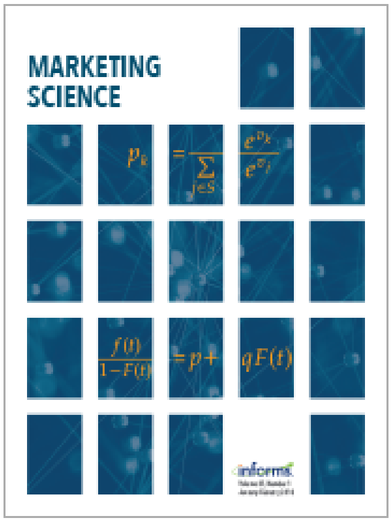

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Managing Channel Profits

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A channel of distribution consists of different channel members each having his own decision variables. However, each channel member's decisions do affect the other channel members' profits and, as a consequence, actions. A lack of coordination of these decisions can lead to undesirable consequences. For example, in the simple manufacturer-retailer-consumer channel, uncoordinated and independent channel members' decisions over margins result in a higher price paid by the consumer than if those decisions were coordinated. In addition, the ensuing suboptimal volume leads to lower profits for both the manufacturer and the retailer.

This paper explores the problems inherent in channel coordination. We address the following questions.
—What is the effect of channel coordination?
—What causes a lack of coordination in the channel?
—How difficult is it to achieve channel coordination?
—What mechanisms exist which can achieve channel coordination?
—What are the strengths and weaknesses of these mechanism?
—What is the role of nonprice variables (e.g., manufacturer advertising, retailer shelf-space) in coordination?
—Does the lack of coordination affect normative implications from in-store experimentation?
—Can quantity discounts be a coordination mechanism?
—Are some marketing practices actually disguised quantity discounts?
We review the literature and present a simple formulation illustrating the roots of the coordination problem. We then derive the form of the quantity discount schedule that results in optimum channel profits.

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1. Introduction

A channel of distribution consists of different channel members each having his own decision variables. However, each channel member's decisions do affect other channel members' actions. For example, if a retailer takes an action (e.g., changed shelf location) which causes a decrease in the volume of a particular product, all members in the product's channel observe the decreased volume and then react to it. Hence numerous interactions take place between channel decisions. Even if a manufacturer does not observe a retailer's action, the manufacturer may still respond to that action because the manufacturer does observe a change in product volume. This fact illustrates that the retailer can exercise some control over the manufacturer. Of course, this is true for all channel members. Each channel member influences other channel members' decisions. The result is a structure of institutional arrangements that should be of great interest to both researchers and practitioners in marketing.

This paper addresses the problem of coordinating channel decisions. This problem and its related issues have generated considerable research in both the marketing and economic literature (Bucklin 1966, 1970; Cox 1956; Doraiswamy et al. 1979; Douglas 1975; Logan 1969; Mattson 1969; McGuire and Staelin 1983a, b; Stasch 1964; Stern and El-Ansary 1977; Thomson 1971; Wedding 1952; White 1971; Williamson 1971; Etgar 1974; Zusman and Etgar 1981). First, and not unlike some of the studies just referenced, we do not attempt to exhaustively describe the channel. Instead, we abstract particular channel phenomena in order to understand them. Second, with a general demand function, we attempt to analyze one channel aspect, namely coordination. Third, we provide a new interpretation for quantity discounts which are commonly viewed as shifting production or inventory costs (see Dolan 1978). In fact, we show that quantity discounts are profitable even with no order or inventory costs. Fourth, we reinterpret many prevalent channel phenomena in the light of coordination showing that they may actually be coordinating mechanisms. Finally, we adopt the approach of economic theory building. For example, we assume channel members are rational, act in their own best interests and seek to maximize their respective profits.

However, we deviate from the related economic literature in several significant ways. First, we explicitly deal with nonprice variables (i.e., typical marketing decision variables like advertising and shelf-space) and their effect on pricing decisions. Second, we shift our emphasis from the currently popular bargaining problem back to the central coordination problem. Third, we provide a new justification for quantity discounts that is different from the celebrated price discrimination explanation given in the economics literature. In fact, we show that quantity discounts are profitable even without multiple retailers. Finally, unlike economists who desire to provide social welfare implications, our ultimate purpose is to provide a simple model that deals with some important aspects of the manager's decisions. In order to help channel managers, we seek to do more than direct them. A seasoned manager may already know which particular actions work and which do not work. What that manager really requires is a more thorough understanding of how the channel functions, i.e., why particular actions work and why others do not. Just as the experienced engineer gains additional insight from theoretical physics, the experienced manager gains additional insight from theoretical marketing.

The major objective of this paper is to examine the problem of channel coordination. We hope to illustrate the fundamental nature of this problem and how the failure to recognize it can distort nearly all channel decisions. We illustrate that the problem is so fundamental that it occurs in the two-member, single manufacturer-single retailer channel known as the bilateral monopoly in the economics literature. Without the distraction of multiple products, multiple retailers, multiple manufacturers, uncertainty, asymmetric power struggles or institutional constraints, the problem of channel coordination still exists. We, therefore, focus on the simple two-member channel which will not distract us from the basic issue of coordination to more complex channel phenomena. However, we do extend our analysis to more complicated channels such as manufacturer-wholesaler-retailer channels.

In the next section, we start our analysis by formalizing the relationships and decision variables of each channel member in the two-member channel. We resolutely avoid analogies which seek to view channel members as agent and principal; or follower and leader. These comparisons put the manufacturer and the retailer in the role of coordinator and coordinated, thus avoiding the real problems of coordination such as the motivation for these roles, how these roles evolve and the stability of these roles. In contrast to this approach, we construct a symmetric formulation where the retailer and the manufacturer are separate decision-making entities—each with his own decision variables (such as his margin) over which he has control. Our formulation views channel outcomes (such as channel profit) as a function of these separate but interdependent decisions. In this way, externalities which may put a particular channel member in a leadership position become a special case of our analysis rather than a driving force of the analysis.

After formalizing our model in §2, §3 begins our analysis of the problem of channel coordination. We illustrate the mutual incentives for coordination and the individual disincentives for cooperation. We find each channel member wants his partner to cooperate but does not want to cooperate himself. With this problem identified, §4 addresses possible solutions together with their strengths and weaknesses. Among the possible solutions discussed are contractual arrangements, implicit understandings and profit sharing. This section then presents the main result of our paper—a new mechanism which overcomes many of the weaknesses of the other mechanisms. However one problem remains. Once coordination is achieved, additional total profits are generated and we must consider their division. Section 5 briefly reviews one classical solution to this problem and its implications. Section 6 discusses managerial implications. Section 7 discusses the related research in marketing. Finally, §8 contains suggestions for future research and §9 gives our conclusions.

2. Formalization of a Simple Channel

As a first step toward understanding the issues concerning the internal functioning of channels of distribution, i.e., the interdependencies between vertical channel members, we start with a simple structure for distribution, namely one manufacturer who sells the brand under investigation and one retailer who resells it to consumers. From this simple model, we deduce conclusions that, insofar as our formulation accurately abstracts an important aspect of reality, are themselves important for management decision-making. We hope future research will examine and overcome the empirical and theoretical limitations of our analysis. One should note that the structure of the simple model is directly usable to analyze the case of a franchise in which a manufacturer sells locally one product exclusively through one retailer. This case is also studied by McGuire and Staelin (1983a) in the context of duopolistic retail competition. For many actual situations, extensions to the simple model are required. Sections 3B and 3C address some of these generalizations.

A. Basic Definitions

For the purpose of keeping notations simple, we denote by capital letters what refers to the manufacturer and small letters what relates to the retailer.

Some basic notations are:

- F, f total fixed costs for the manufacturer and retailer, respectively.
- C, c variable costs of manufacturer and retailer per unit for the product under study.
- Π, π profit functions of manufacturer and retailer.
- $D(p)$ consumer demand as a function of retail price p, $(dD/dp) < 0$.
- G, g margins of manufacturer and retailer per unit.

B. Assumptions

Initially, we make the following four key assumptions:

1. A two-member vertical channel.
2. A downward sloping retail demand function.
3. Certainty over all variables (functions) except channel member behavior.[1]
4. Symmetry.

We now discuss each of these assumptions in detail. We will later discuss the sensitivity of our analysis to these assumptions (see §4H).

A Two-Member Vertical Channel. We initially assume the channel has only two members—the manufacturer and the retailer. The manufacturer can sell to multiple retailers but these retailers are not in direct competition. The manufacturer can manufacture several brands but he does not sell competing brands through the same retailer. The retailer can carry many brands but we consider the profits of only one brand. We make these assumptions to enhance the exposition, augment analytical tractability and emphasize only coordination issues. The extensions to multiple member vertical channels are straightforward (see §3B). However, extensions to multiple manufacturers (and multiple retailers) are complicated by assumptions concerning competition (see §3C) among manufacturers (retailers). Nevertheless, coordination problems remain (see §3C). Additional extensions to both multiple manufacturers and multiple retailers are further complicated by the ambiguity surrounding the definition of a channel and the meaning of channel profits. We leave these other important issues for future research and focus our attention on the coordination issue which appears in all of these situations.

A Downward-Sloping Retail Demand Function. We assume the brand demand function is downward sloping. Our demand function is general in form. We further elaborate on the question of modeling the competition that the retailer faces in §2D.

[1] The situation is analogous to a chess game where all the rules are known and each player's objective is known (i.e., to win). However, the course of the game remains uncertain.

Certainty Over All Variables (Functions) Except Channel Member Behavior. We assume that each channel member knows the retail demand function. In our later analysis we also assume that each channel member knows the retail price. Each channel member knows the amount of marketing effort he is expending on the brand. Therefore, each channel member can infer the marketing effort the other member is exerting on the brand. Finally, we assume that each channel member knows the other channel member's variable costs. However, we later discuss the relaxation of some of these assumptions (see §4F).

Symmetry. We make no initial assumptions concerning channel power or the institutional relationship between channel members other than the fact it is a vertical relationship. We leave channel power exogenous to our model and capture it in several negotiated constants (see §5). Symmetry allows us to take an impartial view of the channel. This view lessens predispositions toward assuming a particular market structure when the interesting questions may be why that structure exists. This unbiased approach is adopted by Gould (1980) who states:

> It seems to be that classifying economic agents into the categories of buyers and sellers is an artificial and potentially misleading way to begin. In a fundamental sense there are neither buyers nor sellers. simply traders. Each trader is simultaneously a buyer and a seller. The fact that in advanced economies one trader gives up money in exchange for a good or service while the other gives up the good or service in exchange for money should not obscure the basic trading relationship that is involved. It is widely recognized in economics that trading occurs because both parties to the trade realize gains from the transaction. This is important because it means that both parties have an interest in making a market.

We do not start with the premise that manufacturer behavior necessarily differs from retailer behavior. Hence each channel member is given the same number of decision variables, each channel member is assumed to be equally sophisticated, and each channel member is assumed to want to maximize his profits. Of course, channel members may have different costs and different channel functions as well as different degrees of channel power. This notion of symmetry has been voiced repeatedly in marketing. Bagozzi (1974) and others have stated that marketing is concerned with exchange and that both buyer and seller must benefit if the exchange is to take place.

C. A Simple Formulation

With the preceding notations and assumptions, manufacturer profits are given by $\Pi = GD - F$ and retailer profits by $\pi = gD - f$ so that total channel profits are

$\Pi + \pi = (G + g)D - F - f$ where the channel margin $G + g$ is linked to retail price p by the relation $G + g + C + c = p$. The downward-sloping demand function, which is a function of retail price, is also a function of all competitive factors beyond the control of the channel members. One assumption is to take these factors as fixed parameters in the function (see §2D for more details and extensions). The preceding formulation is perfectly symmetric with respect to the manufacturer and the retailer. Throughout this paper, it will be assumed that the manufacturer has control over his margin G and the retailer over his margin g. It follows from the preceding formulation that retail price is the direct result of both the manufacturer's decision on his control variable G and the retailer's decision concerning his control variable g.

D. Some Immediate Extensions

The preceding formulation does not recognize that both the manufacturer and the retailer usually have other control variables besides G and g. For example, the manufacturer can modify the quality of his product. Hence, we introduce a second control variable Q for the manufacturer. It represents the manufacturer's opportunity cost due to his effort on the product. Consequently, the profit function of the manufacturer becomes $\Pi = GD - Q - F$.

The same situation also exists for the retailer who, in addition to deciding which margin to take, can also decide how much point-of-sale effort to put into the product, for example shelf-space. For this reason, we introduce a second control variable s so that the retailer's profit function becomes $\pi = gD - S - f$.

Given these new variables, the consumer demand function now has two arguments in addition to p; $D = D(p, Q, s)$ with $\partial D/\partial Q > 0$, $\partial D/\partial s > 0$, $\partial^2 D/\partial Q \partial s > 0$, $\partial^2 D/\partial Q^2 < 0$, $\partial^2 D/\partial s^2 < 0$. Again the extended model is perfectly symmetric with respect to the manufacturer and the retailer.

Moreover, if Q denotes product quality, one would expect the manufacturer's marginal cost of production to be a function of Q. Consequently, we will assume $C = C(Q)$ in the extended formulation. A similar argument leads to the assumption of retailer's marginal cost to be a function of s so that $c = c(s)$. In the simple formulation C and c are constants.

The extended formulation is fairly general in that (1) the presence of the opportunity cost Q accounts for the fact that the manufacturer's funds compete for optimal allocation, (2) the retailer's opportunity costs s are also incorporated and, (3) the downward-sloping demand function reflects the competition faced by the product under study. Concerning assumption (3), and in the practical situation of oligopolistic competition, the demand for the product is $D(p, p_1, \ldots, p_n)$ where p_1 through p_n are the prices of competitive products carried by other retailers. We assume $\partial D/\partial p < 0$ and $\partial D/\partial p_i > 0$. In practice, when the retailer sets price p, reactions may take place. This means that $p_i = R_i(p)$ where $R_i(p)$ is the reaction taken by product i. Consequently, when the retailer is a leader, demand for the product under study becomes $D(p, R_1(p), R_2(p), \ldots, R_n(p))$. We assume that the reaction functions are well behaved so that

$$\frac{dD}{dp} = \frac{\partial D}{\partial p} + \sum_{i=1}^{n} \frac{\partial D}{\partial p_i}\frac{\partial R_i}{\partial p} < 0$$

This condition may be necessary for an equilibrium with finite prices to exist—otherwise, economic agents may keep on increasing their prices. An example of well-behaved reaction functions is developed in the appendix. If there is no immediate reaction, i.e., $R_i(p) \equiv p_i$, then

$$\frac{dD}{dp} = \frac{\partial D}{\partial p} < 0$$

It would thus appear that the downward-sloping demand assumption is robust whether the retailer is a leader or not.

3. The Economics of Cooperation

A. The Simple Channel

If a single individual owned the entire channel, perfect coordination would exist.[2] Manufacturer and retailer activities would both be directed by the common owner for the common good. The owner would seek to maximize the sum of manufacturer and retailer profits, that is, total channel profits. The common owner would direct each channel member to act consistently with this objective. We refer to the result of this overall maximization as the joint maximum. At the joint maximum, $\Pi + \pi$ is maximized and channel members have the most profits to divide between them.

The condition necessary for obtaining the joint maximum that directly involves the manufacturer's margin is given by:

$$\frac{\partial(\Pi + \pi)}{\partial G} = \frac{\partial \Pi}{\partial G} + \frac{\partial \pi}{\partial G} = 0. \tag{1}$$

The joint owner would assign the manufacturer a margin which satisfies Equation (1). But we know that $\pi = gD - s - f$ and hence Equation (2) must hold (see appendix):[3]

$$\frac{\partial \pi}{\partial G} = -\frac{geD}{p} \tag{2}$$

[2] It would exist given the common owner had perfect information and the necessary expertise on every aspect (e.g., manufacturing and retailing) of the business.

[3] In order to enhance the exposition most equations are derived in the appendix.

where
$e =$ the absolute price elasticity of demand,
$e = -(\partial D/\partial p)/(D/p)$.

We know that g, D, and p are positive as well as the absolute price elasticity e (larger prices imply a lower quantity demanded).[4] Hence the common owner would set G and g such that $-geD/p$ and therefore $\partial \pi/\partial G$ are negative. This result indicates that the retailer, if he were only interested in his own profits, would be unhappy with the margin a common owner would assign to the manufacturer. If the retailer had control over the decision variable G, the retailer would set G such that $\partial \pi/\partial G$ equals zero, thereby maximizing his profits. Of course, without joint ownership, the retailer would still have no direct control over the manufacturer's decision variable G.

However, if $\partial \pi/\partial G$ is negative, then for Equation (1) to hold, $\partial \Pi/\partial G$ must be positive. This important implication indicates that at the joint maximum, the manufacturer's profits are increasing in G. That is, the manufacturer would be unhappy with G at the joint maximum and would seek to raise his margin until his profits are maximized. If he were only interested in his own profits, he would seek to raise his margin from the joint maximum margin, denoted G^*, where $\partial \Pi/\partial G > 0$, to the margin maximizing his independent profits, denoted G^{**}, at which point $\partial \Pi/\partial G = 0$.[5] The reason why the manufacturer can raise his margin above the margin G^* that is consistent with maximization of channel profits and, in the short run, obtain more profit is because the initial decrease in volume is completely recovered by the manufacturer's higher per unit profit. The manufacturer does not feel the full volume decrease because his margin determines only part of the price. The retailer, however, would suffer far more from the decreased volume than the manufacturer because the retailer loses volume while obtaining no increase in unit profit. Finally, the symmetry of our formulation dictates similar results for g.

The problems occurring with margin determination also appear in other channel decision variables. Again, the channel members acting independently may not seek to maximize joint profits. For example, consider product quality. Joint maximization requires the condition given by Equation (5) to hold:

$$\frac{\partial(\Pi + \pi)}{\partial Q} = \frac{\partial \Pi}{\partial Q} + \frac{\partial \pi}{\partial Q} = 0. \tag{5}$$

We know that $\pi = gD - s - f$, which yields:[6]

$$\frac{\partial \pi}{\partial Q} = g\frac{\partial}{\partial Q}(D) = g\left\{\frac{\partial D}{\partial p}\frac{\partial p}{\partial Q} + \frac{\partial D}{\partial Q}\right\}. \tag{6}$$

However, it can easily be shown that Equation (5) requires

$$\frac{\partial}{\partial Q}(D) = \frac{\partial D}{\partial p} \cdot \frac{\partial p}{\partial Q} + \frac{\partial D}{\partial Q}$$

to be strictly positive (see appendix). Hence, from Equation (6), $\partial \pi/\partial Q$ must be strictly positive and, for Equation (5) to hold, $\partial \Pi/\partial Q$ must be strictly negative. The manufacturer finds that his profits are currently decreasing in Q. He therefore seeks to lower product quality until $\partial \Pi/\partial Q$ equals zero and his profits are maximized. The manufacturer, who is paying a larger share of the costs for product quality, will thus not seek as high a level of product quality that would be necessary to maximize channel profits. In the case of increased product quality, the retailer gains more from the increased volume, so the manufacturer seeks a lower level of quality than the retailer. Again, the result of this action leads to more profits for the manufacturer, less profits for the retailer, and less combined profits. Using a symmetric argument, we would find the retailer has similar incentives concerning s.

Summarizing, we find that without joint ownership and its associated coordination, the manufacturer has the power and profit maximizing incentive to raise his margin above the level at which total channel profits are maximized. He also has the incentive to lower the product quality below the joint maximum level and lower all other promotional decision variables at his disposal. The lack of coordination leads to self-satisfying behavior, which increases the product's price while lowering its quality. The same is also true for the retailer. This is why the manufacturer (retailer) should seek cooperation with the retailer (manufacturer) when he apparently obtains a greater profit in the short term without cooperation. Otherwise, independently, both the manufacturer and the retailer will see the opportunity to gain profits at the expense of the other. Each member of the channel, by seeking his own best profits, reduces the other member's profits. These actions eventually create a worse situation for both.[7]

[4] Except under very unusual conditions, price elasticities are generally positive.

[5] *Note.* At this point we have not yet discussed the simultaneous determination of g and G. However, in the appendix, we derive Equations (3) and (4):

$$G^* = (g + c + C - e^* g)/(e^* - 1), \tag{3}$$

$$G^{**} = (g + c + C)/(e^{**} - 1). \tag{4}$$

Symmetric equations exist for g.

[6] The notation $\partial(D)/\partial Q$ should not be confused with $\partial D/\partial Q$ since D is a function of both Q and p—$D = D(p, Q, s)$—and $p = G + g + C(Q) + c(s)$ so that $\partial p/\partial Q = dC/dQ$ is different from zero.

[7] This is the classical "prisoner's dilemma" in game theory.

It turns out that parts of this analysis were suspected years ago (Cournot 1838). The lack of coordination, the associated higher prices paid by consumers and the subsequent social welfare issues have been discussed in the economics literature (see Machlup and Taber 1960 for a review). However, early economic research focused on the role of price while subsequent research, with a few exceptions (Lindsay 1979), has emphasized how channel members would bargain for the increased profits made available by cooperation (for example, Greenhut and Ohta 1979). The bargaining problem which we address later in this paper and the pricing problem are both important. However, the above development has shown that nonprice factors are equally important in seeking a suitable mechanism for cooperation. Therefore, we will go beyond the initial work in economics and address how full channel cooperation, i.e., involving other marketing mix variables than price could be achieved.

B. Extensions to Multiple Member Vertical Channels

The extension of the previous analysis to multiple member vertical channels is straightforward. Let us use subscript j to denote the jth member in the vertical channel. Let Π_c denote total channel profits. Then, we know that for the K member channel equation, (7) must hold:

$$\frac{\partial \Pi_c}{\partial G_j} = \frac{\partial \Pi_j}{\partial G_j} + \sum_{k \neq j} \frac{\partial \Pi_k}{\partial G_j} = 0 \quad \text{for } j = 1, 2, 3, \ldots, K. \quad (7)$$

For channel profits to be maximized, we require $\partial \Pi_c / \partial G_j = 0$ for $j = 1, 2, 3, \ldots, K$. But as we have found in our previous analysis, we now find that inequality (8) is true:

$$\frac{\partial \Pi_k}{\partial G_j} = -\frac{G_k e D}{p} < 0 \quad \text{for } k \neq j, \text{ for } j = 1, 2, \ldots, K. \quad (8)$$

Hence $\partial \Pi_j / \partial G_j > 0$ for all j and the coordination problem exists on every margin in the same direction indicated by our previous analysis. In fact, the coordination problem could be worse than before. Intuitively, coordination is more of a problem because $\partial \Pi_j / \partial G_j$ is now the sum of several terms rather than just one single positive term.

C. Extensions to Retailers Carrying Multiple Competing Brands

Until now, we have chosen to limit our attention to one brand carried by the retailer. We have done this to emphasize coordination issues. However, although many issues deserve attention when addressing the problem of retailers carrying multiple competing brands, the coordination issue remains. For example suppose a retailer carries N brands. Then that retailer's profit function is now given by:

$$\pi = \sum_{i=1}^{N} g_i D_i(\mathbf{p}), \quad (9)$$

where

$g_i =$ the retailer's margin for brand i.
$\mathbf{p} =$ the price vector for brands carried by the retailer, i.e., $(p_1, p_2, \ldots, p_N)$, p_i is the price for brand i.
$D_i(\cdot) =$ the demand function for brand i.

This retailer is now a member of N vertical channels. For each of the N channel profits to be maximized, we require expressions (10) and (11) to hold:

$$\frac{\partial (\pi + \Pi_i)}{\partial G_i} = 0 \quad \text{for } i = 1, 2, \ldots, N, \quad (10)$$

$$\frac{\partial (\pi + \Pi_i)}{\partial g_i} = 0 \quad \text{for } i = 1, 2, \ldots, N, \quad (11)$$

where

$\Pi_i =$ the profit of manufacturer $i = G_i D_i(\mathbf{p}) - F_i$,
$G_i =$ the margin for the manufacturer of brand i.

As before, $\partial \Pi_i / \partial g_i < 0$ so $\partial \pi / \partial g_i > 0$ because of Equation (11). Hence the retailer will want a larger margin and, thus, coordination problems exist.

4. Mechanisms for Coordination

A. Joint Ownership

If both channel members agree to cooperate, there will be more total profit to divide between them. Hence both can gain from cooperation. One method for cooperation is to have a centralized decision-maker dictate all channel decisions. This alternative is possible with joint ownership often called vertical integration. Even recently (Klein et al. 1978), joint ownership has been proposed again as the best solution. However, in many situations, there are three important problems with vertical integration.

The first problem with vertical integration involves other products carried by retailers. The retailer (e.g., grocery store) may carry hundreds and possibly thousands of other products whose variety may draw many consumers to the retailer's establishment, hence, minimizing the consumer's cost of shopping. In this common situation, $D(p)$ would be drastically reduced if retailers were to vertically integrate and carry only their respective manufacturers' products.

A second problem with vertical integration involves legal constraints. By vertically integrating, overall competition may be decreased. From a consumer viewpoint, a coordinated bilateral monopoly may be preferable to an uncoordinated bilateral monopoly. However, the law prefers a retailer and a manufacturer who are both in perfect competition to a coordinated bilateral monopoly. The Clayton Act, the Sherman Antitrust Act, and similar legislation which purport to increase competition may prevent joint ownership.[8]

The third, and possibly most important, problem with vertical integration may be its real ability to provide coordination. In many situations, manufacturers and retailers perform specialized functions with associated economies of scale. Until now, our analysis assumed that variable costs, c and C, were fixed. But vertical integration may cause both c and C to increase. A manufacturer may own production equipment, research laboratories, other specialized assets over which the manufacturer has particular managerial expertise. Similarly, the retailer may have expertise at managing his assets such as shopping center property, specialized warehouse equipment and refrigeration facilities. Hence, when the manufacturer and retailer are replaced by a centralized decision-maker, the latter may not have the know-how to manage both the manufacturing and retailing functions equally and efficiently. Thus his costs C and c would be larger than for managers who specialize in production or retailing.

B. Simple Contracts

An alternative to vertical integration is a legal contract specifying each channel member's decision variables. As with vertical integration, channel members abdicate control over their decision variables. With vertical integration, this control is relegated to a centralized authority. With a simple contract, this control is relegated to a legal agreement. For example, the manufacturer and the retailer might agree to fix their respective margins at G^* and g^* by agreeing to a contract denoted $\langle G^*, g^*\rangle$. Obviously, perfect information is needed to set margins so that they satisfy the joint channel profit optimality condition $G^*+g^*+C+c=p^*$.

Unfortunately, following the same reasoning as in §3A, one can find that, although both channel members might agree to such a contract, each could find actions which would make them, in the short run, unilaterally more profitable at the other's expense. Moreover, although each channel member can gain from cooperation, if one member cheats on the agreement, the other member may lose more from abiding by the agreement than having never entered into it.

This problem could be mitigated by strict enforcement of the agreement but even with enforcement both parties would continue to have an incentive to circumvent the spirit of the contract. A sagacious manufacturer might fear that once the retailer has agreed to the margin contract, the retailer might circumvent the contract by decreasing the shelf-space or other promotional effort allocated to the product. This manufacturer might want to prevent this problem by contractually requiring the retailer to buy a fixed number of units at a fixed price. This solution may be more desirable than contractually specifying each retail promotional variable because it leaves the retailer the freedom to optimize shelf-space, product store location, point-of-purchase displays and other promotional methods over which the retailer has particular expertise. Unfortunately, the wary retailer might avoid such a contract because he fears manufacturer circumvention with cuts in product quality, leaving the retailer with the burden of selling the contracted quantity of a lower quality product. The eventual, mutually agreeable contract may need to be quite detailed and, perhaps, quite rigid.

Of course, at this point in our analysis, we have assumed a world of certainty where the variables defined in §2 are known. Hence, cheating and the associated contract enforcement problems may disappear. Even in the real world of uncertainty, enforcement costs may still be reasonable and contracts may be a suitable mechanism for coordination under a wide variety of situations. Nevertheless, the rigidity of the simple contract remains a serious problem. With a detailed simple contract, neither channel member has the freedom to react to temporary external factors. Because the contract does not specify rules of behavior outside the contract point, the resulting coordination may not be lasting.

C. Implicit Understandings[9]

We have seen that channel coordination may be achieved by each channel member agreeing to a simple contract $\langle G^*, g^*\rangle$. However, one might ask whether foresighted partners might obtain the benefits of coordination without having to sign an explicit contract. Foresighted partners would realize that each partner reacts to the other. In other words, each channel member will develop some expectation concerning the other's reactions to his margin decisions. Consequently, each member will factor into his profit maximizing decision rule what he expects the other will

[8] The law implicitly assumes that increased numbers of noncolluding manufacturers and retailers will benefit consumers. However, if an integrated channel is more efficient, allowing vertical integration may lead to numerous integrated units each in competition and an even more beneficial consequence for the consumer.

[9] Concerning the issues related to implicit understandings, we benefited from the questions of Robert C. Blattberg.

do. It is reasonable to assume that expectations will develop from the observation of the other partner's past reactions.

It is beyond the scope of the present paper to go into the important issues surrounding implicit understandings as just defined. Jeuland and Shugan (1983b) formalize, in the context of channels of distribution, the notions of expected reaction functions. If the expected behavior matches the actual behavior for both the retailer and the manufacturer then necessary conditions for an equilibrium exist. The expected reaction function that matches actual behavior is said to be rational. If the expected reaction functions match actual behavior for small deviations around the equilibrium point then the latter is enduring. Jeuland and Shugan (1983b) study simple reaction functions and the ensuing modified behavior of both channel members. They analyze the modified profit maximizing rules that take these expectations into account. They study the question of whether an enduring equilibrium exists (existence of rational expected reactions) and whether resulting channel profits are higher than at the Cournot-Nash equilibrium (i.e., the equilibrium when each partner acts independently and does not recognize that he affects the other partner's decisions). They also investigate whether the more sophisticated behavior (i.e., the case of partners who develop expectations) results in lower profits than with perfectly coordinated behavior. Thus implicit understandings (see also Shugan 1983) may be useful for channel coordination.[10]

In general, we might ask what the theory of games tells us about equilibria for dynamic models. Given the conflict of short term versus long term, i.e., Nash equilibrium versus Pareto optimal coordination, the question of existence of noncooperative multiperiod equilibria becomes important. Can these equilibria exist when the payoffs are Pareto optimal even though the noncooperative equilibria of the single period model are not Pareto optimal? The reaction function approach is older and has been more popular among researchers dealing with oligopolistic market structures. However, the recent approach of supergames seems to hold promise for understanding long-term market competition (see Friedman 1977).

D. Profit Sharing

The result of channel coordination can be achieved by a profit sharing mechanism. Suppose the manufacturer receives fraction k_1 of channel profits plus a fixed amount k_2 while the retailer receives fraction $1-k_1$ $(0<k_1<1)$ minus the fixed amount k_2 so that manufacturer profits and retailer profits are given by:

$$\Pi = k_1[(G+g)D] + k_2 - F, \tag{12}$$

$$\pi = (1-k_1)[(G+g)D] - k_2 - f, \tag{13}$$

respectively (k_2 positive or negative). We see that because Π, π, and $\Pi+\pi$ are all linearly related, the conditions for maximizations of Π, π, and $\Pi+\pi$ are all compatible, i.e., all correspond to:

$$(G+g)\frac{dD}{dp} + D = 0 \tag{14}$$

required for a joint maximum.[11] For the time being, we consider the simple formulation where $D = D(p)$ and variable costs are constant. The extended formulation of §2 is considered in the next section.

If profit sharing does achieve the desirable incentive structure for channel coordination, we must still find a realistic mechanism for implementing profit sharing. Fortunately, quantity discounts provide an excellent mechanism for profit sharing.

E. Quantity Discounts

A manufacturer who offers the retailer a quantity discount varies the price charged to the retailer according to the quantity purchased by the retailer. The retailer obtains a discount for purchasing a larger quantity of the product from the manufacturer. The larger the quantity purchased, the lower the per unit costs to the retailer.

Quantity discounts represent a subtle mechanism for achieving profit sharing. When the manufacturer does not offer quantity discounts, the manufacturer obtains a constant profit of G for each additional unit sold by the retailer. But in order to sell additional units of the product, the retailer must decrease the retail price, i.e., his margin. Because this effort is totally borne by the retailer, a lower than jointly maximum volume is obtained. This condition can be corrected by the manufacturer. The manufacturer can share his profit on the additional unit by giving some of the additional profit to the retailer. He can do this by reducing the retailer's cost for purchasing the additional unit. That is, the manufacturer can give the retailer a quantity discount. The retailer then has an incentive to sell the additional unit. In fact, the manufacturer has the incentive to share additional profits until the decrease in price is no longer worth the resulting increased volume. At this point, the combined channel profits are maximized.

We know from our discussion of profit sharing that a quantity discount schedule which would fix

[10] This research is related to the problem of constructing duopoly or oligopoly models with consistent conjectural variations. This problem has been the object of a series of very recent papers by Laitner (1980), Bresnahan (1981), Perry (1980, 1981), Kamien and Schwartz (1981), Ulph (1981), Boyer and Moreaux (1982a, b).

[11] This is related to the literature on group decision-making. For a discussion of some of the issues, see Eliashberg and Winkler (1981).

the retailer's and hence the manufacturer's profits to some fixed linear function of total channel profits would lead the channel to maximum profits. The discount would also make individual channel member's incentives compatible with overall channel profit maximization. As a result, channel members would no longer have the incentive to selfishly optimize in the short run at the expense of the other partner and of total channel profits.

Of course, not every quantity discount schedule has all the required properties. As stated earlier, the discount schedule must link individual channel member profits to total profits. Equation (15) illustrates the form that a schedule of this type must take for the simple model (see appendix):

$$t = k_1(p(D) - c - C) + (k_2/D) + C \tag{15}$$

where

- k_1, k_2 are the same constants as in Equations (12) and (13), $1 > k_1 > 0$,
- t is the price the retailer pays the manufacturer for the product $t = G + C$ and $p = t + c + g$,
- $p(D) =$ the maximum price which still sells quantity D.[12]

Given the schedule of Equation (15), the retailer's profit function is

$$\pi = (1 - k_1)[(G + g)D] - k_2 - f,$$

and thus is linearly related to total channel profits. Consequently, profit maximizing behavior of the retailer is congruent with channel profit maximization. Manufacturer profits are also linearly related to retailer profits and thus, given schedule t, are maximized when retailer profits and channel profits are maximized.

We want to emphasize that the manufacturer does not impose $t(D)$ on the retailer. The quantity discount schedule is a result of bilateral negotiations between the parties. The results of the negotiation may or may not be symmetric (i.e., provide an equal division of gains). However, each party participates in the schedule's formulation. The schedule does provide both members the incentive for the manufacturer to supply the optimal quantity and the incentive for the retailer to demand the optimal quantity. The analysis of the function $t = t(D)$ shows that t is a quantity discount schedule. It is a discount schedule because inequality (16) holds:

$$\frac{dt}{dD} < 0. \tag{16}$$

(See the appendix for a proof that this condition holds.)

[12] Mathematically, $p(D)$ is the inverse of $D(p)$.

Now if we rewrite Equation (15), we obtain:

$$t(D) = k_1 p(D) + (1 - k_1)C - k_1 c + \frac{k_2}{D}. \tag{17}$$

We realize that schedule t operationalizes simultaneously a revenue sharing mechanism (the term $k_1 p(D)$), two cost sharing mechanisms (terms $(1-k_1)C$ and $-k_1 c$). The last term (term k_2/D) corresponds to a fixed payment (independent of quantity) of the retailer to the manufacturer. The determination of k_1 and k_2 will be addressed in the next section. One can already specify some constraints on k_1 and k_2 as manufacturer and retailer profits must be positive. The conditions $\pi > 0$ and $\Pi > 0$ imply:

$$(G + g)D - f \geqslant k_1(G + g)D + k_2 \geqslant F. \tag{18}$$

As already mentioned, k_2 is a fixed payment (side payment in the terminology of the theory of games) and is not necessary for profit sharing. However, side payments are often convenient mechanisms for getting around constraints in game theoretic problems (see Owen 1968), which is precisely what inequality (18) specifies.

In order to generalize the discount schedule $t = t(D)$ for nonprice variables, we apply the general principle of profit sharing to the model given by:

$$\Pi = GD(p, Q, s) - Q - F, \tag{19}$$

$$\pi = gd(p, Q, s) - s - F, \tag{20}$$

where

$$G = t - C(Q),$$

$$g = p - t - c(s).$$

Writing $\Pi = k_1[(G + g)D - Q - s] + k_2 - F$ implies:

$$t = k_1 p + (1 - k_1)\left(C(Q) + \frac{Q}{D}\right) - k_1\left(c(s) + \frac{s}{D}\right) + \frac{k_2}{D}. \tag{21}$$

This expression is similar to Equation (17) and indicates that coordination must involve sharing of manufacturer costs by the retailer and reciprocally sharing of retailer costs by the manufacturer. This result is consistent with the empirical observation of promotional allowances (retailer and manufacturer both shouldering advertising costs) and of manufacturers providing special displays to their retailers (manufacturer and retailer sharing distribution costs).

Equation (21) shows that schedule t is a general variable price contract and is thus considerably more flexible than the simple contracts discussed earlier.

F. The Implementation of Discount Schedules
The schedule

$$t(D) = k_1 p(D) + (1-k_1)C - k_1 c + k_2/D \qquad (22)$$

is only a function of the quantity ordered, D and the observable consumer price, p. Implementation of the schedule and negotiation of the schedule do not directly require complete knowledge of the demand function. In other words, to implement the quantity discount schedule, the manufacturer and retailer merely agree that the retailer will pay a fraction of the retail price, i.e., $k_1 \cdot p$, on top of the agreed upon constant $(1-k_1)C - k_1 c$. The advantage of this procedure is that it leaves the retailer in charge of his pricing and does not rely explicitly on heterogeneity of consumer demands faced by different retailers. Optimality will be achieved as the retailer seeks to find the retail price that maximizes the retailer's profits.

However, in practice, the constant $(1-k_1)C - k_1 c$ may not be known because manufacturer and retailer do not know each other's costs. Furthermore, we expect that channel members have an incentive to provide biased information to each other about their respective operations when negotiating an agreement. For example, if biased costs $\widehat{C}$ and $\hat{c}$ instead of the exact ones are used, the schedule becomes $\hat{t}(D) = k_1 p(D) + (1-k_1)\widehat{C} - k_1\hat{c}$ (assuming no implicit fixed payment k_2). Unless the constant $(1-k_1)\widehat{C} - k_1\hat{c}$ is equal to $(1-k_1)C - k_1 c$ i.e., $(1-k_1)(\widehat{C} - C) = k_1(\hat{c} - c)$, schedule $\hat{t}$ will not lead to optimality. An interesting question is whether a somewhat biased schedule may be better than no schedule at all.

Another important issue is the legality or illegality of quantity discounts. Legally sellers are prevented, under the Robinson Patman Act, from giving different terms to different resellers in the same reseller class (discounters, merchandisers, etc.) unless these reflect corresponding cost differences, distress sales, or a few other special conditions (Kinter, *A Robinson Patman Primer* 1970). Thus quantity discounts have been justified on the basis of cost: it costs less to supply larger than smaller quantities because, in particular, the fixed order and shipment cost can be averaged over a larger volume. There is obviously nothing illegal with justifying the quantity discount by a cost saving argument when it does provide a real cost savings but in addition serves as a coordination mechanism.

However, the implementation of the form of the quantity discount schedule given by Equation (22) requires more. The form of this schedule shows that a different schedule will be needed for retailers whose costs c are different. It is interesting to note that this difference is justified by cost variations across retailers and, hence, is in some accord with the spirit of the law. Also, as long as retailing costs are homogeneous within a class of retailers, the same conditions can be offered to all retailers in a given class. Another interesting question is whether a single schedule offered to a group of heterogeneous retailers may be more optimal than no schedule at all. Left to future research is the determination of optimality conditions for a single schedule offered to a group of retailers characterized by a distribution of retailing costs c.

Another effect of legislation may be the introduction of more complex marketing procedures. For example, when quality and shelf-space are taken into account, a more complex cost sharing mechanism than represented by the constant $(1-k_1)C - k_1 c$ is needed as shown by Equation (21). This complexity should not necessarily be viewed as a liability when dealing with the implementation of coordination. In effect, many marketing procedures such as promotional allowances, cooperative advertising, manufacturer technical service support, manufacturer supplied promotional materials, retail displays, credit terms, consumer advertising, manufacturer training of retail salespeople, full-line supplying, price rebates and other promotional techniques are different ways in which the manufacturer and retailer can participate in profit sharing, de facto. These marketing procedures are quite common and often have the advantage of being subject to a different interpretation by the courts than quantity discounts. However, the current state of the law is constantly changing and beyond the scope of this paper.

G. Alternative Uses for Quantity Discounts
Quantity discounts, as we have shown, can be a useful tool for achieving channel coordination. However, quantity discounts can be used for more than one purpose. Several other useful applications have been suggested for quantity discounts. These explanations include the transfer of inventory/production costs (e.g., see Dolan 1978) and price discrimination (e.g., see Kinter 1970).

There is no reason why quantity discounts could not exist for a variety of purposes. Inventory cost transference, price discrimination and coordination are all possible usages for quantity discounts. However, an interesting empirical question might be how often do these different explanations account for the current usage of quantity discounts. Let us consider this question by noting the implications of each explanation.

Consider the cost justification for quantity discounts. In this case, the manufacturer has a high production set-up cost or high shipping set-up cost and, therefore, the manufacturer prefers to produce or ship the product in large quantities. (High manufacturer inventory costs discourage infrequent production runs.) The manufacturer encourages orders in large quantities by offering quantity discounts. Hence, quantity discounts must be justified based on high production set-up costs (and a high cost of inventorying finished products) or high shipping set-up costs. If quantity discounts reflect a greater savings to the retailer than justified by cost savings to the manufacturer, this explanation is not sufficient to justify the existence of a quantity discount. Moreover, if the fixed costs of shipping change (e.g., a new type of tank car is developed or a shipping system is automated) or the cost of inventorying products changes (e.g., heating costs change after an oil embargo or a new warehouse is built), the quantity discount should reflect those cost changes. Otherwise, again the discount is not fully justified. Finally, quantity discounts should be highest directly after production runs when inventory costs are highest.

Now consider the price discrimination explanation for quantity discounts. In this case, the manufacturer uses quantity discounts in order to charge different retailers different prices. This action would be profitable when retailers who order less are willing to pay more for the product. For example, suppose a small retailer were located in a small town where little competition exists. That small retailer could make a satisfactory profit on the manufacturer's product at a higher retail price than a larger retailer located in a large city where intense competition exists. The larger retailer would require a lower manufacturer price before this retailer would be willing to carry the product. Hence, the manufacturer charges the larger retailer (who orders a larger quantity because of his size) less than the smaller retailer (who orders less but who is willing to pay more per unit).

If quantity discounts exist, price discrimination will nearly always exist. As long as retailers order different quantities, the retailers will buy at different prices. Almost by definition, quantity discounts imply price discrimination. However, our previous example was more complex. Price discrimination became profitable because consumer segments with different demand curves could be identified by the quantity that they ordered. Hence, the real motivation for quantity discounts is to charge price sensitive customers less. This justification for quantity discounts requires: (1) retailers who order less to be less price sensitive, and (2) all retailers be offered the same discount schedule. The greater price sensitivity of larger retailers is an empirically testable hypothesis. It would also be necessary to determine if the magnitude of the quantity discount is justified by the difference in price sensitivity.

In contrast, when quantity discount schedules are used for coordination purposes, we should find that different schedules would be negotiated with different retailers. Furthermore, these schedules would disappear as retail competition increased, the demand curve would become flat and the problem of coordination would disappear.

H. Sensitivity to Assumptions

It is clear that our analysis is more sensitive to some of our four original assumptions. Assumption one, a two-member vertical channel, was easily relaxed for additional intermediaries (§3B) but less easily relaxed when additional horizontal members were considered (§3C). Nevertheless, the intuitive motivation for quantity discounts remains in far more complex situations than the two-member channel. For example, suppose that the retailer seeks to increase his total store volume by using the manufacturer's brand as a loss leader. Even in this case, the retailer would still desire as small a manufacturer margin as possible. Moreover, the manufacturer would gain even more volume if the retailer margin were negative and larger in absolute magnitude. The same situation (i.e., retailer desiring a lower manufacturer margin) would occur if the retailer were keeping a high margin in order to induce the sale of substitute products offered by the retailer. Each channel member would still prefer the other to lower his margin and quantity discounts could still be used.

Assumption two, a downward-sloping demand function, is critical to our analysis. If the demand function were flat, neither channel member would have control over his margin because the retail price must be the perfectly competitive price. However, marketing studies show that this situation seldom occurs.

The relaxation of assumption three, certainty, was already discussed in §4F so we proceed to examine assumption four, symmetry. Careful examination of symmetry shows that in many respects asymmetry is a special case of symmetry (e.g., see Gould 1980, Shugan and Jeuland 1983a).[13] However, asymmetric channel behavior can be very interesting and has been studied (McGuire and Staelin 1983b).

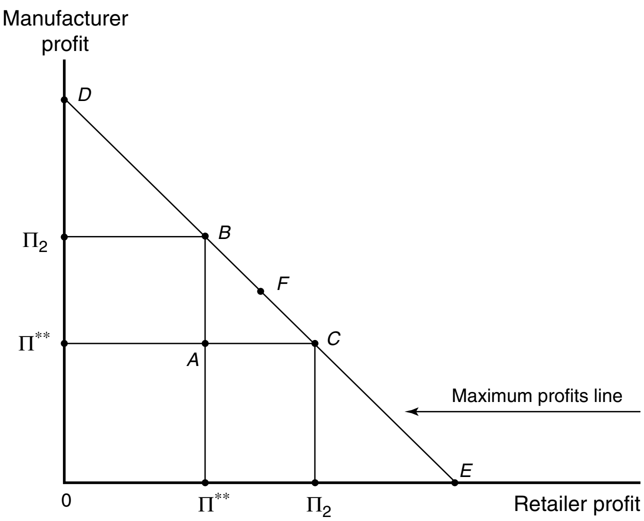
5. Divisions of Cooperative Profits: Bargaining in the Channel

A. A Bargaining Solution

In the previous sections, we have seen that manufacturer and retailer cooperation can lead to larger total profits. We identified several possible solutions for achieving this cooperation including a new mechanism. This new mechanism was a quantity discount procedure. Unfortunately, solving the cooperation problem leads to still another problem. We must now ask how the additional profits available through cooperation are divided. This problem corresponds to the

[13] Further discussion of the assumptions is given in Jeuland-Shugan (1983a).

Figure 1 **Profit Division**



determination of k_1 and k_2—the parameters of the quantity discount schedule.

Figure 1 graphically illustrates the problem of profit division. The indeterminacy of the division of channel profit comes from the identity given by:

$$\frac{\partial(\Pi+\pi)}{\partial G} \equiv \frac{\partial(\Pi+\pi)}{\partial g}. \tag{23}$$

In other words, any G and g given by a point on the line $D-E$ sets both terms in Equation (23) to zero.

If there is no cooperation, the retailer receives profit π^{**} and the manufacturer receives profit Π^{**}, represented in Figure 1 as point "A." However, after cooperation is achieved, it is possible to reach any profit division represented by a point on the line $D-E$ given by:

$$\Pi+\pi = (p^*-c-C)D(p^*)-F-f \tag{24}$$

where p^* is that p which satisfies (see appendix), $p = (c+C)e/(e-1)$. (The simple formulation again is considered here.)

Neither the retailer nor the manufacturer would be willing to accept less after coordination were achieved than before it were achieved. Therefore, likely divisions of profit will correspond to points on the line segment $B-C$. The point B corresponds to a solution where the manufacturer receives all the added benefits of cooperation. At point C the retailer receives all of these benefits. Other points on the line segment $B-C$ correspond to solutions where both receive some benefits.

The question becomes which point on the line segment $B-C$ corresponds to the actual negotiated solution. This problem is a well-known problem in bargaining theory and was recognized some time ago in the economics literature. Shumpeter (1954) cites Cesare Bonesana Marchese di Beccaria as one who in 1764 anticipated the conclusion of Menger (1871) and Edgeworth (1881). These researchers concluded that without any further assumptions it is impossible to determine the division of profits. It took several decades for the economics profession to admit this viewpoint (see Machlup and Taber 1960). However, by making some additional assumptions (e.g., Nash 1950), it is possible to determine a profit division.

One common solution obtained by theorists is that negotiations should lead to an equal division of the additional profits made available through cooperation. (See, for example, Harsanyi 1956, 1961, 1962, 1965, 1966; Nash 1950; or Zeuthen 1930.)

B. Quantity Discounts After Negotiation

Equation (17) represented a quantity discount schedule which achieves channel coordination. The schedule contained two unknown parameters k_1 and k_2, respectively. In fact the parameter k_1 is the quantity discount parameter and k_2 is a functional discount parameter in the sense that it represents a fixed payment.

If we assume $k_2 = 0$, and an equal division of additional profits (profits increase by moving away from the uncoordinated equilibrium "A" to "F," see Figure 1) we obtain:

$$k_1^* = \left[F+\tfrac{1}{2}(\Pi^*+\pi^*+\Pi^{**}-\pi^{**})\right]\big/(\Pi^*+\pi^*+F+f) \tag{25}$$

and the optimal quantity discount is given by:

$$t = k_1^*[p(D)-c-C]+C. \tag{26}$$

As before, the superscript * refers to channel optimum and the superscript ** to the noncooperative equilibrium (see derivation of Equation (25) in appendix).

It is important to note that Equations (25) and (26) are a very special case of Equation (17) and only one solution to the bargaining process. We presented this solution to provide one example of how k_1 may be determined. The functional form of the general quantity discount schedule (Equation (17)) is independent of how the constants in the quantity discount schedules are determined. In fact, k_1 will probably never equal the constant given by Equation (25) and k_1 will depend on many factors external to our formulation. For example, k_1 and k_2 may depend on the strength of each channel member's position (e.g., the number of competing retailers), the skill with which each member bargains, information held by each bargainer and the opportunity costs associated with the breakdown in negotiations.[14]

[14] The interested reader may write to the authors for numerical examples of (26) that illustrate the dependency of k_1^* on the starting point "A." Because of space limitations these examples cannot be reproduced in the paper.

6. Managerial Implications

We started our analysis by demonstrating the fundamental nature of the channel coordination problem. We demonstrated that the coordination problem was a basic problem originating from independent decision-making and present in even simple channels. We rederived the classical result that a lack of coordination leads to margins which are too high by global channel standards. This classical analysis, once extended to include nonprice variables, allowed us to show that the levels of variables with a positive impact on demand (e.g., product quality) would be too low by global channel standards. This result has immediate implications for empirical researchers who perform retail experimentation at one of a retail chain's stores and then suggest managerial actions based on experimental outcomes. Our analysis indicates that such limited experimentation can lead to misleading conclusions because experimentation of this type does not consider channel coordination. For example, consider typical competition between two retailers. Such competition is commonly discussed in the marketing literature. Suppose that neither retailer can significantly change his market share because the other retailer will match his price decreases. Eventually, each retailer learns that price cuts yield only temporary benefits. In this case, each retailer might maintain a price above the price suggested by a retail experiment which does not consider the other retailer's reactions. This conclusion is straightforward. In fact, consultants probably already consider this problem.

However, our economic analysis indicates the opposite effect is caused by a vertical channel. In the case of a vertical channel, the retail experiment will not suggest a retail price which is below the optimum. Instead, the price suggested by the experiment will be above the optimum channel price. If the channel was properly coordinated, short-term experimentation would indicate that the retailer's margin should be raised and that shelf-space should be reduced. Of course, once the retailer permanently implemented the actions suggested by the experiment, other channel members would react to the decreased volume. The long-term consequence would be a less profitable retailer despite experimental predictions. Moreover, if the channel was not coordinated, the experiment would indicate levels for price and nonprice variables that are optimal only in appearance since actions initiating coordination might lead to even better profits.

Of course, the major implication of our analysis is the identification of quantity discount schedules and more generally variable price contracts as coordinating mechanisms. These schedules allow implicit profit sharing by allowing channel members to transfer the costs of unilateral actions. This result has two immediate implications. First, quantity discounts provide an improvement over simple contracts which include fixed conditions. By linking the contract to performance such as quantity ordered for promotional spending, the incentive to achieve coordination can be created without the rigidity associated with fixed requirements. This added flexibility can allow the individual channel members to respond to temporary conditions without breaking the contract. Moreover, even if channel members deviate from the channel optimum, the quantity discount or variable price contract provides incentives to return to the channel optimum. Therefore, variable price contracts created with quantity discount schedules have additional flexibility and stability not possessed by fixed price contracts. Second, quantity discounts provide a mechanism useful for vertical integration. As we have already noted, a centralized decision-maker may not possess all of the skills and information required to perform all the channel functions. In these case, quantity discount schedules provide a mechanism for transfer pricing within a firm. The centralized decision-maker can provide price schedules rather than fixed prices to each channel manager. Again, the individual manager would retain some freedom to set his decision variables while still having the incentive to seek coordination.

7. Related Research in Marketing

Several concepts underlie our approach to modeling channels of distribution. Among them are (1) profit sharing and incentive compatible coordination mechanisms, and (2) symmetry of the relationship manufacturer-retailer. Concerning item (1), Farley (1964) applied, although he did not explicitly say so, the same principle to the question of compensation of the sales force. If $Q_i(t_i)$ denotes the sales volume generated by a salesman if he allocates t_i of his time to selling product i ($i = 1, \dots, n$), and if his remuneration is a commission rate B_i based on gross margins M_i (M_i is equal to the selling price minus variable nonselling cost per unit of product i), then his income is given by:

$$\pi = \sum_{i=1}^{n} M_i B_i Q_i(t_i) \tag{27}$$

where $\sum_{i=1}^{n} t_i = t$, $t =$ total working time of salesman. The contribution to profits of the firm of a salesman is given by:

$$\Pi = \sum_{i=1}^{n} M_i(1 - B_i) Q_i(t_i). \tag{28}$$

Farley finds that if $B_i = B$ for all i, then coordination takes place in the sense that total gross revenue

$\sum_{i=1}^{n} M_i Q_i(t_i)$ is maximized when the salesman maximizes π. It is easy to see that when $B_i = B$ for all i,

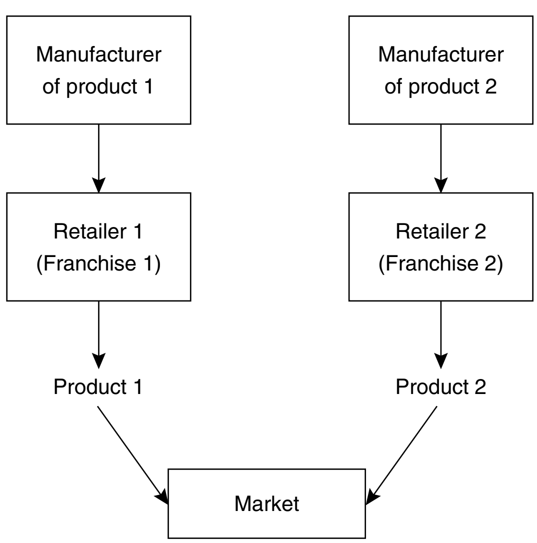
$$\Pi = (1 - B) \cdot \sum_i M_i Q_i \quad \text{and} \quad \pi = B \sum_i M_i Q_i. \tag{29}$$

The similarity with our result stops here, however, as we implement profit sharing in a very different fashion due to the nature of the problem we address.

As far as item (2) is concerned, two recent papers by McGuire and Staelin (1983) and Zusman and Etgar (1981) are relevant.

The objective of McGuire and Staelin is to investigate the desirability of different channel arrangements from the point of view of the manufacturer. Their focus on the manufacturer implies a departure from our symmetric approach. In fact, the major source of departure from symmetry is their assumption that the retailer does not recognize that he can have some control over the manufacturer. McGuire and Staelin assume that the former takes the latter's price as given. They also assume that the manufacturer realizes this lack of sophistication on the part of the retailer and factors this into his decision rule. In essence, they assume a follower-leader structure for the bilateral relationship manufacturer-retailer. They study several cases. One of them is the case of two products competing in the market place and manufactured by two different manufacturers who each distribute their product through a franchise (see Figure 2). Thus, given that the manufacturer-retailer relationship is that of follower-leader mode, that each of two retailers carry only one manufacturer product (duopolistic market structure with two differentiated products), McGuire and Staelin ask the question, should the manufacturer vertically integrate or not?

Figure 2 Duopoly—Two Products Distributed Through Two Franchises



Products 1 and 2 offered at prices p_1 and p_2 in the market place

It is obvious that the coordinated reactions of one channel to the other as previously discussed is quite different from the follower-leader reaction postulated by McGuire and Staelin. It is then not surprising that the industry equilibrium obtained by McGuire and Staelin is different from the equilibrium of coordinated channels. It is possible to show that the coordinated channel equilibrium price is always lower than the price obtained for McGuire and Staelin's follower-leader scenario so that consumer welfare is superior for coordinated channel competition.

Recently, Zusman and Etgar (1981) were inspired by the theories of bargaining, of risk-sharing, of incentive contracting and of the "agency relationship." Concerning the bilateral relationship that we study, their solution is based on the following formulation (p. 287) given by:

$$\pi_i = R^i(q_i) - v^i(q_i) \tag{30}$$

where π_i is the retailer's profit. $R^i(q_i)$ is the net revenue function, i.e., gross revenue net of the retailer's handling cost and $v^i(q_i)$ is the retailer's payment schedule to his partner. The latter's profit is given by:

$$\Pi_i = v^i(q_i) - c_i q_i - F_i \tag{31}$$

where c_i includes variable production costs, handling costs, and costs of delivering to the retailer.

Total profits are $\pi_i + \Pi_i = R^i - C_i q_i - F_i$ and are maximized when the condition $dR^i/dq_i = C_i$ is satisfied. On the other hand, the retailer will try to maximize his own profit function π_i. This gives the condition $dR^i/dq_i = dv^i/dq_i$. Zusman and Etgar (1981) then give a sufficient condition for the two above conditions to be compatible, namely the retailer's payment schedule function is given by:

$$v^i = c_i q + \beta \tag{32}$$

where β is a constant. The implication of this payment function is that profit of the retailer is given by:

$$\pi_i = R^i(q_i) - c_i q - \beta, \tag{33}$$

and the profit of his partner is given by:

$$\Pi_i = \beta - F_i. \tag{34}$$

Thus manufacturer profits are constant and total profit variations are equal to retailer profit variations. This exemplifies a clear dissymmetry in their formulation of the channel interrelationships. For example, if because of some short-term problem of scheduling of production, the manufacturer only delivers a fraction q^0 of what the retailer would wish to purchase from him, then $\pi_i = R(q^0) - Cq^0 - \beta$ and $\Pi_i = Cq^0 + \beta - Cq^0 - F_i = \beta - F_i$. In other words, the manufacturer suffers no penalty at all. Consequently, there is some question whether a payment schedule function like $v^i(q_i)$ can ever be acceptable to the retailer.

In sum, the above examples illustrate that a body of research in marketing is emerging that attempts to deal with the question of interdependencies between institutions. The present paper continues this tradition and focuses on the coordination problem. The model recognizes the symmetry of the bilateral relationship and thus clearly links the coordination problem with the bargaining problem.

8. Future Research

The simplicity of our formulation has both advantages and disadvantages. Among the advantages is the ability to easily extend the formulation in many directions. For example, uncertainty in the demand function can be considered by allowing the demand function to be probabilistic. Channel members then maximize expected profit. The manufacturer of a new product may also have more knowledge about the new product's demand curve than the retailer, the former having done more research. Uncertainty about partners' actual costs, $C(Q)$ and $c(s)$ may lead to nonoptimal schedules. This problem needs to be researched further. The effect of competition on the demand function should be considered further. The effect of multiple retailers and manufacturers should be addressed. The involvement of many economic agents raises questions about the boundary of the channel. More complex formulations are possible where the price of the product changes the retailer's total store volume (across products) or the sales of the retailers' other, possibly unrelated, products. When the retailer carries several competing products, his objective function is no longer the profit of one brand (its margin times its demand) but the sum of each brand's contribution and a more complex model is needed.

Finally, in the context of the conflict of short-term versus long-term profit maximizations, dynamic considerations need to be explored: Both the reaction function approach and supergames might help researchers uncover forms of long-term behavior that insures higher channel profits.

9. Summary and Conclusions

This paper provides a formulation for describing the institutional arrangements present in marketing channels. We started by demonstrating the need for channel coordination. We showed that coordination can lead to results where all channel members received larger profits. However, we saw that this coordination was difficult to achieve because each member has an incentive not to cooperate *unless* all other members are forced to cooperate. Hence, unless each member can be assured of the other's cooperation, coordination is not easy to achieve. We discussed several mechanisms—contracts, joint ownership, implicit understandings—which attempt to achieve coordination. We found that profit sharing mechanisms seem to possess many desirable features. In addition, we found that profit sharing can be implemented with quantity discounts. We then proceeded to derive the optimal quantity discount schedule. However, we encountered a classic problem—given the additional profits made possible through coordination, how should these profits be divided among the channel members? We briefly discussed this problem and mentioned that classical game theory recommends the plausible equal division of additional profits gained from coordination.

Therefore, besides the classical result that channel coordination is a fundamental problem which occurs in even the simplest channels and is caused by fundamental interdependencies in the vertical channel structure, we come to the following conclusions:

1. Channel coordination problems occur with all marketing decision variables albeit in different directions. Without coordination, marketing effort will be smaller than optimum (i.e., to maximize channel profits). This is a generalization of the result concerning margins: without coordination, they will be larger than optimum (i.e., to maximize channel profits).
2. Achieving channel coordination can be difficult. However, several mechanisms do exist for achieving coordination.
3. Many channel phenomena (e.g., integration, contracts, etc.) may be implicit coordinating mechanisms.
4. Joint ownership and fixed-price contracts are often inadequate mechanisms for coordination.
5. Quantity discounts can provide an optimal means for achieving coordination.
6. Quantity discounts can take the form of other marketing phenomena such as cooperative advertising or added service levels.
7. Quantity discounts are a method of profit sharing.
8. The channel coordination issue can be separated from the profit division issue. Although, they are related decisions.
9. A coordinated channel will make retail margins and manufacturer margins appear to be too low.
10. Coordination, once achieved, will lead to lower margins, higher levels of marketing effort, lower retail prices, and larger total channel profits.

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Appendix

Downward-Sloping Demand Functions When Competitive Reactions Exist

Given an oligopolistic market environment, the demand for one of the products depends not only on its own price, p, but also on the n other products' prices, p_i. Moreover, even in this case, the assumption of downward-sloping demand function is still a reasonable one as long as reaction functions $p_i = R_i(p)$ satisfy the conditions

$$\frac{\partial D}{\partial p} + \sum_{i=1}^{n} \frac{\partial D}{\partial p_i} \cdot \frac{dR_i}{dp} < 0.$$

For example, let us consider one independent retailer who sells only one manufacturer product (product 1) and competes against one company store owned by a different manufacturer (product 2). Assume the demand for product i is $q_i = 1 - p_i + \gamma(p_j - p_i)$, $i, j = 1, 2$, $j \neq i$ (1) (see McGuire and Staelin 1983 and Eliashberg and Jeuland 1982). Assume also that the management of the company store sets p_2 by optimizing profits, $\pi_2 = (p_2 - c_2)q_2$, given p_1. This leads to the reaction function

$$p_2(p_1) = \frac{\gamma p_1 + 1 + c_2(1+\gamma)}{2(1+\gamma)}.$$

The retailer then faces the demand function

$$\begin{aligned} q_1 &= 1 - (1+\gamma)p_1 + \gamma p_2(p_1) \\ &= 1 + \frac{[1 + c_2(1+\gamma)]\gamma}{2(1+\gamma)} - \frac{2 + 4\gamma + \gamma^2}{2(1+\gamma)} p_1 \end{aligned}$$

which like (1) is downward sloping.

Derivation of Equation (2)

$$\pi = gD - f,$$

$$\frac{\partial \pi}{\partial G} = g\frac{\partial D}{\partial p}\frac{\partial p}{\partial G} = g\frac{\partial D}{\partial p} = g\left(\frac{\partial D}{\partial p}\right)\left(\frac{p}{D}\right)\left(\frac{D}{p}\right) = -\frac{geD}{p}.$$

Note. In the section of the paper using this derivation, we assume g and G are independent decision variables. Hence, $dg/dG = 0$ and with $p = g + G + c + C$, we have $\partial p/\partial G = 1$ and $\partial D/\partial G = \partial D/\partial p$.

Derivation of Equation (3)

$$\frac{\partial(\pi + \Pi)}{\partial G} = D + (G+g)\frac{\partial D}{\partial p}\frac{\partial p}{\partial G} = D - (G+g)eD/p = 0,$$

then $p - (G+g)e = G + g + c + C - Ge - ge = 0$. Equation (3) follows.

Derivation of Equation (4)

$\partial\Pi/\partial G = D - GeD/p = 0$ then $p - Ge = G + g + c + C - Ge = 0$. Equation (4) follows.

Proof that $\partial\pi/\partial Q$ in Equation (5) Is Positive

$$\begin{aligned} \frac{\partial(\pi+\Pi)}{\partial Q} &= \frac{\partial \Pi}{\partial Q} + \frac{\partial \pi}{\partial Q} = G\frac{\partial}{\partial Q}(D) - 1 + g\frac{\partial}{\partial Q}(D) \\ &= (G+g)\frac{\partial}{\partial Q}(D) - 1, \end{aligned}$$

hence

$$\frac{\partial}{\partial Q}(D) = \frac{\partial D}{\partial p}\frac{\partial p}{\partial Q} + \frac{\partial D}{\partial Q} = 1/(G+g),$$

which is strictly positive, therefore $g\partial(D)/\partial Q$ and $\partial\pi/\partial Q$ are strictly positive.

Derivation of Equation (15)

$$\Pi + F = k_1(\Pi + \pi + F + f) + k_2,$$

$$GD = k_1(p - c - C)D + k_2,$$

$$G = k_1(p - c - C) + (k_2/D),$$

and since $G = t - C$

$$t = k_1[p(D) - c - C] + k_2/D + C.$$

Derivation of Inequality (16)

$$\begin{aligned} \frac{dt}{dD} &= \frac{d}{dD}\left\{k_1 p(D) + \frac{k_2}{D} + (1-k_1)C - k_1 c\right\} \\ &= \frac{k_1}{D'} - \frac{k_2}{D^2} \end{aligned}$$

where

$$D' = \frac{dD}{dp}.$$

Because $p(D)$ is the inverse function of $D = D(p)$, $dp/dD = l/D'$. If $k_2 \geqslant 0$, $dt/dD < 0$. If $k_2 < 0$, the profit of the manufacturer must still be positive so that

$$\Pi(D) = k_1(p - C - c)D + k_2 - F > 0.$$

At the channel optimum, $(p - C - c)D' + D = 0$ so that $p - C - c = -D/D'$. Consequently,

$$\Pi(D^*) = k_1\left\{\frac{-D^2(p^*)}{D'(p^*)}\right\} + k_2 - F > 0$$

implies

$$\frac{dt(D^*)}{dD} = \frac{k_1}{D'(p^*)} - \frac{k_2}{D^2(p^*)} < -\frac{F}{D^2(p^*)} < 0.$$

With dt/dD continuous, then dt/dD is negative over an interval containing the optimal point $(p^*, D^* = D(p^*))$. The width of the interval increases as $k_2 < 0$ increases toward zero.

Derivation of the Condition for p^* in Equation (23)

$$\pi + \Pi = (p - c - C)D - f - F,$$

$$\frac{d(\pi+\Pi)}{dp} = D + (p - c - C)D' = 0$$

where

$$D' = \frac{dD}{dp},$$

$$p - c - C = -D/D',$$

$$p - c - C = p/e,$$

$$(e-1)p = e(c+C),$$

$$p = (c+C)e/(e-1).$$

Derivation of Equation (25)
From Equation (7),

$$\Pi = k_1(p-c-C)D - F + k_2$$

hence if

$$k_2^* = 0 \quad \text{then} \quad \Pi^* = k_1^*(p^* - c - C)D(p^*) - F \quad \text{and}$$
$$\Pi^* = k_1^*[\Pi^* + \pi^* + F + f] - F.$$

Equal division of additional profits implies

$$\Pi^* - \Pi^{**} = \pi^* - \pi^{**}$$

hence,

$$\Pi^* = \pi^* - \pi^{**} + \Pi^{**}$$

and

$$k_1^*[\Pi^* + \pi^* + F + f] - F = \pi^* - \pi^{**} + \Pi^{**}.$$

Finally,

$$k_1^* = (\pi^* - \pi^{**} + \Pi^{**} + F)/(\Pi^* + \pi^* + F + f).$$

Note.

$$\begin{aligned}\Pi^* &= G^* D(p^*) - F\\ &= (t^* - C)D(p^*) - F\\ &= k_1^*(p^* - c - C)D(p^*) - F\\ &= k_1^*(\Pi^* + \pi^* + F + f) - F\\ &= \pi^* - \pi^{**} + \Pi^{**} \quad \text{as required.}\end{aligned}$$

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