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# Vertical Merger: Monopolization for Downstream Quasi-rents

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**This paper provides a welfare analysis of vertical merger between an input monopolist and downstream firms that compete perfectly in a homogeneous product market. The distinguishing feature of the present model is that the downstream firms face capacity constraints. As a result of downstream quasi-rents, vertical merger—the extent of merger is gauged by the capacity share of the acquired downstream firm—may either raise or lower final output. An analytical criterion for distinguishing pro- and anti-competitive mergers is derived, which relies entirely on pre-merger market quantities and the capacity share of the downstream target. A common result is that vertical merger is output-increasing even when unaffiliated downstream rivals are completely foreclosed. Copyright © 2008 John Wiley & Sons, Ltd.**

## INTRODUCTION

Vertical merger has been thoroughly studied from several standpoints: limits to firm organization, monopoly leveraging, as a substitute for non-linear contracts and price discrimination, the presumption of one monopoly profit, strategic behavior and so on. There is at least one situation that to my knowledge has received no attention in the literature.[1] It is possible, indeed, probable that the oversight is the result of its theoretical simplicity. In fact, the model and its results may be well known among economists. In any event, the implications of this simple model of vertical merger are not common knowledge among antitrust attorneys. Moreover, the heat generated by professional exchanges among antitrust practitioners—economists and attorneys, alike—about the need for vertical merger guidelines and enforcement suggests the importance of formally describing this model.

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When a non-vertically integrated input monopolist supplies a perfectly competitive downstream market in which the monopolized input is combined with other inputs to produce a final product at increasing marginal cost, vertical integration is not neutral in its allocative effects. This conclusion applies even when third-degree price discrimination is feasible prior to vertical integration and the (monopolized) input/output ratio is constant, provided the upstream monopolist cannot replicate vertical integration through contract or non-linear pricing. Failure to recognize this aspect of vertical merger is especially surprising since antitrust analysis is all about the short run. That is, merger evaluations are made within a time frame in which essential, fixed inputs are committed to the market. In such instances, constant marginal cost is atypical. Diminishing marginal productivity is the essence of the short run.

The following is demonstrated for the case of linear demand and marginal cost: (1) vertical merger is almost always profitable; (2) vertical merger always harms unaffiliated downstream competitors; (3) vertical merger sometimes results

in complete foreclosure of the monopolized input to unaffiliated downstream rivals; and (4) vertical merger more often than not raises consumer welfare even when it results in complete foreclosure.

As indicated in (4), the pro-competitive effect of vertical merger under the posited circumstances is not general. However, it is a simple matter to describe conditions necessary and sufficient for increasing consumer welfare in terms of readily observable pre-merger market quantities. These conditions involve downstream market demand elasticity and variable contribution margins. A principal goal of this paper is to describe these conditions explicitly.

## LITERATURE REVIEW

The welfare analysis of vertical merger has a controversial history.[2] From the perspective of applied antitrust economics, in contrast to that of the history of economic thought, this history begins with the Chicago School critique of vertical input foreclosure based on the hypothesis of one monopoly profit (McGee and Bassett, 1976; Director and Levi, 1956).[3] These authors demonstrated that with fixed input proportions and constant marginal cost, vertical merger of an input monopolist and some or all of downstream capacity would be competitively neutral. That is, such an input monopolist would be indifferent between integrating forward and controlling the downstream market solely through its choice of input price. That this long-run, fixed-proportions assumption was ever thought to be generally applicable by Chicagoans is doubtful; however, careful exegesis is irrelevant here. What matters here is that theorists quickly demonstrated that the 'neutrality' result is driven by the fixed-proportions assumption and that with variable proportions the potential for an allocative effect indeed exists (see, for example, Vernon and Graham, 1971), even under conditions of constant returns to scale.

With variable proportions, an input monopolist that can only control resource use through single-part pricing will find that vertical integration is profitable (Blair and Kaserman, 1978). The gains from trade arise because in the absence of vertical control the input demanders contract their use of the monopolized input as its price is raised, thereby combining variable inputs inefficiently. In contrast, with vertical integration, the input monopolist is able to direct efficient resource use in its own downstream operations, which enables it to squeeze out its downstream rivals. Thus, vertical merger provides the input monopolist with additional downstream market power while at the same time enabling more efficient input use. On balance, vertical merger may raise or lower total welfare (Warren-Boulton, 1974). Subsequently, Westfield (1981) proved analytically that vertical merger may even raise consumer welfare.

Ultimately, the outcome in terms of total or consumer welfare depends on the relationship between the following several quantities, the last of which is hard to measure: final demand elasticity, the cost of the input relative to overall marginal cost in the no-integration state and the elasticity of input substitution. To date, the difficulty in informing this determinative relationship has prevented antitrust analysts from evaluating the competitive effects of vertical merger in this context. In response, antitrust practitioners have embraced what facially appears to be a new theory of vertical integration.

The so-called theory of 'raising rivals costs' (RRC) has recently been used as the basis for predicting the competitive effect of vertical merger. Originally devised by Salop and Scheffman (1983, 1987) as a basis for analyzing extra-market predatory practices, including practices condemned in the first instance by non-antitrust law, RRC implies that vertical merger by an input monopolist has ambiguous welfare consequences. Subsequently, several authors have been inspired by RRC to create models suggesting that vertical merger may be anticompetitive in less restrictive fact situations. Specifically, Salinger (1988) purports to show that with oligopolistic competition in both the input and output markets—viz., Cournot quantity setting—an increase in vertical integration may or may not result in a higher merchant-market input price (i.e. in foreclosure) and, in the case of foreclosure, may or may not result in a higher downstream price. Ordover, Saloner and Salop (1990) (hereafter, OSS) demonstrate that even with perfect competition upstream, vertical merger will reduce consumer welfare under some circumstances and that this foreclosure equilibrium is impervious to counter-strategies. Both the Salinger and the OSS models



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depend critically on a built-in foreclosure assumption that may only be rational in a dynamic context, as it appears to require either commitment or an implicit self-enforcing agreement.[4]

In the foregoing models, including the RRC models, the factual circumstances that permit a reasonable decision about the welfare effects of vertical merger are difficult to evaluate. The present paper seeks a partial redress of these conditions. Also, all of the models cited assume that the market of the foreclosed rivals or, alternatively, the market into which market power is leveraged exhibits constant marginal cost. In contrast, unlike these previous models, the present model describes short-run price determination. That is, there are sunk costs, rising marginal cost and competitive downstream quasi-rents. A short-run model is especially relevant for purposes of antitrust evaluations, which are almost entirely short-run assessments.

## THE MODEL ASSUMPTIONS

In this section, the assumptions underlying the model adopted here are made explicit. Linear demand and quadratic cost functions are presumed.

1. $Q^{\mathrm{d}} = a + bP$. Linearity is likely to be appropriate for the range of output changes caused by vertical merger. And, as has been observed by several antitrust practitioners (Werden and Froeb, 1994), linear demand has the advantage over constant-elasticity demand that buyers turn away in larger percentages as price is increased which, unlike the log-linear model, is consistent with the facts surrounding the *cellophane fallacy*.[5]
2. Short-run marginal cost increases, which is reasonable for short-run output changes. And, as in the case of demand, marginal cost is assumed to be linear for the incremental output changes entailed by vertical merger. There are two alternative cost functions. In Case 1, there are two downstream rivals with marginal costs, $\mathrm{MC}_A = P_A + cQ_A/s$ and $\mathrm{MC}_B = P_B + cQ_B/(1-s)$; $s$ and $1-s$ are the capacity shares of the downstream duopolists.[6] In Case 2, $\mathrm{MC}_A = (P_A + c)Q_A/s$ and $\mathrm{MC}_B = (P_B + c)Q_B/(1-s)$. In Case 1, the input/output ratio is fixed at unity without loss of generality and, as the input price rises, the marginal cost function is translated upward. In contrast, in Case 2, the input/output ratio increases with output and, as the input price rises, the marginal cost function rotates counterclockwise.[7]
3. There is perfect downstream competition: $Q^{\mathrm{d}} = Q^{\mathrm{s}}_A + Q^{\mathrm{s}}_B$, notwithstanding the duopoly market structure downstream. Price taking may be more acceptable when there are many downstream rivals; however, none of the results is affected by the number of downstream rivals, provided there is perfect competition among them. The perfect competition assumption militates against pro-competitive vertical integration since there is then no double marginalization to mitigate.
4. The input monopolist produces at zero marginal cost.
5. There is no arbitrage of $P_A$ and $P_B$ in the absence of vertical integration. Price discrimination, which is intrinsic to vertical integration, is assumed to be feasible in its absence to avoid attributing competitive effects to vertical integration that more correctly depend on the ability to price discriminate acquired through vertical merger.
6. Without vertical integration, the monopolist chooses $P_A$ and $P_B$ in stage 1 and, in stage 2, the two downstream firms engage in Bertrand competition and equate downstream marginal cost to price; the monopolist anticipates $Q^{\mathrm{d}} = Q^{\mathrm{s}}$, given $P_A$ and $P_B$, and acts like a Stackelberg leader, maximizing profit on input sales.
7. With vertical integration, the integrated monopolist chooses $P_A$ and $P_B$ in stage 1, anticipating the reactions of the perfectly competitive downstream firms, as in 6. However, with vertical integration, the monopolist's objective function is the sum of profit on sales of the input and the quasi-rent earned by its downstream affiliate.[8]

### Case 1: $\mathrm{MC}_x = P_x + (c/s_x)Q_x$

*No vertical integration*. The input monopolist chooses $P_A$ and $P_B$ to maximize $P_AQ_A + P_BQ_B$, or

$$s(P - P_A)P_A/c + (1-s)(P - P_B)P_B/c, \tag{1}$$

subject to $Q^{\mathrm{d}} = Q^{\mathrm{s}}$.

The marginal conditions imply

$$P^*_A = P^*_B = a/-2b, \tag{2a}$$



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$$Q_T^* = a/2(1 - bc), \tag{2b}$$

$$Q_A^* = sa/2(1 - bc), \tag{2c}$$

$$Q_B^* = (1 - s)a/2(1 - bc), \tag{2d}$$

$$P^* = (a/ - 2b)(1 - 2bc)/(1 - bc). \tag{2e}$$

Each downstream firm has sales share equal to its capacity share. Final good output, $Q_T^*$, is produced at minimum cost net of outlays for the monopolized input; the firms' marginal costs are equal with and without reckoning the downstream input costs. Regardless of the capacity shares of the downstream firms, they are charged the same input price. While price discrimination is feasible, there is no profit in it here for the upstream monopolist—given the linear–quadratic model.

The profit enjoyed by the input monopolist is equal to $a^2/ - 4b(1 - bc)$, and the profit enjoyed by the downstream firm with $s$ percent of capacity is equal to $sca^2/8(1 - bc)^2$. Total welfare is $3a^2/ - 8b(1 - bc)$.

*Vertical integration*. The input monopolist buys $A$'s capacity. The post-merger input prices will differ generally because the input monopolist now considers the quasi-rent loss at its downstream affiliate that results when $A$ pays a higher input price $P_A$, which quasi-rent it ignores as an unintegrated supplier. Analytically, the monopolist is assumed to choose $P_A$ and $P_B$ to maximize

$$Q^{\mathrm{d}}(P)P - cQ_A^2/2s - cQ_B^2/2(1 - s) - (P - P_B)^2(1 - s)/2c, \tag{3}$$

subject to $Q^{\mathrm{d}} = Q_A^{\mathrm{s}} + Q_B^{\mathrm{s}}$.

The maximand in (3) is industry profit above social cost less the quasi-rent earned by firm $B$: The first term is the total revenue, the second and third terms are the social costs of producing $Q_A$ and $Q_B$, respectively, and the fourth term is $B$'s quasi-rent. Thus, (3) represents the total profit earned by the integrated input monopolist.

The marginal conditions associated with (3) are

$$-(a - s - bc)P^{**} - (1 - s - bc)P_A^{**} + 2(1 - s)P_B^{**} = -ac \tag{4a}$$

$$sP^{**} + sP_A^{**} - 2(s - bc)P_B^{**} = -ac \tag{4b}$$

$$(1 - bc)P^{**} - sP_A^{**} - (1 - s)P_B^{**} = ac \tag{4c}$$

Equilibrium prices for the final good and the input sold externally and transferred internally are, respectively, given by

$$P^{**} = (a/ - 2b)(1 + s - 2bc)/(1 + s - bc), \tag{5a}$$

$$P_B^{**} = a/ - 2b, \tag{5b}$$

$$P_A^{**} = (a/ - 2b)(1 + s)/(1 + s - bc). \tag{5c}$$

The implied outputs are

$$Q_A^{**} = as/(1 + s - bc), \tag{6a}$$

$$Q_B^{**} = a(1 - s)/2(1 + s - bc), \tag{6b}$$

$$Q_T^{**} = a(1 + s)/2(1 + s - bc). \tag{6c}$$

The vertically integrated monopolist has profit equal to $a^2(1 + s)/ - 4b(1 + s - bc)$, and the non-integrated firm has profit equal to $a^2c(1 - s)/4 \times (1 + s - bc)^2$. Finally, the total welfare is equal to $a^2(3 - bc)/ - 2b(1 + s - bc)^2$.

*Comparing no integration and vertical integration*. The noteworthy findings are (i) vertical merger lowers final price for all $s > 0$ (compare (2e) and (5a)); (ii) the pro-competitive price effect of vertical merger is larger for larger $s$ (5a); and (iii) consistent with expectations, when vertically integrated, the input monopolist whose marginal cost is lower, expands its share of the downstream market (compare (2c) and (2d) with (6a) and (6b)).

What is unexpected, however, is that the vertically integrated input monopolist expands share by maintaining price to its downstream rival ((2a) and (5b)), while lowering input price to its downstream affiliate (5c). Vertical merger does not raise rivals' costs, instead, it lowers its own costs. Competitors are harmed only because final price declines. Upon integration, regardless of the value of $s$, the integrated input monopolist lowers the price charged its downstream affiliate from $(a/ - 2b)$ to $(a/ - 2b)(1 + s)/(1 + s - bc)$.[9] The more control the input monopolist has over the downstream market through ownership the higher is this internal transfer price.

Although consumer welfare, which is proportional to output, is higher with partial integration than without integration, total welfare may not increase with vertical integration.[10] This is because without vertical integration the cost of overall output is minimized, whereas with vertical integration higher market output is produced at greater



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than minimum cost. Marginal costs are unequal in the case of vertical integration; specifically, $MC_B = 2MC_A$. A direct welfare comparison indicates that for $s > s^{**}$ and $s^{**}$ close to zero, the welfare with vertical integration—$[a^2(3 - bc)/ -2b(1 + s - bc)^2]$—is higher than the total welfare with no vertical integration—$[3a^2/ - 8b(1 - bc)]$. The difference between them is always positive but it is smaller for larger $s$.

Finally, for all $s > 0$, vertical merger is profitable, since vertically integrated profit—$a^2(1 + s)/ -4b(1 + s - bc)$—is greater than the sum of profits for the non-integrated input monopolist and its downstream target—$a^2[2 - bc(2 + s)]/ - 8b(1 - bc)^2$.[11]

**Case 2:** $MC_x = (P_x + c)Q_x/s_x$

*No vertical integration*. The monopolist chooses $Q_A$ and $Q_B$ to maximize

$$P^d(Q)Q_A/2 - cQ_A^2/2s + P^d(Q)Q_B/2 - cQ_B^2/2(1 - s), \quad (7)$$

where $P^d(Q)$ is the inverse demand function and $Q = Q_A + Q_B$. The area between a downstream firm's marginal cost functions, inclusive and exclusive of the monopolized input cost, is the total revenue from the sale of the monopolized input to that customer. The first two and the last two terms in (7), respectively, measure the revenues from sales of the monopolized input to firms $A$ and $B$. The marginal conditions associated with (7) imply

$$Q_A^* = as/2(1 - bc), \quad (8a)$$

$$Q_B^* = a(1 - s)/2(1 - bc), \quad (8b)$$

$$Q_T^* = a/2(1 - bc), \quad (8c)$$

$$P^* = a(1 - 2bc)/ - 2b(1 - bc) \quad (8d)$$

The input prices are found from $P = (P_x + c)Q_x/s_x$:

$$P_A^* = P_B^* = (1 - bc)/(-b). \quad (9)$$

As in Case 1, the profit-maximizing input price is the same to each downstream firm regardless of capacity. The input monopolist's profit is $P^*Q_T^*/2 - cQ_T^{*2}/2 = a^2/ - 8b(1 - bc)$, and the downstream profit for the firm with share $s$ is equal to $sa^2(1 - 2bc)/ - 8b(1 - bc)^2$.[12] The total welfare is equal to $3a^2/ - 8b(1 - bc)$.

*Vertical integration*. With vertical integration, the input monopolist maximizes (7), plus $P^d(Q)Q_A/2$. The marginal conditions yield

$$Q_A^{**} = sa[(1 - s) - 4bc]/D \quad (10a)$$

$$Q_B^{**} = -2(1 - s)a(s + bc)/D, \quad (10b)$$

where
$D = [4(bc)^2 - 4bc(1 + s) - s(1 - s)]$.

Inspection of (10b) indicates that for $s > -bc$, $Q_B^{**} < 0$. Since $Q_B$ cannot be less than zero, $Q_T^{**}$ cannot simply be the sum of $Q_A^{**}$ and $Q_B^{**}$ in (10). Instead, $Q_T^{**}$ is $Q_A^{**} + Q_B^{**}$ for $s < -bc$ and $Q_T^{**}$ is $Q_A^{**}$ alone for $s$ at least as large as $-bc$. Of course, since $s$ cannot be greater than 1, $Q_T^{**}$ is correctly given by $Q_A^{**} + Q_B^{**}$ for $-bc > 1$. In contrast, for $-bc < 1$, $Q_T^{**} = Q_A^{**} + Q_B^{**}$ for $s < -bc$ and, for $s > -bc$, $Q_T^{**} = Q_A^{**}$. The latter rises at a decreasing rate to $a/(2 - bc)$ at $s = 1$. Finally, for $-bc > 1$, $Q_T^{**} = Q_A^{**} + Q_B^{**}$ for all $s$, rising from $a/2(1 - bc)$ at $s = 0$ to $a/(2 - bc) > a/2(1 - bc)$ at $s = 1$.

*Comparing vertical integration and no vertical integration*. The vertically integrated input monopolist tempers its effective transfer price to its downstream affiliate because post-merger it is mindful of the downstream quasi-rent earned by its affiliate. It is informative to derive the expressions for the explicit and implicit input prices charged in the internal and merchant markets. Specifically, the input prices are, for $s < -bc$,

$$P_A^{**} = c(1 + 3s)/(1 - s - 4bc) \quad (11a)$$

$$P_B^{**} = c(1 + 2s - bc)/ - (s + bc). \quad (11b)$$

$P_B^{**}$ rises without bound as $s$ approaches $-bc$ from the left. Thus, for $-bc < 1$ and $s = -bc$, the input monopolist implements a 'price squeeze'—i.e. it prices the downstream rival out of the market altogether, notwithstanding the non-integrated rival's shut-down price of zero.[13] That is, for all values of $s \geqslant -bc$, the input monopolist completely forecloses the input market to its downstream rival. When $-bc > 1$ there is no complete foreclosure for any value of $s$, and the optimal value of $P_B^{**}$ is given by (11b). Thus, (11b) indicates the value of $P_B^{**}$ for $s$ in the domain



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$[0, -bc)$ when $-bc < 1$, and in $[0, 1]$, when $-bc > 1$. Similarly, (11a) gives the optimal value of $P_A$ over these same intervals. When $-bc < 1$ and $s \geqslant -bc$, only firm $A$ produces downstream, and $P_A^{**}$, which is based on $Q_A^{**}$ alone, is equal to $c(3+s)/(1-s-4bc)$. This price rises from $c(3-bc)/(1-3bc)$ at $s = -bc$ to $-1/b$ at $s = 1$.

Thus, unlike Case 1, in which there is no foreclosure, in Case 2, vertical integration always results in some degree of foreclosure—that is, $P_B^{**} > P_A^{**}$—which of course would be expected to prompt unintegrated rivals to complain to antitrust authorities about a proposed vertical merger.[14] Also, unlike in Case 1, in Case 2, there may be harm both to competitors and to competition. Whether competition is harmed depends on the values of $s$ and of $-bc$. Specifically, when $-bc > [(5^{(1/2)}+1)/4] = 0.8 = (-bc)^{**}$, vertical merger raises consumer welfare regardless of $s$.[15] For $-bc < 0.8$ and $s \geqslant -bc$, there is complete foreclosure and $QT^{**} = Q_A^{**}$. The no-vertical integration output is $a/2(1-bc)$; thus when $s \geqslant -bc$, vertical merger increases consumer welfare when $Q_A^{**} > a/2(1-bc)$.

When $s < -bc$, the output criterion is $Q_A^{**} + Q_B^{**} >$ or $< a/2(1-bc)$. Since these criteria depend solely on $s$ and $-bc$, one could determine for any vertical merger whether it is or is not pro-competitive with the knowledge of $-bc$. For example, if $-bc = \frac{1}{4}$, it is easy to demonstrate that there is no $s < -bc$ that makes $Q_A^{**} + Q_B^{**} > a/2(1-bc)$.

Figure 1 summarizes the criteria for a consumer-welfare-enhancing vertical merger in Case 2. The sharp-peaked curve with maximum at $(\frac{1}{2}, \frac{1}{2})$ separates output-increasing or output-neutral vertical mergers from output-decreasing vertical mergers. The equation for $s^*$ to the right of $-bc = \frac{1}{2}$ is a simple quadratic in $-bc$, $s^* = 1 - [4(-bc)^2/(1-2bc)]$. Since $s^* = 0$ at $(1+5^{1/2})/4$, vertical merger is output-increasing whenever $s \geqslant (1+5^{1/2})/4$. Otherwise, for $\frac{1}{2} < -bc < (1+5^{1/2})/4$, a vertical merger raises consumer welfare for $s > s^*$.

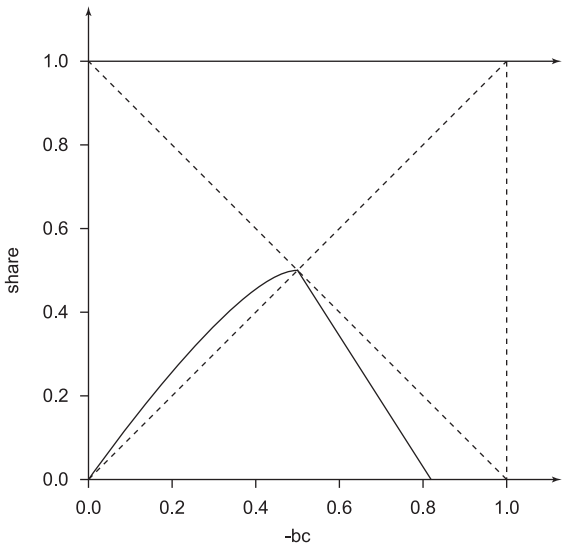


**Figure 1.** Threshold share, $s^*$.

The equation for $s^*$ for $-bc < \frac{1}{2}$ is more complex:

$$s^* = \{\{[3 - 6bc + 8(-bc)^2] - \{[3 - 6bc + 8(-bc)^2]^2 + 16bc(1-bc)(3-2bc)\}^{1/2}\}\}/2(3-2bc).$$

Values of $s^*$ rise above the line, $s = -bc$ for all values of $-bc > 0$ and $< \frac{1}{2}$ and are equal to $-bc$ at the ends, $-bc = 0$ and $-bc = \frac{1}{2}$.

In Figure 1, there is complete foreclosure for all values of $(-bc, s)$ on or above the line $s^* = -bc$. A large percentage of this area lies above the threshold $s$-curve, $s^*$, which implies that complete foreclosure is often accompanied by higher consumer welfare. In contrast, the relatively small lens-like area between $s^*$ and the 45° line for $-bc < \frac{1}{2}$ represents points of anti-competitive, complete foreclosure.

Clearly, the product, $-bc$, is essential for evaluating the competitive effects of vertical merger in Case 2. It is a simple matter here of estimating $-bc$: since pre-merger $Q_T^* = a/2(1-bc)$, one needs only to observe pre-merger output and estimate demand—in particular the choke price, 'a'—to solve for $-bc$. Given $-bc$, one can then inform the appropriate quadratic formulas to determine the threshold value of $s$. Of course, there remains the question of whether it is Case 1 or Case 2 that applies. A conservative approach, which the merging parties should be allowed to rebut, would assume the worse and use the values of $s^*$ given in Case 2 and depicted in Figure 1.

Alternatively, it is notable that in light of the linear-homogeneous marginal social cost assumption, marginal social cost is two times the average variable cost exclusive of the monopolized input cost, which is denoted AVC. Thus, in Case 1 and in Case 2, the corresponding respective margins, $m1^* = (P^* - P_x^*)/P^*$ and $m2^* = (P^* - P_x^* Q_T^*)/P^*$, are equal to $2\text{AVC}/P^*$. This provides a means of testing whether $m1^*$ or $m2^*$ applies. One would form the two alternative percentage margins, $m1^*$ and $m2^*$, which are based on observable quantities, and then



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compare each one with two times (total variable cost −total cost of the monopolized input)/total revenue. Thus, if $m1^*$ were more nearly equal to the latter than $m2^*$, the Case 1 model, which predicts a consumer-welfare-enhancing vertical merger regardless of $s$, would be applied.

As in Case 1, in Case 2 cost is not minimized with vertical integration; marginal social costs are unequal. As a result there is also in Case 2 the possibility that although consumer surplus increases upon vertical merger, total welfare falls, at least for some values of $s$. If $-bc > (5^{(1/2)} + 1)/4$, vertical merger increases consumer welfare for all $s$. Total welfare is expressed by $W(s) = [a^2c \times (1 + 3s)/D][1 - 4bc(1 + s - 2bc)/D]$, where $D$ is defined as in (10). The value of this function at $s = 0$ exceeds welfare without vertical integration—$3a^2(1 - 2bc)/ - 8b(1 - bc)$—and its value at $s = 1$ is larger yet. Differentiating the expression for $W(s)$ indicates that $W(s) > W(0)$ for all $s$.

In the case with $-bc < 0.8$, the expression for total welfare is the same as the above for $s < -bc$ but, when $s \geqslant -bc$, the expressions for total welfare differ because $Q_T^* = Q_A^*$, since $B$ is completely foreclosed. In this case, the relevant welfare function is $a^2s(3s - bc)/ - 2b(2s - bc)^2$. This expression is greater than the total welfare without vertical integration, $3a^2/ - 8b(1 - bc)$, whenever $s > (1 + 3^{(1/2)})/4$, which is approximately $\frac{2}{3}$. Thus, given $-bc < 0.8$, although consumer welfare may increase with vertical merger for some range of $s < \frac{2}{3}$, the total welfare would be reduced for such $s$.

It remains to investigate whether vertical merger is always profitable. In general, the answer is no, when $-bc < 1$. It can be demonstrated, however, that vertical merger is profitable for all $s > (-bc/2)(1 - 2bc)/(1 - 2bc + 2b^2c^2)$. For example, if $-bc = \frac{1}{4}$, vertical merger is profitable for $s > 0.12$; pro-competitive (i.e. consumer welfare enhancing) for $s > 0.32$, and welfare increasing for $s > 0.67$. There is definitely a range of profitable vertical mergers that would reduce consumer welfare and a range of profitable consumer-welfare increasing mergers that are inefficient.

## CONCLUSION

A short-run model of vertically related markets is constructed, assuming there is a single input monopolist upstream and a perfectly competitive final goods market downstream. Based on the assumption of linear demand and quadratic cost, the competitive effects of the acquisition by the upstream monopolist of some share of capacity downstream are derived for two different assumptions about cost. In Case 1, the ratio of the monopolized input and downstream output is fixed; thus, a change in input price translates the downstream marginal cost function up or down. In Case 2, the input/output ratio increases as output increases, given sunk-cost capacity, and an increase in input price rotates the downstream marginal cost function counterclockwise. Within this context, it is demonstrated that vertical merger always increases consumer welfare and total welfare in Case 1 and in Case 2 increases consumer and total welfare for most demand/marginal cost configurations but not for all. In this latter case, sufficient conditions for pro-competitive vertical merger are derived. Also, a means of deciding whether Case 1 or Case 2 more closely applies is given and, in the event of Case 2, necessary and sufficient conditions are described that can be evaluated with readily available market data.

Counter-intuitively, perhaps, the profit-maximizing input price charged the vertically integrated firm's downstream rivals remains unchanged with vertical merger in Case 1, while the implicit internal transfer price falls. In Case 2, the input price to the merchant market is increased at the same time that the internal transfer price is reduced. Moreover, vertical merger may increase consumer and total welfare while at the same time that the merchant-market input price is increased, perhaps even to the point of inducing the non-integrated rivals to exit.

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## NOTES

1. Neither Church (2004) nor Riordan (2005) addresses this case in recent summaries of the literature on vertical merger.
2. Theories of vertical integration and the limits of internal organization are important topics as well. However, since these theories are not based on welfare tradeoffs, they are typically ignored in antitrust merger analysis, except as backdrops for



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the real action under scrutiny. Principally, there are two such theories: the property-rights theory of the firm (Alchian and Demsetz, 1972; Grossman and Hart, 1986), and the transaction cost theory of Coase (1937), Williamson (1979) and Klein *et al.* (1978).

3. Throughout the paper input foreclosure is addressed, instead of output foreclosure. An equivalent, symmetrical analysis applies to the latter.
4. This last observation is controversial; see Reiffen's comment on OSS (Reiffen, 1992), where he observes that in a dynamic context vertical merger is not necessary to justify a non-cooperative anticompetitive outcome, and the OSS reply (Ordover *et al.*, 1992). For a critique of Salinger's model based on similar grounds, see Higgins (1999).
5. The cellophane fallacy refers to the fact that an individual firm with market power will raise its price up to the point where a further increase would cause substitutes, however imperfect they are at the competitive price for the hypothetical monopolized product, to be viewed as perfect alternatives for marginal consumers. As a result, the DOJ/FTC Horizontal Merger Guidelines market definition test if based on current prices would invariably place the hypothetical good and its substitutes in the same relevant market. The Guidelines thus emphasize the importance of basing the price test on an estimate of the competitive price instead of the actual price which, in general, leads to narrower relevant antitrust markets.
6. Nothing significant depends on the duopoly assumption. The model equally well might contain many downstream competitors.
7. In this special case of variable proportions (Case 2), the variable inputs used with the monopolized input are limitational—i.e. minimal use of them is necessary regardless of how much of the monopolized input is used. Thus, marginal cost is positive for positive output even when the monopolized input is free.
8. Given perfect competition downstream, there are several equivalent ways of modeling the dominant firm's conduct: (1) maximize profit on merchant-market sales of the input and on own production (total profit) by choosing input prices for the affiliated and unaffiliated downstream firms in stage 1, while anticipating their price-taking behavior and downstream market equilibrium in stage 2; (2) given an input price to unaffiliated downstream firm, and anticipating price-taking behavior in stage 2, define the affiliate's residual demand for the input and choose the non-affiliate's input price and own production to maximize total profit given this demand and own production capacity; and (3) choose the affiliate's and the non-affiliate's outputs subject to downstream market equilibrium in order to maximize total profit. One or the other of these formulations is alternatively used, depending on the difficulty of obtaining explicit solutions to the first-order conditions.
9. Strictly speaking, downstream rivals are not harmed by foreclosure; instead, they are harmed because they must compete with a lower cost rival. That is, they suffer from enhanced competition.
10. The welfare standard applied at the federal antitrust agencies appears to be consumer welfare, not total welfare. Thus, provided there is no loss of variety, if product price falls because of certain business practices, including vertical merger, the practices are approved.
11. These expressions are equal at $s = 0$, and vertically integrated profit is higher than non-vertically integrated profit when $s = 1$. At $s = 0$, the slope of the expression for vertical integration profit is positive and twice the magnitude of the slope of the expression for no-vertical integration profit, and the slope of the vertically integrated profit function falls monotonically as $s$ approaches unity.
12. Note that the monopolist's profit is not equal to $P_x^*$ times $Q_T^*$; this is because, the input/output ratio in Case 2 is not constant.
13. If marginal cost were non-homogeneous, there would be some minimum finite full-foreclosure input price.
14. Recall, in Case 1, although the relative input price paid by the unintegrated downstream firm is raised, its absolute price remains at the pre-merger level.
15. This is indicated by equating $Q_T^*$ to the no-vertical integration level of output, $a/2(1 - bc)$ and noting that for $-bc > -bc^{**}$, there is no non-zero value of $s$ that equates the two outputs.

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