http://clevelandfed.org/research/review/
Economic Review 1999 Q1

The Effects of Vertical Integration on Competing Input Suppliers

by R. Preston McAfee

R. Preston McAfee is a professor of economics at the University of Texas at Austin. He thanks Joseph G. Haubrich and James B. Thomson for their beneficial comments.

Introduction

Vertical integration is a booming phenomenon in many U.S. industries. Massive consolidation of the defense industry has left only three or four developers producing many of the components used in military platforms.[1] Banking also is consolidating at a rapid pace, with integration of related financial services (insurance, credit cards) and input services (check clearing, payments, electronic funds transfer) into parent companies. Telecommunications firms' mergers combine cable, wireless, local wireline, and long-distance services. Simultaneously, firms in other industries are concentrating on their core competencies and selling off related lines of business. Automobile manufacturers, for example, are becoming more reliant on independent or semi-independent parts suppliers.

What are the effects of vertical integration? The large body of literature on this subject might reasonably be described as disjointed. It has focused mostly on providing a rationale for opposing vertical mergers on antitrust grounds. When a firm buys an upstream input supplier that also supplies its downstream competitor, the vertically integrated firm can raise the price of the input to its competitor, thereby obtaining an advantage in the downstream market. This is the standard "raising-rivals'-cost" argument pioneered by Salop and Scheffman (1987).[2] In extreme cases, the vertically integrated firm might refuse to sell to competitors and, if the input supplier's product was necessary for production, might be able to foreclose its competitors from the downstream market.

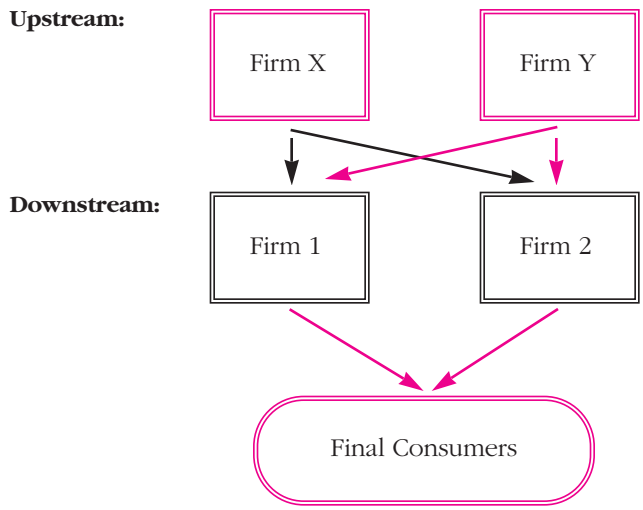
This paper examines an opposing effect of the raising-rivals'-cost theory. In particular, the analysis focuses on other input suppliers' reaction to vertical integration. Its main insight is that vertical integration, by providing easier access to one input, reduces demand for the other inputs and tends to lower their prices. This, in turn, encourages the vertically integrated firm to sell its input at a lower price as well, which may reduce the costs of all inputs. Thus, accounting for the reaction of substitute input suppliers may reverse the traditional conclusions of the raising-rivals'-cost theory.

■ **1** An item like an aircraft or a submarine is a platform, which holds a variety of weapons systems, detection systems like radar or sonar, and other systems like landing gear, engines, and so on.

■ **2** Ordover, Saloner, and Salop (1990) is the best-known treatment. Salinger (1988) and Hart and Tirole (1990) also provide related, and more general, analyses.

FIGURE 1

Competition Layout



I. Structure of the Model

The model's general form is set out in figure 1. Two upstream suppliers, X and Y, sell to two downstream firms, which in turn sell to the final consumers. I will focus on the effects of the vertical integration that occurs when firm 1 purchases firm X. Suppose that the products of the upstream firms are imperfect substitutes and that, having purchased firm X, firm 1 will continue to use some of the inputs supplied by Y. Then vertical integration will affect firm Y's pricing decision.[3]

In this paper, I set aside the incentive to raise rivals' costs by assuming that firms 1 and 2 do not compete in the output market. I focus instead on vertical integration's effects on the alternative input supplier and find that vertical integration tends to lower the prices of both inputs to firm 2. The intuition is straightforward: The purchase of firm X by firm 1 lowers the price of input x to firm 1, reducing the demand for y by firm 1. In response to this reduction in demand, firm Y lowers the price of y to both firms. The response of the integrated firm is to lower the price of x to firm 2.

The situation is less clear when firms 1 and 2 compete imperfectly in the downstream market. There are two direct effects of the merger: First, the price of x to the combined entity falls, tending to reduce the price of y. Second, the price of x to firm 2 rises, tending to increase the price of y. Either effect can dominate, and the price of y may rise or fall, depending on the extent of substitution between the outputs of firms 1 and 2 and the substitutability of the two inputs.

Let x_i, y_i denote the demand for the two inputs by firm 1. I assume constant returns to scale. The timing is that the input sellers simultaneously set input prices p_x, p_y, respectively. Then firms 1 and 2 choose their input quantities and output prices.

II. Raising Rivals' Costs

The standard raising-rivals'-costs theory is best explained by eliminating firm Y. In this case, X is a monopoly supplier of the input. If x is necessary for production, the merged firm has the ability to foreclose firm 2 from production. Even if x is valuable but not strictly necessary for production, the merged firm can raise the cost of x to firm 2, thereby increasing firm 2's overall costs.

Even in this simple scenario, the price that firm 2 is charged for x can fall. Suppose 1 and 2 barely compete in the final output market. Moreover, suppose firm 1 has significantly more inelastic demand for x, so that the monopoly price for firm 1 exceeds the monopoly price for firm 2. Prior to vertical integration, the price of x will lie between the two monopoly prices. After the merger, the price of x will fall to approximately the monopoly price for firm 2. Moreover, insofar as firms 1 and 2 do compete, the monopoly price for firm 2 will fall, since firm 1's lower marginal cost will make it a more aggressive competitor after the merger.

The standard analysis focuses on the case where X and Y are Cournot competitors with constant marginal costs. In this case, if the merged firm uses its own inputs and withholds output from firm 2, firm 2 is facing a monopoly and will generally experience higher input prices. This is true even when firm Y is actually several firms that are in Cournot competition, although the more firms there are in the input supply market, the smaller is the effect.

The results concerning Cournot input supply generalize to increasing marginal costs. With increasing marginal costs, firm 1 may wish either to sell to or buy from firm Y, even after

3 It might seem that services such as check clearing are homogeneous. However, distinct banks have an advantage in being able to clear their own checks quickly, and large banks may have a greater netting out of checks. In addition, distinct suppliers of check clearing may have distinct regional advantages.

the merger with firm X. However, consider the symmetric case, in which X looks like Y and 1 looks like 2. After the merger, firm 1 does not need to buy from firm Y, and thus can increase the costs to firm 2 by refusing to sell.

This literature has played an important role by showing that vertical mergers could potentially foreclose competition downstream. However, the literature has focused primarily on mergers' *bad* effects on rivals, without examining their potential for good effects.

III. Lowering Rivals' Costs

I start the analysis using the demand for inputs as primitives. To facilitate the analysis, I distinguish between the prices firm X charges to firms 1 and 2. With independent downstream demands, the effect of the merger of X with 1 is to change the input price of x to firm 1. Firm X earns profits on its sale to firm 2 of

$$(1) \qquad \pi = (p_x^2 - c_x)x_2(p_x^2, p_y).$$

I divide firm Y's profits into the components earned on firm 1 and firm 2:

$$(2) \qquad \psi^1 = (p_y - c_y)y_1(p_x^1, p_y),$$

$$\psi^2 = (p_y - c_y)y_2(p_x^2, p_y).$$

Using numerical subscripts to denote partial derivatives, profit maximization yields

$$(3) \qquad \pi_1 = \psi_2^1 + \psi_2^2 = 0.$$

The direct effect of the merger of X and 1 on the input supply prices is to lower p_x^1 from its monopoly level to marginal cost c_x. Because of the assumed independence of demands for the outputs of 1 and 2, the merged entity will choose the price of p_x^2 to maximize π, and firm Y will maximize the sum of ψ^1 and ψ^2.

I am assuming that firm Y cannot price discriminate. If both input suppliers are able to do so, nothing changes in the prices charged to firm 2. If firm Y can price discriminate but firm X cannot, then the merger permits firm X to price discriminate, since the only relevant price is that charged to 2. As a consequence, p_x^2 will increase if firm 2's demand for x is less elastic than firm 1's. This will have effects on the price of y, usually of the same direction.

Differentiating the first-order conditions, one obtains

$$(4) \qquad \begin{bmatrix} \pi_{11} & \pi_{12} \\ \psi_{21}^2 & \psi_{22}^1 + \psi_{22}^2 \end{bmatrix} \begin{pmatrix} dp_x^2 \\ dp_y \end{pmatrix} + \begin{pmatrix} 0 \\ \psi_{21}^1 \end{pmatrix} dp_x^1 = \begin{pmatrix} 0 \\ 0 \end{pmatrix}.$$

This gives

$$(5) \qquad \begin{pmatrix} dp_x^2 \\ dp_y \end{pmatrix} = \frac{1}{\Delta} \begin{pmatrix} \pi_{12}\psi_{21}^1 \\ -\pi_{11}\psi_{21}^1 \end{pmatrix} dp_x^1.$$

Stability implies that

$$(6) \qquad \Delta = \pi_{11}(\psi_{22}^1 + \psi_{22}^2) - \pi_{12}\psi_{21}^2 > 0.$$

The terms π_{12} and ψ_{21} are similar in that they represent the effect of a competitor's price increase on the marginal profitability of a price increase for the firm. If the input pricing game is one of strategic complements, then these terms are positive. Alternatively (and equivalently), if an increase in the price of one input makes the demand for the other input less elastic, these cross-partials will be positive.

It can be shown that if the downstream production functions have constant elasticity of substitution with constant returns to scale, and demand is constant up to a choke price (which is tantamount to assuming that the downstream quantity is exogenous), then the cross-partials are positive. This special case will be explored in the following numerical simulation.

When these input profit cross-partials are positive, then

$$(7) \qquad \frac{dp_x^2}{dp_x^1} > 0, \quad \frac{dp_y}{dp_x^1} > 0.$$

Thus, the merger, which lowers the price of x to firm 1 by eliminating firm X's marginalization, lowers *both* of the input prices to firm 2 as well as the price of y to firm 1.

This result is intuitive. The reduction in the price of x to firm 1 makes that firm's demand for y more elastic, since it now has a less expensive substitute. This causes Y to lower the price of y.[4] The lower price of y induces a reaction from the combined firm—it lowers the price of x.

■ **4** This is where the assumption that firm Y cannot price discriminate is critical. If Y could price discriminate, the reduction in the price of x to firm 1 would reduce the price of y to firm 1 but not to firm 2.

IV. Numerical Example

A numerical example illustrates and quantifies the effects described in the theory. Suppose that the two downstream firms can sell one unit each at a price high enough so that each firm will always buy inputs sufficient to produce one unit. The downstream firms have a constant elasticity-of-substitution production technology with constant returns to scale and parameter $\alpha\varepsilon[½,1]$[5]:

$$(8) \qquad q = (x^{\alpha} + y^{\alpha})^{\frac{1}{\alpha}}.$$

Let the marginal production costs of the upstream firms be c.

Without Vertical Integration

If there is no vertical integration, the downstream firms minimize $p_x x + p_y y$ s.t. q = 1. This gives

$$(9) \qquad x = \left(\frac{p_y^{\frac{\alpha}{1-\alpha}}}{p_x^{\frac{\alpha}{1-\alpha}} + p_y^{\frac{\alpha}{1-\alpha}}}\right)^{\frac{1}{\alpha}},$$

$$y = \left(\frac{p_x^{\frac{\alpha}{1-\alpha}}}{p_x^{\frac{\alpha}{1-\alpha}} + p_y^{\frac{\alpha}{1-\alpha}}}\right)^{\frac{1}{\alpha}}.$$

Firm X chooses p_x to maximize

$$(10) \qquad \pi = (p_x - c)x.$$

Routine calculations yield

$$(11) \qquad 0 = (1-\alpha)p_y^{\frac{\alpha}{1-\alpha}} - \alpha p_x^{\frac{\alpha}{1-\alpha}} + cp_x^{\frac{2\alpha-1}{1-\alpha}}.$$

For $\alpha > ½$ and $p_x > c$, this equation characterizes a maximum. A symmetric solution to the first-order conditions yields

$$(12) \qquad p_x = p_y = \frac{c}{2\alpha - 1}.$$

As $\alpha \to 1$, the goods become perfect substitutes, and prices fall to marginal costs.

With Vertical Integration

When firms 1 and X merge, firm 1 can purchase x at price c. In this case, the combined entity will price x to maximize[6]

$$(13) \qquad \pi = (p_x - c)x_2 = (p_x - c)\left(\frac{p_y^{\frac{\alpha}{1-\alpha}}}{p_x^{\frac{\alpha}{1-\alpha}} + p_y^{\frac{\alpha}{1-\alpha}}}\right)^{\frac{1}{\alpha}}.$$

As before, this gives the first-order condition

$$(14) \qquad 0 = (1-\alpha)p_y^{\frac{\alpha}{1-\alpha}} - \alpha p_x^{\frac{\alpha}{1-\alpha}} + cp_x^{\frac{2\alpha-1}{1-\alpha}}.$$

Firm Y faces a more complicated problem because it will generally sell to both firms 1 and 2, and these two firms generally face distinct input prices for x. Firm Y chooses p_y to maximize

$$(15) \qquad \psi = (p_y - c)(y_1 + y_2) = (p_y - c)\left[\left(\frac{c^{\frac{\alpha}{1-\alpha}}}{c^{\frac{\alpha}{1-\alpha}} + p_y^{\frac{\alpha}{1-\alpha}}}\right)^{\frac{1}{\alpha}} + \left(\frac{p_x^{\frac{\alpha}{1-\alpha}}}{p_x^{\frac{\alpha}{1-\alpha}} + p_y^{\frac{\alpha}{1-\alpha}}}\right)^{\frac{1}{\alpha}}\right].$$

While closed forms for the first-order conditions exist (and are sufficient to characterize equilibrium in the range posited), it is not possible to solve the first-order conditions for the equilibrium prices explicitly because the prices enter these equations in complex ways. Consequently, I have used *Mathematica 3.0* to find the roots of the first-order conditions and to plot the outcome as a function of α.

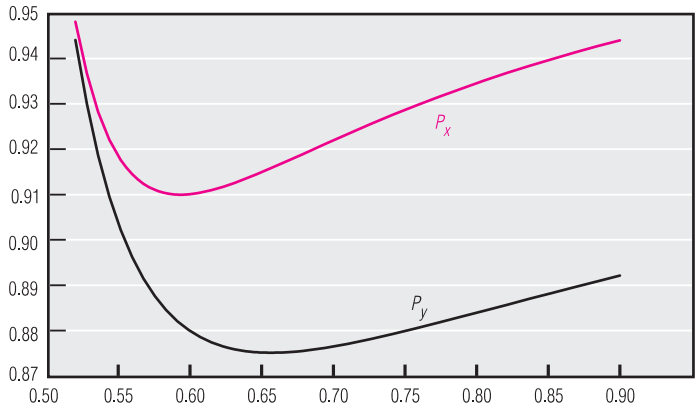
To simplify the calculations, note that c can be set to unity without loss of generality (prices measured in cost units). Moreover, for scaling purposes, it is useful to plot the markup reductions associated with vertical integration rather

■ **5** For $\alpha \geq 1$, only one input is chosen. For $\alpha < ½$, demand is inelastic and the input pricing equations solve with infinite prices.

■ **6** Because the vertically integrated firm is assumed not to compete with firm 2, downstream profits can be ignored. However, if there is a low level of competition, then downstream profits must be included here, dramatically complicating the analysis.

FIGURE 2

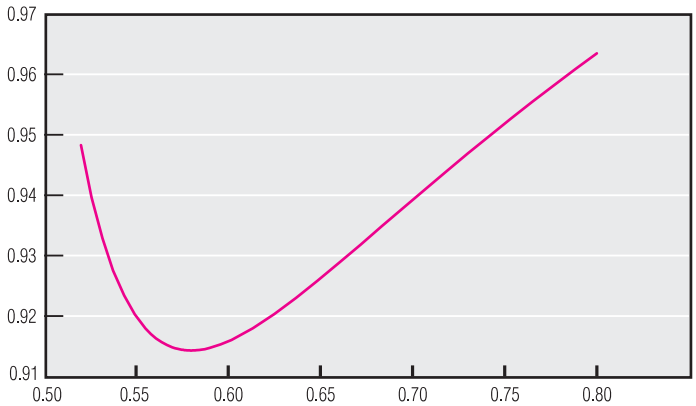
Input Markups under Vertical Integration[a]



a. As a proportion of the markup without vertical integration, plotted against α.
SOURCE: Author's calculations.

FIGURE 3

Firm 2's Marginal Cost under Vertical Integration[a]



a. As a proportion of its marginal cost without vertical integration, plotted against α.
SOURCE: Author's calculations.

than the actual prices. Thus, the prices relative to the nonintegrated prices are plotted; in particular, for $z = x, y$,

$$(16) \quad P_z = \frac{p_z - c}{\frac{c}{2\alpha - 1} - c} = \frac{(2\alpha - 1)(p_z - 1)}{2(1 - \alpha)}.$$

When $P_z = 1$, there is no cost reduction, while $P_z = 0$ would be competitive or marginal cost pricing. When the outcome is plotted (see figure 2), several observations emerge. First, the reductions in input prices are significant, on the order of 5 percent or 10 percent. Second, firm Y reduces its prices more than firm X does. This should be a reasonably general property, since firm X is responding to firm Y's price reduction. In symmetric models like the one examined, the price of the unintegrated input should fall more than the price of the integrated input (to the rest of the world).

In asymmetric models, there is an additional effect. As an independent firm, X priced to serve both firms 1 and 2; therefore, firm X's price is an average of the two monopoly prices associated with 1 and 2. After the merger, firm X will price only for firm 2; this could increase or decrease the postmerger price. The effect identified in this article, however, should continue to hold, using as a benchmark the monopoly price for firm 2 rather than the monopoly price for both downstream firms.

Third, the markups are not monotonic in α. This is interesting because the prices are monotonic, with prices diverging as $\alpha \to ½$, and prices going to costs as $\alpha \to 1$. Simulations suggest that the markup on y is below the markup without vertical integration (as a proportion of the vanishing markup without vertical integration), even in the limit.

While prices are more indicative of the asymmetric effects on the individual input suppliers, firm 2 cares primarily about its marginal cost. In figure 3, the marginal cost is plotted relative to the marginal cost in the absence of vertical integration.

Firm 2's marginal cost is lowered as much as 8½ percent. This amount is, of course, less than the reduction enjoyed by firm 1, but substantial nevertheless.

V. Banking Applications

The Federal Reserve System recently studied the implications of its potential exit from the provision of retail payments services such as check clearing and electronic payments. In the case of many community banks, especially those in rural markets, the remaining providers of these services would be vertically integrated competitors. Moreover, as Osterberg and Thomson (in this issue) show, branching deregulation is leading to consolidation of both upstream and downstream banking markets. The extant industrial organization literature suggests that increased vertical integration in banking, coupled with consolidation in the interbank market, may have deleterious effects on downstream banking competition.

However, the literature itself is a poor guide to the likelihood of anticompetitive effects. First, much of the research arose from a desire to understand how vertical mergers might matter for antitrust enforcement. In particular, the Clayton Act, which gave courts the ability to block a variety of vertical practices, preceded clear understanding of *any* circumstances in which vertical integration might be harmful to competition. Consequently, a literature developed to show that vertical integration might have a negative effect, instead of assessing the likelihood that vertical integration is harmful to competition.

Second, much of the literature focuses on the Cournot model, primarily for tractability reasons. While Cournot competition might be a reasonable characterization of downstream competition for customers, where firms' capacities are relatively inflexible (at least compared to prices), Cournot competition seems a poor model of the provision of many upstream services like check clearing, where capacity constraints are unlikely to bind. Results from models employing Cournot competition upstream may not be applicable to integration in the banking industry.

Third, the key ingredient of the raising-rivals'-costs story is that the primary motivation for vertical integration is a wish to damage competitors. One plausible future for the banking industry features a handful of very large interstate banks, along with a great number of relatively small local banks. The large institutions will offer banking, mortgage, insurance, finance, and other services, will mainly operate electronically, and will be vertically integrated into most or all financial services areas. In contrast, the local banks will be predominantly rural and will offer personalized service, creating a market niche by exploiting the superior information and goodwill that local interaction provides. These different styles of banks will probably not compete with each other in the minds of most customers. The large banks will compete strongly with other large banks, at least until their numbers are whittled down to three or four in any given region. The rural banks will only face the threat that their best (largest) customers may be induced to use large, inexpensive banks; for most customers, a given rural bank will compete with other rural banks.

In this scenario (which does not result from any study on my part), rural banks will not compete significantly with large banks. As a result, they are not likely to be the target of anticompetitive vertical integration, nor are they likely to be harmed by a reduction in the number of large, vertically integrated banks. The largest banks may try to harm one another through their pricing of banking service inputs, but these institutions are in the best position to fend for themselves.

The lowering-rivals'-costs story is inapplicable to the present analysis as long as the Federal Reserve continues to provide check clearing and other services at some reasonable approximation of cost. As a consequence, rural banks could benefit from vertical integration of large banks only if the Federal Reserve were inefficient, so that a mechanism for price reductions existed. Prices cannot be dropped below minimum cost.

VI. Conclusion

The standard analysis of vertical integration's effect on competitors emphasizes the vertically integrated firm's incentive to foreclose downstream rivals or raise their costs. While this effect is natural in some applications, there is an offsetting effect on suppliers of substitute inputs. If firms 1 and 2 compete weakly enough in the output market, the effect on other input suppliers may dominate the foreclosure effect, causing vertical integration to benefit downstream rivals while harming upstream competitors. The harm to upstream competitors, however, lies in reducing their markups over marginal cost, that is, damaging their monopoly power.

A significant aspect of the effect of vertical integration is that both the unmerged input supplier and the vertically integrated firm lower their input prices. The mechanism is that the merger eliminates the markup on the input by the purchased firm. The other input supplier reduces its prices in response to this lower-priced substitute from the merged firm. The vertically integrated firm lowers its input prices to the rest of the world in response to the lowered price of the other input supplier.

Simulations with constant-elasticity-of-substitution production functions indicate potential reductions of as much as 8½ percent in the downstream competitor's marginal costs.

References

Hart, Oliver, and Jean Tirole. "Vertical Integration and Market Foreclosure," *Brookings Papers on Economic Activity,* Special Issue (1990), pp. 205–76.

Ordover, Janusz A., Garth Saloner, and Steven C. Salop. "Equilibrium Vertical Foreclosure," *American Economic Review,* vol. 80, no. 1 (March 1990), pp. 127–42.

Salinger, Michael. "Vertical Mergers and Market Foreclosure," *Quarterly Journal of Economics,* vol. 103, no. 2 (May 1988), pp. 345–56.

Salop, Steven C., and David T. Scheffman. "Cost-Raising Strategies," *Journal of Industrial Economics,* vol. 36, no. 1 (September 1987), pp. 19–34.