The Effects of Vertical Integration on Competing Input Suppliers

by

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Abstract: When a downstream firm buys an input supplier, the downstream firm can reduce its costs of using that input. Other input suppliers typically respond by pricing more aggressively, given the demand reduction, which tends to lower input supply costs to other firms. Thus a vertical merger may lower rival's costs, rather than raise them.

* I have benefited from the comments of Joe Haubrich and William Thompson.

Vertical integration is a booming phenomenon in many US industries. The massive consolidation of the defense industry has resulted in three or four platform developers[1] that produce many of the components used in military platforms. Banking is consolidating at a rapid pace, with integration of related financial services (insurance, credit cards) along with input services (check clearing, payments, electronic funds transfer) into the parent companies. Telecommunications firms are merging, combining cable, wireless, local wireline and long distance services. Simultaneously, other firms are concentrating on their "core competency" and selling off related lines of business. Automobile manufacturers, for instance, are increasing their dependence on independent or semi-independent parts suppliers.

What are the effects of vertical integration? There is a large literature that might reasonably be described as disjointed. Much of the focus has been on providing a rationale for opposing vertical mergers on antitrust grounds. When a firm *F* buys an input supplier (upstream firm) *U* that also supplies *F*'s (downstream) competitor, the firm can raise the price of the input to its downstream competitor, thereby providing an advantage in the downstream market. This is the standard "raising rivals' costs" argument pioneered by Scheffman and Salop.[2] In extreme instances, the vertically integrated firm might refuse to sell to the competitor. If the input supplier's product was necessary for production, *F* might be able to foreclose its competitors from the downstream market.

This paper will examine an opposing effect to the well-known raising rival's cost theory. In particular, the analysis focuses on the reaction of other input suppliers to vertical integration. The main insight is that vertical integration, by reducing the demand for other inputs given easier access to one, tends to lower the prices of the other inputs. This, in turn, induces 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 conclusions of the raising rival's cost theory.

Structure of the Model

The general form of the model is set out in Figure 1. There are two upstream firms, X and Y, which sell to two downstream firms. The downstream firms sell to the final consumers. I will focus on the effects of firm 1 vertically integrating by purchasing firm X.

Suppose that the products produced 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]

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[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, etc.

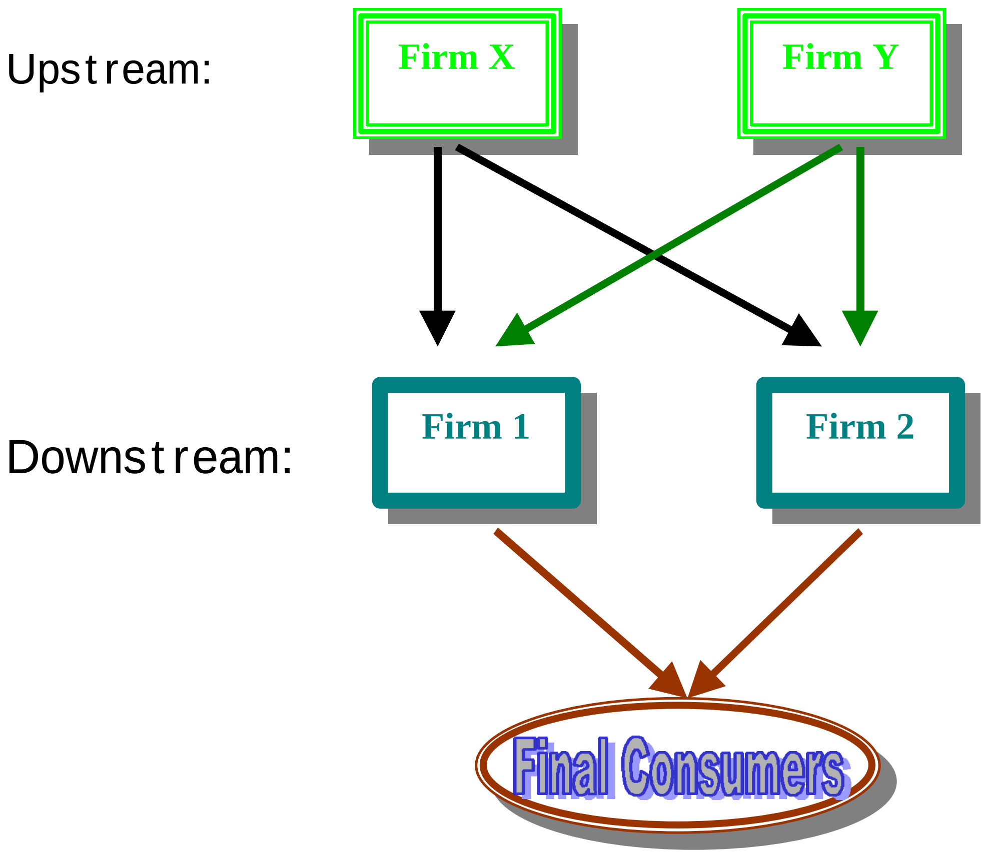
[2] Ordover, Saloner and Salop, 1990, is the best known treatment. Salinger, 1988 and Hart and Tirole, 1990, also provide related, and more general, analyses.

[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.

In this paper, I will set-aside the incentive to raise rival's costs, by assuming that firms 1 and 2 do not compete in the output market. Instead, the focus will be on the effects of vertical integration on the alternative input supplier. I find that vertical integration tends to *lower* 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 firm 1's demand for y. In response to this reduction in demand by firm 1, 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.

When firm 1 and 2 compete imperfectly in the downstream market, the situation is less clear. 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 should rise, 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.

Figure 1: Competition Layout



Let x_i, y_i denote the demand for the two inputs by firm i. 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.

Raising Rival's Costs

The standard raising rival's cost 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 2 from production. Even if x is not necessary, but valuable for production, the merged firm can raise the cost of x to 2, thereby raising 2's costs.

Even in this simple scenario, the price charged for X to firm 2 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 be 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 is now a more aggressive competitor with its lowered marginal costs post-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 competing in cournot competition, although the more firms 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 either wish to sell or buy from firm Y even after the merger with firm X. However, consider the symmetric case, so that X looks like Y and 1 looks like 2. Post merger, firm 1 does not need to buy from firm Y, and thus can increase the costs to firm 2 via a refusal to sell.

This literature served an important role, by showing that vertical mergers had the potential to foreclose competition downstream. However, the literature has focused primarily on the *bad* effects of mergers, without examining the potential for good effects on rivals.

Lowering Rival's Costs

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

$$p = (p_x^2 - c_x)x_2(p_x^2, p_y)$$

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

$$y^1 = (p_y - c_y) y_1 (p_x^1, p_y), \quad y^2 = (p_y - c_y) y_2 (p_x^2, p_y).$$

Using numerical subscripts to denote partial derivatives, profit maximization yields:

$$p_1 = y_2^1 + y_2^1 = 0.$$

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 the demands for the outputs of 1 and 2, the merged entity will choose the price of p_x^2 to maximize p and firm Y will maximize the sum of y^1 and y^2.

I am assuming that firm Y can't price-discriminate. If both input suppliers can price discriminate, nothing changes to the prices charged to firm 2. If firm Y can price discriminate but firm X could not, 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 demand for X. This will have effects on the price of Y, usually of the same direction.

Differentiating the first order conditions, one obtains:

$$\begin{bmatrix} p_{11} & p_{12} \\ y_{21}^2 & y_{22}^1 + y_{22}^2 \end{bmatrix} \begin{pmatrix} dp_x^2 \\ dp_y \end{pmatrix} + \begin{pmatrix} 0 \\ y_{21}^1 \end{pmatrix} dp_x^1 = \begin{pmatrix} 0 \\ 0 \end{pmatrix}.$$

This gives:

$$\begin{pmatrix} dp_x^2 \\ dp_y \end{pmatrix} = \frac{1}{\Delta} \begin{pmatrix} p_{12} y_{21}^1 \\ -p_{11} y_{21}^1 \end{pmatrix} dp_x^1.$$

Stability implies that

$$\Delta = p_{11}(y_{22}^1 + y_{22}^2) - p_{12} y_{21}^2 > 0.$$

The terms p_{12} and y_{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 are CES with constant returns to scale, and demand is constant up to a choke price (which is tantamount to assuming that downstream quantity is exogenous), then the cross-partials are positive. This special case will be explored in the numerical simulation given below.

When these input profit cross-partials are positive, then

$$\frac{dp_x^2}{dp_x^1} > 0, \frac{dp_y}{dp_x^1} > 0.$$

Thus, the effect of the merger, which lowers the price of x to firm 1 through the elimination of 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 firm 1's demand for y more elastic, since firm 1 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.

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 sufficiently high that each firm will always buy inputs sufficient to produce one unit. The downstream firms have a CES production technology with constant returns to scale and parameter $a \in [\frac{1}{2},1]$[5]:

$$q = (x^a + y^a)^{\frac{1}{a}}.$$

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

No Vertical Integration

Without vertical integration, the downstream firms minimize

$p_x x + p_y y$ s.t. q=1. This gives:

$$x = \left(\frac{p_y^{\frac{a}{1-a}}}{p_x^{\frac{a}{1-a}} + p_y^{\frac{a}{1-a}}} \right)^{\frac{1}{a}}, y = \left(\frac{p_x^{\frac{a}{1-a}}}{p_x^{\frac{a}{1-a}} + p_y^{\frac{a}{1-a}}} \right)^{\frac{1}{a}},$$

[4] This is where the assumption that Y can't price discriminate is critical. If Y could price discriminate, the reduction in the price of X to firm 1 would reduce Y's price to firm 1, but not Y's price to firm 2.

[5] For $a \geq 1$, only one input is chosen. For $a < \frac{1}{2}$, demand is inelastic and the input pricing equations solve with infinite prices.

Firm X chooses p_x to maximize:

$$p = (p_x - c)x.$$

Routine calculations yield:

$$0 = (1 - a)\, p_y^{\frac{a}{1-a}} - a p_x^{\frac{a}{1-a}} + c p_x^{\frac{2a-1}{1-a}} .$$

For a>½ and p_x>c, this equation characterizes a maximum. A symmetric solution to the first order conditions yield:

$$p_x = p_y = \frac{c}{2a - 1}.$$

As a®1, the goods become perfect substitutes, and prices fall to marginal costs.

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]:

$$p = (p_x - c)x_2 = (p_x - c)\left(\frac{p_y^{\frac{a}{1-a}}}{p_x^{\frac{a}{1-a}} + p_y^{\frac{a}{1-a}}} \right)^{\frac{1}{a}} .$$

As before, this gives the first order condition:

$$0 = (1 - a)\, p_y^{\frac{a}{1-a}} - a p_x^{\frac{a}{1-a}} + c p_x^{\frac{2a-1}{1-a}} .$$

Firm Y faces a more complicated problem, as firm Y 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

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

$$y = (p_y - c)(y_1 + y_2) = (p_y - c)\left[\left(\frac{c^{\frac{a}{1-a}}}{c^{\frac{a}{1-a}} + p_y^{\frac{a}{1-a}}}\right)^{\frac{1}{a}} + \left(\frac{p_x^{\frac{a}{1-a}}}{p_x^{\frac{a}{1-a}} + p_y^{\frac{a}{1-a}}}\right)^{\frac{1}{a}}\right]$$

While closed forms for the first order conditions exist (and are sufficient to characterize equilibrium in the range of of a posited), it is not possible to solve the first order conditions for the equilibrium prices explicitly, as 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 graph the outcome, as a function of a.

To simplify the calculations, note that c can be set to unity without loss of generality (prices measured in cost units). In addition, for scaling purposes, it is useful to plot the markup reductions associated with vertical integration, rather than the actual prices. Thus, the prices relative to the non-integrated prices are plotted, in particular plotting (for z=x,y):

$$P_z = \frac{p_z - c}{\frac{c}{2a-1} - c} = \frac{(2a-1)(p_z - 1)}{2(1-a)}.$$

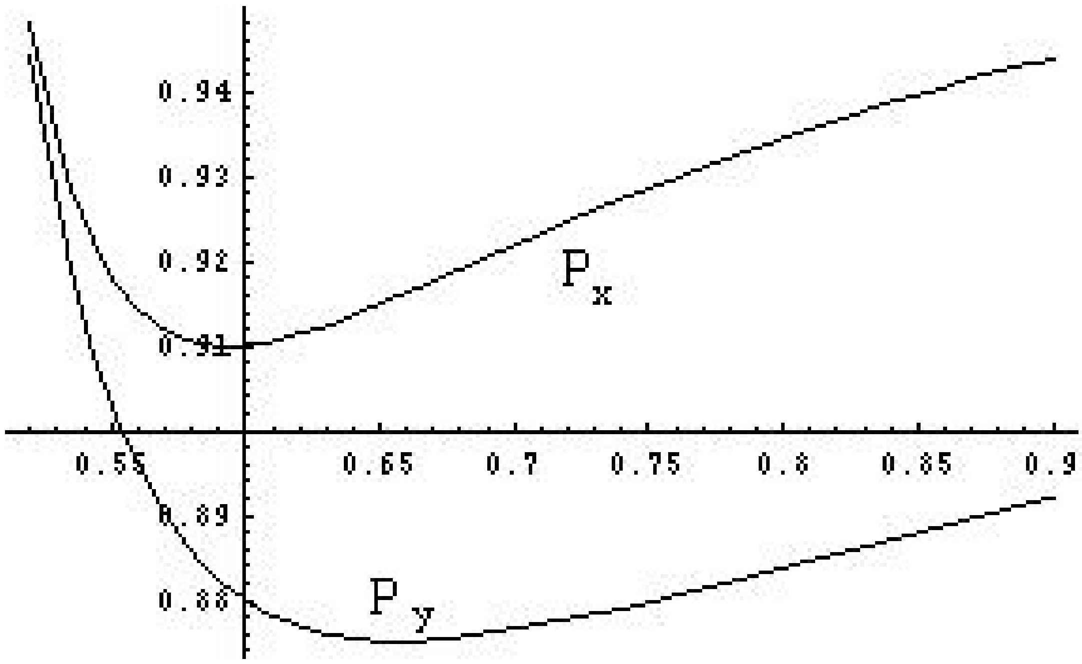


Figure 2: The input markups under vertical integration, as a proportion of the markup without vertical integration, graphed against a.

When P_z is 1, there is no cost reduction, while P_z equal to zero would be competitive or marginal cost pricing. The outcome is plotted in Figure 2. Several observations emerge.

First, the reductions in input prices are significant, on the order of 5% or 10%. Second, firm Y reduces price more than firm X. This should be a reasonably general property, since firm X is responding to firm Y's price reduction. In symmetric models such as 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, firm X priced to serve both firms 1 and 2, and 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 post-merger price. The effect identified in the paper, however, should continue to hold, using the monopoly price for firm 2 as a benchmark, rather than the monopoly price for both downstream firms.

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

While prices are more indicative of the asymmetric effects on the individual input suppliers, firm 2 primarily cares about its marginal cost. In Figure 3, the marginal cost is plotted, relative to the marginal cost without vertical integration.

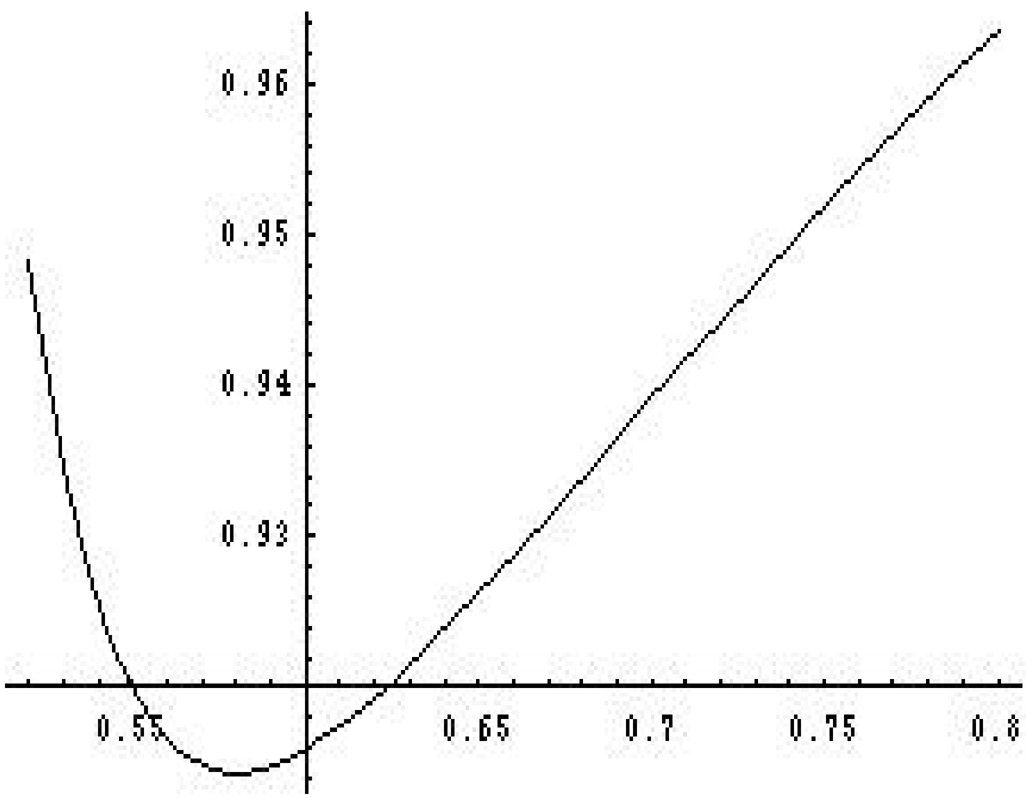


Figure 3: The marginal cost of firm 2 under vertical integration as a proportion of the marginal cost without vertical integration, graphed against a.

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

Discussion of Banking Applications

Recently, the Federal Reserve System studied the implications of its exit from the provision of retail payments services, such as check-clearing and electronic payments. For many community banks, especially those in rural markets, the remaining providers of these services would be vertically integrated competitors. Moreover, as Osterberg and Thomson (1998 - this issue) show, branching deregulation is leading to the consolidation of both the upstream and downstream markets in banking. The extant industrial organization literature suggests that increased vertical integration in banking coupled with consolidation in the inter-bank market may have deleterious effects on downstream banking competition.

However, the literature itself is a poor guide to the likelihood of anti-competitive effects. First, much of the literature was driven in an attempt to understand how vertical mergers might matter for antitrust enforcement. In particular, the Clayton Act, which provided courts with the ability to block a variety of vertical practices, preceded a clear understanding of *any* circumstances in which vertical integration might be harmful to competition. As a consequence, a literature developed to show that vertical integration could matter in a negative way, rather than 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 like a poor model of the provision of many of the upstream services such as 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 stories is that the prime motivation for vertical integration is damaging competitors. One plausible future for the banking industry involves a handful of very large, interstate banks, along with a large number of relatively small, local banks. The large banks will offer banking, mortgage, insurance, finance, and other services, primarily operate electronically, and be vertically integrated into most or all areas of financial services. In contrast, the local banks will be primarily rural, offering personalized service, and creating a market niche by exploiting the superior information and goodwill that local interaction provides. These different styles of banks will not likely compete with each other in the minds of most customers. The large banks will compete strongly with the 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 are induced to use the large, inexpensive banks; for most customers, a given rural bank will compete with other rural banks.

In this scenario (which is not the result of any study on my part), the rural banks will not compete significantly with the large banks. As a consequence, they are unlikely to be a target of anti-competitive vertical integration, nor are they likely to be harmed by the reduction in the number of large vertically integrated banks. The largest banks may attempt to harm each other by their pricing of banking service inputs, but these banks are in the best position to fend for themselves.

The lowering rivals' costs story of this paper is inapplicable to the present analysis so long as the Federal Reserve remains a provider of check clearing and other services at some reasonable facsimile of cost. As a consequence, the only mechanism by which rural banks could benefit through vertical integration of large banks is if the Federal Reserve is inefficient, so that a mechanism for price reductions existed. Prices can't be lowered below minimum cost.

Conclusion

The standard analysis of the effects of vertical integration on competitors emphasizes the incentive of the vertically integrated firm to foreclose its downstream rivals, or raise their costs. While this effect is natural in some applications, there is an off-setting effect on suppliers of substitute inputs. If firms 1 and 2 compete sufficiently weakly 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 the upstream competitors, however, is to reduce their markups over marginal cost, that is, harm to their monopoly power.

A significant aspect of the effect of vertical integration is that both the un-merged 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 price substitute for 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 in marginal costs of the downstream competitor of as much as 8½%.

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