Some Aspect of Price Discrimination Under Vertical Integration

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An upstream monopolist has an incentive to integrate forward with downstream monopolists while practicing implicit third-degree price discrimination. The effect is to eradicate the pricing inefficiency normally associated with successive monopolies. The subject integration may lead to Pareto improvement depending on the type of firm (or set) that is merged with the upstream monopolist. This paper also demonstrates that integration of a firm with spatially dispersed downstream monopolists may lead to Pareto improvement under general demand conditions.

Introduction

It is well-known that an upstream monopolist (UM) has an incentive to integrate forward with firms in related downstream industries (DIs) as a means of practicing implicit third-degree price discrimination. This type of integration has involved situations in which the DIs are perfectly competitive, of course, characterized by classical free entry-exit properties. This type of model also restricts the DIs into which the UM can integrate and successfully practice implicit price discrimination to the sets in which relatively elastic derived demands apply. Otherwise, the practice of price discrimination through integration would generate decreased input prices for non-integrated firms. Thus entry into the newly integrated sector would be open, and the gains from forward integration associated with attempts to practice implicit price discrimination would be eliminated. Moreover, in the cases where the UM practices implicit price discrimination through forward integration, the effect on social welfare is ambiguous.

As well-known, the UM also has an incentive to integrate vertically with a downstream monopolist (DM). This type of integration increases joint profits by eliminating the inefficiency associated with successive monopolies. Since the optimal price selected for the newly integrated DI falls as a direct consequence of the integration, the social welfare effect is definitely positive. It warrants special emphasis in this regard that a paper (Romano 1988) considers vertical integration when the UM serves a set of monopolized DIs. In this case, the UM has a two-fold incentive to integrate forward as the natural gains which stem from eliminating successive monopolies and those gained by practicing

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The present paper will evaluate vertical integration when the UM serves a set of spatially dispersed downstream monopolists (DMs). This setting reflects Romano (1988), but requires more detailed analysis in providing rather significant results.

Unlike the instances where perfectly competitive downstream industries (or firms) are assumed, the set of DIs (or DMs) into which the UM can integrate and successfully practice implicit price discrimination is unconstrained. However, the impacts on social welfare are ambiguous and depend essentially on the integration strategy the UM firm will adopt. For example, the impacts on social welfare depend on which downstream firm the UM firm will integrate with. If the UM integrates with a DM possessing a relatively inelastic demand for the UM's product, final output prices fall in both the integrated and non-integrated sectors. In this case, there is a Pareto improvement. However, if the UM integrates with a DM possessing a relatively elastic demand for the UM's product, then output price falls in the integrated sector but output price rises in the non-integrated firm. Here, the effect on social welfare is ambiguous. Since the price discrimination that is associated with vertical integration can become a severe problem in anti-trust proceedings, the welfare results that can be derived have important implications for antitrust policy. Recognize in this regard that if the UM can integrate with only a specific spatially dispersed downstream monopolist, for example because of governmentally imposed development policy, the effect of implicit price discrimination on social welfare is necessarily ambiguous. In fact, it depends on the type of consumers demanding the product and the locations of rival firms. A more sophisticated analysis of consumer types is required than that which traditional nonspatial theory provides. A main purpose of this paper is therefore to ascertain the impact on social welfare of the vertical integration of spatially separated monopolists, and its implications in the sense of regional policy.

The Basic Model

Our basic assumptions are as follows:
1. A UM produces good v at constant marginal cost c.
2. There are two spatially dispersed monopolists using v as an input.
3. The UM prices f.o.b. mill in selling to two downstream monopolists which are producing an identical good x under conditions of demand x(p).
4. The input v is used in fixed proportions to produce x.
   This condition eliminates the incentive to integrate which otherwise derives from downstream technologies that involve variable proportions in production.6
5. For simplicity, a perfectly elastic supply of other inputs applies in the production of x. Thus, monopsony incentives to integrate do not exist and we can employ the elementary production function: \[ x_i = d_i v_i, \] where \[ v_i \] stands for the employment of \[ v \] in \[ DM_i. \]
6. Since the two DMs are assumed to be located at different points, we shall, for simplicity and convenience, assume that the two downstream sellers (firms 1 and 2) located respectively near to and at a substantial distance from the UM: in addition,
each is a spatial monopolist with respect to consumers located nearest to them. According to assumption 3, the UM prices f.o.b. mill, which means that the actual input prices for the DMs depend not only on the input price itself, but also on the distances separating the UM and the DMs, provided transportation cost is not zero.

7. It follows from 6. that the demand curve $v(k)$ for the DMs will be in the form of:

$$v = v(k) = v(z + tr),$$

where $z$ is the input price, $r$ is the distance between the UM and the DMs, and $t$ is the transportation rate on the input. More specifically, the DM's demand curves become $v_i = v(z + tr_i), i=1,2,$ and $r_1 < r_2,$ where subscript 1 relates to the firm 1 which is assumed to be located near to the UM and the subscript 2 relates to the second firm assumed to be located at a substantial distance from the UM. Hence, $r_1$ ($r_2$) respectively provide the distances between the UM and downstream monopolists. To focus an analysis, from here on, the subscript 1 (2) implies the firm located near to (far away from) the UM.

The elasticity of $v$ with respect to $r$ for a given $z$ plays a critical role in spatial price theory. The elasticity of $v$ with respect to $z$ is

$$
\varepsilon(r) = \left(\frac{dv}{dz}\right) \frac{z}{v} = -z \left(\frac{v'}{v}\right),
$$

because

$$
\frac{dv}{dz} = \left(\frac{dv}{dk}\right) \left(\frac{dk}{dz}\right) = \frac{dv}{dk}.
$$

We obtain for a given $z$

$$
\frac{d\varepsilon(r)}{dr} = \frac{d(-\frac{v'}{v})}{dr} = t \left\{ \frac{d(-\frac{v'}{v})}{dk(r)} \right\}
= t \left\{ -v''v + (v')^2 / v^2 \right\}.
$$

It follows that $d\varepsilon(r)/dr \equiv 0$ as $v'' \equiv (v')^2 / v.$ (And see J. Greenhut M.L. Greenhut 1977; and also H. Ohta 1981 for a diagrammatic interpretation of this relations). Specifically, when $v'' \equiv (v')^2 / v$, i.e., when the negative exponential demand curve applies, $d\varepsilon(r)/dr$ equals 0; when a more convex demand holds, $d\varepsilon(r)/dr > 0$, i.e., elasticity decreases as distance increases; and when a less convex demand set exists, elasticity increases with greater distance. These alternatives provide all feasible homogeneous demand forms.

Note further that if the type of demand curve is less (more) convex, it follows that $v_1(v_2)$ is less elastic than $v_2(v_1)$ for the UM. Recalling Robinson's terminology of 'strong' and 'weak' markets, we can refer to DM$_1$ (the relatively inelastic demander of $v$) as the strong DM and DM$_2$ (the relatively elastic demander of $v$) as the weak DM if the type of demand curve is less convex. And the opposite result holds if the type of demand curve is more convex. The market condition (strong or weak) is therefore determined by the relative degree of elasticity, which depends not only on the distance between the UM and the DM but also on the type of basic demand curve that prevails in the market for the product in question. Note further that there is no strong (or weak) market in the case of the negative exponential demand curve.
Since the DMs are assumed to be monopolies in this analysis, the inverse derived demand for $v_i$ by $DM_i$ is given by the marginal revenue of $x_i$, with appropriate adjustment for the input coefficient given by:

$$z_i(v_i) + t_i = \frac{1}{p_i'(d_i v_i)} \left( d_i v_i + p_i(d_i v_i) \right),$$

where $i = 1, 2$ and where $z_i$ is the price of $v$ to $DM_i$. Here $z_i' < 0$ is assumed, which implies $v_i(z_i) = z_i^{-1}(z_i)$. Moreover, it is assumed that the profit to the UM from the $i$th DM, $\pi_i(z_i) = v_i(z_i)(z_i - c)$, is concave in $z_i$ (for $z_i \geq c$).

We can provide some preliminary results at this point in our analysis. The UM which can practice third-degree price discrimination has to solve the maximum problem given by

$$\text{Max } \pi_i(z_i), \quad i = 1, 2$$

The solution yields the discriminatory price, denoted by $z_{id}$, which in turn satisfies:

$$\pi'(z_{id}) = z_{id} \left[ 1 - \frac{1}{\epsilon_i(v_i(z_{id}))} \right] - c = 0, \quad i = 1, 2$$

Note that $\epsilon_i = -v_i'(z_i)/v_i$ is the elasticity of the derived demand for $v_i$ by $DM_i$. Unless the type of demand curve is the negative exponential, $\epsilon_1 \neq \epsilon_2$, which implies $z_{1d} > z_{2d}$ (For the purposes of this paper, the very special negative exponential demand curve possibility is clearly irrelevant).

Consider the case where $z_{1d} > z_{2d}$. Using (1), the following relationships apply:

$$\epsilon_1(v_1(z_{1d})) < \epsilon_2(v_2(z_{2d})).$$

This case corresponds to the situation when the demand is less convex.* That is, at first, the less convex demand curve is considered. A UM which cannot practice price discrimination solves

$$\text{Max } \sum_{i=1}^N \pi_i(z)$$

Denoting the solution value by $z^*$, we establish

$$\sum_{i=1}^N \pi'(z^*) = z^* \left[ 1 - \frac{1}{\eta(z^*)} \right] - c = 0$$

where

$$\eta(z^*) = \sum_{i=1}^N \left[ \epsilon_i(v_i(z^*)) \frac{v_i(z^*)}{\sum_{i=1}^N v_i(z^*)} \right]$$

is the elasticity of the aggregate derived demand. We assume that $v_i(z^*) > 0, i = 1, 2$. Since $\pi_i'(z_i) > (>) 0$ for $z_i < (>) z_{id}$ (from the concavity of $\pi_i$), it also follows from (1) and (2) that

$$z_{1d} > z^* > z_{2d}$$

Utilizing Robinson’s terminology of ‘strong’ and ‘weak’ markets, we can refer to $DM_1$, the relatively inelastic demander of $z$, as the strong $DM$, and hence to $DM_2$, the relatively
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elastic demander of \( z \), as the weak \( DM \). In other words, if the type of demand curve is less convex, the firm located proximate to \( UM(DM_1) \) becomes the strong \( DM \) and the firm located at the substantial distance from \( UM(DM_2) \) is the weak \( DM \). Of course, this situation is reversed completely when the type of demand curve is of the more convex order (again see note 9). For simplicity, the strong \( DM \) will henceforth be specified by use of the subscript \( s \) and the weak \( DM \) by the subscript \( w \).

The Analysis

If price discrimination is not practiced, the UM must supply both \( DMs \) at the same price. By integrating forward with one of the DMs, the UM acquires a monopoly, so that it is able to supply the non-integrated \( DM \) at the appropriate discriminatory price without fear of entry into the newly integrated firm.

While the above discussion may appear to be strained in the case of only two \( DMs \), it warrants advance note that the following results generalize to the cases of any number of \( DMs \). In contrast to the situations discussed in the literature with competitive \( DMs \), the set of firms into which the UM can profitably integrate is unconstrained and the supply price of \( v \), following integration, can fall to the UM's optimum level. Consider, accordingly, the following:

After integration takes place, a strategy of charging the appropriate discriminatory price to the non-integrated \( DM \) and internally transferring \( v \) in the integrated industry at the pre-integration price (\( z^* \)) generates a profitable integration. However, the UM can increase its profits still further by the internal transfer of \( v \) at the integrated firm's marginal cost. Hence, there is a twofold incentive to integrate, where the second part of the gain from integration comes from eliminating the successive monopoly effect in the integrated industry, which condition does not apply of course to a competitive firm situation.

All gains from price discrimination are easily obtained by the integration of the UM with either of the \( DM \) firms. The incentive to integrate with the \( DM \) resolves the successive-monopoly distortion. Hence, if the act of integration is costless and not prohibited, the UM would optimally integrate with each of the \( DMs \). However, the situation for integration is not frictionless. The costs include the legal costs involved in integrations besides the management cost in directing two spatially separated \( DMs \). This latter cost, namely that which is involved in directing spatially separated \( DMs \) requires further discussion, not only because of the complexity of managing the firms but because of the problems of regional integration. Manifestly, the latter problems are most important for countries which are inclined to plan national economic growth over time. For example, the authority in certain developing countries may suggest that any UM which cannot integrate with all \( DMs \) because of the cost of management should integrate with at least one of the downstream firms towards the end of advancing regional development. Or, the authority may allow the UM, which can integrate with all downstream firms, to integrate with only one of the downstream firms because of a desire to maintain certain
facets of an antitrust policy.

In the situations described above, questions arise as to which firms should be selected for integration by the UM when downstream firms are spatially separated? As far as social welfare is concerned, the result depends largely on the type of consumer demand that holds for the final product and the specific locations of the downstream firms.

A Proposition and Its Corollary

Consider the case of integrating with only one firm among two downstream firms:

Proposition 1. Integration by the UM with the strong (weak) downstream firm leads to a lower (higher) supply price of v. The internal transfer price of v in the newly integrated firm falls to c, the marginal cost of input.

Corollary 1. Integration by the UM with the DM located near to (far away from) the UM leads to a lower (higher) supply price of v if the basic demand curve for v is less convex; in turn, the integration of the UM with the DM located far from (near to) the UM leads to a lower (higher) supply price of v when the basic demand curve for v is more convex.

Proof of proposition 1. When the UM integrates with the strong (weak) DM, the optimal supply price of v becomes the discriminatory price \( z_{wd}(z_{sd}) \). The first statement then follows immediately from (3). After integration, it is definitely optimal to transfer v in the newly integrated firm at the marginal cost \( c \). It follows that the internal price 'falls' after integration, since \( z_{id} > c, i=w, s \).

The proof of corollary 1 is rather obvious. Note that if the basic derived input demand curve is less (more) convex, the net derived input demand curve becomes more elastic (inelastic) as the distance between UM and the DM increases. Hence, if the derived input demand curve is less convex, the DM located near to UM (DM located far from UM) becomes the strong (weak) market. Completely opposite results hold if the basic input demand curve is more convex.

The intuition behind proposition 1 (and corollary 1) is straightforward. The strong (weak) DM puts upward (downward) pressure on the supply price of v. The elimination of the firm as a market-demander through the integration reverses this effect. Here, it is desirable to mention a rather practical implication of corollary 1. As far as the supply price of the input is concerned, it seems desirable at first glance for the UM to integrate with the DM which is located near to the UM. Furthermore, the UM has an incentive to integrate with the proximate DM because the integrated (proximate) DM obtains the input at a lower transportation cost. However, these relationships hold only if the basic input demand curve is of the less convex type; if the basic input demand curve is of the more convex kind, the UM should integrate with the DM which is located far from the UM. This integration with DM2 brings about the lower supply price of the input v. The specification as to the type of demand curve (less convex, more convex) can therefore be
expected to be relevant to the matter of welfare effects, which matter can now be discussed with advantage.

**Social Welfare and Other Propositions**

Unless otherwise indicated, our measure of social welfare is consumer surplus plus producer surplus. We thus obtain:

**Proposition 2.** Integration by the UM with the strong DM results in Pareto improvement. Integration by the UM with the weak DM may or may not generate an increase in social welfare.

**Corollary 2.** Integration by the UM with the DM located near to (far from) the UM results in Pareto improvement if the basic derived input demand curve is less (more) convex. Integration by the UM with the DM located at a substantial distance from (near to) the UM may or may not lead to social welfare improvement if the basic derived input demand is less (more) convex.

**Proof of proposition 2.** Let \( p_{mi}(k_i) \) be the monopoly price of \( x_i \), given that the full price of \( v_i = k_i = z_i + tr_i \). Of course, \( dp_{mi}/dk_i > 0 \) for \( x_i(p_{mi}) > 0 \); and also \( p_{mi}(c + tr_i) > 0 \), where \( c \) is a constant marginal cost of \( v_i \). If integration is with the strong DM, it follows from proposition 1 that \( p_{m}(zwd + tr) < p_{m}(z* + tr) \); i.e. the final output price in the non-integrated firm is decreased. On the other hand, \( p_{m}(zsd + tr) > p_{m}(z* + tr) \) if the integration is with the weak DM. In either case, \( p_{m}(c + tr) < p_{m}(z* + tr) \). Recall further that \( c \) is the assumed constant marginal cost of the input \( v_i \) and \( p_{i}(c + tr) \) is the price that prevails in the integrated industry following integration. In the case of integration with the strong DM, consumers of both DMs are better off since the final prices of each firm are decreased. The weak DM is better off because the supply price of \( v \) has gone down; meanwhile, the UM and strong DM are also better off as their joint profits have risen. Because the supply price of \( v \) rises in the case of integration with the weak DM, the strong DM is less well off and so too are the consumers in this market. However, both the UM and the weak DM are better off as in the case of integration with the strong DM. Neither effect dominates in general, as can be shown upon request of the author.10 For present purposes, it suffices to reflect on the practical implications of colollary 2.

As in the case of corollary 2, simple selection of the DM located proximate to the UM does not always increase social welfare nor does it always result in Pareto improvement. The selection of the downstream firm and the related impact on welfare requires detailed analysis of the demand convexity of the derived spatial input demand curve.

**Conclusion**

The results of this paper have important implications for antitrust proceedings as well as for any governmental regional integration program. If the DIs are competitive and the UM integrates into one DI with price discrimination resulting, there will be a social
welfare loss in most cases. Furthermore, consumers of the nonintegrated DIs will definitely be worse off, since output prices will increase. If the nation’s antitrust laws take the narrow view that vertical integration should be illegal if it adversely affects any consumer group, then vertical integration should be prevented under these structural conditions. However, even given that the nation’s antitrust laws confine to such strict criteria, preventing vertical integration may bring about a social welfare loss when DIs are monopolized. Under monopoly conditions, any related integration that promotes price discrimination can lead to Pareto improvement. Hence, a detailed analysis is necessary for evaluating vertical mergers.

Also, it has been shown that vertical integration among spatially dispersed downstream firms requires more detailed analysis of the shape of derived input demand curves. The naive view that the upstream monopolist should integrate with the firm located nearest the UM is, in the social welfare sense, valid to the limited extent of applying only when the derived input demand curve belongs to a specific demand curve type, namely the less convex set.

Endnotes

2. See Perry (1978) for detailed analysis and further variation.
9. The reason is that subscript 1 (2) relates to the downstream monopolist which is located near to (far away from) UM. Note that the more convex demand curve brings about a completely opposite case, that is, \(v_1(z_1) > v_2(z_2)\) and \(z_{1d} < z_{2d}\).
10. The type of demand function such as \(p = a - bx^n/n, n > 1\), has been used. Note that if \(-1 < n < 0\), the demand function belongs to more convex type and if \(n > 0\), it belongs to less convex type. However, we can easily show the ambiguity of welfare change through using a linear demand curve case, \(i.e. n=1\).

References


