical relevance. For example, polyvinyl chloride (PVC) is one of the world's most widely produced synthetic plastic polymers. It can be used for sewerage pipes, electrical cable insulation, clothing, furniture, and so forth. Another example is the various applications of thin-film-transistor liquid-crystal display (TFT LCD) panels. TFT LCDs are used in appliances including television sets, computer monitors, mobile phones, and navigation systems. Furthermore, it is very common to observe intra-industry trade in TFT LCD markets by vertically integrated firms.[6] Therefore, the analysis of this study is expected to have important policy implications.

We find that when the vertically merged firm continues to trade in the upstream market, it becomes a net seller in this market if the downstream products are sufficiently differentiated. The difference between the incentives of a vertically integrated and a nonintegrated firm to sell upstream is that the former accounts for its downstream profit. Therefore, ceteris paribus, the former sells less than the latter and even becomes a net buyer if it is profitable to do so. This difference dwindles, however, when downstream products become differentiated. In the limiting case in which the downstream products are completely differentiated, the upstream division of an integrated firm will just sell inputs like any other nonintegrated upstream firm. The input selling by the integrated firm mitigates the adverse market structure effect, and an instance of vertical integration is always welfare-improving. One policy implication that might be drawn from this result is as follows: in markets in which vertically integrated firms actively buy or sell upstream, antitrust authorities likely do not need to devote considerable effort to assessing market shares when evaluating whether a vertical merger is procompetitive.

The remainder of this paper is organized as follows. Section 2 formulates the model and derives the equilibrium outcomes. Section 3 presents the main result of this study that a vertical merger is always welfare-improving as long as the merged firm continues to trade in the upstream market. The final section concludes the paper. Some proofs involving lengthy algebraic calculations are relegated to the Appendix.

[6] For example, Samsung, a vertically integrated firm with its own TFT LCD panel factories, sourced TFT LCD panels from Taiwan's Chi Mei Optoelectronics (CMO) and AU Optronics (AUO).

2. THE MODEL

To demonstrate how the integrated firm's trading in the upstream market mitigates the market structure effect, we consider a model in which there are M firms, $B_1, \cdots, B_M$, $M > 1$, in the upstream market, and each produces a homogeneous input. The downstream market is assumed to comprise N firms, $D_1, \cdots, D_N$, $N > 1$, and each produces a differentiated good. Following Häckner (2000, 2003), we assume that the final consumers' preference takes the following form:

$$U(\mathbf{q}, E) = \sum_{i=1}^{N} q_i - \frac{1}{2}\left(\sum_{i=1}^{N} q_i^2 + 2\gamma \sum_{i \neq j} q_i q_j\right) + E. \tag{1}$$

That is, the utility is quadratic in the consumption of N downstream goods and linear in the expenditure on a numeraire good, E.[7] The parameter $\gamma \in [0, 1]$ measures substitutability among the final goods in the downstream market, ranging from 0 for independent goods to 1 for perfect substitutes. Consumers maximize utility subject to the following budget constraint:

$$\sum_{i=1}^{N} p_i q_i + E \leq \sum_{i=1}^{M} \pi_{B_i} + \sum_{j=1}^{N} \pi_{D_j} + S, \tag{2}$$

where $\sum_{i=1}^{M} \pi_{B_i}$, $\sum_{j=1}^{N} \pi_{D_j}$ and S denote the aggregate upstream profits, downstream profits and exogenous income, respectively. We again follow Häckner (2003) in assuming that the consumers do not internalize the effect of the final goods consumption on the firms' profits in the vertically related markets. With the first-order condition determining the optimal consumption of good i being

$$\frac{\partial U}{\partial q_i} = 1 - q_i - \gamma \sum_{j \neq i} q_j - p_i = 0,$$

[7] This quasilinear utility function was first proposed by Dixit (1979) in a setting of differentiated duopoly. Häckner (2000) extended it to allow for an arbitrary number of firms each producing one variant of the differentiated goods.

firm i's inverse demand is therefore given by

$$p_i = 1 - q_i - \gamma \sum_{j \neq i} q_j.$$

Firms in both the upstream and downstream markets are assumed to compete à la Cournot. One unit of input is transformed into one unit of the downstream good without additional cost. To procure the input from the upstream market, nonintegrated downstream firms pay the per unit market input price w, which they take as given, whereas the vertically integrated firm can acquire the input from its upstream division at cost.[8] The input is produced with a constant marginal cost that is normalized to zero. The total downstream production constitutes the derived demand for the input. w is determined by equating the input demand and input supply. We use backward induction to solve for the subgame perfect Nash equilibrium.

2.1 The Premerger Equilibrium

We first consider the benchmark case in which there is no vertical merger. An independent downstream firm D_i takes the input price w as given and chooses a quantity q_i to solve the following profit-maximization problem:

$$\max_{q_i} \pi_{D_i} = \left(1 - q_i - \gamma \sum_{j \neq i}^{N} q_j - w\right) q_i, \quad \forall_i \in \{1, 2, \cdots, N\}.$$

The symmetric downstream equilibrium quantity as a function of w for firm i is

$$q_i^*(w) = \frac{1 - w}{2 + \gamma N - \gamma},$$

and the total downstream production is

[8] This is how Greenhut and Ohta (1979) model successive oligopoly. In that seminal paper, the authors assume that both the upstream and downstream firms are Cournot oligopolists in their respective product markets while the downstream firms are price-takers in the input market. Together with the assumption that inputs are transformed into final goods in fixed proportion, a market-clearing condition equating the input supply and derived input demand solves the equilibrium input price. This approach is followed by subsequent research papers such as Salinger (1988), Higgins (1999), Gaudet and Long (1996), Häckner (2003), just to name a few.

$$Q^*(w) = N \cdot q_i^*(w) = \frac{N(1-w)}{2+\gamma N-\gamma}. \tag{3}$$

Since the downstream firms transform the input one for one, upstream market clearing requires that the input supply equals the derived input demand. Let b_k denote the input production of upstream firm k, then the market-clearing condition is given as follows:

$$\sum_{k=1}^{M} b_k = Q^*(w). \tag{4}$$

By combining equations (3) and (4), we derive the inverse demand for the input:

$$w = 1 - \frac{2+\gamma(N-1)}{N} \sum_{k=1}^{M} b_k.$$

An independent upstream firm B_k chooses a quantity b_k to solve the following profit-maximization problem.

$$\max_{b_k} \pi_{B_k} = w \cdot b_k, \quad \forall_k \in \{1, 2, \cdots, M\}.$$

The profit-maximizing amount of input supplied by each upstream firm is:

$$b_k^{NVI} = \frac{N}{(M+1)(2+\gamma N-\gamma)}.$$

Accordingly, the equilibrium input price and the downstream production for individual firm i are as follows:

$$w^{NVI} = \frac{1}{M+1}, \quad q_i^{NVI} = \frac{M}{(M+1)(2+\gamma N-\gamma)}. \tag{5}$$

The profits earned by an individual upstream and downstream firm are, respectively,

$$\pi_B^{NVI} = \frac{N}{(M+1)^2(2+\gamma N-\gamma)}, \quad \pi_D^{**} = \frac{M^2}{(M+1)^2(2+\gamma N-\gamma)^2}.$$

Social welfare is measured by the consumers' gross utility net of total payments for goods plus the firms' profits and the consumers' exogenous income. That is,

$$\mathrm{SW} = U(\mathbf{q}, E) - \sum_{i=1}^{N} p_i q_i - E + \sum_{i=1}^{M} \pi_{B_i} + \sum_{j=1}^{N} \pi_{D_j} + S.$$

Because we assume that the production costs are zero, the total expenditure of the consumers on the differentiated final goods must equal the total profits of the firms. That is,

$$\sum_{i=1}^{N} p_i q_i = \sum_{i=1}^{M} \pi_{B_i} + \sum_{j=1}^{N} \pi_{D_j}.$$

With the consumers' budget constraint in equation (2) being binding, it must be that $E = S$ and the social welfare is derived as

$$\mathrm{SW} = U(\mathbf{q}, E) = \sum_{i=1}^{N} q_i - \frac{1}{2}\left(\sum_{i=1}^{N} q_i^2 + 2\gamma \sum_{i \neq j} q_i q_j\right) + S. \tag{6}$$

Note that with quasilinear utility separable in the numeraire good, that is, $U(\mathbf{q}, E) = U(\mathbf{q}) + E$, the optimal consumption of the numeraire good is simply equal to the exogenous income S, and any change in S has no income effects on the oligopolistic sector.[9]

Substituting the equilibrium downstream productions into equation (6) yields the social welfare:

$$\mathrm{SW}^{NVI} = \frac{MN[(N-1)(2+M)\gamma + 3M + 4]}{2(M+1)^2(2+\gamma N - \gamma)^2} + S.$$

[9] This point is well documented in the literature. For examples, see Dixit (1979) and Singh and Vives (1984).

2.2 The Postmerger Equilibrium (i): The Merged Firm Exits the Upstream Market

Now, suppose that B_1 merges with D_1 to form a vertically integrated firm I.[10] Firm I's upstream division supplies the input to its downstream division at cost and does not externally buy or sell any input. In the downstream market, firm I chooses q_1 to maximize the following objective function:

$$\max_{q_1} \pi_I = \left(1 - q_1 - \gamma \sum_{i=2}^{N} q_i\right) q_1.$$

The nonintegrated downstream firm i, $i \in \{2, \cdots, N\}$, chooses q_i to maximize the following objective functions:

$$\max_{q_i} \pi_{D_i} = \left(1 - \gamma q_1 - q_i - \gamma \sum_{i \neq j}^{N} q_j - w\right) q_i, \quad \forall i, j \in \{2, \cdots, N\}.$$

Downstream profit-maximization yields the following equilibrium quantities as functions of w:

$$q_1^*(w) = \frac{\gamma N w - \gamma w - \gamma + 2}{(2-\gamma)(2+\gamma N - \gamma)}, \quad q_i^*(w) = \frac{2 - 2w - \gamma}{(2-\gamma)(2+\gamma N-\gamma)}. \tag{7}$$

The total downstream production is

$$Q^*(w) = q_1^*(w) + (N-1) q_i^*(w) = \frac{N - wN + w}{2 + \gamma N - \gamma}.$$

Again, given the upstream market-clearing condition,

$$\sum_{k=2}^{M} b_k = (N-1) \cdot q_i^*(w),$$

[10] To avoid unnecessary complications, we consider the simplest case in which only one integrated firm exists. Apart from providing expositional clarity and tractability for the model, this is also a "worst-case scenario" in the sense that the efficiency gains from the elimination of double marginalization are minimal. Therefore, if the vertical integration between one pair of upstream and downstream firms is welfare-improving, then the same result is expected to hold when more pairwise vertical integrations are considered.

we derive the inverse demand for the input as follows:

$$w = 1 - \frac{\gamma}{2} - \frac{(2-\gamma)(2+\gamma N-\gamma)}{2(N-1)} \cdot \sum_{k=2}^{M} b_k. \tag{8}$$

In the upstream market, a nonintegrated firm B_k's objective is

$$\max_{b_k} \pi_{B_k} = w \cdot b_k, \quad \forall k \in \{2, \cdots, M\}. \tag{9}$$

Upstream profit-maximization yields

$$b_k^{VIx} = \frac{(N-1)}{M(2+\gamma N-\gamma)}.$$

Accordingly, the equilibrium input price and downstream production quantities for the integrated firm and an independent firm i are as follows:

$$w^{VIx} = \frac{2-\gamma}{2M}, \;\; q_1^{VIx} = \frac{\gamma(N-1)+2M}{2M(2+\gamma N-\gamma)}, \;\; q_i^{VIx} = \frac{M-1}{M(2+\gamma N-\gamma)}.$$

The profits earned by the integrated firm 1, independent upstream and downstream firms are, respectively,

$$\pi_1^{VIx} = \frac{(4+\gamma N-\gamma)^2}{16(2+\gamma N-\gamma)^2}, \;\; \pi_B^{VIx} = \frac{(2-\gamma)(N-1)}{8(2+\gamma N-\gamma)}, \;\; \pi_D^{VIx} = \frac{1}{4(2+\gamma N-\gamma)^2}.$$

The social welfare is now

$$\begin{aligned} \text{SW}^{VIx} = & \frac{1}{8M^2(2+\gamma N-\gamma)^2}\{3\gamma^2(N-1)^2 + 4\gamma(N-1)(NM^2-N+M+2) \\ & + 4[(3M^2-2M-1)N+2M+1]\} + S. \end{aligned}$$

2.3 The Postmerger Equilibrium (ii): The Merged Firm Trades in the Upstream Market

In this section, we instead assume that the merged firm will continue to trade in the upstream market. Now firm I has a decision to make in both stages of production. It chooses its net sales of input in the upstream production stage; and given its upstream decision, it determines how much to produce downstream in the face of $N-1$ Cournot competitors. Let s_1 denote the amount of its net sales of input in the upstream market (if $s_1 < 0$, then it buys in the upstream market). Then, the downstream firms' objective functions are given as follows:

$$\begin{aligned} &\max_{q_1} \pi_I = \left(1 - q_1 - \gamma \sum_{i=2}^{N} q_i\right) q_1 + w s_1, \\ &\max_{q_i} \pi_{D_i} = \left(1 - \gamma q_1 - q_i - \gamma \sum_{j \neq i}^{N} q_j - w\right) q_i, \quad \forall_{i,j} \in \{2, \cdots, N\}. \end{aligned} \tag{10}$$

With firm I taking its own upstream net sales, s, as given, downstream profit-maximization yields the following equilibrium quantities as functions of w:

$$q_1^*(w) = \frac{\gamma N w - \gamma w - \gamma + 2}{(2-\gamma)(2+\gamma N - \gamma)}, \quad q_i^*(w) = \frac{2 - 2w - \gamma}{(2-\gamma)(2+\gamma N-\gamma)}. \tag{11}$$

The total downstream production is

$$Q^*(w) = q_1^*(w) + (N-1) q_i^*(w) = \frac{N - wN + w}{2 + \gamma N - \gamma}.$$

Combining equation (11) and the upstream market-clearing condition,

$$s_1 + \sum_{k=2}^{M} b_k = (N-1) \cdot q_i^*(w),$$

we derive the inverse demand for the input as follows:

$$w = 1 - \frac{\gamma}{2} - \frac{(2-\gamma)(\gamma N - \gamma + 2)}{2(N-1)} \left(s_1 + \sum_{k=2}^{M} b_k\right).$$

In the upstream market, foreseeing the equilibrium downstream production quantities, firm I chooses s_1 and firm B_k chooses b_k to maximize equations (10) and (9), respectively. Upstream profit-maximization yields

$$\begin{aligned} s_1 &= \frac{2(N-1)(2-2\gamma+\gamma^2-M\gamma+\gamma N-\gamma^2 N)}{(2+\gamma N-\gamma)G}, \\ b_k &= \frac{(N-1)(4-2\gamma+\gamma^2+2\gamma N-\gamma^2 N)}{(2+\gamma N-\gamma)G}, \end{aligned} \tag{12}$$

where

$$G \equiv 4(M+1)+2\gamma(M+1)(N-2)-\gamma^2(M+2)(N-1) > 0.$$ [11]

Accordingly, the equilibrium input price and downstream production quantities for the integrated firm I and an independent firm i are as follows:

$$\begin{aligned} w^{VIe} &= \frac{(2-\gamma)(4-2\gamma+\gamma^2+2\gamma N-\gamma^2 N)}{2G}, \\ q_1^{VIe} &= \frac{(2-\gamma)[2(M+1)+\gamma(N-1)]}{2G}, \qquad q_i^{VIe} = \frac{2M-\gamma(M+1)}{G}. \end{aligned} \tag{13}$$

The social welfare is now

$$\begin{aligned} \mathrm{SW}^{VIe} = \frac{1}{8G^2}\{&3\gamma^4(N-1)^2+4\gamma^3(N-1)(M+4)(NM+1)-4\gamma^2(4N^2M^2 \\ &-7NM^2+7N+12N^2M-4M-14NM-11+N^2)+16\gamma(N^2M^2 \\ &-2M+N+2N^2M-4NM^2-6NM-4)+16(3+2M+4NM \\ &+3NM^2)\}+S. \end{aligned}$$

Lemma 1 If the integrated firm trades in the upstream market, then it sells a positive amount of input in the upstream market, namely $s_1 > 0$, if and only if $2-\gamma^2 N+\gamma^2+\gamma N-2\gamma-M\gamma > 0$. As a corollary, the integrated firm buys (sells) a positive amount of input if and only if $\gamma > \overline{\gamma}$ ($\gamma < \overline{\gamma}$), where

[11] This is because $G > 4\gamma(M+1)+2\gamma(M+1)(N-2)-\gamma(M+2)(N-1) = \gamma(M+MN+2) > 0$.

$$\overline{\gamma} \equiv \frac{N-M-2+\sqrt{(N-M-2)^2+8(N-1)}}{2(N-1)}.$$

Furthermore, $\overline{\gamma}$ is increasing in N and decreasing in M.

Proof $\overline{\gamma}$ is derived directly from Equation (12). To determine how changes in N and M affect $\overline{\gamma}$, we take the partial derivatives of $\overline{\gamma}$ with respect to N and M and find:

$$\frac{\partial\overline{\gamma}}{\partial N}=\frac{\sqrt{(M^2+3M-MN+3N-2)^2+8(M-1)(N-1)^2}-(M^2+3M-MN+3N-2)}{2(N-1)^2\sqrt{(M-N)^2+4(M+N-1)}}>0,$$

and

$$\frac{\partial\overline{\gamma}}{\partial M}=\frac{(M-N+2)-\sqrt{(M-N+2)^2+8(N-1)}}{2(N-1)\sqrt{(M-N)^2+4(M+N-1)}}<0.$$

An integrated firm's incentives to foreclose its downstream rivals depend on downstream product differentiation and upstream and downstream market concentrations. The firm tends to foreclose its downstream rivals when the downstream products are close substitutes. By raising its rivals' costs, the integrated firm earns a larger profit downstream. However, when the downstream products are differentiated, downstream foreclosure is not a particularly profitable strategy – the firm is better off selling inputs to other downstream firms. Lemma 1 shows that for any $N>1$, there always exists a threshold level of differentiation $\overline{\gamma}$ such that strategic buying is profitable for any $\gamma>\overline{\gamma}$.

To put this result into perspective, we take a closer look at firm I's upstream optimization problem.

Since the downstream profit-maximization requires $p_1\cdot(1-\frac{1}{|\epsilon|})=0$, where $\epsilon\equiv\frac{\partial p_1}{\partial q_1}\frac{q_1}{p_1}$ denotes the price elasticity of demand for good 1, the integrated firm's upstream first-order condition can be simplified as follows:

$$\frac{\partial\pi_I(s_1)}{\partial s_1}=\left[\gamma q_1\cdot\sum_{i=2}^{N}\left(\frac{\partial p_1}{\partial q_i}\frac{\partial q_i}{\partial w}\right)+s_1\right]\cdot\frac{\partial w}{\partial s_1}+w=0. \tag{14}$$

Compared to the nonintegrated upstream firm's first-order condition,

$$\frac{\partial \pi_{B_k}(b_k)}{\partial b_k} = b_k \frac{\partial w}{\partial b_k} + w = 0, \tag{15}$$

one may find that s_1 is smaller than b_k in equilibrium because $\gamma q_1 \cdot \sum_{i=2}^{N}(\frac{\partial p_1}{\partial q_i}\frac{\partial q_i}{\partial w}) > 0$. Furthermore, the difference dwindles as γ becomes smaller and disappears as γ approaches zero. Intuitively, an integrated firm earns a higher profit downstream if it can raise the input price by selling less or even buying inputs. However, when the downstream products become differentiated, an integrated firm acts more like any other nonintegrated upstream firm because the benefit of raising downstream rivals' costs diminishes.

The second part of Lemma 1 states that strategic buying is profitable only if the downstream market is more concentrated and/or the upstream market is less concentrated.[12] This profitability occurs because more strategic buying is required to raise the input price by one unit when there are more downstream firms; however, a one-unit increase in the input price can only yield reduced downstream profits for the integrated firm if the downstream market is more competitive. Therefore, the threshold $\overline{\gamma}$ becomes higher as N increases. In contrast, a more concentrated upstream market gives rise to a higher opportunity cost for strategic buying because selling the input now becomes more profitable. Therefore, the threshold $\overline{\gamma}$ becomes higher as M decreases.

3. WELFARE COMPARISONS

Theorem 1 Compared to the case in which the integrated firm exits the upstream market, trading in the upstream market increases welfare if and only if the integrated firm sells the intermediate good. That is, $\text{SW}^{VIe} > \text{SW}^{VIx}$ if and only if $s_1 > 0$.

Proof Let $\Delta\text{SW}_{ex} \equiv \text{SW}^{VIe} - \text{SW}^{VIx}$; then,

$$\Delta\text{SW}_{ex} = \frac{(N-1)(2-\gamma^2 N+\gamma^2+\gamma N-2\gamma-M\gamma)}{2M^2(2+\gamma N-\gamma)^2[(2+M)(N-1)\gamma^2-2(M+1)(2+\gamma N-2\gamma)]^2}\cdot A(M,N,\gamma).$$

[12] These results have been discussed in Wang et al. (2005) and Wen et al. (2016).

where

$$
\begin{aligned}
A(M,N,\gamma) \equiv\ & 3(N-1)^2(M+1)\gamma^4+(N-1)(2M^2+21M+14-10MN-7N)\gamma^3 \\
& +[2N(2M+1)(-2M-13+2N)+(56M+12M^2+26)]\gamma^2 \\
& +(12N-24+8NM^2+32NM-68M-24M^2)\gamma+8(2M^2+4M+1).
\end{aligned}
$$

To show that $A(M,N,\gamma) > 0$, first notice that

$$\frac{\partial^2 A(M,N,\gamma)}{\partial N^2} = 2\gamma^2(4-3\gamma)(2M+1-M\gamma-\gamma) > 0.$$

With

$$
\begin{aligned}
\left.\frac{\partial A(M,N,\gamma)}{\partial N}\right|_{N=1} = \ & \gamma\{2(2-\gamma)^2M^2+[20(1-\gamma)^2+3(4-3\gamma^2)]M+9(1-\gamma)^2 \\
& +3-2\gamma^2\} > 0,
\end{aligned}
$$

we know that $A(M,N,r)$ is increasing in N. Since

$$\left.A(M,N,\gamma)\right|_{N=1} = 4(2-\gamma)^2M^2+[9(1-\gamma)^2+7-5\gamma^2]M+4(1-\gamma)(2-\gamma) > 0,$$

we conclude that $A(M,N,\gamma) > 0$ for all $\gamma \in [0,1]$. Therefore,

$$\text{sgn}\{\Delta \text{SW}_{ex}\} = \text{sgn}\{2-\gamma^2N+\gamma^2+\gamma N-2\gamma-M\gamma\}.$$

Using this result and invoking Lemma 1, we have completed the proof.

Figures 1 and 2 provide two examples of Theorem 1. Setting $M=2$, for $N=2$ and $N=3$, the corresponding $\overline{\gamma}$ values are 0.732 and 0.78, respectively. When $\gamma > \overline{\gamma}$, $\text{SW}^{VIe} < \text{SW}^{VIx}$ because strategic buying increases the input price and, in turn, reduces the production quantities of the nonintegrated downstream firms. However, when $\gamma < \overline{\gamma}$, input selling becomes operative, a reduced input price increases downstream production quantities and $\text{SW}^{VIe} > \text{SW}^{VIx}$.

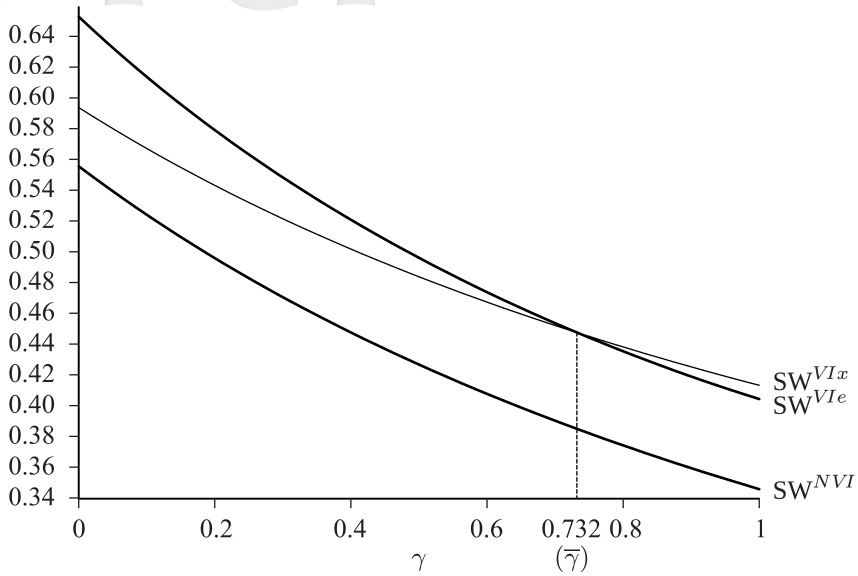

Figure 1 Welfare Comparisons with $M = 2$ and $N = 2$

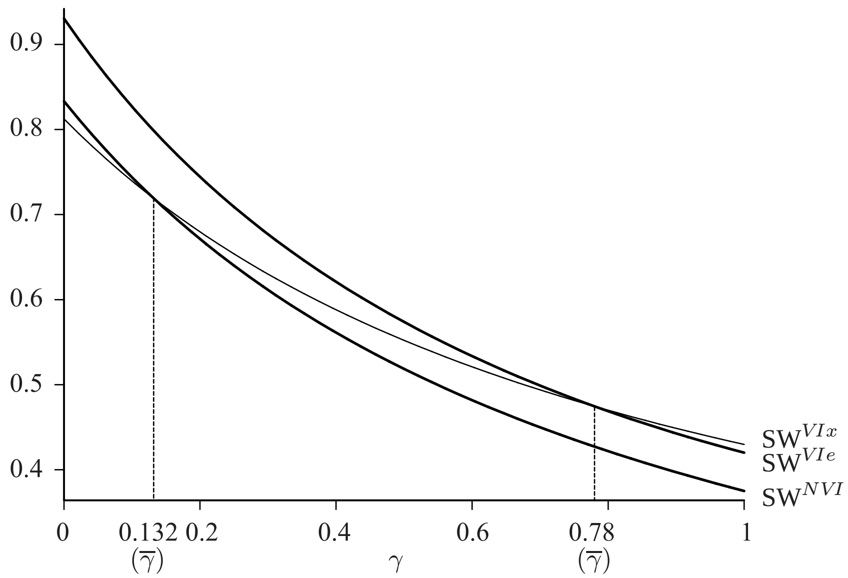

Figure 2 Welfare Comparisons with $M = 2$ and $N = 3$

Theorem 2 If the integrated firm exits the upstream market and both M and N are natural numbers greater than 1, then for $N \leq M$, vertical integration increases welfare; for $M < N$, there exists a unique threshold level of product differentiation, $\hat{\gamma}$, such that vertical integration reduces welfare if $\gamma < \hat{\gamma}$. However, if the integrated firm trades in the upstream market, vertical integration always increases welfare for all $\gamma \in [0, 1]$.

Proof See Appendix.

The first statement of Theorem 2 paraphrases the main result of Häckner (2003)'s Proposition 1. It is the interplay between the aforementioned market structure effect and cost effect that determines whether the vertical integration is welfare-improving. Intuitively, the adverse market structure effect which results from the merged firm's exiting upstream market is more pronounced when the upstream market is relatively concentrated. Furthermore, "[w]hen products are differentiated, changes in the marginal cost of one firm will have a relatively small impact on the pricing decisions of other firms in the downstream market."[13] Therefore, when these two conditions hold at the same time, the market structure effect dominates and the vertical integration reduces welfare.[14]

The second statement is the main result of this paper: vertical integration is in fact always welfare-improving, provided that the integrated firm trades in the upstream market. The reason is that, by invoking Lemma 1, the integrated firm will now sell the input if the downstream products are differentiated. In the following, we use Figures 1 and 2 to illustrate these two statements.

In Figure 1, $M = N = 2$; this is a case in which $\text{SW}^{VIx} > \text{SW}^{NVI}$ for all $\gamma \in [0, 1]$. For $\gamma < \overline{\gamma}$, $\text{SW}^{VIe} > \text{SW}^{VIx}$ and, therefore, $\text{SW}^{VIe} > \text{SW}^{NVI}$; for $\gamma > \overline{\gamma}$, although $\text{SW}^{VIe} < \text{SW}^{VIx}$ due to the strategic buying, the cost effect stemming from the amelioration of double marginalization is stronger than the strategic buying effect and, therefore, $\text{SW}^{VIe} > \text{SW}^{NVI}$.

In Figure 2, $M = 2$ and $N = 3$; this is a case in which the adverse market structure effect resulting from the merged firm's exiting the upstream market is more pronounced. It shows that $\text{SW}^{VIx} < \text{SW}^{NVI}$ for $\gamma < \hat{\gamma} = 0.132$. Now, the input selling effect will completely compensate for the adverse market structure effect and

[13] Häckner (2003, p. 220).

[14] As shown in the Appendix, $\hat{\gamma} > 0$ if and only if $N > \tilde{N} \equiv (2M+1)(M+1)^2/(2M^2+4M+1)$. Since $M < \tilde{N} < M+1$, when M and N are restricted to natural numbers, the condition that $N \leq M$ must imply $N < \tilde{N}$; $N > M$ must imply $N > \tilde{N}$.

render $\mathrm{SW}^{VIe} > \mathrm{SW}^{NVI}$.

To disentangle the various forces at work, we can rearrange the social welfare function (6) as follows:

$$\mathrm{SW} = \sum_{i=1}^{N} q_i - \frac{\gamma}{2}\left(\sum_{i=1}^{N} q_i\right)^2 - \frac{1-\gamma}{2}\sum_{i=1}^{N} q_i^2 + S. \tag{16}$$

To determine how the cost effect dominates the strategic buying effect when the downstream goods are close substitutes, we first consider the case in which $\gamma = 1$. Using equation (16), we have

$$\begin{aligned}\mathrm{SW}^{VIe} - \mathrm{SW}^{NVI} &= \left(\sum_{j=1}^{N} q_j^{VIe} - \sum_{j=1}^{N} q_j^{NVI}\right) - \frac{1}{2}\left[\left(\sum_{j=1}^{N} q_j^{VIe}\right)^2 - \left(\sum_{i=1}^{N} q_j^{NVI}\right)^2\right] \\ &= \left(\sum_{j=1}^{N} q_j^{VIe} - \sum_{j=1}^{N} q_j^{NVI}\right)\left[1 - \frac{1}{2}\left(\sum_{j=1}^{N} q_j^{VIe} + \sum_{j=1}^{N} q_j^{NVI}\right)\right].\end{aligned}$$

Note that $\sum_{j=1}^{N} q_j^{VIe} < 1$ and $\sum_{j=1}^{N} q_j^{NVI} < 1$ when the firms compete à la Cournot. Therefore, $\mathrm{SW}^{VIe} > \mathrm{SW}^{NVI}$ if $\sum_{j=1}^{N} q_j^{VIe} > \sum_{j=1}^{N} q_j^{NVI}$. Now according to equations (5) and (13),

$$\sum_{j=1}^{N} q_j^{VIe}\Big|_{\gamma=1} - \sum_{j=1}^{N} q_j^{NVI}\Big|_{\gamma=1} = \frac{(M-1)N^2 + 2N + 3M + 3}{2(MN + M + 2)(M+1)(N+1)} > 0.$$

which shows that vertical integration with trades in the upstream market is welfare-improving.

In contrast, to determine how the input selling effect completely offsets the adverse structure effect when the downstream goods are differentiated, we consider the case in which $\gamma = 0$. Again, we use equation (16) and have

$$\mathrm{SW}^{VIe} - \mathrm{SW}^{NVI} = \left(\sum_{j=1}^{N} q_j^{VIe} - \sum_{j=1}^{N} q_j^{NVI}\right) - \frac{1}{2}\left[\sum_{j=1}^{N}(q_j^{VIe})^2 - \sum_{j=1}^{N}(q_j^{NVI})^2\right]. \tag{17}$$

Now, according to equations (5) and (13), all of the nonintegrated downstream firms, regardless of whether they coexist with a vertically integrated firm, face an input price

$w = \frac{1}{M+1}$ and produce a quantity of $\frac{M}{2(M+1)}$.[15] Therefore, equation (17) is reduced to

$$\begin{aligned}\mathrm{SW}^{VIe} - \mathrm{SW}^{NVI} &= \left(q_1^{VIe} - q_j^{NVI}\right) - \frac{1}{2}[(q_1^{VIe})^2 - (q_j^{NVI})^2] \\ &= \left(q_1^{VIe} - q_j^{NVI}\right)\left[1 - \frac{1}{2}(q_1^{VIe} + q_j^{NVI})\right] > 0.\end{aligned}$$

In this case, the welfare increases because although all nonintegrated downstream firms produce the same amount of output, as they face no vertically integrated firm, the integrated firm now produces more due to the elimination of double marginalization.

4. CONCLUSION

In this study, we show that a vertical merger in markets with downstream product differentiation is always welfare-improving if the merged firm continues to trade in the upstream market. This result contrasts sharply with those derived in previous studies. A vertically merged firm's trading in the upstream market has a previously neglected effect on welfare: the firm tends to be a net seller in the upstream market when the downstream goods are differentiated. This input selling effect mitigates the adverse structure effect emphasized in the literature and makes a vertical merger welfare-improving in the face of downstream product differentiation. Therefore, in addition to market shares and concentration ratios, it is likely worthwhile for the antitrust authorities to scrutinize upstream trading patterns when assessing the welfare effect of a vertical merger.

There are, of course, limitations to our stylized model. First, in the current analysis, the downstream product differentiation is assumed to be exogenous. Matsushima (2009) and Zanchettin and Mukherjee (2017) are two papers that endogenize the choice of downstream product differentiation. The former adopts a Hotelling-type location model to show that vertical integration may enhance downstream product differentiation, which increases the final consumer's transport costs and, in turn, reduces social

[15] When there is no vertical integration, if downstream demand is linear, then a change in the number of downstream firms only pivots the derived input demand around the initial vertical intercept. Now, with a constant upstream marginal cost, the input price is solely determined by the number of upstream firms. In contrast, when there is a vertically integrated firm but all of the downstream markets are unrelated, as shown by equations (14) and (15), the integrated firm simply acts like a nonintegrated firm in the upstream market. Therefore, the input price is identical to that without vertical integration.

welfare. The latter considers an upstream monopolist selling a generic input to two downstream firms producing differentiated outputs. They show that vertical integration may reduce social welfare by inducing too much or too little product differentiation. Since the model employed in Zanchettin and Mukherjee (2017) is close to ours, how adding upstream competition to their model would affect the welfare implications is an interesting topic for future research.

Second, how a vertical merger alters the incentives for downstream investments is an issue that has attracted antitrust attention. The EU Non-Horizontal Merger Guidelines state the following:

> More generally, a vertical merger may align the incentives of the parties with regard to investments in new products, new production processes and in the marketing of products. For instance, whereas before the merger, a downstream distributor entity might have been reluctant to invest in advertising and informing customers about the qualities of products of the upstream entity when such investment would also have benefited the sale of other downstream firms, the merged entity may reduce such incentive problems.[16]

Buehler and Schmutzler (2008) examine the interplay between endogenous vertical integration and cost-reducing downstream investments in a successive oligopoly with homogeneous downstream products. They find that vertical integration increases own investments but discourages investments by competitors. This hold-up problem is further studied by Allain et al. (2016). They show in a successive duopoly that vertical integration not only provides *ex ante* incentives to discourage a downstream rival's investments, but also creates hold-up problems *ex post* by providing degraded input to its downstream rival if the quality is unverifiable. It would be interesting to extend our analysis by allowing for *ex ante* and *ex post* hold-up possibilities and investigate the welfare implications in a context with downstream product differentiation.

[16] Guidelines on the assessment of non-horizontal mergers under the Council Regulation on the control of concentrations between undertakings (2008/C 265/07), paragraph 57.

APPENDIX

Proof of Theorem 2 For the first statement, let $\Delta\mathrm{SW}_{xn} \equiv \mathrm{SW}^{VIx} - \mathrm{SW}^{NVI}$. Using the results from previous sections, we have

$$\begin{aligned}\Delta\mathrm{SW}_{xn} = {} & \frac{1}{8M^2(M+1)^2(2+\gamma N-\gamma)^2}\{\gamma[3(M+1)^2\gamma - 4(2M+1)]N^2 \\ & - [6(M+1)^2\gamma^2 - 4(M^3+4M^2+7M+3)\gamma + 4(2M^2+4M+1)]N \\ & + (2-\gamma)(M+1)^2(4M+2-3\gamma)\}.\end{aligned}$$

Let

$$\begin{aligned}C(M,N,\gamma) \equiv {} & \gamma[3(M+1)^2\gamma - 4(2M+1)]N^2 - [6(M+1)^2\gamma^2 \\ & - 4(M^3+4M^2+7M+3)\gamma + 4(2M^2+4M+1)]N \\ & + (2-\gamma)(M+1)^2(4M+2-3\gamma).\end{aligned}$$

Therefore,

$$\mathrm{sgn}\{\Delta\mathrm{SW}_{xn}\} = \mathrm{sgn}\{C(M,N,\gamma)\}.$$

Note that $C(M,N,\gamma)$ is strictly convex in γ because

$$\frac{\partial^2 C(M,N,\gamma)}{\partial\gamma^2} = 6(M+1)(N-1)^2 > 0.$$

Setting $C(M,N,\gamma)=0$ and solving for γ give two roots:

$$\begin{aligned}\hat{\gamma} = {} & \frac{2}{3(M+1)^2(N-1)}\Big\{(2M+1)N - (M+1)^2(M+2) \\ & + \sqrt{(2M+1)^2N^2 + (M+1)^2(2M^2+2M-1)N + (M-1)^2(M+1)^4}\Big\},\end{aligned}$$

and

$$\hat{\gamma}' = \frac{2}{3(M+1)^2(N-1)}\Big\{(2M+1)N-(M+1)^2(M+2) - \sqrt{(2M+1)^2N^2+(M+1)^2(2M^2+2M-1)N+(M-1)^2(M+1)^4}\Big\}<0, \quad \forall N>1.$$

A straightforward calculation yields $\hat{\gamma}>0$ if and only if $N>\tilde{N}\equiv(2M+1)(M+1)^2/(2M^2+4M+1)$. Therefore, when $N<\tilde{N}$, $\Delta\text{SW}_{xn}>0$ for any $\gamma\in[0,1]$ because $\hat{\gamma}<0$. However, when $N>\tilde{N}$, with $\hat{\gamma}>0$ and $\hat{\gamma}'<0$, the convexity of $C(M,N,\gamma)$ guarantees that $\Delta\text{SW}_{xn}<0$ for all $\gamma\in[0,\hat{\gamma}]$. Since $M<\tilde{N}<M+1$, when M and N are natural numbers, the condition that $N\le M$ must imply $N<\tilde{N}$; $N>M$ must imply $N>\tilde{N}$.

For the second statement, let $\text{SW}_{en}\equiv\text{SW}^{VIe}-\text{SW}^{NVI}$. Using the results from previous sections, we have

$$\begin{aligned}\Delta\text{SW}_{en} = {} & \frac{1}{8(M+1)^2\{(2-\gamma)[(2+\gamma N-\gamma)M+2(N+\gamma N-\gamma)]-4(N-1)\}^2(2+\gamma N-\gamma)^2}\\ & \cdot\{3\gamma^6(M+1)^2(N-1)^4-4\gamma^5(N-1)^3(3M^2N+4MN-M^3-9M^2-15M-7)\\ & +4\gamma^4(N-1)^2[(M+1)(3M-1)N^2-(4M^3+28M^2+32M+7)N+2(M+1)^2(4M+15)]\\ & +16\gamma^3(M+1)(N-1)[M(M+4)N^2-(6M^2+22M+12)N+7M^2+26M+19]\\ & +16\gamma^2(M+1)[2(2M^2+6M+3)N^2-(16M^2+51M+33)N+2(M+1)(7M+15)]\\ & +64\gamma(M+1)^2[(4+2M)N-4M-7]+64(M+1)^2(2M+3)\}.\end{aligned}$$

Let $B(M,N,\gamma)$ denote the numerator of ΔSW_{en}; then, for all $\gamma\in[0,1]$, we claim that $B(M,N,\gamma)>0$ and therefore $\Delta\text{SW}_{en}>0$. To establish the claim, first notice that $B(M,N,\gamma)|_{\gamma=0}=64(2M+3)(M+1)^2>0$. Next, to show $B(M,N,\gamma)>0$ for $\gamma\in(0,1]$, we take the first-, second- and third-order partial derivatives of $B(M,N,r)$ with respect to N and evaluate them at $N=1$ as follows:

$$\frac{\partial B(M,N,\gamma)}{\partial N}\bigg|_{N=1} = 4\gamma\Big\{8(2-\gamma)^2M^3+\frac{1}{32}[(64-35\gamma)^2+55\gamma^2]M^2 +\frac{4}{5}[8(5-3\gamma)^2+3\gamma^2]M+\frac{1}{16}[(32-21\gamma)^2+7\gamma^2]\Big\}>0, \quad \text{(A1)}$$

$$
\begin{aligned}
\left.\frac{\partial^2 B(M,N,\gamma)}{\partial N^2}\right|_{N=1} &= 4\gamma^2\left\{8(2-\gamma)^2M^3+\frac{1}{2}[(16-9\gamma)^2+3\gamma^2]M^2\right.\\
&\quad\left.+\frac{4}{9}[(18-13\gamma)^2+2\gamma^2]M+48-96\gamma+44\gamma^2\right\}\\
&> 4\gamma^2\left\{8(2-\gamma)^2+\frac{1}{2}[(16-9\gamma)^2+3\gamma^2]\right.\\
&\quad\left.+\frac{4}{9}[(18-13\gamma)^2+2\gamma^2]+48-96\gamma+44\gamma^2\right\}\\
&= \frac{8}{11}\gamma^2[4(22-15\gamma)^2+35\gamma^2]>0, \qquad \text{(A2)}
\end{aligned}
$$

$$
\begin{aligned}
\left.\frac{\partial^3 B(M,N,\gamma)}{\partial N^3}\right|_{N=1} &= 24\gamma^3\left\{[(2-\gamma)^2M^3+2(2-\gamma)(5-3\gamma)M^2+\frac{1}{4}[(8-7\gamma)^2\right.\\
&\quad\left.-5\gamma^2]M-9\gamma+7\gamma^2\right\}\\
&> 24\gamma^3\left\{[(2-\gamma)^2M^3+\frac{1}{4}(8-7\gamma)^2M+2(2-\gamma)(5-3\gamma)\right.\\
&\quad\left.-\frac{5}{4}\gamma^2-9\gamma+7\gamma^2\right\},\\
&= 24\gamma^3\left\{[(2-\gamma)^2M^3+\frac{1}{4}(8-7\gamma)^2M+\frac{31}{2}(1-\gamma)^2\right.\\
&\quad\left.+\frac{9}{2}-\frac{15}{4}\gamma^2\right\}>0. \qquad \text{(A3)}
\end{aligned}
$$

Then we take the fourth-order partial derivatives of $B(M,N,r)$ with respect to N, yielding

$$
\begin{aligned}
\frac{\partial^4 B(M,N,\gamma)}{\partial N^4} &= 24\gamma^4[3(1-\gamma)^2M^2+3(3-2\gamma)M^2+2(2-3\gamma)(2-\gamma)M-4+3\gamma^2]\\
&> 24\gamma^4\{3(1-\gamma)^2M^2+[3(3-2\gamma)+2(2-3\gamma)(2-\gamma)]M-4+3\gamma^2\}\\
&= 24\gamma^4\{3(1-\gamma)^2M^2+[11(1-\gamma)^2+6-5\gamma^2]M-4+3\gamma^2\}\\
&> 24\gamma^4[3(1-\gamma)^2M^2+11(1-\gamma)^2+6-5\gamma^2-4+3\gamma^2]\\
&= 24\gamma^4[3(1-\gamma)^2M^2+11(1-\gamma)^2+2(1-\gamma^2)]\geq 0. \qquad \text{(A4)}
\end{aligned}
$$

With $M > 1$, equation (A4) shows that $\partial^3 B(M, N, \gamma)/\partial N^3$ is strictly increasing in N. Because $N > 1$, equations (A3) and (A4) together imply that $\partial^3 B(M, N, \gamma)/\partial N^3 > 0$ for all N, or equivalently, $\partial^2 B(M, N, \gamma)/\partial N^2$ is strictly increasing in N. This result together with equation (A2) in turn implies that $\partial B(M, N, \gamma)/\partial N$ is strictly increasing in N. Again, this result together with equation (A1) implies that $B(M, N, \gamma)$ is strictly increasing in N. With $B(M, N, r)|_{N=1} = 16(2M + 3)(M + 1)^2(2 - \gamma)^2 > 0$, it is concluded that $B(M, N, r) > 0$ for $\gamma \in (0, 1]$. This establishes the claim.

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下游異質產品競爭下增進福利的垂直結合

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摘　要

本文探討下游異質競爭下的垂直結合的福利效果。過去的研究發現, 如果下游產品的異質程度高, 而且垂直結合後的廠商不再參與中間財市場的買賣, 則垂直結合傾向於降低福利; 原因是上游廠商家數的減少會提高中間財價格, 從而減少下游的產出。本文與過去文獻不同之處在於假設垂直結合後的廠商會繼續在上游市場買賣中間財。在此假設下, 垂直結合一定會提升福利; 因為當下游產品的異質程度高時, 垂直結合後的廠商會在上游市場賣出中間財。