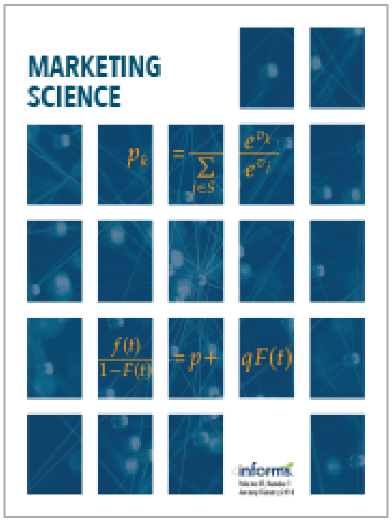

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An Industry Equilibrium Analysis of Downstream Vertical Integration

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This paper investigates the effect of product substitutability on Nash equilibrium distribution structures in a duopoly where each manufacturer distributes its goods through a single exclusive retailer, which may be either a franchised outlet or a factory store. Static linear demand and cost functions are assumed, and a number of rules about players' expectations of competitors' behavior are examined. It is found that for most specifications product substitutability does influence the equilibrium distribution structure. For low degrees of substitutability, each manufacturer will distribute its product through a company store; for more highly competitive goods, manufacturers will be more likely to use a decentralized distribution system.

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1. Introduction

Every producer must decide how many levels of intermediary to use to distribute its products to the ultimate consumer. In making such a determination the producer must trade off the benefits of not having to bear distribution and selling expenses directly with the costs of losing complete control over how the products are marketed. Most marketing texts, when discussing this trade-off, point out that intermediaries are used primarily because of "their superior efficiency in making goods widely available and accessible to target markets" (Kotler 1980, p. 417). In this study we examine another reason why a producer may want to place one or more levels of intermediary between itself and the marketplace *even when the producer is capable of carrying out the selling functions with the same efficiency as the intermediary.*

We restrict our attention to an industry structure with only a few upstream producers, each of which uses downstream intermediaries which carry only its product line. Consequently we do not address situations in which intermediaries carry more than one seller's product in a given class (e.g. grocery stores, department stores) and situations where there are more than two levels. A number of industries meet these criteria. Gasoline, new automobiles, soft drinks and fast food chains are important consumer product class examples. Industrial products satisfying these criteria include industrial gases, fork lift trucks and heavy farm equipment. Also covered by our analysis are situations where a large wholesaler (buying possibly from a number of manufacturers) distributes its line through retail outlets dealing only with the specific wholesaler (e.g., Fox Grocery, Sears, and Montgomery Ward).

Our work is closely related to the extensive literature on bilateral monopolies, since we model the business relationships between, and the economic incentives of, the different channel members. However, it differs in a number of important ways. First, although our model, like others (e.g., Wu 1964), has a multiple number of manufacturers and sellers, it restricts any one seller to carry the product line of only one manufacturer. Second, it focuses on retail markets where each of two manufacturers sells its product through a single retailer. Third, our model explicitly reflects different degrees of substitutability of the two end products as perceived by the consumers. In fact we show that it is this degree of interdependence between the end-user demand for the two products that determines whether the Nash equilibrium channel structure in an industry is a zero-level distribution system (i.e., vertically integrated) or one having more channel levels with independently-owned intermediaries distributing the product. Finally, our interests differ somewhat from most of the previous work on bilateral monopolies in that we are more interested in the determination of channel structure and the implications for channel management than the impact of the structure on consumer welfare.

In the next section we describe the games which determine the equilibrium channel structures. Following that we summarize related research. We develop our model in §4 and present and discuss the results of our analysis in §5. In §6 we compare and contrast our results with those for three competing game specifications. The final section contains a summary and concluding remarks.

2. Equilibrium Conditions

Before presenting our model, we discuss the key aspects of our analysis and how we determine industry equilibrium for different channel structures. The type of industry analyzed is comprised of two firms manufacturing (or wholesaling) differentiated but competing products. For convenience we refer to the upstream firms as manufacturers and the downstream channel members as retailers. To simplify the analysis, we assume that although a manufacturer may use a large number of retailers to distribute its product, within a given marketing area a manufacturer distributes its products through one retail outlet, where an outlet can be owned either by it (i.e., a company store) or privately (i.e., a franchised outlet). Furthermore, we assume that managers for company stores and entrepreneurs for franchised outlets are supplied competitively. Consequently, the manufacturers hold most of the power in the producer-retailer dyads.

The two types of retail outlet yield three types of industry structure within a given market area. In the first, both manufacturers distribute their products through privately owned retailers. This structure can be described by a game with four players, each of which has some decision-making power. Secondly, each manufacturer can own its retail outlet. In this vertically integrated case, there are only two players (the two manufacturers). The third case is a mixed structure, with one manufacturer selling through a private retailer and the other selling through a company store; it has three players.

Each retail outlet faces a downward sloping demand curve of the form

$$q_i = f_i(p_1, p_2), \tag{2-1}$$

where q_i is the quantity sold by retail outlet i and p_1 and p_2 are the two retail prices. Each vertically integrated manufacturer i has one decision variable, the retail price p_i of its product. In a decentralized channel system manufacturer i decides the wholesale price w_i it charges its private retailer while the retailer sets the retail price p_i of the product. In this way we assume no conflict between the two agents in a decentralized channel, since the manufacturer has no direct control over the marketing policies of the retailer. Nevertheless, the manufacturer does have some influence on the final retail price. This derives from the assumptions that the manufacturer possesses sufficient channel power to set its own wholesale price w_i and that it knows how much its retailer will order at any given price w_i. This knowledge of the retailer's reaction function enables the manufacturer to set w_i to maximize its own profit taking into consideration the retailer's reaction to any w_i and conditional on its competitor's decisions.

The actual sequence of decisions is as follows. In a decentralized structure, each retailer, faced with a downward sloping demand curve and a given wholesale price, noncooperatively selects its pricing policy to maximize its profits given the competitor's price. The simultaneous solution to these problems produces Nash equilibrium retail prices conditional on the wholesale prices and the decentralized structure. Denote the quantities associated with these equilibrium retail prices by q_i^*. Since the equilibrium retail prices depend on the wholesale prices chosen by the two manufacturers, q_i^* also is a function of these wholesale prices:

$$q_i^* = g_i(w_1, w_2). \tag{2-2}$$

In this way, $g_i(\cdot)$ represents the demand facing manufacturer i as a function of the wholesale prices set by the two manufacturers.

We next must make an assumption about how the manufacturers in the pure decentralized structure go about setting their wholesale prices. Although it is possible to postulate a number of different strategies for setting wholesale price, we initially assume the following rule.

D1. Each [decentralized] manufacturer chooses its wholesale price to maximize its profits conditional on its competitor's wholesale price and on the conditional equilibrium retail price (or quantity) functions, which are functions of the two wholesale prices. That is, each manufacturer takes account of the reactions of both retailers to its moves but assumes that the competing manufacturer will not respond.

The second stage of the four-person game is played by each manufacturer noncooperatively selecting the wholesale price which maximizes its profits given its competitor's wholesale price. The simultaneous solution produces Nash equilibrium wholesale prices. Since the demand functions used in this two-player game are associated with Nash equilibrium solutions at the retail level, the final solution is a Nash equilibrium at both the wholesale and retail levels.

In evaluating the appropriateness of the above set of rules, it is necessary to look at two different aspects of the game. The first is the use of the Stackelberg model to represent the relative power between the manufacturer and its retailer. For the types of industries we are studying, we find the assumption that each decentralized manufacturer conditions on its private retailer's decision rule eminently reasonable. The second concerns what the manufacturer assumes to be fixed when setting its control variable. We are less sure whether the appropriate behavioral assumption is that the manufacturer conditions on the reaction of its competitor's retailer, as we have assumed, or some other rules, such as the manufacturer taking its competitor's retail price as given or taking into account not only the reaction of its competitor's retailer but also the response of the other manufacturer.

In addition to the question of what manufacturers take as given in determining their control variable, there are possible conceptual problems in (1) assuming that the manufacturer conditions on its competitor's wholesale price, since it may not observe directly this price, and (2) deriving the Nash equilibrium wholesale prices in the absence of a wholesale market. We believe this formulation is reasonable, however, for the following reasons. First, since the two retailers' conditional equilibrium decision rules are a function of known demand and cost functions as well as the wholesale prices of the competitors, each manufacturer can infer its rival's wholesale price from the observed retail prices. Second, the manufacturers' demands are derived demands. Hence, they are indeed competing in a market—the retail market. In summary, the absence of a wholesale market or directly observed wholesale prices is not restrictive, and the concept of Nash equilibrium wholesale prices is operational.

Even though we believe that our assumptions about firms' expectations of competitors' reactions in this four-person game are reasonable, we do not have a strong basis for preferring them over a number of other reasonable specifications. Consequently, in §6 we postulate alternative behavioral assumptions and explore their implications. Which, if any, of the formulations proves fruitful is an empirical question.

For the mixed structure, we employ the following game rules.

M1. The integrated firm sets its [retail] price to maximize profits conditional on the decentralized retailer's price. This decentralized retailer conditions on its manufacturer's wholesale price and its competitor's retail price when selecting its profit-maximizing price. The decentralized manufacturer chooses its wholesale price to maximize profits conditional on the conditional equilibrium retail price functions, which are functions of its wholesale price. In other words, the two retailers compete head-to-head as in the decentralized structure game D1; the nonintegrated firm takes account of all responses to its moves when choosing its profit-maximizing wholesale price.

Again, this sequential solution guarantees the equilibrium to be Nash in wholesale price and retail prices.

Finally, we note that the factory outlet structure is simply a two-person game which can be solved directly for the Nash equilibrium. Since the game is in terms of prices, this equilibrium is the Bertrand solution; if the game were played in quantities, it would be the Cournot solution. Formally, the rules of the game are described below.

I1. Each [integrated] manufacturer chooses the retail price that maximizes its profits given its competitor's retail price.

We have discussed the determination of the industry Nash equilibrium in prices conditional on a particular distribution structure and particular modes of behavior of channel members. The equilibrium determination of distribution structures selected by the manufacturers is straightforward once the solutions for each structure have been obtained. In this higher level game the manufacturers each have two strategies available: decentralization and vertical integration. The payoffs to this two-person game are the four manufacturer profit pairs associated with the four conditional Nash equilibrium solutions, one for each distribution system. As in the previous games, it is possible to find Nash solutions.

It should be noted that the assumption that retailers are price takers is implicitly embedded in our game formulations and therefore is crucial in any further analysis. This assumption is based on our belief that in many industries retailers have little control over the manufacturer's wholesale price. For example, it is our experience that individual privately-owned automobile dealers have little influence on the wholesale price set by the motor company manufacturing the cars. Similarly, the local independent gas station dealer has little influence on the wholesale tank price it must pay to the oil company. The only price under this dealer's control is the retail pump price.

While we would not expect this assumption to be controversial in the automobile and gasoline industries, where there are over 23,000[1] and 146,500[2] retailers, respectively, it is interesting to speculate about the conditions under which this assumption is reasonable. Surely two important factors are the monopoly power of the manufacturers and the relatively competitive supply of potential dealers. We are currently investigating this question in greater detail. In any event, we can say that we would not expect our

[1] Source: *Ward's Automotive Yearbook, 1981*, p. 137.

[2] Source: U.S. Department of Commerce, U.S. Bureau of the Census, *Census of Retail Trade*, 1977.

results to apply in situations where the manufacturers lack substantial monopoly power or the potential retailers possess it, due to either a limited number of potential retailers or to the formation of a strong retailer association organized by manufacturer (as opposed to across manufacturers).

Finally, it should be noted that our analysis differs from many economic analyses in that the decision variables are prices, not quantities. We do this for two reasons. First, because the prices for differentiated products need not be identical in equilibrium, there is no industry demand of the form $p = f(\sum q_i)$. While these equations can be solved for prices as functions of quantities,

$$p_i = h_i(q_1, q_2), \tag{2-3}$$

this does not seem to us to be the natural way to view the problem.

More importantly, if the manufacturers were able to set the quantities the retailers had to purchase, the retailers would have no decision-making role, since the market-clearing condition would determine the retail price. While setting quantities would work for vertically integrated organizations with centralized decision making, it is inappropriate for vertically integrated organizations using decentralized systems, including those where manufacturers sell through private retailers.

3. Related Research

Our game-theoretic approach differs from most previous analyses of channel structure in that our ultimate aim is to determine the equilibrium channel structure under different market conditions rather than equilibrium conditions under a given channel structure. However, since this latter determination is a necessary part of our analysis, we briefly review prior work in this area, as well as a slowly growing set of analyses which are concerned with the broader issue of industry equilibrium.

Most work in determining equilibrium conditions for a particular channel structure has characterized the structure as a bilateral monopoly with the manufacturer as seller and the retailer as intermediate buyer. This characterization, which was used to determine equilibrium prices, first appeared in the marketing literature in 1950 (Hawkins 1950) and was later expanded on by Douglas (1975). More recently, Jeuland and Shugan (1982) have used this approach to explore methods of optimizing channel profits. All three analyses are somewhat akin to our four-player game, a main difference being that our analysis is expanded to acknowledge explicitly the competitive influence of one retailer's actions on the second retailer's profits. As we show in a later section, this competitive reaction affects the equilibrium solution. A second related analysis which takes off from the bilateral paradigm was proposed by Wu (1964). He argues that the results for bilateral monopolies extend directly to three cases: "a small number of large buyers face a large number of small sellers; a small number of large sellers face a large number of small buyers; a large number of small buyers face a large number of small sellers." Our analyses differ from these three cases in that they address a fourth case: "a small number of large buyers face a small number of large sellers" where the buyers are competitively supplied, i.e., have little power relative to the seller. Moreover, our model differs from Wu's approach in that we are concerned with situations where the seller deals only with one buyer in any particular geographic region rather than with more than one buyer.

A second stream of research investigates specific aspects of the relationship between manufacturer and retailer. Pashigian (1961) assumes an industry structure where manufacturers in an oligopoly sell through privately owned franchised dealerships. He then explores the choice of the optimal number of retailers. White (1971) argues that Pashigian's result has little empirical relevance and proposes an alternative equilibrium model of the industry to explain why manufacturers limit the number of dealers within a given geographic area. Although both approaches are similar to ours in that they (a) characterize the industry structure in terms of a small number of manufacturers selling to specific retailers and (b) use similar types of demand functions, neither Pashigian nor White treats the retail distribution structure as a control variable in the context of an industry equilibrium model.

A third line of related research employs a game-theoretic paradigm to investigate channel strategies. Baligh and Richartz (1967) and Richartz (1970) postulate a vertical market system with L levels and then define the conditions under which such a system could exist taking into consideration both internal (e.g., working capital, capacity of existing production facilities) and external (e.g., availability of land, labor) constraints. Game theory is then used to derive a solution for the optimal number of levels, and Nash equilibrium solutions are sought. However, the formulation is very general, and consequently the authors are not able to derive specific results. Zusman and Etgar (1981) employ Nash bargaining theory and economic contract theory to develop optimal transfer prices (contracts) between manufacturers, wholesalers and retailers. Their model differs from ours in two important respects: (i) they do not restrict the retailers and wholesalers from carrying more than one manufacturer's product; (ii) they do not allow for product differentiation.

In a fourth approach which is tangentially connected to our work, Stern and Reve (1980) postulate that channel-member behavior is influenced by both economic and sociopolitical determinants. Based on this general nonmathematical model of channel behavior, the authors derive propositions which predict the predominant mode of exchange (e.g., company outlets or privately-owned intermediaries) for different types of internal economic and sociopolitical conditions. In contrast, we are concerned with the impact of the external economic environment (i.e., the interdependence of final demand) on channel structure.

Finally, there are one published paper (Doraiswamy et al. 1979) and two working papers (Hibshoosh 1978, Coughlan 1982) which use the channel structure paradigm originally presented by McGuire and Staelin (1976) upon which this analysis is based. The analysis of Doraiswamy et al. (1979) assumes linear demand functions, as we do herein. Each player in their analysis has two control variables, price and advertising expenditures. They show that when the competing brands are highly substitutable (i.e., when consumers perceive the brands to be very similar and thus price differences become very important) it is most profitable for the producers to distribute their products through intermediaries. However, when the degree of substitutability is low, producers are best off vertically integrating. In no case was the mixed structure found to be a Nash equilibrium. In Hibshoosh (1978) and Coughlan (1982), the same basic channel structures are used, but the assumption of linear demand functions is relaxed. In general, their findings are consistent with those reported herein.

4. The Model

As stated earlier, our primary goal is to investigate under what conditions a manufacturer may want to place intermediaries between itself and the next level in the channel even when the manufacturer can perform the selling tasks as efficiently as the intermediary. In specifying industry structure we make three assumptions which allow us to obtain easily interpretable closed-form solutions and yet capture the essence of the problem. First, the industry structure is assumed to consist of two manufacturers selling competing but differentiated products, where each manufacturer is assumed to have one outlet per market area which carries only its products. Second, although there are r distinct market areas, each area is assumed to be identical. In this way we can confine our attention to one region.

Finally and possibly most important, the retail-level demand functions, although quite general, are assumed to be linear in prices. We caution that linearity is more restrictive here than in analyses in which primary interest focuses on the optimal response of variables to incremental changes in various parameters. This is because we are most interested in how the optimal distribution system depends on the demand and cost structures facing the firms. Such a determination depends on the shape of the demand functions over a range of prices, not just on the slopes or elasticities of the functions in a neighborhood of equilibrium.

The demands facing retail outlets 1 and 2, respectively, are

$$q_1' = \mu S\left[1 - \frac{\beta}{1-\theta}p_1' + \frac{\beta\theta}{1-\theta}p_2'\right], \tag{4-1}$$

$$q_2' = (1-\mu)S\left[1 + \frac{\beta\theta}{1-\theta}p_1' - \frac{\beta}{1-\theta}p_2'\right], \tag{4-2}$$

where $0 \le \mu \le 1$, $0 \le \theta < 1$, and β and S are positive.[3] The constant S is a scale factor which is equal to industry demand $q' \equiv q_1' + q_2'$ when the prices of both products are zero. The parameters μ and θ capture two different aspects of product differentiation: the absolute difference in demand and the substitutability of the end products as reflected by the cross elasticities (Dixit 1979). The former is represented by μ. When prices are equal, the ratio of quantities sold $q_1'/q_2' = \mu/(1-\mu)$. Changes in μ alter the relative product preferences in a way that preserves own- and cross-price elasticities, although the rates of change of quantities with respect to price are affected.

The parameter θ, in contrast, affects the substitutability of the two products in terms of changes in prices. More specifically, θ is the ratio of the rate of change of quantity with respect to the competitor's price to the rate of change of quantity with respect to own price. When $\theta = 0$, the demands are independent, and each firm is a monopolist. Product substitutability increases with θ until as θ approaches unity the products are maximally substitutable. We show that in our model industry equilibria depend only on this aspect of product differentiation.

It is necessary to impose additional inequality constraints on these parameters in order to guarantee three additional conditions: prices must exceed marginal costs; quantities must be nonnegative; and industry demand must not increase with increases in prices for either product. We discuss these restrictions next.

Each product is assumed to have constant variable manufacturing and selling costs per unit of m' and s',

[3] Linear demand systems have been used extensively in the marketing and economics literatures for theoretical and empirical analyses of differentiated oligopolies and monopolistically competitive industries (see, e.g., Henderson and Quandt 1980, Pashigian 1961, McGuire et al. 1977, and Staelin and Winer 1976).

respectively.[4] Since marginal costs should not exceed prices and quantities should be non-negative, the prices which are allowable in this model are restricted to the set

$$\mathbb{P} = \{p_1', p_2' \mid p_i' - m' - s' \geq 0,\ i = 1, 2;\ (1-\theta) - \beta p_1' + \beta\theta p_2' \geq 0,\ (1-\theta) + \beta\theta p_1' - \beta p_2' \geq 0\}. \tag{4-3}$$

Nonemptiness of $\mathbb{P}$ requires

$$\beta \leq 1/(m' + s'); \tag{4-4}$$

that is, the intersection of the two positively-sloped quantity restrictions must not be to the left of the vertical line $p_1' = m' + s'$ or below the horizontal line $p_2' = m' + s'$. In other words, there must be some nonempty set of prices which both (a) exceed marginal costs and (b) result in positive quantities demanded.

When the demands are independent ($\theta = 0$), the feasible region for prices is the rectangle

$$\mathbb{P} = \{p_1', p_2' \mid p_i' - m' - s' \geq 0,\ p_i' \leq 1/\beta,\ i = 1, 2\}. \tag{4-5}$$

As θ increases from zero, the upper and lower bound constraint functions for p_1' and p_2' given by

$$p_2' \leq \frac{(1-\theta)}{\beta} + \theta p_1' \tag{4-6}$$

and

$$p_1' \leq \frac{(1-\theta)}{\beta} + \theta p_2' \tag{4-7}$$

rotate counterclockwise and clockwise, respectively, and shift downward and upward, respectively, until they converge to the 45-degree line through the origin as θ approaches unity (see Figure 1).

A second restriction is obtained from the constraint that industry demand should not increase with an increase in either retail price. To see this, note that industry demand is obtained by adding (4-1) and (4-2), yielding

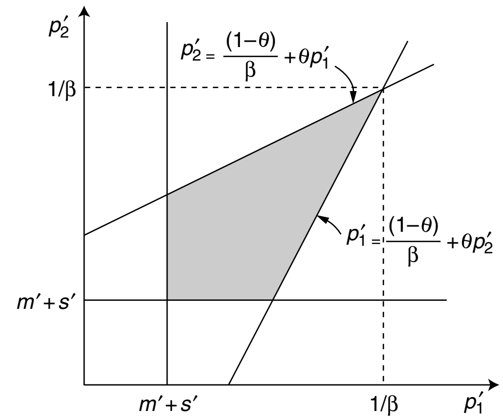
$$q' = S\left[1 - \frac{\beta(\mu - \theta + \mu\theta)}{1-\theta} p_1' - \frac{\beta(1 - \mu - \mu\theta)}{1-\theta} p_2'\right]. \tag{4-8}$$

When prices are equal (say to p'), industry demand simplifies to

$$q' = S(1 - \beta p'). \tag{4-9}$$

[4] We assume that there are no fixed costs at either the manufacturing or retail level. Since we assume profit maximizing behavior by all parties, including any amount of fixed costs less than equilibrium contributions to profit and overhead would not affect any of our results (except net profit).

Figure 1 **Feasible Region for Prices**



Hence industry demand is not affected by variations in either of our product differentiation parameters. However, to insure that industry demand not increase with increases in either price requires that the coefficients of p_1' and p_2' in (4-8) be nonnegative. These restrictions will be satisfied if the relative product preference parameter μ is bounded by two functions of the substitutability parameter, i.e.,

$$\frac{\theta}{1+\theta} \leq \mu \leq \frac{1}{1+\theta}. \tag{4-10}$$

Hence μ is constrained to lie in an interval symmetric around 0.5. This interval is greatest when $\theta = 0$, in which case it is $[0, 1]$; it is the point 0.5 when $\theta = 1$.

The concept of industry demand must be interpreted with care, since we are dealing with differentiated products. Consequently, summing output across firms involves adding units of apples and oranges and measuring the result in units of fruit. Such calculations are commonplace; how meaningful such figures are depends on attributes of the "industry." The interpretation of industry demand will be even more problematical below when we rescale quantities for mathematical convenience.

Finally, the discussion above implicitly assumes that changes in θ affect the rates of change of quantities with respect to both prices. However, it is also possible to represent the situation where own-price rate of change does not vary with changes in θ. To show this, the model can be reparameterized by defining $\beta' = \beta/(1-\theta)$. If there is no functional relationship between β' and θ, then β' can be defined to be constant as θ varies. Consequently, as θ increases, the constraints (4-6) and (4-7) rotate as above but do not shift. As θ approaches unity, these constraints become parallel with intercepts of $1/\beta'$ and $-1/\beta'$, respectively. In other words, a high degree of substitutability does not force prices to equality if the own-price elasticity remains bounded. Which situation better mirrors reality in a particular industry is an empirical question; our model will accommodate either.

4.1. The Model Rescaled

The model as specified contains six parameters: S, μ, β, θ, m', and s'. By rescaling prices and quantities, with no loss of generality this structure can be expressed as a system with only one parameter. To see this, define

$$\phi = 1 - \beta(m' + s'), \tag{4-11}$$

$$q_1 = q_1'/(\phi\mu S), \tag{4-12}$$

$$q_2 = q_2'/[\phi(1-\mu)S], \tag{4-13}$$

$$p_i = \frac{\beta}{\phi(1-\theta)}(p_i' - m' - s'), \quad i = 1, 2. \tag{4-14}$$

Equations (4-12) and (4-13) redefine quantities in new units, q_i, where the rescaling is based on the parameters of the model. Rescaled prices p_i are obtained by multiplying variable gross profit $(p_i' - m' - s')$ by the factor $\beta/[\phi(1-\theta)]$.

Rewriting the demand relations (4-1) and (4-2) in terms of the rescaled prices and quantities yields a demand structure which is a function of only the single parameter θ:

$$q_i = 1 - p_i + \theta p_j, \quad j = 3 - i, \; i = 1, 2. \tag{4-15}$$

It is this parsimony that motivates the rescaling of quantities and prices.

We next examine profits of the different players. In a decentralized channel system, retailer profits before fixed costs in the original units (i.e., p_i' and q_i') are

$$\pi_i^{R'} \equiv (p_i' - w_i' - s')q_i', \quad i = 1, 2, \tag{4-16}$$

where w_i' is the wholesale price per unit of product i (also in the original dollar units). Using the transformations set forth in (4-11) to (4-14), profits in the rescaled units become

$$\pi_i^R \equiv (p_i - w_i)q_i, \quad i = 1, 2, \tag{4-17}$$

where w_i is the wholesale price net of manufacturing costs in the same units as p_i, i.e.,

$$w_i \equiv \frac{\beta}{\phi(1-\theta)}(w_i' - m'), \quad i = 1, 2. \tag{4-18}$$

The relationship between these two retail profit measures $\pi_i^{R'}$ and π_i^R is

$$\pi_i^{R'} = \rho_i \pi_i^R, \tag{4-19}$$

where

$$\rho_i = \frac{\phi^2\mu^{2-i}(1-\mu)^{i-1}(1-\theta)S}{\beta}, \quad i = 1, 2. \tag{4-20}$$

Using similar logic, it is easy to show analogous relationships both at the manufacturer level in decentralized systems, where

$$\pi_i^{M'} \equiv (w_i' - m')q_i' = \rho_i \pi_i^M, \quad i = 1, 2, \quad \text{with} \tag{4-21}$$

$$\pi_i^M \equiv w_i q_i, \tag{4-22}$$

and in vertically integrated channels, where

$$\pi_i^{I'} \equiv (p_i' - m' - s')q_i' = \rho_i \pi_i^I, \quad i = 1, 2, \quad \text{with} \tag{4-23}$$

$$\pi_i^I \equiv p_i q_i. \tag{4-24}$$

Three features of this rescaled system might be noted. First, the original and rescaled retail, manufacturing and integrated profit functions for a particular product i are related by the same constant of proportionality ρ_i, which is not a function of any of the decision variables (i.e., the p_i's and the w_i's). Consequently, the optimizing behavior of the players will be the same whether the analysis is based on the relevant π_i' functions (in the original quantity and price units) or the relevant π_i functions (in the rescaled units). Second, the rescaled system has only one parameter, θ, which is directly traceable to the original demand equations.

Finally, industry demand is obtained straightforwardly by summing the demands for products 1 and 2 given by (4-15), yielding

$$q = 2 - (1-\theta)(p_1 + p_2), \tag{4-25}$$

with $q \equiv q_1 + q_2$.

4.2. Illustrative Analysis

We illustrate our method of analysis for the case of a pure franchised system of distribution. Following the game rules as specified earlier, i.e., D1, we derive the retail outlet's profit-maximizing behavior (in terms of the retail price charged) conditional on the wholesale price set by the manufacturer.

We assume that the retailers behave noncooperatively. Hence, the (Nash) equilibrium in prices is that price pair (p_1, p_2) at which neither retailer can increase its profits by changing its price if the wholesale price it faces and the other retailer's price remain fixed. To calculate this conditional equilibrium, we find each retailer's reaction function by differentiating its profit function [given by (4-17)] partially with respect to its own price, p_i, holding constant w_i and p_j $(j = 3 - i)$, and equating the resulting expression to zero:

$$\left.\frac{\partial \pi_i}{\partial p_i}\right|_{w_i, p_j} = 1 - 2p_i + \theta p_j + w_i = 0, \quad j = 3 - i, \; i = 1, 2. \tag{4-26}$$

Solving (4-26) for conditional Nash equilibrium values of the p_i's *as functions of the* w_i's gives

$$p_i = \frac{1}{2-\theta} + \frac{2}{(2+\theta)(2-\theta)}w_i + \frac{\theta}{(2+\theta)(2-\theta)}w_j, \quad j = 3 - i, \; i = 1, 2, \tag{4-27}$$

and

$$q_i = \frac{1}{2-\theta} - \frac{2-\theta^2}{(2+\theta)(2-\theta)} w_i + \frac{\theta}{(2+\theta)(2-\theta)} w_j, \quad j = 3-i, \ i = 1, 2. \quad \text{(4-28)}$$

In our model, wholesale prices are Nash equilibrium in prices if neither manufacturer has an incentive to change its wholesale price given the wholesale price of the other manufacturer and given the *decision rules* of the retailers as specified in (4-27). Substituting the manufacturers' derived demand functions (4-28) into their profit functions (4-22), differentiating π_i^M partially with respect to w_i, equating the resulting expression to zero and solving yields

$$w_1 = w_2 = \frac{2+\theta}{4-\theta-2\theta^2}. \quad \text{(4-29)}$$

Substituting (4-29) into (4-27) and (4-28),

$$p_1 = p_2 = \frac{2(3-\theta^2)}{(2-\theta)(4-\theta-2\theta^2)} \quad \text{(4-30)}$$

and

$$q_1 = q_2 = \frac{2-\theta^2}{(2-\theta)(4-\theta-2\theta^2)}. \quad \text{(4-31)}$$

Then the profits of the manufacturers when both sell through private retailers, π_i^M, are

$$\pi_1^M = \pi_2^M = \frac{(2+\theta)(2-\theta^2)}{(2-\theta)(4-\theta-2\theta^2)^2}. \quad \text{(4-32)}$$

5. Results

We also derive the equilibria for a pure company store distribution system and a mixed distribution system (where one [arbitrary] manufacturer sells through a company store and the other distributes through a privately-owned retailer) for the previously specified game rules, i.e., I1 and M1, respectively. The results are summarized in Table 1 along with those for the pure private system assuming game rule D1.

In each case the manufacturers' profits depend on the one parameter of our rescaled model, the degree of substitutability between the two manufacturers' end products. For example, when each manufacturer is a monopolist ($\theta = 0$), it is twice as profitable for each manufacturer to sell through company stores than through private dealers. However, when demand is influenced maximally by the actions of the competing retailers (i.e., θ is close to unity), it is three times as profitable for the manufacturers to distribute through private dealers rather than through company stores,

Table 1 Equilibrium Prices, Quantities, and Profits for Different Channel Structures and Game Specifications

Game and industry structures	Wholesale price	Retail price	Quantity	Manufacturer profits	Retailer profits	Total channel profits
Pure decentralized structure						
D1	$\frac{2+\theta}{4-\theta-2\theta^2}$	$\frac{2(3-\theta^2)}{(2-\theta)(4-\theta-2\theta^2)}$	$\frac{2-\theta^2}{(2-\theta)(4-\theta-2\theta^2)}$	$\frac{(2+\theta)(2-\theta^2)}{(2-\theta)(4-\theta-2\theta^2)^2}$	$\left[\frac{2-\theta^2}{(2-\theta)(4-\theta-2\theta^2)}\right]^2$	$\frac{2(2-\theta^2)(3-\theta^2)}{(2-\theta)^2(4-\theta-2\theta^2)^2}$
D2	$\frac{1}{2(1-\theta)}$	$\frac{(3-2\theta)}{2(1-\theta)(2-\theta)}$	$\frac{1}{2(2-\theta)}$	$\frac{1}{4(1-\theta)(2-\theta)}$	$\left[\frac{1}{2(2-\theta)}\right]^2$	$\frac{3-2\theta}{4(1-\theta)(2-\theta)^2}$
D3	$\frac{2}{4-3\theta}$	$\frac{3}{4-3\theta}$	$\frac{1}{4-3\theta}$	$\frac{2}{(4-3\theta)^2}$	$\frac{1}{(4-3\theta)^2}$	$\frac{3}{(4-3\theta)^2}$
Mixed structure						
M1 decentralized system	$\frac{2+\theta}{2(2-\theta^2)}$	$\frac{3-\theta^2}{(2-\theta)(2-\theta^2)}$	$\frac{1}{2(2-\theta)}$	$\frac{(2+\theta)}{4(2-\theta)(2-\theta^2)}$	$\left[\frac{1}{2(2-\theta)}\right]^2$	$\frac{3-\theta^2}{2(2-\theta)^2(2-\theta^2)}$
M1 integrated system		$\frac{4+\theta-2\theta^2}{2(2-\theta)(2-\theta^2)}$	$\frac{4+\theta-2\theta^2}{2(2-\theta)(2-\theta^2)}$	$\left[\frac{4+\theta-2\theta^2}{2(2-\theta)(2-\theta^2)}\right]^2$		$\left[\frac{4+\theta-2\theta^2}{2(2-\theta)(2-\theta^2)}\right]^2$
M2 decentralized system	$\frac{4+2\theta-\theta^2}{8-5\theta^2}$	$\frac{3(4+2\theta-\theta^2)}{2(8-5\theta^2)}$	$\frac{4+2\theta-\theta^2}{2(8-5\theta^2)}$	$\frac{(4+2\theta-\theta^2)^2}{2(8-5\theta^2)^2}$	$\left[\frac{4+2\theta-\theta^2}{2(8-5\theta^2)}\right]^2$	$\frac{3(4+2\theta-\theta^2)^2}{4(8-5\theta^2)^2}$
M2 integrated system		$\frac{4+3\theta}{8-5\theta^2}$	$\frac{(2-\theta^2)(4+3\theta)}{2(8-5\theta^2)}$	$\frac{(2-\theta^2)(4+3\theta)^2}{2(8-5\theta^2)^2}$		$\frac{(2-\theta^2)(4+3\theta)^2}{2(8-5\theta^2)^2}$
Pure integrated structure						
I1		$\frac{1}{2-\theta}$	$\frac{1}{2-\theta}$	$\frac{1}{(2-\theta)^2}$		$\frac{1}{(2-\theta)^2}$
I2		$\frac{1}{2(1-\theta)}$	$\frac{1}{2}$	$\frac{1}{4(1-\theta)}$		$\frac{1}{4(1-\theta)}$

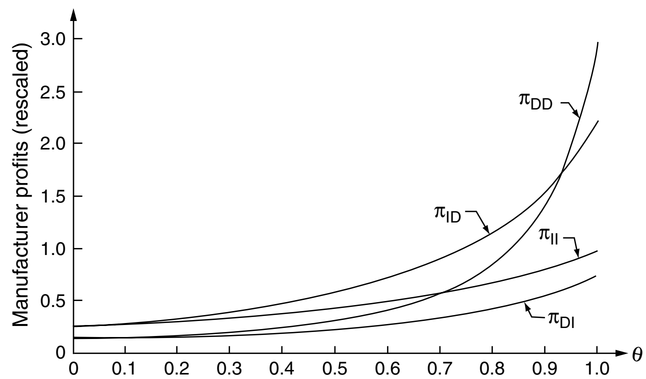
even though there is no increase in efficiency by utilizing this channel structure.[5] The profit breakeven point between the pure factory store system and the pure private system occurs when $\theta = 0.708$.[6] Hence, which distribution system is best for the manufacturers depends upon the degree of demand interdependence at the retail level.

These results have intuitive appeal. If the retail market is highly competitive (in the sense that the demands are sufficiently interdependent), manufacturers in a duopoly are better off if they can shield themselves from this environment by inserting privately-owned profit maximizers between themselves and the ultimate retail markets even though they lose control of retail price. This condition should hold even though there are many such retail outlets within a geographically separated region. However, if a retail outlet's marketing efforts do not strongly influence (as measured by θ) its competitor's retail demand, there is no profit incentive to create such buffers. Rather, the manufacturer would prefer to control its channels of distribution and obtain the profit at the retail level as well as the manufacturing profit (assuming there is no loss of efficiency when the manufacturer vertically integrates).

We next consider whether there is ever any incentive for a firm to switch from a franchised dealer to a company store in an industry where a pure private franchised dealer system (DD) is more profitable than a pure company store system (II). Alternatively, is there any incentive for a firm to switch from a company store outlet to a private franchised dealer in an industry where a pure company store system is more profitable than a pure private franchised system? To answer these questions we plot the four profit functions $\pi_{DD}(\theta)$, $\pi_{DI}(\theta)$, $\pi_{ID}(\theta)$, and $\pi_{II}(\theta)$ in Figure 2, where the subscripts identify the channel structures of the first and second manufacturers, respectively. The relevant characteristics of these functions are summarized in Table 2 and the subsequent discussion.

We previously showed that for $\theta \geq 0.708$ the pure franchised system dominates the pure company store outlet system. However, from Figure 2 and Table 2, it can be seen that for $\theta \leq 0.931$ a firm can make greater profits selling through a company outlet rather than through a private franchised dealer so long as its competitor sells through a franchised dealer, i.e., $\pi_{ID} > \pi_{DD}$.[7] Thus, for $\theta \leq 0.931$ the pure franchised system is not a Nash equilibrium.

Figure 2 **Manufacturer's Profits as a Function of θ for Pure and Mixed Distribution Systems When Franchises Are Given Away**



Given that one manufacturer has vertically integrated, is the second manufacturer better off staying with a private dealer channel structure or should it also vertically integrate? From Figure 2 and Table 2 it is seen that $\pi_{II} > \pi_{DI}$ for all θ. Thus, given that the structure is mixed, there is an economic incentive for the manufacturer selling through the private dealer to vertically integrate also. Hence, the mixed system is never a Nash equilibrium, and for $0 \leq \theta \leq 0.931$ the pure vertically integrated structure is the unique Nash equilibrium. Since both manufacturers are better off with a pure decentralized system than with a pure integrated system when $\theta \geq 0.708$, the problem of choosing an optimal structure when $0.708 \leq \theta \leq 0.931$ is a classical prisoners' dilemma game or, equivalently, what Shubik (1959, pp. 222–226) calls a game of economic survival.

For $\theta \geq 0.931$ there are two Nash equilibria. In the private structure it does not pay either manufacturer to vertically integrate, and if both manufacturers have company stores, neither would want to make the first move to distribute through a privately-owned outlet. Thus, both structures are Nash, although the former is dominant in that profits are higher. Because elasticities may have more intrinsic meaning than our interdependence parameter θ, in Table 3 we display the own- and cross-price elasticities of demand evaluated at the equilibrium prices and quantities for the various critical values of θ at which the Nash equilibrium switches from one to another configuration.

[5] The reader is cautioned against comparing results across different values of θ without first rescaling quantities and prices. The above reported results do not require such rescaling since they concern the ratio of profits for two different channel systems for a fixed value of θ (and μ, S, β, m', and s').

[6] From Table 1, the pure factory store system and the pure private system are equally profitable when $(2+\theta)(2-\theta^2)/[(2-\theta)(4-\theta-2\theta^2)^2] = 1/(2-\theta)^2$. The critical value of $\theta = 0.7078$ is the root of the fourth-order polynomial equation $8-8\theta-9\theta^2-4\theta^3+3\theta^4=0$ for θ in the interval $[0, 1]$.

[7] From Table 1, a firm is indifferent between decentralized and integrated systems given that its competitor is decentralized when

$$(2+\theta)(2-\theta^2)/[(2-\theta)(4-\theta-2\theta^2)^2] = \{(4+\theta-2\theta^2)/[2(2-\theta)(2-\theta^2)]\}^2.$$

The critical value $\theta = 0.9309$ is the root of the fourth-order (in θ^2) polynomial equation $128-320\theta^2+273\theta^4-96\theta^6+12\theta^8=0$ for θ (and θ^2) in the interval $[0, 1]$.

Table 2 Stability Analysis for Game 1 = (D1, M1, I1)

		Manufacturer 1		Manufacturer 2	
Range for θ	Original structure	New structure	Change in profits	New structure	Change in profits
0.932,1	DD*	ID**	<0	DI	<0
	ID	DD	>0	II	>0
	DI	II	>0	DD	>0
	II*	DI	<0	ID	<0
0, 0.932	DD	ID	>0	DI	>0
	ID	DD	<0	II	>0
	DI	II	>0	DD	<0
	II*	DI	<0	ID	<0

*Nash equilibrium in prices.
**Read Manufacturer 1 company store, Manufacturer 2 private dealer.

One way of testing our model would be to compare our predictions for equilibrium channel structure with industry structures for various values of θ. We have not done this, however, since we view our model as an initial exploration of the effects of market conditions on channel structure. Thus, for example, even though we observe mixed structures in numerous industries, including automobiles, sewing machines, and fast food outlets, it is possible that relevant parameters have changed and we are observing a transition to a new equilibrium which does not occur instantaneously as a result of stickiness due to contractual obligations, adjustment costs, etc. Moreover, our model analyzes only a market with two manufacturers with one exclusive retailer each; we do not know the implications of relaxing any of these conditions. Also, in McGuire and Staelin (1983), we show that if a company store cannot be operated as efficiently as a franchised dealership, then for a certain range of such inefficiencies a mixed structure is Nash equilibrium for $0 \leq \theta \leq 0.708$. Finally, mixed structures can be Nash equilibria for ranges of values of θ in different game structures (see the discussion of §6 below).

5.1. Maximizing Total Channel Profits

The Nash equilibria derived above are based on the assumption that the manufacturers cannot appropriate any retail-level profits by requiring the retailer to pay for the right to sell the manufacturer's product. One might conjecture that franchised dealers would always be optimal if manufacturers could appropriate some or all retail-level profits (e.g., by auctioning off the franchises to the highest bidder). This conjecture turns out to be false.

Still assuming that potential franchised dealers are supplied competitively, we note that a manufacturer can capture any share of retail profits not exceeding 100% without affecting the dealer's optimal behavior by charging a fixed fee which is not tied to any performance indicators of the retail outlet such as sales quantity or revenues or costs. Furthermore, since this charge would be viewed as sunk by the franchisees, retailer behavior would not be affected by this franchise fee. Nevertheless, even using total channel profits as the criterion, the pure franchised system is Nash equilibrium only for $0.771 \leq \theta \leq 1$, while the pure factory outlet structure remains a Nash equilibrium for all $0 \leq \theta \leq 1$ (see Table 1 and Figure 3).[8] Hence, by allowing the manufacturer to capture all retail-level profits in a decentralized system, the range of substitutability over which the pure private system is a Nash equilibrium is expanded. However, it does not eliminate the pure factory store Nash equilibrium for any values of θ. Based on these results it seems that when $\theta \leq 0.771$ the manufacturers are better off setting their own retail prices than allowing the retailers this freedom, even though in both situations the manufacturers are able to capture total channel profits.

Our specification extends the work of Jeuland and Shugan (1982), who consider only the problem of one manufacturer selling through a single retailer (which corresponds to our model with $\theta = 0$). We and they have shown that manufacturer and total channel profits are maximized when a monopolist vertically integrates, or, equivalently, when the retailer and manufacturer cooperate to maximize joint profits; Jeuland and Shugan show how this optimum also can be achieved in a decentralized structure by means of quantity discounts. However, we just have shown that vertical integration does not necessarily maximize total channel profits in a duopoly. In fact, Figure 3 shows that for $\theta \geq 0.432$ total channel profits are greater in the pure decentralized system than in the pure integrated system (although the pure

Table 3 Own- and Cross-Elasticities of Demand Evaluated at Equilibrium Prices and Quantities for Game 1 for Various Critical Values of θ

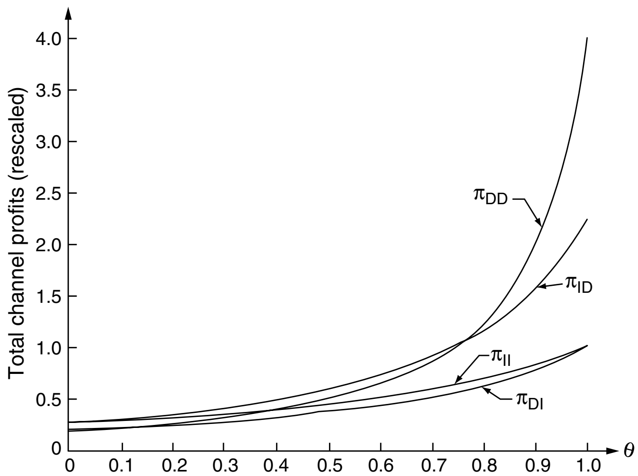
θ	Market structure	Firm structure	Own elasticity	Cross elasticity
1.0	DD	D	−4	4
0.932	DD	D	−3.767	3.511
	ID	D	−3.767	2.632
	ID	I	−1	1.243
0.708	II	I	−1	0.708

[8] From Table 1, a firm using total channel profits as its objective function is indifferent between decentralized and integrated systems given that its competitor is decentralized if

$$2(2-\theta^2)(3-\theta^2)/[(2-\theta^2)(4-\theta-2\theta^2)^2]$$
$$= \{(4+\theta-2\theta^2)/[2(2-\theta)(2-\theta^2)]\}^2.$$

The critical value $\theta = 0.7705$ is the root of the fourth-order (in θ^2) polynomial equation $64 - 192\theta^2 + 177\theta^4 - 64\theta^6 + 8\theta^8 = 0$ for θ (and θ^2) in the interval $[0, 1]$.

Figure 3 Total Channel Profits as a Function of θ for Pure and Mixed Distribution Systems



decentralized system is not a Nash equilibrium unless $\theta \geq 0.771$).[9] It is possible that other mechanisms, such as quantity discounts, can yield even greater total channel profits.

Why do Jeuland and Shugan's results differ from ours? The main reason is in our respective assumptions about the rules of the game within the oligopoly. They use as their retail demand function a "reduced-form" or "dynamic" or "long-run" relationship which reflects all competitive reactions. The attractiveness of this approach is that it obviates specification of the game rules and the need to consider explicitly each player's reactions. Consequently, a multi-firm industry can be reduced to a single-firm model by replacing the analyzed firm's competitors' retail prices with their decision rules (or reaction functions) as functions of the analyzed firm's retail price in its demand function. (If there are more than two firms, the conditional equilibrium competitor retail prices as functions of the analyzed firm's price would be used in place of the individual decision rules.) The analyzed firm then chooses its profit-maximizing price conditional on these decision rules, which is by definition the Stackelberg solution. In effect, such an approach assumes that the analyzed firm is dominant, i.e., the price leader, since all other firms set their prices conditional on the analyzed firm's price. In this way such an approach is useful for studying monopolies and oligopolies with a dominant firm. On the other hand, our approach, which allows for a broad variety of behavioral assumptions, seems more applicable in situations where there is no price leader, and thus the interaction of all price setters must be modeled explicitly. It is this difference in behavioral assumptions that accounts for the differences between Jeuland and Shugan's conclusions and ours.

5.2. Sales Quotas and Channel System Management

In the preceding analyses, we have assumed that when the manufacturer uses an intermediary to sell and distribute its product, it does not manage any aspect of the downstream member's business operation (although it may capture all its profits via some fixed-fee tax). In this way we have assumed a channel structure with no direct conflict between channel members. Since such conflict-free channels are the exception rather than the rule (Stern and Reve 1980), we next investigate when it is in the best interests of the manufacturer to attempt to control (modify) the profit-maximizing behavior of the independent downstream intermediary. We do this by assuming the manufacturer has the power to control the one marketing decision variable available to the retailer, i.e., the retail price. This control can be accomplished by the manufacturer imposing retail price ceilings or (since there is a one-to-one relationship between retail prices and quantities) by setting retail sales quotas.[10]

Common sense might lead one to hypothesize that a manufacturer selling through a franchised system could always increase its profits by exerting control over the private dealer's operations. However, in our model, allowing the manufacturer to set the retail price ceilings (or sales quotas) is equivalent to having the manufacturer control the total operation of the retail outlet. We have seen that a pure company store distribution system yields greater profits to the manufacturers than a pure franchised system only for $\theta \leq 0.708$. Consequently, control via sales quotas or price ceilings will not necessarily increase the profits of the manufacturers. Rather, we would expect manufacturers to attempt to control their dealers only if the cross-elasticity of demand is sufficiently low, i.e., only in those cases where a company store structure would be more profitable than a private dealer channel structure.

In addition to providing insights concerning channel system management, the above discussion points out that a channel system should not be classified strictly by legal definitions. A franchised system where the manufacturer imposes sales quotas as a condition of the franchise is equivalent to the manufacturer distributing through company stores, since the private retailer has no control over the operation of the firm. Why a manufacturer would choose

[9] From Table 1, total channel profits are identical for the pure decentralized and pure integrated structures when $2(2-\theta^2)(3-\theta^2)/[(2-\theta)^2(4-\theta-2\theta^2)^2] = 1/(2-\theta)^2$. The critical value $\theta = 0.4323$ is the solution to the fourth-order polynomial equation $4 - 8\theta - 5\theta^2 - 4\theta^3 + 2\theta^4 = 0$ for θ in the interval $[0, 1]$.

[10] Most empirical studies indicate that manufacturers are more likely to impose sales quotas than to try to dictate retail price.

a franchised dealer system with quotas rather than company stores (or conversely) will depend on external factors such as availability of capital, the desire to share risk, and legal considerations (e.g., anti-trust and special franchising laws).

Finally it should be noted that this analysis of sales quotas (more precisely, retail price ceilings) reaches different conclusions from those of previous studies (e.g., Burstein 1960, Pashigian 1961, White 1971). This is because we acknowledge explicitly the effect of each manufacturer's quota on the behavior of its competitor. It is true that a manufacturer could increase its profits by requiring its dealer to sell more of the product at the given wholesale price if the competing retail dealer continued to charge the equilibrium price in the absence of quotas and the competing manufacturer did not alter its relationship with its dealer. However, with interdependent demands, these assumptions seem unreasonable.

5.3. Consumer Welfare Implications

The preceding analyses have taken the viewpoint of the manufacturer. What are their implications for the consumer in terms of prices? A comparison of equilibrium retail prices as functions of product substitutability (see Table 1) reveals that for any degree of substitutability, vertical integration yields the lowest retail prices, independent of whether the distribution system is Nash equilibrium. This is an extension of the well-known results for bilateral monopoly and oligopoly where each downstream firm is supplied by an upstream firm(s) (see, e.g., Machlup and Taber 1960, Wu 1964). Furthermore, retail prices are highest for the pure decentralized system for any value of θ. Retail prices of both firms in a mixed system lie between those of the two pure systems, with the decentralized outlet's price at least as great as the company store's price for all θ. Interestingly, such conclusions hold even when the game is played according to the following rules.

M2. The decentralized retailer maximizes its profits conditional on the wholesale price it faces and its competitor's retail price; the decentralized manufacturer and the integrated firm maximize their profits conditional on the decentralized retailer's decision rule and on the integrated firm's retail price (in the case of the decentralized manufacturer) and the decentralized manufacturer's wholesale price (in the case of the integrated firm). In other words, the two manufacturers compete head-to-head, both conditioning on the decentralized retailer's decision rule and the other's price.

5.4. Colluding Manufacturers

To investigate whether these welfare conditions would continue to hold if the manufacturers colluded and set the prices under their direct control to maximize joint manufacturer profits, we analyzed the following two game structures.

D2. The two [decentralized] manufacturers set their wholesale prices to maximize the sum of their profits conditional on the conditional equilibrium retail price (or quantity) functions.

I2. The two [integrated] manufacturers choose the retail prices that maximize the sum of their profits.

Using the same general methodology as illustrated above, it can be shown that under such perfect collusion it is in the best economic interests of the manufacturers to vertically integrate downstream as long as θ is less than unity (see the rows marked D2 and I2 in Table 1). Interestingly, the equilibrium retail price in the pure factory store configuration is less than equilibrium price in the pure private retailer structure when the manufacturers collude. Only for $\theta = 1$ are the prices (and profits) for the two structures the same. In other words, eliminating collusion at the retail level by inserting noncolluding private profit maximizers between colluding manufacturers and the consumers does not benefit the consumer; instead, it increases retail prices.

As expected, prices in the cooperative solutions are strictly greater than the noncooperative prices with the same channel structure and market demand parameters except in the limiting case of franchised dealers facing independent demands (i.e., $\theta = 0$), where the cooperative and noncooperative prices are identical. In this latter situation, manufacturers set wholesale prices in decentralized systems and retail prices in vertically integrated systems at 0.5; this result is well known for vertically integrated structures.

It is evident from Table 1 that the rescaled prices p_i increase without bound as θ approaches unity when the manufacturers collude with each other, i.e., D2 or I2. However, of more interest in this limiting case is the behavior of the original prices, p_i'. To simplify the interpretation, we have rewritten the constraint on β [see (4-4)] as

$$\frac{1}{\beta} = m' + s' + \frac{1}{b}, \tag{5-1}$$

where b is some positive constant. Using (4-11) and (4-14) along with (5-1) it is possible to restate the noncooperative and cooperative conditional equilibrium wholesale and retail prices in terms of the original prices (i.e., p_i') for the pure decentralized and pure integrated structures. Again these prices are functions of θ (as well as m', s' and b; see Table 4).

It can be seen that as the products become maximally substitutable ($\theta = 1$), prices in the noncooperative solutions equal marginal costs: variable manufacturing costs in the case of wholesale prices

Table 4 Noncooperative and Cooperative Conditional Equilibrium Wholesale and Retail Prices in Original Units in the Pure Decentralized and Pure Integrated Structures

	Game I	Game 2
	Noncooperative solution	Cooperative solution
Wholesale prices		
(Pure decentralized structure)	$m' + \frac{1}{b}\frac{(1-\theta)(2+\theta)}{(4-\theta-2\theta^2)}$	$m' + \frac{1}{2b}$
Retail prices		
Pure decentralized structure	$m'+s'+\frac{2}{b}\frac{(1-\theta)(3-\theta^2)}{(2-\theta)(4-\theta-2\theta^2)}$	$m'+s'+\frac{1}{2b}\frac{(3-2\theta)}{(2-\theta)}$
Pure integrated structure	$m'+s'+\frac{1}{b}\frac{(1-\theta)}{(2-\theta)}$	$m'+s'+\frac{1}{2b}$

Note. $1/b \equiv 1/\beta - m' - s' \geq 0$. [See (5-1) and (4-4).]

and variable manufacturing plus selling costs in the case of retail prices. It is also evident that when the manufacturers collude, prices exceed marginal costs when $\theta = 1$, even at the retail level where there is no collusion. Furthermore, for all $\theta > 0$, the cooperatively set prices exceed the noncooperatively determined prices (they are equal when $\theta = 0$, since a monopolist has no firm with which to cooperate).

The above discussion has centered on the effects of changes in the substitutability parameter, θ. However, it should be remembered that in the model described, θ is not a pure substitutability parameter, since own-price sensitivity, $\beta/(1-\theta)$, also depends on θ. As discussed earlier, this problem can be circumvented by reparameterizing the system with β replaced by $\beta' \equiv \beta/(1-\theta)$. Then the model (4-1) and (4-2) would be rewritten

$$q_1' = \mu S(1 - \beta' p_1' + \theta\beta' p_2'), \tag{5-2}$$

$$q_2' = (1-\mu) S(1 + \theta\beta' p_1' - \beta' p_2'), \tag{5-3}$$

and inequality (4-4) becomes $1/\beta' \geq (1-\theta)(m' + s')$. Consequently, for a fixed feasible β' we can increase θ to unity without violating any constraints.

We expand on this line of reasoning by increasing the cross-price sensitivity parameter θ to unity while fixing own-price sensitivity. Now the noncooperatively determined equilibrium retail prices in the original units when $\theta = 1$ are $m' + s' + (4/\beta')$ in the pure decentralized system and $m' + s' + (1/\beta')$ in the pure integrated system. Thus we see that it is the own-price sensitivity of demand going to infinity that drives prices down to marginal cost, not the substitutability increasing to its limit. Although it is an empirical question as to which, if either, of these two limiting models is more applicable to a particular industry, the derived results on industry structure are not affected by the outcome of such a question. Thus, the only unresolved question is what happens to the unscaled prices as substitutability increases. Resolution hinges on whether own-price sensitivity of demand goes to infinity as substitutability increases to its limit or remains finite. However, as can be seen in Table 1, the unpalatable result that cooperatively set prices increase without bound as $\theta \to 1$ with β' fixed leads us to prefer parameterization (4-1)–(4-2) to (5-2)–(5-3).

6. Some Other Game Structures

Virtually all of the results reported above are for the noncolluding game specification G1 $\equiv$ (D1, M1, I1) or the colluding game structure G2 $\equiv$ (D2, M1, I2). In this section we define another plausible behavioral rule for the decentralized structure and then analyze three additional noncooperative games.

D3. Each manufacturer maximizes its profits conditional on its competitor's retail price and on its own retailer's decision rule, which is a function of its own wholesale price and its competitor's retail price.

The difference between D3 and D1 is that in D1 each manufacturer conditions on the conditional equilibrium retail price functions whereas with D3 each manufacturer conditions on its own retailer's decision rule but takes the competing retailer's price as given.

The set of noncolluding behavioral rules {D1, D3, M1, M2, I1} leads to three possible games in addition to G1.

G3: (D1, M2, I1)
G4: (D2, M1, I1)
G5: (D3, M2, I1)

The Nash equilibrium prices, quantities, and profits for each specification conditional on market structure also are presented in Table 1. The results for the three new games are consistent with those for G1. Integrated systems are more profitable than decentralized systems when the products are not very substitutable ($\theta \leq 0.708$ for rule D1 and $\theta \leq 0.739$[11] for rule D3); this relationship reverses for more highly substitutable products (see Table 5). Retail prices are lower in the pure integrated structure than in the pure decentralized structures, and in mixed structures the integrated firms' prices are less than the decentralized retailers' prices. The behavioral rule D1 leads to higher prices and profits than D3. Moreover, prices and profits are greater under either of these rules than the prices and profits of the decentralized system in either mixed structure.

Table 5 shows the Nash equilibrium and dominant structure as a function of θ for each of the games G1 and G3 through G5. G1 is the only game with

[11] Equating profits for the pure integrated structure to those for the pure decentralized structure using assumption D3 yields $\theta = (8 - 2\sqrt{2})/7$ as the unique solution for θ in the interval $[0, 1]$.

Table 5 **Comparison of Nash Equilibrium and Dominant Structures for Four Noncolluding Game Specifications**

Game	Nash equilibria		Dominant structure	
GI: (D1, M1, I1)	$0 \le \theta \le 0.931$	(I, I)	$0 \le \theta \le 0.708$	(I, I)
	$0.931 \le \theta \le 1$	(I, I), (D, D)	$0.708 \le \theta \le 1$	(D, D)
G3: (D1, M2, I1)	$0 \le \theta \le 0.912$	(I, I)	$0 \le \theta \le 0.708$	(I, I)
	$0.912 \le \theta \le 0.972$	(D, I) or (I, D)	$0.708 \le \theta \le 1$	(D, D)
	$0.972 \le \theta \le 1$	(D, D)		
G4: (D3, M1, I1)	$0 \le \theta \le 1$	(I, I)	$0 \le \theta \le 0.739$	(I, I)
			$0.739 \le \theta \le 1$	(D, D)
G5: (D3, M2, I1)	$0 \le \theta \le 0.912$	(I, I)	$0 \le \theta \le 0.739$	(I, I)
	$0.912 \le \theta \le 1$	(D, I) or (I, D)	$0.739 \le \theta \le 1$	(D, D)

a nonunique Nash equilibrium. In G4 the pure integrated structure is Nash for all θ. In G3 and G5, where the mixed game is played with behavioral rule M2, the Nash equilibrium switches from the pure integrated structure to a mixed structure when θ surpasses 0.912.[12] Furthermore, in G3 the pure decentralized structure is Nash for $\theta > 0.972$.[13] Hence, in each game based on behavioral assumption D1, and only in these games, is the pure decentralized structure Nash for sufficiently large θ. However, the dominant structure results are almost invariant to the D1, D3 assumption, with the break point moving only from 0.707 to 0.739.

In summary, the analysis of other game specifications indicates that the qualitative results reported in this paper do not depend critically on our assumptions. Which (if any) formulation best describes any particular industry is an empirical question; but except for G4, the equilibrium industry structure will be a function of product substitutability.

7. Summary and Concluding Remarks

We have examined and compared the economic implications of various retail distribution structures in the context of a simple model of two manufacturers selling their competing brands through retail outlets. Our model differs from previous studies of bilateral monopolies in two important ways. First, although we have a multiple number of manufacturers and sellers, we allow any one seller to carry the product line of only one manufacturer. Thus, our results should not be applied to industries where retail outlets sell the product line of more than one manufacturer (wholesaler) in a product class. Second, unlike most other studies which use reduced-form demand functions, our model explicitly considers the impact of one player on the actions of others through our parameter θ, which reflects different degrees of substitutability of the two end products as perceived by the consumers. In fact, it is the degree of interdependence between the end-user demand for the two products which determines whether a manufacturer finds it more profitable to use an intermediary or carry out the selling and distribution functions itself. In this way we show another reason why firms might want to vertically integrate, namely because of the lack of competition at the retail level.

Secondly, our analysis indicates that consumers are best off when manufacturers sell through company stores independent of whether the manufacturers are colluding or behaving noncooperatively. This result extends previous analyses of bilateral monopolies. It also suggests that when manufacturers in an oligopoly are behaving noncooperatively, we should not infer from their use of privately-owned franchised dealers in a conflict-free channel structure that the consumer is getting as low a price as possible. Thus, for example, the apparently fierce competition among automobile dealers or (at times) gasoline station dealers does not imply that the automobile manufacturing or petroleum industries are highly competitive. Rather, the use of franchised dealers by profit-maximizing manufacturers implies that both retail prices and manufacturers' profits are greater than they would be if the manufacturers were to switch to a pure factory outlet distribution structure.

A third result, which is counter to most prior conjectures, is that it is not always in the best self-interests of a manufacturer to attempt to control the operations of a privately-owned franchised outlet. Instead, control is optimal only when the cross-elasticities of demand are reasonably low. This leads us to speculate that channel conflict should be greater in industries with greater product differentiation.

Fourth, total channel profits are not always greater when the manufacturer gains complete control of the system, either by vertically integrating or by imposing quotas (or setting the retail price) than when it lets the independent retailer set the retail price. In our model, such a situation occurs only when the competitor's product is reasonably well differentiated so that the cross-elasticities of demand are low. Also, the Nash equilibrium industry structure where each manufacturer uses the criterion of maximizing channel profits for its system is not always the same as that resulting from manufacturers maximizing their own profits. In the former situation the decentralized system is Nash

[12] Equating profits for the pure integrated structure to those for the decentralized firm in a mixed structure using behavioral rule M2 results in the sixth-order polynomial equation $64 - 96\theta^2 - 16\theta^3 + 34\theta^4 + 8\theta^5 - \theta^6 = 0$, which yields the unique value $\theta = 0.9121$ in the interval $[0, 1]$.

[13] Equating profits in the pure decentralized system using behavioral rule D1 with profits of the integrated firm in a mixed structure using assumption M2 gives the seventh-order polynomial equation $256 + 128\theta - 512\theta^2 - 288\theta^3 + 318\theta^4 + 189\theta^5 - 60\theta^6 - 36\theta^7 = 0$, which has the unique root $\theta = 0.97165$ in the interval $[0, 1]$.

for values of $\theta \geq 0.771$, while in the latter situation the decentralized system is Nash only for values of $\theta \geq 0.931$.

Fifth, our results for four sets of behavioral rules show that the conclusion that the Nash equilibrium structure depends on the degree of product substitutability holds for all but one of the specifications, although the particular equilibria depend on the assumptions. In all cases, the pure vertically integrated structure is Nash equilibrium for poor substitutes, a finding which is consistent with monopoly theory. As substitutability increases, decentralization becomes the more attractive, and sometimes Nash equilibrium, alternative.

Finally, we show that if the manufacturers behave cooperatively, profits are greater and retail prices lower with a pure company store system than with privately owned dealers. This last result is also counterintuitive. For example, we suspect that if the automobile manufacturers were to announce that they intended to switch to a pure company-store distribution system, the Department of Justice would move to block the change on the grounds that it would give the automobile manufacturers greater control over the market (which indeed it would). Yet if our model captures the basic economic forces, it is likely that such a change in the distribution structure would result in lower retail prices of automobiles, assuming that manufacturers could carry out the retail functions as efficiently as the private dealers.[14] Perhaps the manufacturers should be required to sell through company-owned outlets!

Following this example further, we noted that the manufacturer-imposed sales quotas can have the effect of making a private retail outlet indistinguishable from a company store. Since we showed that a company-store distribution system is always optimum for colluding manufacturers no matter the degree of substitutability of end-user demand, it follows that if automobile manufacturers collude and also impose sales quotas, they have found a way of "taking over the private dealers" so as to maximize corporate profits while maintaining the appearance of distributing through private dealers. Surprisingly, the consumer is better off by having the manufacturer control the operations of the private dealer than allowing the retailer to set its price to maximize retail-level profits. Of course, the retail prices under such a colluding channel system are higher than they would be if the manufacturers behaved noncooperatively.

[14] This implication would not hold if manufacturers who behave competitively with decentralized structures would cooperate when vertically integrated; however, we know of no good reason to suspect that such an assumption would hold.

7.1. Directions for Further Research

We set out to investigate the relationship between market structure and product substitutability. We have done this in the context of a linear duopoly model for a number of sets of assumptions about the gaming behavior between the different players. In our view, this paper answers one question: might the equilibrium product distribution structure depend on product substitutability? Our answer is, yes, it might and probably does. (The one case we examined where it does not, game G4, results in a pure vertically integrated structure for all values of θ, a result which is not consistent with empirical evidence.) However, the paper raises many more questions than it answers definitively.

What happens when the firms face different cost structures? What if costs depend on structure? For example, it is alleged frequently that integrated systems are less efficient than decentralized systems. Under what conditions would firms still use factory stores?

Also, we have seen that for one set of behavioral assumptions, a mixed distribution structure is Nash equilibrium over a certain range of substitutability. If one or more firms had one or more retail outlets in the same marketing area, would a dual distribution system, where a single manufacturer uses both private retailers and factory stores, ever be Nash? What is the equilibrium number of outlets, and how should they be organized with respect to decentralization vs. integration? This is a topic of widespread interest in the petroleum industry at the present time.

Ultimately all theoretical models should be subjected to empirical verification. However, we argue that to confront our models to empirical data would be premature. In focusing on the effect of product substitutability on equilibrium distribution structures, we have abstracted from a number of important dimensions. For example, in addition to the topics for further research discussed above, we have ignored risk preferences of relevant agents, optimal reward structures with asymmetric information (including the possibility of equity as well as profit-sharing schemes), financing considerations, other distribution mechanisms (retailers who handle a variety of brands and, perhaps, products), and a host of other, probably less important, issues.

Ignoring our own caveat, we observe that franchised outlets tend to be associated with highly substitutable products (fast food, soft drinks, gasoline, and new automobiles), while company-owned stores are found in industries with little competition (telephone centers).

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