Complements Integration and Leverage: The Case of the Middleman

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Abstract: In some cases, complementary products are sold to different sets of agents to aid in transactions between them. In the context of a simplified model, this paper shows that a monopolist has an incentive to integrate into and foreclose other sellers of a complementary product used in fixed proportions with the monopolized product, but which is sold to different consumers. While these latter consumers are made worse off by integration and leverage, output is expanded and the monopolist's original consumers are made better-off. The effect of integration and leverage on overall welfare is uncertain. I illustrate this model with an example involving trucking fleet cards (sold to trucking companies) and fuel desk point-of-sale systems (sold to truck stops) that are used in conjunction when diesel fuel is purchased.

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1. Introduction

The recent antitrust trial pitting the Department of Justice against Microsoft and the Telecommunications Act of 1996--which set guidelines for local exchange carrier entry into long distance telephony--have both sparked a renewed interest in the economic effects of vertical and complementary products integration. A number of recent articles have investigated the incentive of a dominant firm to integrate into a complementary market and foreclose rivals and the associated welfare effects of this foreclosure (e.g., Economides (1998), McAfee (1999), Riordan (1998), and Sibley and Weisman (1998)). While the results of these studies are mixed, the general message of the recent literature is that vertical integration can reduce welfare if the integrating firm is dominant in its original market.[2] This contrasts with the traditional view that vertical integration, with some exceptions (e.g., regulated industries and variable proportions production), is most likely beneficial if it has any welfare effect at all.[3]

Despite the wide array of results in the literature, all of the articles analyzing vertical or complementary product integration have one thing in common. They all assume that both complementary products are purchased and used in conjunction by a particular consumer (just as a vertical relationship concerns the inputs and outputs of a particular firm). This seemingly tautological assumption does not always hold. In some cases, complementary products are sold to different consumers or firms. For instance, in 1995 Comdata Corporation–the dominant supplier of fleet card services to long-haul trucking companies–purchased Trendar Corporation–the

[2] Ordover et al. (1990), Salinger (1988), and Whinston (1990) are also examples of this new approach to vertical integration and foreclosure.

[3] For instance, see Tirole (1993) pp. 169-186.

dominant supplier of diesel fuel point-of-sale (POS) devices to truck stops.[4] Fleet cards and fuel desk POS systems are complements that work in conjunction to facilitate the sale of diesel fuel between truck stops and truckers. Other examples which defy the normal assumption are credit cards and credit card stripe readers and photographic film and film processing equipment.[5] In the latter case, film processing equipment is sold to retail firms that develop film (e.g., Wal-Mart, Eckerd, etc.), while film is sold to consumers through a variety of outlets. Although sold to different agents, the two products are used in conjunction to produce photographs. In these somewhat unusual cases, the complementary products are used in conjunction to aid transactions between economic agents. Thus, the firms selling these complementary products and services are best thought of as middlemen.

In what cases does a middleman have an incentive to merge with the maker of a complementary product as Comdata did with Trendar? If an incentive exists, would the merger increase or reduce social welfare? As with traditional vertical and complementary product mergers, there are many factors which can determine the answers to these questions. The Federal Trade Commission recently signed a consent order with Ceridian (the parent company of Comdata and Trendar) to allow fleet cards access to the Trendar machine and to allow other POS systems access to ComChek cards. The FTC alleged that the merger of Comdata and Trendar significantly increased the barriers to entry in fleet cards and fuel desk POS systems since Comdata/Trendar became a closed network after the merger. In other words, after the merger an entrant would need to introduce a fleet card and a fuel desk POS system simultaneously since the

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[4] Federal Trade Commission (1999)

[5] Denis Breen suggested this latter example.

entrant would not have access to the ComChek cards or the Trendar machine. As in Aghion and Bolton (1987) and Nalebuff (1999), the increased barriers to entry of a closed system can reduce welfare by allowing the merged firm the ability to increase price without enticing new entry. However, if both firms had market power before the merger, their combination may lead to reduced prices through the elimination of the double margin.

In order to isolate the effects of a merger of firms making complementary products sold to different consumers, it is useful to abstract from the many factors that can lead to increases or decreases in welfare after a complementary products merger. For instance, in this paper I assume the merger will not result in any cost savings on the margin. In addition, a complementary products merger is assumed not to heighten or reduce barriers to entry. To abstract from the reduction of the double margin, it is assumed that one product is supplied monopolistically while the other is supplied competitively. Finally, to facilitate comparisons with the previous literature it is assumed that the complementary products are always used together in a one-to-one ratio. Under these circumstances, it has been shown on numerous occasions that a monopolist of one product has no incentive to integrate into the sale of the other product if they are both sold to the same consumer. Even if the monopolist merged with one of the complementary product producers and foreclosed other producers, the monopolist could not increase its profits since the consumer only cares about the combined price of the products.

Does this result change if the complementary products are sold to different consumers to aid in transactions between them? The answer depends on whether the monopolist has the ability to price discriminate in the previously competitive market. If a uniform price must be charged in both complementary product markets (e.g., because of arbitrage), then a monopolist of one does not gain by integrating into the other market and foreclosing other producers to gain another monopoly. The reason is that a price increase on one set of consumers will be passed on to the other set of consumers via the transactions between them. (For instance, if Comdata were to raise the price of Trendar services, truck stops would pass this price increase onto truckers through the fuel price.) However, a monopolist can gain by integrating into the other market and foreclosing other producers if price discrimination is feasible in the second market (e.g., if Comdata could charge a price for the Trendar machine that varies non-linearly with its use). With quantity-dependent prices, the monopolist can capture rents from the new consumers without reducing the quantity demanded by the monopolist's current customers. In fact, the monopolist has an incentive to lower the price charged to his current customers in order to increase the rents that can be gained in the complementary market. Thus, the monopolist's current customers are made better off when the monopolist integrates and forecloses to gain a monopoly in a complementary market with different customers. These new customers are obviously made worse off, but the overall effect on welfare is less clear. In many but not all cases, overall welfare increases after integration and foreclosure.

At first glance, this result may seem similar to the literature on vertical integration as a means to effect price discrimination (see, for example, Gould (1977)), but it is actually quite different. In that literature, it is shown that an input monopolist that serves at least two different output markets can effect third-degree price discrimination by integrating into the market with the most elastic demand for the input. In this paper, I show that a monopolist has an incentive to integrate into and foreclose other producers of a complementary product (sold to different consumers) in order to gain a monopoly in the complementary product market. This incentive exists if quantity-dependent prices can be charged when a monopoly is achieved in this market.

The results of this paper are closely related to the widely known fact that vertical restraints such as tying and bundling can be profitable for a monopolist facing heterogeneous consumers since the restraints can mimic the benefits of price discrimination (Adams and Yellen (1976)). In my model, the monopolist has an incentive to integrate and foreclose even if the ultimate consumers are homogeneous, as long as the upstream consumers of the complement are heterogeneous and quantity-dependent prices are feasible.[6]

Since complements sold to different consumers often exhibit strong network externalities, the results of this paper are related to the literature on vertical integration and compatibility choice in network industries (e.g., Church and Gandal (1993)). However, this literature focuses on compatibility in hardware-software systems where the complements are sold to the same consumer. To my knowledge, the model in this paper is unique in its exploration of contexts where the complements are sold to separate consumers.

The model is described in section 2. The results are discussed in more detail in section 3. Section 4 concludes with a discussion of possible extensions.

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[6] I am thankful to Mike Vita for pointing out this relationship between my model and the literature.

2. The Model:

In this model, there are three goods (A,B, and X) and three classes of economic agents. I will refer to the agents as "the middlemen," "the producers," and "the consumers." A is sold by the middlemen to the consumers and is necessary for the consumers to purchase X. B is used by the producers as a necessary input to produce good X. Good X is sold by the producers to the consumers. Figure 1 illustrates the relationship between the three sets of agents. Table 1 summarizes two of the previously mentioned examples that fit this scenario.

Table 1

	Trucking		**Film Processing**	
	Good	**Sold to (examples)**	**Good**	**Sold to (examples)**
A	Fleet card services (data capture & transaction authorization)	Trucking companies (Schneider, J.B. Hunt, Swift, etc.)	Camera film	consumers
B	Fuel desk automation systems (e.g., Trendar)	Truck Stops (TA, Flying-J, etc.)	Film developing equipment	Retail stores (Wal-Mart, Eckerd, Moto Photo, etc.)
X	Diesel fuel		Film developing	

It is assumed that A and X are perfect complements always consumed in a one-to-one ratio (e.g., for every roll of film you buy, you use one unit of "film developing").[7] Thus, A = X

[7] In the short-run, this assumption also probably fits in the fleet card case as the amount purchased per diesel fueling transaction does not vary much. However, the assumption may be violated in the long-run as trucking companies could use larger fuel tanks if fleet card transaction

and the demand for A and/or X is a function of the sum of their prices (p_a+p_x). The aggregate demand for A and/or X is given by:

$$A = X = D(p_a + p_x)$$

where $D' < 0$.

Producers are characterized by the cost function $C(?,x)$ where x is the amount produced and ? is a productivity factor. C_x and C_{xx} are both strictly positive, implying diminishing returns to scale.[8] Higher values of ? imply lower costs and lower marginal costs ($C_? < 0$, $C_{x?} < 0$, $C_{xx?} < 0$). Producers exist in two types: high cost producers with $? = ?_1$ and low cost producers with $? = ?_2$ ($?_2 > ?_1$). There are $?_1$ high cost producers and $?_2$ low cost producers. To simplify notation, let $C(?_i,x) \equiv C^i(x)$ for i = 1,2. In addition, producers need B to produce their output, x. As with A, it is assumed that B and x are perfect complements in production and always used in a one-to-one ratio. In the examples listed above, this is not the case. However, this assumption is made to facilitate comparisons between the results of this model and those in the existing literature in which the fixed proportions assumption is common.

Middlemen can sell to consumers or producers or sell to both. It is assumed that they can produce A at a constant marginal cost of c and can produce B at a constant marginal cost of d.

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fees increase. Again, this assumption is included primarily to help promote comparisons between the results of this model and those of the previous literature on vertical integration.

[8] If the production processes were instead constant returns to scale, then only one type of producer would exist in equilibrium, the lowest cost producer. Furthermore, this type of producer would earn no rents in equilibrium, so a middleman monopolist of A would have no incentive to integrate into B and foreclose other makers of B, since no rents can be captured through the sale of B.

Since there are numerous consumers and numerous producers, the market for X between them can be characterized as perfectly competitive. In addition, it is assumed that the producers and consumers observe the prices offered by the middlemen before purchasing A or B and trading X between themselves. Consider the following scenarios:

Case 1:

Suppose one middleman has a monopoly on the sale of A while B is supplied competitively. Consider first the market for X between the producers and the consumers. The producers, in general, solve the following problem:

(PP) $$Max_x \quad V_i = (p_x - p_b)x - C^i(x) \quad for \;\; i = 1,2$$

where p_b is the price of B. The solution to this problem, denoted as $x_i(p_x,p_b)$ for i=1,2, is implicitly described by the following condition:

$$p_x - p_b = C^i_x(x) \quad for \;\; i = 1,2 \qquad \textbf{(1)}$$

The equilibrium price of X, $p_x(p_a,p_b)$, is that which equates supply and demand in the market between the producers and consumers. This is implicitly given as the p_x which solves:

$$D(p_a + p_x) = ?_1 x_1(p_x,p_b) + ?_2 x_2(p_x,p_b) \qquad \textbf{(2)}$$

Since B is competitively provided, p_b = d. Thus, the monopolist producing A solves:

(MP1) $$Max_{p_a} \;\; (p_a - c)D(p_a + p_x(p_a,d))$$

Therefore, the monopolist chooses p_a to satisfy:

$$D + D'(p_a - c)\left(1 + \frac{\mathrm{d}p_x}{\mathrm{d}p_a}\right) = 0 \qquad \textbf{(3)}$$

where:

$$\frac{\mathrm{d}p_x}{\mathrm{d}p_a} = \frac{-D'}{\left(D' - \frac{?_1}{C^1_{xx}} - \frac{?_2}{C^2_{xx}}\right)} \in (-1,0) \tag{4}$$

by the implicit function rule. Denote the solution to (1) and (MP1) as ($\tilde{p}_a$, $\tilde{p}_x$, $\tilde{x}_1$, $\tilde{x}_2$).

Case 2:

Now suppose the monopolist of A vertically integrates into the sale of B and forecloses other sellers of B until they exit. This could be accomplished by making A only compatible with the B sold by the monopolist, as long as there are sufficient barriers restricting the successful introduction of competing A's that are compatible with the foreclosed B's. If price discrimination is not feasible in the market for B (e.g., because of arbitrage), then the monopolist's solves:

(MP2) $$Max_{p_a,p_b} \quad (p_a - c)D(p_a + p_x(p_a,p_b)) + (p_b - d)(?_1 x_1 + ?_2 x_2)$$

after integration and foreclosure. Using (2), this simplifies to:

(MP2′) $$Max_{p_a,p_b} \quad [(p_a + p_b) - (c + d)]D(p_a + p_x(p_a,p_b))$$

In this case, the p_a chosen by the monopolist may be different from that chosen in case 1. However, it is clear from a comparison of (MP1) and (MP2′) that p_a+p_b will be the same as it was in case 1. That is:

$$p_a + p_b = -\frac{D}{D'\left(1 + \frac{\mathrm{d}p_x}{\mathrm{d}p_a}\right)} + c + d \tag{5}$$

in both case 1 and case 2. It follows that the monopolist's profits in this case are the same as in case 1. Therefore, if the monopolist cannot price discriminate in the market for B, then the monopolist has no incentive to foreclose other sellers of B. Without the ability to price discriminate, the incentive (or lack thereof) for integration and foreclosure when complements are sold to separate sets of agents is the same as that when complements are both sold to the same agent. As in the standard case with fixed proportions, an increase in the price of one complement causes the profit maximizing price of the other to drop by an exactly off-setting amount. In this case, there is a slightly different mechanism, but the overall effect is the same. An increase in the price of B, for instance, causes the equilibrium price of X to rise, reducing the amount demanded of X and thus reducing the demand for A. An increase in the price of A has the same effect on the demand for B. Thus, nothing can be gained by monopolizing B if A is already monopolized, and vice versa.

Case 3:

Now suppose the monopolist of A vertically integrates and forecloses other sellers of B, but, in this case, price discrimination is feasible. To be specific, the newly created monopolist of B can sell B at quantity-dependent prices. However, the monopolist cannot offer type-dependent prices. This is consistent with cases in which the monopolist cannot directly observe whether a producer is a low-cost or high-cost producer. Even if the monopolist can observe the producer's type, he may not be able to verify it in a way that can be the basis of a contract. If it is profitable to price discriminate, the monopolist will offer a menu of contracts $\{(s_1,x_1),(s_2,x_2)\}$ in which s_i is the payment required for buying x_i of B. After integration and foreclosure, the monopolist solves:[9]

(MP3)

$$
\begin{aligned}
Max_{p_a,p_x,s_1,s_2,x_1,x_2} \quad & (p_a - c)D(p_a,p_x) + ?_1(s_1 - dx_1) + ?_2(s_2 - dx_2) \\
s.t.\ (P1) \quad & p_x x_1 - s_1 - C^1(x_1) \geq 0 \\
(P2) \quad & p_x x_2 - s_2 - C^2(x_2) \geq 0 \\
(IC1) \quad & p_x x_1 - s_1 - C^1(x_1) \geq p_x x_2 - s_2 - C^1(x_2) \\
(IC2) \quad & p_x x_2 - s_2 - C^2(x_2) \geq p_x x_1 - s_1 - C^2(x_1) \\
(SD) \quad & D(p_a + p_x) = ?_1 x_1 + ?_2 x_2
\end{aligned}
$$

The first two constraints in (MP3) are participation constraints which insure that the menu item intended for each type of producer gives the producer its reservation profit level (normalized to zero). The second two constraints in (MP3) are incentive compatibility constraints which insure that the menu item intended for each type of producer will be selected over that item intended for the other producer. The fifth constraint is simply the equilibrium condition that supply equals demand in the market for X.

(MP3) can be simplified considerably. First, notice that (IC2) and (P1), plus the fact that $C^1(x) > C^2(x)$ for all x, imply that (P2) will not bind at the solution to (MP3). In other words, the low-cost producer will earn a premium over its reservation profit level when the middleman monopolist price discriminates. If (P2) does not bind, then (IC2) must bind at the solution since s_2 could be increased slightly, improving the monopolist's profits, if both (IC2) and (P2) did not

[9] This assumes that $?_1$ is sufficiently close to $?_2$ so that the monopolist profits by serving the high cost producer. Otherwise, the problem is essentially equivalent to (MP2) with $?_1 = 0$.

bind. This, in turn, implies that (IC1) does not bind since $C_{x?} < 0$.[10] Finally, this implies that (P1) binds, since s_1 could be increased slightly if it did not.

Using these facts, (MP3) can be simplified to:

(MP3′)
$$\begin{aligned} Max_{p_a, p_x, x_1, x_2} \quad & (p_a - c)D(p_a + p_x) + ?_1[(p_x - d)x_1 - C^1(x_1)] \\ & \quad + ?_2[(p_x - d)x_2 - C^2(x_2)] - ?_2[C^1(x_1) - C^2(x_1)] \\ s.t. \quad & D(p_a + p_x) = ?_1 x_1 + ?_2 x_2 \end{aligned}$$

Essentially, (MP3′) mirrors the standard discrete-type adverse selection problem. The monopolist wants to capture all of the producers' surplus, but cannot because he must give the low-cost producers enough rent to make them indifferent between choosing the bundle intended for them and the bundle intended for the high-cost producers. The magnitude of this premium for each low cost producer is $[C^1(x_1)-C^2(x_1)]$(i.e., their cost advantage over the high-cost producers at the high-cost production level). The monopolist can lower the premium required by the low-cost producers by making the high-cost producers' bundle less attractive. This entails less production from the high-cost producers than the monopolist would prefer under full information.

Notice, also, that (MP3') can be rewritten as:

(MP3″)
$$\begin{aligned} Max_{p, x_1, x_2} \quad & (p - c - d)D(p) - ?_1 C^1(x_1) - ?_2 C^2(x_2) - ?_2[C^1(x_1) - C^2(x_1)] \\ s.t. \quad & D(p) = ?_1 x_1 + ?_2 x_2 \end{aligned}$$

where $p = p_a + p_x$. Denote the solution to (MP3) (as well as (MP3′) and (MP3″)) as $(\bar{p}, \bar{x}_1, \bar{x}_2)$. In other words, any p_a and p_x in which $p_a + p_x = \bar{p}$ is a partial solution to (MP3).

[10] That is, as long as $x_1 \neq x_2$. If they are equal, then the constraints imply $s_1 = s_2$ and the monopolist is no longer price discriminating. The monopolist's problem then essentially reverts back to case 2.

3. The Results:

A comparison between case 1, in which the middleman only has a monopoly over A, and case 3, in which the middleman has also monopolized B through integration and foreclosure, reveals the following:

Result 1: If price discrimination is feasible when selling B, then a monopolist of A can profit by integrating into the market for B and foreclosing other sellers of B to force their exit.[11]

With price discrimination, the tradeoff between profits from A and profits from B illustrated in case 2 is no longer present. A monopolist of A can integrate into (and foreclose other sellers of) B to capture producers' rents without necessarily sacrificing profits from the sale of A. In particular, with quantity dependent prices, the monopolist can capture at least a portion of the producers' rents without necessarily reducing the amount of X sold, and thus without reducing his profits from the sale of A.

Result 2: After integration and foreclosure, the total price paid by consumers ($p_a + p_x$) is less than before. Thus, the equilibrium quantities of X, A, and B are greater than before and consumers' surplus is greater than before.

If price discrimination is feasible in the market for B, not only does the monopolist profit by using integration and foreclosure to gain a monopoly in B, but the monopoly in B is more

[11] The proof of this and other results is found in the Appendix.

profitable on the margin than that in A. The monopolist has an incentive to lower the total price of A ($p_a + p_x$) from its stand-alone profit maximizing level so that more X, A, and, in particular, B are produced. Essentially the monopolist has an incentive to subsidize the production of B by lowering the price of X and A, since the monopolist captures a greater portion of the producers' surplus through price discrimination in B than he is able to capture in the market for A. This, of course, makes consumers of X and A better off and leads to larger amounts of X, A, and B in equilibrium.[12]

An alternative rationale for the lower total price after integration and leverage relates to the relative movements of p_a and p_x. Before integration, the monopolist only cares about the market for A. If he increases the price of A, demand for A will decrease, but this is ameliorated somewhat by a decrease in the equilibrium price of X. Thus, the impact of a price increase on the monopolist's profits is lessened by the effect of the price increase on the equilibrium price of X. However, after integration and leverage, this reduction in the price of X will lower the rents that the monopolist can capture through price discrimination in the market for B. Therefore, the monopolist is better off reducing the price of A after gaining a monopoly over B.

Result 3: After integration and foreclosure, the production of the low-cost producers (x_2) increases and the difference between low-cost production and high-cost production (x_2 - x_1) also increases.

[12] One can think of this as an efficiency rationale for integration, but it is distinct from other common vertical efficiencies such as marginal cost reduction and the elimination of the double margin.

Since the combined price of A and X will fall and the amount of A and X demanded will increase after integration and foreclosure, the amount of X and B produced will also increase. However, since the monopolist wants to minimize the premium he pays to the low cost producers, the high cost producers' production will not increase by as much as that of the low cost producers, if it increases at all. In many cases, the high cost producers will produce less after integration and foreclosure.

Result 4: After integration and foreclosure, producers' surplus is reduced.

This simply comes about because the monopolist can now capture most of the producers' rents through price discrimination. This reduction in producers' surplus is also enhanced by an inefficient level of production from high-cost producers. After integration and foreclosure, these producers produce too little so that low-cost producers do not choose the high-cost option when buying B.

If price discrimination is feasible, integration and foreclosure by a monopolist of A to create a monopoly of B is profitable for the monopolist, beneficial to the consumers, and harmful to the producers. Overall welfare could increase or decrease as a result of integration and foreclosure. This is because foreclosure has two opposing effects on welfare. As described in Result 2, welfare increases because the monopolist has an incentive to see increased production after gaining a monopoly over B if price discrimination is possible. However, to sustain price discrimination, the monopolist must offer the high-cost producers a relatively unfavorable menu option specifying too little production. This latter inefficiency could outweigh the former efficiency and cause welfare to decline after integration and foreclosure.

To illustrate these two opposing effects and their overall effect on welfare, a simulation of the model is useful. Suppose $D(p_a+p_x) = a - ß(p_a+p_x)$ and $C(?,x) = (x^2)/?$. In addition, let $?_1 = 2$, $?_2 = 4$, $a = 10$, $c = d = 1$, and $?_1 = ?_2 = ½$. Table 1 gives changes in various measures resulting from integration and foreclosure as ß becomes smaller (i.e., as the demand for X and A becomes less responsive to price). Notice that the simulation confirms the conclusions stated above in Results 1 through 4. The combined price of A and X falls while overall production of X, A, and B, and consumers' surplus, increases. Low-cost producers produce more than before, while high cost producers produce less than before. The middleman monopolist's profits increase and producers' surplus falls. The change in total welfare depends on the size of the increase in consumers' surplus and the degree to which high-cost production is reduced. As seen in Table 2, when ß is relatively large, the increase in consumers' surplus associated with integration and leverage is large while the reduction in high-cost production necessary to sustain price discrimination is relatively small. In these cases, overall welfare increases after integration and foreclosure. When ß is relatively small, the decrease in price causes a small increase in consumers' surplus while a relatively large reduction in high-cost production is needed to sustain price discrimination. In these cases, integration and foreclosure can cause overall welfare to decline.

Table 2

Measure	**ß=1**	**ß=1/2**	**ß=1/4**	**ß=1/16**	**ß=1/32**	**ß=1/64**
? Price	-0.51	-0.83	-1.09	-1.35	-1.40	-1.43
? X	0.51	0.41	0.27	0.08	0.04	0.02

Measure	ß=1	ß=1/2	ß=1/4	ß=1/16	ß=1/32	ß=1/64
? x_1	-0.15	-0.36	-0.54	-0.75	-0.79	-0.81
? x_2	1.16	1.18	1.09	0.92	0.88	0.86
? Consumers' Surplus	1.35	0.90	0.50	0.13	0.06	0.03
? Monopolist's Profit	2.04	3.73	5.16	6.67	6.97	7.13
? Producers' Surplus	-1.66	-3.35	-4.94	-6.76	-7.14	-7.34
? Welfare	1.73	1.28	0.72	0.04	**-0.11**	**-0.18**

Conclusion and Extensions:

When complements are sold to different groups of consumers or producers to aid in transactions between them, it is possible for vertical integration and leverage to reduce welfare. However, any reduction in welfare comes about despite an increase in output. The possible inefficiency of integration and leverage in this case comes about because the high-cost producers produce too little, even though overall production increases. If this production inefficiency is small, the benefit of increased output may lead to greater overall welfare.

While illustrating the effects of integration when complements are sold to different consumers, these results do not account for other potentially important factors such as variable proportions production, strategic behavior, innovation, and entry. In particular, the incorporation of entry into the model may indicate that vertical integration and leverage is more harmful (or less beneficial) in cases where complements are sold to different consumers. For instance, entry might be more difficult after a middleman monopolist forecloses other producers of a complementary product since a potential entrant would need to develop and market both complementary products simultaneously. This entry barrier might be heightened by the fact that an entrant would have to sell the two products to different consumers. It is also possible that the increased profits from integration could spur more research and development from potential entrants wishing to capture this profit, ultimately increasing welfare.

References:

Adams, W.J. and Yellen, J.L. (1976), "Commodity Bundling and the Burden of Monopoly," *Quarterly Journal of Economics*, 90, 475-98.

Aghion, P., and Bolton, P. (1987), "Contracts as a Barrier to Entry," *American Economic Review*, 77(3), 388-401.

Church, Jeffrey and Gandal, Neil (1993), "Equilibrium Foreclosure and Complementary Products," *Tel Aviv Sackler Institute of Economic Studies Working Paper 3/93*.

Economides, N. (1998), "The Incentive for Non-Price Discrimination by an Input Monopolist," *International Journal of Industrial Organization*, 16, 271-84.

Federal Trade Commission (1999), "Ceridian Corporation - Analysis of Proposed Consent Order to Aid Public Comment," 9/30/99, http://www.ftc.gov/os/1999/9909/ceridiananalysis.htm

Gould, J.R. (1977), "Price Discrimination and Vertical Control: A Note," *Journal of Political Economy*, 85, 1063-1071.

McAfee, Preston (1999), "The Effects of Vertical Integration on Competing Input Suppliers," *Federal Reserve Bank of Cleveland Economic Review*, 35, 2-8.

Nalebuff, B. (1999), "Bundling," Mimeo, Yale University.

Ordover, J., Saloner, G., and Salop, S. (1990), "Equilibrium Vertical Foreclosure," *American Economic Review*, 80, 127-142.

Riordan, M.. (1998), "Anticompetitive Vertical Integration by a Dominant Firm," *American Economic Review*, 88, 1232-1248.

Salinger, M. (1988), "Vertical Mergers and Market Foreclosure," *Quarterly Journal of Economics*, 77, 345-356.

Sibley, David S. and Weisman, Dennis L. (1998), "Raising Rivals' Costs: The Entry of an Upstream Monopolist into Downstream Markets," *Information Economics and Policy*, 10, 451-470.

Tirole, Jean (1993), *The Theory of Industrial Organization*, Cambridge, MA: MIT Press.

Whinston, M.(1990), "Tying, Foreclosure, and Exclusion," *American Economic Review*, 80, 837-859.

Appendix

Proof of Result 1: I will prove this result by showing that there exists an outcome that is feasible under the constraints of (MP3) that results in more profit for the monopolist than in (MP1). Since $\tilde{x}_i$ = argmax $V_i(\tilde{p}_x,d)$ for i = 1,2, and since $C^1(x) \neq C^2(x)$ for all x, there exists an e > 0 such that $\{p_a,p_x,(s_1,x_1),(s_2,x_2)\}= \{\tilde{p}_a,\tilde{p}_x,(e,\tilde{x}_1),(e,\tilde{x}_2)\}$ satisfies the constraints of (MP3). This outcome results in $e(?_1+ ?_2)$ more profit for the monopolist than is possible in (MP1). ∎

Proof of Result 2: Expression (3) which characterizes $p_a + p_x$ before integration and leverage can be expressed as:

$$D(p_a+p_x)+D'(p_a+p_x)[p_a-c](1+\frac{dp_x}{dp_a}) = 0 \qquad \textbf{(P2.1)}$$

The first order condition that characterizes the $p_a + p_x$ which solves (MP3') can be expressed as:

$$D(p_a+p_x)+D'(p_a+p_x)[(p_a+p_x)-c-d-C^2{}_x] = 0 \qquad \textbf{(P2.2)}$$

Notice from (MP3') that, given p_x, x_2 will be chosen by the monopolist so that $p_x-d-C^2{}_x=0$. Then (P2.2) becomes:

$$D(p_a+p_x)+D'(p_a+p_x)[p_a-c] = 0 \qquad \textbf{(P2.3)}$$

Since $dp_x/dp_a \in (-1,0)$, the $p_a + p_x$ characterized by (P2.2) and (P2.3) is less than that characterized by (P2.1). ∎

Proof of Result 3: The first order conditions of (MP3') with respect to x_1 and x_2 imply:

$$C^2{}_x(x_2)-C^1{}_x(x_1) = \frac{?_1}{?_2}[C^1{}_x(x_1)-C^2{}_x(x_1)]$$

which implies that $C^2{}_x(x_2) > C^1{}_x(x_1)$. Before integration and leverage, $C^2{}_x(x_2) = C^1{}_x(x_1) = p_x - d$. Therefore, since $C_{xx?} < 0$, this implies that $x_2 - x_1$ is greater after integration and leverage. This, along with result 2, implies that x_2 is greater than before integration and leverage. ∎

Proof of Result 4: Under (MP1), producers' surplus is:

$$\tilde{PS} = ?_1[(\tilde{p}_x-d)\tilde{x}_1-C^1(\tilde{x}_1)]+?_2[(\tilde{p}_x-d)\tilde{x}_2-C^2(\tilde{x}_2)] \qquad \textbf{(P4.1)}$$

Under (MP3), producers' surplus is:

$$\overline{PS} = ?_2[C^1(\overline{x}_1) - C^2(\overline{x}_1)] \qquad \textbf{(P4.2)}$$

Suppose, producers' surplus is greater after integration and foreclosure. This implies:

$$C^1(\overline{x}_1) - C^2(\overline{x}_1) > (\tilde{p}_x - d)\tilde{x}_2 - C^2(\tilde{x}_2) \qquad \textbf{(P4.3)}$$

This implies:

$$(\overline{p}_x - d)\overline{x}_1 - C^2(\overline{x}_1) > (\tilde{p}_x - d)\tilde{x}_2 - C^2(\tilde{x}_2) \qquad \textbf{(P4.4)}$$

Since $\hat{p}_x$ can take on any value as long as $p_a + p_x = \overline{p}$ without changing profit, producers' surplus, or consumers' surplus, there exists a solution to (MP3) with $\hat{p}_x = \tilde{p}_x$. However, this solution along with (P4.4) contradicts the fact that $\tilde{x}_2 = \text{Argmax } V_2$ for $p_b = d$. €