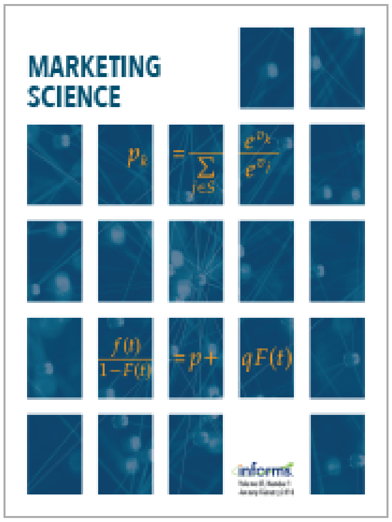

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Benefits of Channel Discord in the Sale of Durable Goods

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Minimizing strife through vertical integration is commonly seen as the "holy grail" for long-term success in product distribution. In this paper, we take a different slant, showing that sometimes a separated channel that embodies a degree of discord can be helpful, particularly when a long-term view is taken. This result is shown in the context of durable goods manufacturing. The quandary of durable goods production is that once demand for a certain time frame is met, there is a subsequent temptation to flood the market with additional goods. As such, consumers are reluctant to buy immediately, instead opting to wait for discounted prices. This problem can be alleviated by a degree of channel discord: High wholesale prices ensure future sales will slow to a trickle.

Key words: channel coordination; double marginalization; durable goods
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1. Introduction

Conventional wisdom suggests that a vertically integrated firm exemplifies an efficient manufacturing and distribution channel. The view that any channel disharmony is unhealthy because it prevents a unified front to consumers has intuitive appeal. In this paper, we add a word of caution: In some circumstances, strife can actually bolster a channel's profitability. In particular, we show that a disintegrated channel whose members are fixated on their own profitability can help in alleviating the time-inconsistency problem of durable goods production.

The time-inconsistency problem stems from incentives to lower prices and sell more after an initial round of sales is completed. Doing so reduces the holding value of the goods purchased by early consumers. Foreseeing such price drops, early consumers mark down what they are willing to pay for the product in the first place. The channel is hurt by its inability to convince consumers that it will keep prices consistently high. Coase (1972), who first suggested this problem, conjectured that if a monopolist can adjust prices frequently he may, in fact, lose his entire monopoly power in the "twinkling of an eye."

Given this problem, a vertically integrated firm would do better if it could commit to restricting production (thus keeping prices high) in future periods. This suggests that a disintegrated channel, often blamed for creating production distortions, can turn out to be a blessing in disguise.

To elaborate, consider a channel consisting of an upstream (manufacturing) and a downstream (intermediary) firm. Under integrated (coordinated) decisions, the channel parties pick prices and quantities to maximize channel profits at each point in time. Under a decentralized channel, the manufacturing firm sets wholesale prices and the intermediary decides how many units to procure and sell, each fixating on their respective firm value. This leads to the familiar double-marginalization problem—the manufacturer charges more than marginal cost, and the intermediary cuts supply (e.g., Spengler 1950).

In this model, the rub is that the double-marginalization "problem" can be desirable because it yields the production pattern for late sales to which the channel would like to precommit. A decentralized channel subject to double marginalization signals loud and clear that market prices for the good will be kept high via naturally restricted supply. Here, we stress that no party in our model makes binding commitments; rather, all parties make pricing and production decisions that are optimal at the time the decisions are made.

The extant literature presents other ways of minimizing the durable goods predicament, such as a firm putting funds into escrow with an arbitrator, destroying its own production capabilities, offering money-back guarantees, and leasing. (Tirole 1993, pp. 85–86, provides a synopsis of remedies, including a discussion of problems associated with each.) Most closely related to this paper is the solution provided by Desai et al. (2004), who show that a substitute for commitment to consumer pricing is to introduce an intermediary with whom the manufacturer can commit to wholesale prices. With precommitted wholesale prices, the channel can replicate the sales schedule under consumer-pricing commitment. In our setting, where precommitment to wholesale prices is not possible, the strife embedded in a disintegrated channel can prove helpful in convincing consumers that prices will stay high. In this sense, our result demonstrates that benefits to decentralization in durable goods markets (as in Desai et al. 2004) are robust to the extent of the firms' capabilities to commit.

Also related to this paper is the literature on double marginalization and channel coordination. This literature identifies several remedies to channel conflict, including providing quantity discounts (Jeuland and Shugan 1983, 1988), setting two-part tariffs (Moorthy 1987), or promoting market segmentation (Villas-Boas 1998).[1] This paper takes a different slant: In some cases, double marginalization can reign in production run amuck. Still, we stress that double marginalization is not a cure-all in our setting. In fact, if the commitment problem is not too severe, the costs of channel strife can outweigh any apparent benefits. Hence, our point is not to extol decentralization as a panacea, but rather simply to highlight a potential silver lining associated with coordination breakdowns.[2]

2. Model

We adapt the standard Bulow (1982) setup to model the sale of durable goods and analyze the effects of channel structure. In particular, we consider two cases: a manufacturer sells goods directly to consumers (an integrated channel), or the manufacturer sells to an intermediary who, in turn, sells to consumers (a decentralized channel). Under decentralization, the manufacturer sets per-unit wholesale prices and the intermediary chooses how many units to procure at that price.

For simplicity, we assume goods are perfectly durable in that there is no difference between a good that is produced in period $t+1$ and one that is carried over by consumers from period t. We also normalize the cost of production to zero.

To vary the severity of the channel's commitment problem, we consider both two-period and three-period product life cycles. A longer life cycle provides the channel with increased opportunities to adjust prices and, hence, undercuts any pledge to ration supply. (An appendix presents the solution for the general n-period case.)

As is standard, we assume a secondhand market exists.[3] Goods produced in any period compete freely with goods produced and sold in prior periods. The consumption (utilization) demand for the durable good in period t is:

$$R_t = \alpha - \beta Q_t, \tag{1}$$

where R_t is the "rental" price in period t, Q_t is the quantity of the durable good available in period t (i.e., total production up to that date), and α and β are constant intercept and slope demand parameters. To differentiate it from cumulative production, Q_t, we use small case q_t to denote the production in period t.

The selling price of the durable good in any period, p_t, reflects not just the benefits provided in period t, but also the present value of future benefits. To avoid notational clutter, we assume the consumers' and the firms' discount rates are zero. In the two-period setting, $p_1 = R_1 + R_2$ and $p_2 = R_2$. Note that although discount rates are normalized to zero, the firm nonetheless incurs a cost to delaying production and not immediately servicing the market. Because the durable good's price is rooted in the number of periods it can be consumed, the sooner the product is sold, the more it is worth (all else equal). Including firm and/or consumer discount rates can capture other costs of delayed production but does not alter the results.

Given this setup, if q_1 and q_2 units are put up for sale in the first and second period, respectively, the (present) value of channel profits is:

$$\begin{aligned} V = {} & \left[\alpha - \beta q_1 + \alpha - \beta(q_1 + q_2)\right] q_1 \\ & + \left[\alpha - \beta(q_1 + q_2)\right] q_2. \end{aligned} \tag{2}$$

(Prices and value are defined analogously when the model is extended to more periods.) The firms make pricing and/or production decisions that are optimal at the time the decisions are made; i.e., no binding commitments are made.

3. Results

3.1. Benchmark

We begin with a natural benchmark in which parties can precommit to actions. In this case, of course, an

[1] Recent work by Raju and Zhang (2005) contrasts the relative effectiveness of quantity discounts and two-part tariffs as mechanisms to promote channel coordination in the presence of a dominant retailer.

[2] In a similar vein, McGuire and Staelin (1983) and Moorthy (1988) show a competitive benefit to coordination problems brought about by decentralization. Depending on the complementarity/substitutability of products offered in the market, a firm may gain an advantage on its rivals by introducing an intermediary through which its products are sold to consumers.

[3] The secondhand market ensures that the durable nature of the goods is critical even if a consumer in one period does not demand the good in subsequent periods. Alternatively, one can assume consumers (and their valuations) remain the same in each period.

integrated channel is (weakly) preferred. In the two-period setup, q_1 and q_2 are chosen to maximize (2). The first-order conditions yield:

$$q_1 = \frac{\alpha}{2\beta}; \qquad q_2 = 0. \tag{3}$$

Plugging (3) in (2), the benchmark value of channel profits is:

$$V = \frac{\alpha^2}{2\beta}. \tag{4}$$

The value in (4) is achieved by providing units to the market in the first period and committing to not produce any additional units in the second period. It is straightforward to show that this trend persists if the time period is extended: $q_1 = \alpha/2\beta$ and all other $q_t = 0$. The problem is that, once first-period sales have cleared, there is a temptation to provide some added units to satisfy residual demand. If the integrated firm cannot commit to zero production, first-period consumers realize this temptation and insist on paying less (aware they could just wait and get the product cheaper later).

Even if the integrated firm cannot commit to maintaining a minimum external price, there may still be credible means (e.g., contracts) of committing to prices charged among firms within a decentralized channel. If so, decentralization and a reliance on a hefty future-period wholesale price can dissuade added production. With a second-period wholesale price of α, the intermediary will choose $q_2 = 0$, and a first-period wholesale price equal to marginal cost (here, zero) ensures the intermediary will choose $q_1 = \alpha/2\beta$. Thus, channel value is undiminished by an inability to commit to external market prices as long as there is an ability to commit to prices in some realm. This benchmark result mirrors the findings in Desai et al. (2004), who show that a monopolist manufacturer can replicate its ideal production pattern if it can commit to prices it will charge a retailer.[4] If such commitments are difficult, however, it is unclear whether any benefits to a decentralized channel persist.

3.2. Two-Period Model

We now return to our model, wherein no party has the ability to commit to prices either internally or externally. On the face of it, decentralization appears unlikely to benefit the channel. All that an intermediary brings is goal incongruity. However, can some incongruity send the right signal to consumers?

[4] Following this logic, other channel commitments that prevent markdowns in the final-good market may also have spillover benefits on the durable goods problem. Exclusive distribution arrangements (e.g., Desiraju 2004) and agreements not to encroach on a franchisee's territory (e.g., Kalnins 2004) are cases in point. The broader theme that channel structure can influence customer response and thus impact channel value is also stressed in Shaffer and Zettelmeyer (2004).

3.2.1. Integrated Channel. First consider the outcome under an integrated channel, wherein production at each point in time is chosen to maximize channel profits. Backward induction yields the equilibrium production levels. q_2 is chosen to maximize Period 2 channel profit: $[\alpha - \beta(q_1 + q_2)]q_2$. For a given q_1, then, the choice of q_2 is:

$$q_2 = \frac{\alpha}{2\beta} - \frac{q_1}{2}. \tag{5}$$

Working backwards, plugging (5) in (2), q_1 is chosen to maximize overall profit. The first-order condition yields q_1, and substituting in (5) yields q_2:

$$q_1 = \frac{2\alpha}{5\beta}; \qquad q_2 = \frac{3\alpha}{10\beta}. \tag{6}$$

Without the ability to commit to second-period behavior, the integrated firm cannot resist the temptation to add units to the market in Period 2, which, in turn, means it is limited in the price it can fetch in Period 1. In fact, due to this lack of commitment, p_1 falls from α to $9\alpha/10$, resulting in a lower channel value than in (4). Plugging (6) into (2) yields the integrated channel value:

$$V = \frac{9\alpha^2}{20\beta}. \tag{7}$$

3.2.2. Decentralized Channel. Introducing an intermediary that is left to its own devices creates strife in the channel—the manufacturer profits from wholesale prices above marginal cost, and this creates concerns of underprocurement by the intermediary. While such conflicts are often viewed as detrimental to the channel as a whole, they may serve a useful purpose in the setup. Channel discord may be the glue that holds in place a vow of second-period underproduction. We next examine the outcome under a decentralized channel to see if this intuition holds up.

Again, the equilibrium can be determined by working backwards in the sequence. Given q_1 and the second-period wholesale price, w_2, the intermediary chooses q_2 to maximize $[\alpha - \beta(q_1 + q_2)]q_2 - w_2 q_2$, its Period 2 profit. The choice of q_2 is:

$$q_2 = \frac{\alpha}{2\beta} - \frac{q_1}{2} - \frac{w_2}{2\beta}. \tag{8}$$

Anticipating this response by the intermediary, the manufacturer maximizes its second-period profit, $w_2 q_2$. Plugging q_2 from (8) and taking the first-order condition yields the Period 2 wholesale price and the resulting production level:

$$w_2 = \frac{\alpha}{2} - \frac{\beta q_1}{2}; \qquad q_2 = \frac{\alpha}{4\beta} - \frac{q_1}{4}. \tag{9}$$

As for Period 1, both firms make decisions foreseeing the ensuing wholesale prices and quantities in Period 2. In particular, given w_1, the intermediary chooses q_1 to maximize $[\alpha-\beta q_1+\alpha-\beta(q_1+q_2)]q_1+[\alpha-\beta(q_1+q_2)]q_2-w_1q_1-w_2q_2$, where w_2 and q_2 are as in (9). Taking the intermediary's first-order condition yields:

$$q_1=\frac{13\alpha}{27\beta}-\frac{8w_1}{27\beta}. \qquad (10)$$

Again, recognizing this response, the manufacturer maximizes its overall profit, $w_1q_1+w_2q_2$. Using w_2 and q_2 from (9) and plugging q_1 from (10), the manufacturer's first-order condition yields the Period 1 wholesale price. The equilibrium wholesale prices and resulting production levels are:

$$w_1=\frac{379\alpha}{416}; \qquad w_2=\frac{41\alpha}{104};$$
$$q_1=\frac{11\alpha}{52\beta}; \qquad q_2=\frac{41\alpha}{208\beta}. \qquad (11)$$

Substituting the q-values in (2), channel value under decentralization is:

$$V=\frac{17{,}671\alpha^2}{43{,}264\beta}. \qquad (12)$$

Alternatively, using (11), manufacturer and intermediary profits are $225\alpha^2/832\beta$ and $5{,}971\alpha^2/43{,}264\beta$, respectively. Channel value in (12) is simply the sum of the profits of each firm.

Comparing (7) and (12) reveals that channel value is greater under integration. This is consistent with the standard view that channel conflicts should be avoided. However, here there is more to the story. The usual complaint of underproduction is present in Period 1: With decentralization, $q_1\approx 0.21\alpha/\beta$ and with integration, $q_1=0.4\alpha/\beta$, where the ideal full-commitment q_1 is $0.5\alpha/\beta$. In terms of Period 2 production, the underproduction curse becomes a boon by allowing the channel to effectively commit to less production: With decentralization, $q_2\approx 0.20\alpha/\beta$ and with integration, $q_2=0.3\alpha/\beta$, where the ideal q_2 is zero. As confirmed above, the cost of underproduction in the first period outweighs the commitment benefit gained from the second period. However, the intuition suggests that in circumstances where the channel's commitment problem is more severe, the benefits of decentralization can outweigh the costs. We next analyze an extended product life cycle (the three-period setup) to check this thinking.

3.3. Three-Period Model

3.3.1. Integrated Channel. In determining the outcome under integration, one approach is to follow the same backward induction process as before, now cycling through three periods. An equivalent approach is to exploit the fact that in the three-period setting, Periods 2 and 3 effectively represent a two-period model, except that the demand intercept is $\alpha-\beta q_1$. In this case, the Periods 2 and 3 results are simply the Periods 1 and 2 results, respectively, from the previous section (adjusted for the intercept). Hence, the problem reduces to solving for the Period 1 production level.

To elaborate, from (6), the production levels in Periods 2 and 3 are:

$$q_2=\frac{2(\alpha-\beta q_1)}{5\beta}; \qquad q_3=\frac{3(\alpha-\beta q_1)}{10\beta}. \qquad (13)$$

From (7), channel value from the last two periods is $9(\alpha-\beta q_1)^2/20\beta$. Hence, channel value in the three-period setting is:

$$p_1q_1+\frac{9(\alpha-\beta q_1)^2}{20\beta}, \quad \text{where}$$
$$p_1=\alpha-\beta q_1+\alpha-\beta(q_1+q_2)+\alpha-\beta(q_1+q_2+q_3). \qquad (14)$$

Plugging q_2 and q_3 from (13) in p_1, (14) is expressed as a function of q_1. The first-order condition of (14) yields q_1, and plugged into (13) yields q_2 and q_3:

$$q_1=\frac{10\alpha}{29\beta}; \qquad q_2=\frac{38\alpha}{145\beta}; \qquad q_3=\frac{57\alpha}{290\beta}. \qquad (15)$$

(15) confirms that another period simply intensifies the commitment problem. Although the channel would benefit from halting production in future periods, the integrated firm cannot resist the temptation once the time arrives. In this case, substituting q-values from (15) in (14), the three-period firm value with an integrated channel is:

$$V=\frac{361\alpha^2}{580\beta}. \qquad (16)$$

3.3.2. Decentralized Channel. Again, rather than solve optimization problems at each stage, the three-period decentralized channel value can be obtained using the iterative process described above, which entails solving the problem only at the start of Period 1.

From (11), the wholesale prices and production levels in Periods 2 and 3 are:

$$w_2=\frac{379(\alpha-\beta q_1)}{416}; \qquad w_3=\frac{41(\alpha-\beta q_1)}{104};$$
$$q_2=\frac{11(\alpha-\beta q_1)}{52\beta}; \qquad q_3=\frac{41(\alpha-\beta q_1)}{208\beta}. \qquad (17)$$

From §3.2.2, the manufacturer and intermediary profit numbers are $225\alpha^2/832\beta$ and $5{,}971\alpha^2/43{,}264\beta$, respectively, in the two-period setting. Hence, with the appropriately adjusted intercept, the intermediary chooses q_1 to maximize:

$$p_1 q_1 - w_1 q_1 + \frac{5{,}971(\alpha - \beta q_1)^2}{43{,}264\beta}. \tag{18}$$

Plugging q_2 and q_3 from (17) in p_1, (18) is expressed as a function of q_1 and w_1. The first-order condition of (18) with respect to q_1 implies:

$$q_1 = \frac{45{,}509\alpha}{96{,}989\beta} - \frac{21{,}632 w_1}{96{,}989\beta}. \tag{19}$$

The manufacturer chooses w_1 to maximize:

$$w_1 q_1 + \frac{225(\alpha - \beta q_1)^2}{832\beta}. \tag{20}$$

Plugging q_1 from (19) into (20), and solving the first-order condition, yields w_1. Substituting back into (19) and then (17) provides the chosen wholesale prices and production levels in the three-period decentralized setting:

$$\begin{aligned} &w_1 \approx 1.27\alpha; \qquad w_2 \approx 0.74\alpha; \qquad w_3 \approx 0.32\alpha; \\ &q_1 \approx 0.19\alpha/\beta; \qquad q_2 \approx 0.17\alpha/\beta; \qquad q_3 \approx 0.16\alpha/\beta. \end{aligned} \tag{21}$$

As in the two-period setup, decentralization comes with the cost of underproduction in Period 1 ($0.19\alpha/\beta$ versus $0.34\alpha/\beta$). The benefit comes from the ability to commit to rationing supply in Periods 2 and 3 (both q_2 and q_3 are closer to the benchmark of zero production). The ensuing channel value is:

$$V \approx 0.6305\alpha^2/\beta. \tag{22}$$

Comparing (16) and (22), a net benefit of decentralization emerges, leading to the following proposition.

Proposition. *Depending on product life-cycle length, a durable goods channel can be better off with the conflicts brought about by an intermediary. In particular, the channel value is higher under integration if the product lasts two periods, while it is higher under decentralization if the product lasts three periods.*

A longer product life cycle increases the severity of the channel's commitment problem by, in effect, providing the firm(s) with increased opportunities to adjust prices. It is then that the channel most benefits from double marginalization. Our results in the two-period and three-period settings serve to prove the proposition.

Given the intuition for the proposition, one may also conjecture that benefits of a decentralized channel increase as the product life cycle further increases. Using the iterative expressions presented in the appendix for the general n-period life-cycle case, we verified this conjecture via numerical simulations. The results confirm the intuition. For example, while the benefit to decentralization is 1.3% in three periods, the gains quickly rise to 8.95% (from $0.7765\alpha^2/\beta$ to $0.846\alpha^2/\beta$) and 14.84% ($0.917\alpha^2/\beta$ and $1.053\alpha^2/\beta$) in four and five periods, respectively.

4. Conclusion

The time-inconsistency problem of a durable goods monopolist has been extensively studied. A variety of mechanisms that curb the monopolist's temptation to eventually flood the market with its product have been discussed. In this paper, we show that the durable goods dilemma can be mitigated by the commonly confronted issue of channel discord. Though channel coordination problems are usually thought of as deleterious, such conflicts may have an upside when the channel seeks to encourage consumers to purchase early at high prices, rather than wait for reduced prices down the road. Taking the reasoning one step further, even a vertically integrated firm may suffer from distribution inefficiencies. Bickering among divisions in the form of transfer-pricing disputes are a routinely discussed example. In this case, the results herein suggest that a vertically integrated firm that deals in durable goods may not be so eager to completely squelch division conflicts, but may instead benefit from a measure of disagreement.

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Appendix

For any n-period product life cycle, we present the (iterative) solution for the channel value, V^n, and quantities, q_t^n, $t = 1, \ldots, n$.

Define $a^n = (\alpha/\beta)[(n+1)\alpha - \sum_{k=1}^{n}(n+1-k)\beta q_k^n]$.

Integrated Channel

Initialization step: $q_1^1 = \alpha/2\beta$, $V^1 = \alpha^2/4\beta$.

Continuation step: for $n \geq 1$,

$$q_1^{n+1} = \frac{\alpha(a^n - 2V^n)}{2\beta(a^n - V^n)};$$

$$q_t^{n+1} = q_{t-1}^n[1 - (\beta/\alpha)q_1^{n+1}], \quad t = 2, \ldots, n+1; \quad \text{and}$$

$$V^{n+1} = \frac{(a^n)^2}{4(a^n - V^n)}.$$

Under decentralization, the iterative process requires tracking each firm's profits. Denote the manufacturer and intermediary profit values by V_M^n and V_I^n, respectively. Channel value, V^n, is of course $V_M^n + V_I^n$.

Decentralized Channel

Initialization step: $q_1^1 = \alpha/4\beta$, $V_M^1 = \alpha^2/8\beta$, $V_I^1 = \alpha^2/16\beta$.
Continuation step: for $n \geq 1$,

$$q_1^{n+1} = \frac{\alpha[a^n - 2(V_M^n + V_I^n)]}{2\beta[2a^n - (V_M^n + 2V_I^n)]};$$

$$q_t^{n+1} = q_{t-1}^n[1 - (\beta/\alpha)q_1^{n+1}], \quad t = 2, \ldots, n+1;$$

$$V_M^{n+1} = \frac{(a^n - 2V_I^n)^2 + 4a^n V_M^n}{4[2a^n - (V_M^n + 2V_I^n)]}; \quad \text{and}$$

$$V_I^{n+1} = \frac{1}{4[2a^n - (V_M^n + 2V_I^n)]^2} \cdot ((a^n)^3 + (a^n)^2[11V_I^n - 4V_M^n] + 4(V_I^n)^2[3V_I^n + 2V_M^n] - 4a^n[6(V_I^n)^2 + V_M^n V_I^n - (V_M^n)^2]).$$

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