經濟與管理論叢(Journal of Economics and Management), 2014, Vol. 10, No. 1, 1-26

On Marketing Channel Structures and Quality Choices

Wei-Wei Lee
Department of Economics, National Dong Hwa University, Taiwan

Bo-Tai Tzeng*
Center of General Education,
Min-Hwei College of Health Care Management, Taiwan

This study applies the vertical differentiation model to issues of channel choice. The primary goal is to examine how channel structures may influence a firm's strategies and consumer welfare. Because our concerns are more about coordination rather than competition, the effects of strategic interaction are dominated by the two manufacturers and one retailer channel configuration. We observe that the decentralized firm has incentives to extend the degree of quality differentiation to relax price competition. Moreover, retail price and quality move in the same direction. We also find that the consumer's surplus, producer's surplus and social welfare are the largest when both manufacturers are integrated, but the smallest when both manufacturers are decentralized.

Keywords: marketing channel, vertical differentiation, integration, decentralization
JEL classification: C70, D4, L13

1 Introduction

The channel structure between upstream and downstream firms can be classified into two categories, namely, integration and decentralization. Regardless of whether a channel structure is chosen by firms or is enforced by regulation, firms must

Received April 23, 2012, first revision February 20, 2013, second revision April 27, 2013, accepted May 1, 2013.
*Correspondence to: Center of General Education, Min-Hwei College of Health Care Management, Tainan, 73658, Taiwan (R.O.C.). E-mail: botai.tzeng@msa.hinet.net.

respond, which affects both competitors and consumers. Channel structure and how it influences firms' strategies are important issues in economics and management.

This study applies the vertical differentiation model to the issues of channel choice. Traditional vertical differentiation models typically examine zero-level channels, whereas this paper expands its scope to one-level channel relationships.[1] Although the game structure is more complex, the interaction between upstream and downstream firms can be observed. This study focuses on the case of two manufacturers and one retailer engaged in common dealing.[2] In our model, the firm endogenizes its quality and pricing decisions, and obtains clear numerical solutions. The primary goal of this paper is to examine how channel structures may influence a firm's strategies and consumer welfare.

The vertical differentiation model, in contrast to the horizontal differentiation one, has the following characteristics: (1) Consumers reach a consistent consensus about the order of product qualities. (2) The low- and high-quality product markets are asymmetric. (3) Because the consumer's willingness to pay is different, a consumer either buys one unit of product, or buys nothing at all. A consumer has at most unit demand. In studies related to the vertical differentiation model, Shaked and Sutton (1982) analyzed the equilibrium of industries under monopolistic competition with quality differentiation. Choi and Shin (1992) studied the competitive behavior between firms under uncovered markets. Motta (1993) compared price and quantity competition by considering quality improvement as either a fixed or variable cost. He proved that one firm offering higher quality than another is in equilibrium, and that firms do not benefit from leapfrogging over their rivals. Wauthy (1996) mentioned that when there is a wide distribution of consumer preference, an uncovered market typically forms; conversely, a narrow distribution leads to a covered market. Chambers *et al*. (2006) observed that slight changes to the curvature of cost functions cause significant changes in quality differentiation.

In studies relevant to channel management, Spengler (1950) believed that vertical integration should not be considered to impede competition. McFetridge

[1]If a manufacturer directly sells products to consumers without an intermediary, it is referred to as a zero-level channel. If a manufacturer sells products through retailers, it is referred to as a one-level channel.

[2]The market structure of two manufacturers and one retailer is referred to as an $2M1R$ channel configuration. A single retailer simultaneously selling products made by two manufacturers is referred to as common dealing.

(1994) provided a brief summary of the economic theory of vertical integration and its application. Chen (2001) demonstrated that when vertical integration is formed by firms obtaining productive assets from existing firms or shared ownership from asset owners, competition issues may occur. Jacobson (2003) suggested that although vertical mergers can create anti-competitive enclosures or collusion incentives, they may also increase efficiency. Riordan (2008) then outlined the opinions on integration and decentralization in academia.[3]

The selection of vertical integration and decentralization is mainly affected by either economic factors or industry regulations. McGuire and Staelin (1983) showed that the relative profitability of using decentralization is a positive function of the degree of demand substitutability. Jeuland and Shugan (1983) argued that there are various methods in which coordination can occur, but only one is through vertical integration. Bonanno and Vickers (1988) mentioned that decentralization is profitable in the interest of manufacturers when there are fully extracting franchise fees. Moorthy (1988) demonstrated that when products are demand substitutes (complements) coupled with strategic complements (substitutes), decentralization can be a Nash equilibrium strategy. Coughlan and Wernerfelt (1989) suggested that decentralization is a manufacturer's optimum choice, because it gives a manufacturer the ability to become a Stackelberg leader. Riordan (2008) mentioned that the authorities are always cautious regarding vertical integration, since they are concerned with anti-competitive effects that could arise because of channel structure changes.

There are some existing studies that use the monopoly common retailer channel.[4] It deals with an arrangement where there is a monopoly common retailer

[3]Between the 1950s and 1960s, economists analyzed the problem of vertical integration using the Structure-Conduct-Performance method, and were concerned with vertical integration to enclose or exclude competitors. The Chicago School criticized the enclosure theory during the 1960s and 1970s, highlighting the difficulty of collusion and advocating tolerance for vertically-integrated industries. The Economics of Transaction Costs adopted a neutral stance in the 1970s and 1980s by recognizing the new efficiency principle of vertical integration. In recent years, the Post-Chicago School has adopted a viewpoint that emphasizes the detrimental aspects of vertical integration.

[4]Choi (1991) used the monopoly common retailer (2M1R) channel, with the Manufacturer Stackelberg (MS), Vertical Nash (VN) and Retailer Stackelberg (RS) channel power. McGuire and Staelin (1983) and Moorthy (1988) used the integrated (2M), mixed (2M1R), and the exclusive dealing (2M2R) channel, with the MS channel power. Chung (1995) used the exclusive dealing (2M2R), and the monopoly common retailer (2M1R) channel, with the RS channel power. Raju *et al*. (1995) used the common dealing (nM1R), and the common dealing + private brand (nM1R) channel, with the MS channel power. Chung (1997) used the exclusive dealing (2M2R), common dealing (2M1R), and the exclusive dealing + private brand (1M2R) channel, with the VN channel power. Liao and Tseng (2008)

who sells two competing products. The focus of this channel is on the effects of the retailer's ability to coordinate the retail prices of multiple products. For example, McGuire and Staelin (1983) and Moorthy (1988) investigated the issues related to the manufacturer's channel structure decision. Choi (1991) compared different types of channel power between two manufacturers and one common retailer. Chung (1995) analyzed the economic effects for the situation in which the retailer asked its upstream suppliers to pay the slotting allowances. Raju *et al*. (1995) analyzed what makes a product category more conducive to private brand introduction. Chung (1997) studied the situation where a retailer sells a manufacturer's product as well as its own private brand. Liao and Tseng (2008) studied the strategic selection of a manufacturer's direct selling and a retailer's private brand in the retail market.

The above studies are all based on horizontally differentiated models in nature and regard product differentiation as exogenously given, which deprives firms of an important strategic tool under different channel structures. Zhao *et al*. (2009) pioneered endogenous quality decisions in the vertical differentiation model with one-level channel relationships. Under $2M2R$ and exclusive dealing channels,[5] when the low- (high-) quality firm decentralized, the low- (high-) quality level increased (decreased).

Our model includes two manufacturers and one common retailer. Manufacturers produce quality-differentiated products and may choose either an integrated or decentralized channel structure. The firms' quality and price strategies are compared in four different scenarios: both manufacturers are integrated (decentralized); the low-quality manufacturer is integrated, but the high-quality one is decentralized; and vice versa. This study primarily refers to the concepts of Zhao *et al*. (2009). Both studies are similar because they endogenize quality and pricing decisions, use the same power utility function, and examine how the channel structure affects a manufacturer's strategy.

However, Zhao *et al*. (2009) employed $2M2R$ and the exclusive dealing channel, whereas this study uses $2M1R$ and the common dealing system.[6] Under

---

used the monopoly common retailer + private brand + direct selling (2M1R) channel, with the MS channel power.

[5]The market structure of two manufacturers paired with two retailers is referred to as $2M2R$. Using $2M2R$, a retailer selling only the products produced by a single manufacturer is referred to as an exclusive dealing channel.

[6]Choi (1996) stated that "the exclusive dealer channel has been studied in two different perspectives.

an exclusive dealing channel, a retailer only sells products produced by one manufacturer, and maximizes the profits of that variety. Conversely, under a common dealing system, the retailer simultaneously sells both products, and therefore has incentives to coordinate the sales of two varieties to maximize joint profits. We found that when the low- (high-) quality manufacturer chooses decentralization, the low- (high-) quality level and its price decrease (increase). When a manufacturer chooses decentralization, its demand and profits decrease. Decentralization reduces the consumer's surplus, producer's surplus, and social welfare. Moreover, both manufacturers have no incentive to deviate from integration.

2 Modeling Framework

Two upstream manufacturers, M_1 and M_2, produce low- and high-quality products, respectively, with the quality level $0 < q_1 < q_2$ and the marginal cost $c(q_i) \equiv q_i$, $i = 1, 2$. Only one common downstream retailer R exists. The relationship between manufacturers and the retailer can either be integrated (I) or decentralized (D).

The consumer type θ is distributed uniformly between 0 and 1, and the net utility function of consumer θ is expressed as:

$$U(\theta) = \begin{cases} \theta \cdot u(q_i) - p_i & \text{if pay } p_i \text{ to buy one unit of quality } q_i \text{ product} \\ 0 & \text{if not buy} \end{cases}.$$

The equation $u(q_i) \equiv \sqrt[n]{q_i}$ is the power utility function, which represents the utility level obtained by consuming one unit of quality q_i product, and $n = 2, 3, ..., 9$ represents the power.[7]

The first focuses on the channel control problems, and the second focuses on the channel integration/ decentralization problem. On the other hand, the monopoly common retailer channel focuses on the effects of the retailer's ability to coordinate the retail prices of multiple products. In addition, the retailer can be a powerful player that can assume leadership positions against the manufacturers."

[7] It is not interesting for n=1 in our model, since the net utility of consumer θ is negative ($(\theta \cdot q_i - p_i) \le -(p_i - q_i) \le 0$), hence all consumers will not buy. Moreover, when n ranges between 2 and 9, the shape of the utility function changes significantly under different values of n ($n = 2, 3, ..9$), enabling the model to cover a large range of utility patterns with a manageable set of parameter values, as mentioned in Zhao (2009). Finally, the cases of n > 9 will not provide much extra information, since the importance of quality in terms of its contribution to utility becomes smaller and smaller when n increases.

The game structure consists of three stages. In stage one, the manufacturers (or integrators) choose qualities simultaneously. In stage two, if the manufacturer decentralizes, the wholesale price (w_i) is chosen by the manufacturer. In stage three, the retailer (or integrator) chooses the retail price (p_i). If a manufacturer integrates with the retailer, the manufacturer's profit is used to represent the integrator's profit.

Because the relationship between the manufacturer and retailer can be either integrated or decentralized coupled with low- and high-quality products, this study distinguishes the following four channel structures. The II channel indicates that both manufacturers are integrated. For example, Toyota has its own sales system, and sells both high-end cars (the Camry series) and economy cars (the Vios series) simultaneously. The ID channel shows that the low-quality manufacturer is integrated, but the high-quality one is decentralized. For example, BLUEsky and Carrefour can be regarded as an integrated channel for low-quality products. However, Carrefour sells both averagely priced media players (BLUEsky series) and high-end audio/video players (Sony series). The DI channel shows that the low-quality manufacturer is decentralized, but the high-quality one is integrated. For example, Feng-Yuan Organic Farm and GREEN & SAFE can be considered to be an integrated channel for high-quality products; however, GREEN & SAFE sells both organic molasses and general molasses in its stores. The DD channel indicates that both manufacturers are decentralized. For example, the iPhone, a high-end mobile phone produced by Apple, and ULC, the ultra-low-price mobile phone produced by Nokia, both use Chunghwa Telecom as the sales platform. The graphs of the II, ID, DI and DD channel structures are shown in Fig. 1.[8]

[8]For the ID channel, $\pi_{m1}=(p_1-c_1)\lambda_1(\pi_{r2}=(p_2-w_2)\lambda_2)$ refers to the integrated manufacturer $M_1's$ profits from selling the low- (high-) quality product. For the DI channel, $\pi_{r1}=(p_1-w_1)\lambda_1$ $(\pi_{m2}=(p_2-c_2)\lambda_2)$ refers to the integrated manufacturer $M_2's$ profits from selling the low- (high-) quality product. For the DD channel, $\pi_{r1}=(p_1-w_1)\lambda_1(\pi_{r2}=(p_2-w_2)\lambda_2)$ refers to retailer $R's$ profits from selling the low- (high-) quality product.

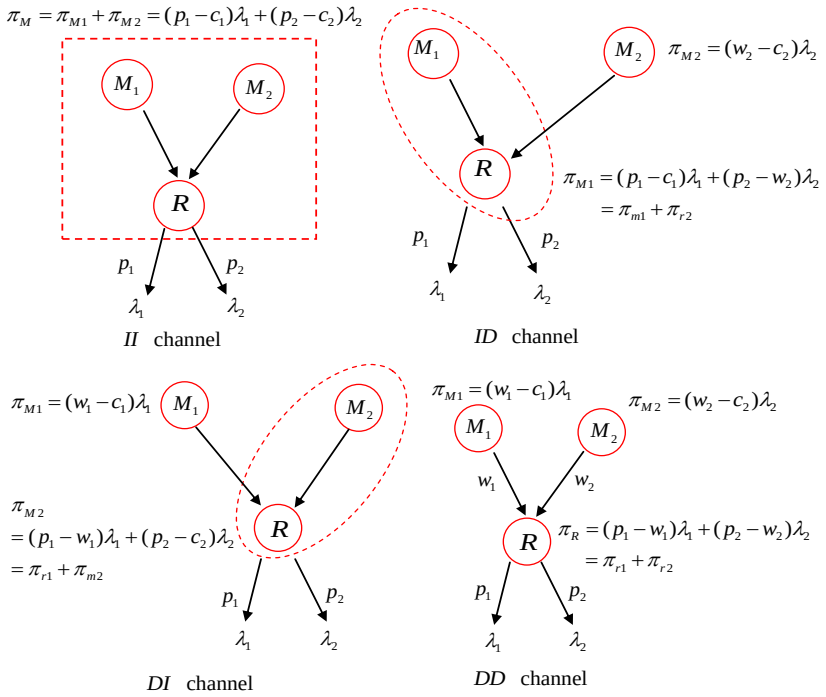

Figure 1: Channel Structures of *II*, *ID*, *DI*, and *DD*

Let $x_{i,n}^{j}$ represent the equilibrium value of variable x under quality i ($i = 1, 2$), channel j ($j = II$, ID, DI, DD), and power n ($n = 2, 3, ..., 9$). Let $c(q_i) \equiv q_i$ be manufacturer $i's$ marginal cost of making products of quality q_i. Let p_i, w_i, and λ_i represent product $i's$ retail price, wholesale price, and market demand, respectively. Let π_R, $\pi_M \equiv (\pi_{M1} + \pi_{M2})$, *CS*, *PS*, and *SW* represent the retailer's profit, the sum of the profits of both manufacturers, the consumer's surplus, producer's surplus and social welfare, respectively.

3 Equilibrium Outcomes

3.1 The Derivations of the Four Channel Structures

Let $\alpha = 1/(u_2 - u_1)$, $\beta = [1/(u_2 - u_1)] + (1/u_1)$, $u_i = \sqrt[n]{q_i}$, $c_i = q_i$, $i = 1, 2$. The marginal consumer is indifferent between "not buy" and "buy one unit of

low-quality product" ("buy one unit of low-quality product" and "buy one unit of high-quality product") which is expressed as $\theta_1 = (p_1 / u_1)(\theta_2 = (p_2 - p_1)/(u_2 - u_1))$. The low (high)-quality market demand is then $\lambda_1 = (\theta_2 - \theta_1)(\lambda_2 = (1-\theta_2))$, as shown in Fig. 2.

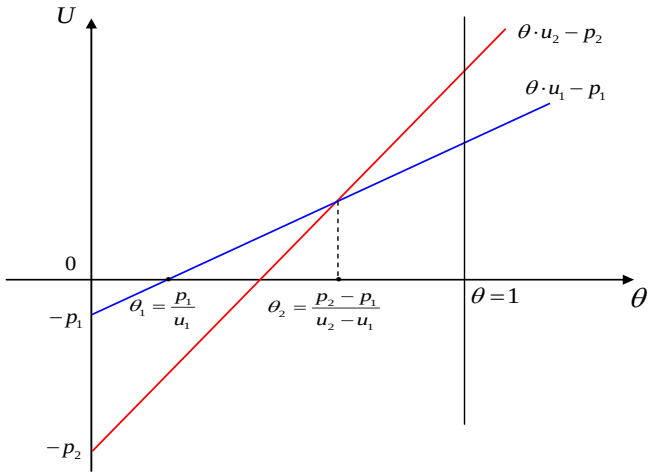

Figure 2: Consumer's Net Utility Profile

After the equilibrium qualities and prices are solved, the consumer's surplus (CS) can then be obtained by $CS = \int_{\theta 1}^{\theta 2} [\theta \cdot u(q_1) - p_1]\, d\theta + \int_{\theta 2}^{1} [\theta \cdot u(q_2) - p_2]\, d\theta$. Moreover, the producer's surplus (PS) is represented by the profit sum of firms, and the social welfare (SW) is the sum of CS and PS.

3.1.1 The Derivations of II Channel Structure

The II channel can be pinned down to a monopolist who first determines to produce and sell "only one variety (II with one variety)" or "both high- and low-quality products (II with two varieties)".

For II with one variety, the manufacturer's profit is $\pi_M = (p-c)(1-p/u)$. The monopolist selects p to maximize π_M in stage 3. By substituting $u = \sqrt[n]{q}$ and $c = q$ into π_M, we can obtain $\pi_M = (\sqrt[n]{q} - q)^2 / 4\sqrt[n]{q}$. In stage two, the monopolist selects q to maximize π_M. We can derive the equilibrium solutions in the general form, represented as $\tilde{q} = (2n-1)^{(-n/n-1)}$, $\tilde{p} = (2n-1)^{(-1/n-1)}/2 + (2n-1)^{(-n/n-1)}/2$,

and $\tilde{\pi}_M = ((2n-1)^{(-1/n-1)} - (2n-1)^{(-n/n-1)})^2 (2n-1)^{(1/n-1)} / 4$.

For II with two varieties, the monopolist produces and sells both high- and low-quality products. The low- (high-) quality market demand is $\lambda_1 = \alpha p_2 - \beta p_1 (\lambda_2 = 1 - \alpha(p_2 - p_1))$, and the manufacturer's profit is $\pi_M = (p_1 - c_1)(\alpha p_2 - \beta p_1) + (p_2 - c_2)(1 - \alpha(p_2 - p_1))$.

The monopolist simultaneously selects p_1 and p_2 to maximize π_M in stage 3. We can obtain $\pi_M = (-2\alpha^3 c_1 c_2 + \alpha^3 c_2^{\,2} + 2\beta c_1 \alpha^2 c_2 - 2\alpha^2 c_2 + \alpha^2 c_1^{\,2} \beta - \beta^2 c_1^{\,2} \alpha + 2\beta\alpha c_2 - \beta) / 4\alpha(\alpha - \beta)$, and then substitute α, β, u_i, c_i into π_M. In stage 2, the monopolist simultaneously selects q_1 and q_2 to maximize π_M. Since the analytical solutions are infeasible due to the complexity of the model, numerical methods are instead employed to solve the model.

In stage 1, the monopolist compares profits between "II with one variety" and "II with two varieties" under $n = 2,3,..,9$. Because it is better off when producing two differentiated varieties, the "II with two varieties" is chosen by the monopolist. The numerical outcomes are shown in Table 1.[9]

Table 1: Numerical Outcomes for "II with One Variety" and "II with Two Varieties"

	II Channel with One Variety				II Channel with Two Varieties					
n	$\tilde{q}$	$\tilde{p}$	$\tilde{\lambda}$	$\tilde{\pi}_M$	q_1	q_2	p_1	p_2	λ	π_M
2	111.11	222.22	0.3333	37.04	40.00	160.00	120.0	280.0	0.4000	40.00
3	89.44	268.33	0.4000	71.55	33.46	127.40	178.0	315.6	0.4481	75.25
4	74.68	298.72	0.4286	96.02	28.42	105.80	219.4	337.7	0.4654	99.43
5	64.15	320.75	0.4444	114.04	24.65	90.66	250.7	354.7	0.4741	117.30
6	56.28	337.66	0.4546	127.90	21.76	79.38	274.6	367.3	0.4794	130.80
7	50.17	351.15	0.4615	138.92	19.48	70.66	295.6	378.8	0.4829	142.20
8	45.30	362.23	0.4667	147.91	17.64	63.72	310.9	386.4	0.4854	150.60
9	41.28	371.52	0.4706	155.41	16.12	58.05	324.7	394.0	0.4872	158.10

Note: All values are expressed as 1/1000's except for market demand.

[9]By comparing the numerical outcomes between "II with one variety" and "II with two varieties" under $n = 2,3,..9$, we can find $q_1 < \tilde{q} < q_2$, $p_1 < \tilde{p} < p_2$, $\tilde{\lambda} < \lambda$ ($\tilde{\lambda} > \lambda_1$, $\tilde{\lambda} > \lambda_2$), and $\tilde{\pi}_M < \pi_M$ ($\tilde{\pi}_M > \pi_{M1}$, $\tilde{\pi}_M > \pi_{M2}$).

3.1.2 The Derivations of the *ID* and *DI* Channel Structures

Under the *ID* Channel, the integrated firm's profit is $\pi_{M1} = (p_1 - c_1)(\alpha p_2 - \beta p_1) + (p_2 - w_2)(1 - \alpha(p_2 - p_1))$, and the decentralized firm's profit is $\pi_{M2} = (w_2 - c_2)(1 - \alpha(p_2 - p_1))$. The integrator M_1 simultaneously selects p_1 and p_2 to maximize π_{M1} in stage 3.

In stage 2, the decentralized manufacturer M_2 selects w_2 to maximize π_{M2}. We can obtain $\pi_{M2} = (1 + \alpha(c_1 - c_2))^2 / 8\alpha$, and then substitute α , β , u_i , c_i into π_{M1} and π_{M2}. In stage 1, M_1 selects q_1 to maximize π_{M1}, whereas M_2 selects q_2 to maximize π_{M2} simultaneously. Since the analytical solutions are infeasible, numerical methods are instead employed. The deduction process of *DI* is similar to that of *ID* .

3.1.3 The Derivations of the *DD* Channel Structure

The manufacturer $M_1's$ profit is $\pi_{M1} = (w_1 - c_1)(\alpha w_2 - \beta w_1)/2$, $M_2's$ profit is $\pi_{M2} = (w2 - c2)(1 + \alpha(w_1 - w_2))/2$, and the retailer's profit is $\pi_R = (p_1 - w_1)(\alpha p_2 - \beta p_1) + (p_2 - w_2)(1 - \alpha(p_2 - p_1))$. The retailer simultaneously selects p_1 and p_2 to maximize π_R in stage 3. We can arrive at $\pi_R = (-2\alpha^3 w_1 w_2 + \alpha^3 {w_2}^2 + 2\beta w_1 \alpha^2 w_2 - 2\alpha^2 w_2 + \alpha^2 {w_1}^2 \beta - \alpha^2 \beta {w_2}^2 - \beta^2 {w_1}^2 \alpha + 2\beta\alpha w_2 - \beta)/4\alpha(\alpha - \beta)$. In stage 2, manufacturer M_1 selects w_1 to maximize π_{M1} whereas M_2 selects w_2 to maximize π_{M2} . We can derive $\pi_{M1} = (1 - 2\beta c_1 + \alpha(c_1 + c_2))^2 \beta / 2(\alpha - 4\beta)^2$ and $\pi_{M2} = (\alpha\beta c_1 + \alpha^2 c_2 + 2\beta - 2\beta\alpha c_2)^2 / 2\alpha(\alpha - 4\beta)^2$, and then substitute α , β , u_i , c_i into π_R , π_{M1} , and π_{M2}. In stage 1, M_1 selects q_1 to maximize π_{M1} , whereas M_2 selects q_2 to maximize π_{M2}. Since the analytical solutions are infeasible, numerical methods are instead employed.

3.2 Impact of the Power n on the Equilibrium Variables

Since the endogenously chosen qualities are between 0 and 1, the utility level

$u(q) = \sqrt[n]{q}$ will be raised with n for the consumption of equal-quality products.[10] Furthermore, the quality elasticity of utility $(\varepsilon = d\ln u(q)/d\ln q = 1/n)$ and the quality elasticity of marginal utility $(\eta = d\ln u'(q)/d\ln q = 1/n - 1)$ are both related to n. With these characteristics, we can obtain the qualities and the wholesale prices decrease with n. The retail prices, the total demand, the retailer's profits, the sum of the profits of both manufacturers, the consumer's surplus, the producer's surplus, and social welfare increase with n. The numerical outcomes and the corresponding explanations are presented in Appendix 1.

3.3 Impact on Equilibrium Variables Under Decentralization

In this study, $II \to DI$ $(ID \to DD)$ denotes a "low-quality firm unilateral decentralization" ("low-quality firm decentralization"). This represents the move of a low-quality manufacturer toward decentralization, whereas the high-quality one is integrated (decentralized). This is similar for $II \to ID$ $(DI \to DD)$, which refers to a "high-quality firm unilateral decentralization" ("high-quality firm decentralization"). $II \to DD$ denotes "enforced decentralization," which represents the simultaneous move of high- and low-quality manufacturers toward decentralization. In the following context, we examine the impact when a manufacturer chooses decentralization.

Lemma 1. *When the low-quality manufacturer chooses decentralization, low quality decreases. When the high-quality manufacturer chooses decentralization, high quality increases.*

The numerical outcomes regarding **Lemma 1** are shown in Table 2.

Under $2M1R$ and the common dealing channel, the decentralized manufacturer has an inferior position because of the channel structure. When firms can choose quality, the decentralized manufacturer has incentives to extend the degree of quality differentiation to relax price competition. Thus, the low-quality firm has incentives to decrease the quality level, whereas the high-quality firm has incentives to increase the quality level when he (unilaterally) decentralizes.

---

[10] $\partial u/\partial n = -u \cdot \ln q/n^2 > 0$, where $0 < q < 1$, $n = 2,3,...,9$.

Table 2: Table of Quality Variations from Integration to Decentralization

	Low Quality (q_1)						High Quality (q_2)					
	Low Quality Firm Unilateral Decentralization		Low Quality Firm Decentralization		Enforced Decentralization		High Quality Firm Unilateral Decentralization		High Quality Firm Decentralization		Enforced Decentralization	
n	$II \to DI$		$ID \to DD$		$II \to DD$		$II \to ID$		$DI \to DD$		$II \to DD$	
2	40.00	29.70	101.80	39.74	40.00	39.74	160.00	193.30	118.80	167.90	160.00	167.90
3	33.46	25.00	82.63	24.77	33.46	24.77	127.40	151.70	95.21	137.20	127.40	137.20
4	28.42	21.30	69.23	15.84	28.42	15.84	105.80	125.20	79.34	115.20	105.80	115.20
5	24.65	18.51	59.59	10.27	24.65	10.27	90.66	106.80	68.08	98.92	90.66	98.92
6	21.76	16.36	52.34	6.66	21.76	6.66	79.38	93.28	59.68	86.27	79.38	86.27
7	19.48	14.66	46.69	4.26	19.48	4.26	70.66	82.89	53.17	76.14	70.66	76.14
8	17.64	13.28	42.17	2.66	17.64	2.66	63.72	74.65	47.97	67.84	63.72	67.84
9	16.12	12.14	38.47	1.61	16.12	1.61	58.05	67.94	43.72	60.92	58.05	60.92

Note: All values are expressed as 1/1000's.

By contrast, Zhao *et al*. (2009) used $2M2R$ and the exclusive dealing channel. Because Zhao's model focuses on competition, when the low- (high-) quality manufacturer chooses decentralization, low- (high-) quality increases (decreases).[11] This implies that there is a lower quality differentiation if either channel is decentralized.

Lemma 2. *When the low-quality manufacturer chooses decentralization, the price of low-quality products decreases. When the high-quality manufacturer chooses decentralization, the price of high-quality products increases.*

[11]As mentioned by Zhao *et al*. (2009), if the low-quality product channel is decentralized, the price of low-quality products increases because of double marginalization. This causes increases in the price of high-quality products. Thus, a high-quality product channel focuses on the right-side consumers as they obtain higher profit margins. Therefore, a proportion of consumers originally purchasing high-quality products become potential consumers of low-quality products. Because decentralization leads to an increase in the price of low-quality products, low-quality firms improve quality to avoid losing too many left-side consumers.

If the high-quality product channel is decentralized, the price of high-quality products increases. The high-quality firm has two options: (1) improve high quality to retain the consumers that were originally purchasing high-quality products, while also obtaining some consumers that purchased low-quality products; or (2) decrease high quality to prevent substantial reductions in profit margins. For a high-quality product channel, the benefits of capturing the middle-segment consumers are minimal. Thus, high-quality firms tend to adopt the second option. The high-quality manufacturer reduces costs by reducing the high-quality level and focuses on the right-side consumers that are willing to pay.

The numerical outcomes regarding **Lemma 2** are shown in Table 3.

Table 3: Price Variations from Integration to Decentralization

	Price of Low Quality Product (p_1)						Price of High Quality Product (p_2)					
	Low Quality Firm Unilateral Decentralization		Low Quality Firm Decentralization		Enforced Decentralization		High Quality Firm Unilateral Decentralization		High Quality Firm Decentralization		Enforced Decentralization	
n	$II \to DI$		$ID \to DD$		$II \to DD$		$II \to ID$		$DI \to DD$		$II \to DD$	
2	120.0	108.5	210.3	137.1	120.0	137.1	280.0	323.5	231.7	318.1	280.0	318.1
3	178.0	167.6	259.6	182.6	178.0	182.6	315.6	350.0	276.0	366.9	315.6	366.9
4	219.4	210.5	291.0	212.8	219.4	212.8	337.7	366.5	304.9	394.7	337.7	394.7
5	250.7	242.9	313.9	234.1	250.7	234.1	354.7	378.5	326.0	413.8	354.7	413.8
6	274.6	267.8	331.1	249.9	274.6	249.9	367.3	387.8	342.2	428.2	367.3	428.2
7	295.6	288.2	346.2	261.4	295.6	261.4	378.8	396.2	355.3	439.7	378.8	439.7
8	310.9	304.8	354.4	269.9	310.9	269.9	386.4	400.2	365.8	449.2	386.4	449.2
9	324.7	317.5	368.6	275.4	324.7	275.4	394.0	410.2	373.5	457.7	394.0	457.7

Note: All values are expressed as 1/1000's.

There are two primary effects influencing the retail price of a decentralized firm. One is quality positioning,[12] and the other is the double-marginalization effect. Because our model has only one common-dealing channel at the retail level, coordination rather than competition is a greater concern for the retailer (integrator). The quality positioning effect dominates; therefore, the retail price and quality move in the same direction when a manufacturer (unilaterally) decentralizes.

By contrast, the double-marginalization effect dominates in Zhao's model; therefore, retail prices in both channels increase when either channel is decentralized.

Lemma 3. *When a manufacturer chooses decentralization, its quantity demanded decreases.*

The numerical outcomes regarding **Lemma 3** are shown in Table 4.

[12]Retail price is a function of quality. Moreover, the quality level also represents the manufacturer's marginal cost in both Zhao's and our model.

Table 4: Quantity Variations from Integration to Decentralization

	Quantity Demanded of Low Quality Product (λ_1)						Quantity Demanded of High Quality Product (λ_2)					
	Low Quality Firm Unilateral Decentralization		Low Quality Firm Decentralization		Enforced Decentralization		High Quality Firm Unilateral Decentralization		High Quality Firm Decentralization		Enforced Decentralization	
n	$II \to DI$		$ID \to DD$		$II \to DD$		$II \to ID$		$DI \to DD$		$II \to DD$	
2	0.2000	0.0861	0.2798	0.1722	0.2000	0.1722	0.2000	0.0602	0.2845	0.1396	0.2000	0.1396
3	0.2077	0.0856	0.3322	0.1938	0.2077	0.1938	0.2404	0.0733	0.3410	0.1794	0.2404	0.1794
4	0.2076	0.0837	0.3533	0.1986	0.2076	0.1986	0.2578	0.0791	0.3650	0.2014	0.2578	0.2014
5	0.2067	0.0822	0.3652	0.1984	0.2067	0.1984	0.2674	0.0824	0.3785	0.2165	0.2674	0.2165
6	0.2058	0.0812	0.3725	0.1963	0.2058	0.1963	0.2736	0.0845	0.3868	0.2278	0.2736	0.2278
7	0.2051	0.0804	0.3779	0.1931	0.2051	0.1931	0.2778	0.0858	0.3928	0.2370	0.2778	0.2370
8	0.2047	0.0798	0.3815	0.1895	0.2047	0.1895	0.2807	0.0869	0.3970	0.2445	0.2807	0.2445
9	0.2038	0.0792	0.3849	0.1856	0.2038	0.1856	0.2834	0.0877	0.4005	0.2511	0.2834	0.2511

In both Zhao *et al.* (2009) and our studies, decentralization leads to a lower demand. The vertical externality problem exists in the decentralized channel; therefore, there is less demand in a decentralized firm than in the case where there is integration. The (unilaterally) decentralized firm has a lower demand for its own products, whereas enforced decentralization reduces demand for both varieties, with a greater decline in high-quality products.

Proposition 1. *When a manufacturer chooses decentralization, its profits decrease.*

The numerical outcomes regarding **Proposition 1** are shown in Table 5.

Table 5: Manufacturers' Profit Variations from Integration to Decentralization

	Low Quality Manufacturer's Profit (π_{M1})						High Quality Manufacturer's Profit (π_{M2})					
	Low Quality Firm Unilateral Decentralization		Low Quality Firm Decentralization		Enforced Decentralization		High Quality Firm Unilateral Decentralization		High Quality Firm Decentralization		Enforced Decentralization	
n	$II \to DI$		$ID \to DD$		$II \to DD$		$II \to ID$		$DI \to DD$		$II \to DD$	
2	16.00	1.28	37.18	6.07	16.00	6.07	24.00	0.88	37.62	8.22	24.00	8.22
3	30.01	1.54	72.08	9.52	30.01	9.52	45.24	1.05	72.25	14.42	45.24	14.42
4	39.65	1.50	96.50	10.95	39.65	10.95	59.78	1.02	96.70	18.50	59.78	18.50

	Low Quality Manufacturer's Profit (π_{M1})						High Quality Manufacturer's Profit (π_{M2})					
	Low Quality Firm Unilateral Decentralization		Low Quality Firm Decentralization		Enforced Decentralization		High Quality Firm Unilateral Decentralization		High Quality Firm Decentralization		Enforced Decentralization	
n	$II \to DI$		$ID \to DD$		$II \to DD$		$II \to ID$		$DI \to DD$		$II \to DD$	
5	46.71	1.40	114.30	11.48	46.71	11.48	70.59	0.96	114.70	21.49	70.59	21.49
6	52.03	1.29	127.80	11.62	50.23	11.62	78.77	0.88	128.40	24.02	78.77	24.02
7	56.63	1.19	138.90	11.54	56.63	11.54	85.59	0.81	139.50	26.25	85.59	26.25
8	60.04	1.10	146.90	11.39	60.04	11.39	90.58	0.76	148.30	28.47	90.58	28.47
9	62.89	1.02	156.60	11.20	62.89	11.20	95.22	0.70	155.30	30.66	95.22	30.66

Note: All values are expressed as 1/1000's.

The condition required for a manufacturer to benefit from decentralization is that two products be demand substitutes coupled with strategic complements in prices. Therefore, strategic interaction allows a manufacturer's retail demand curve to rise when decentralization is chosen. In previous studies,[13] McGuire and Staelin (1983) and Moorthy (1988) concluded that, when two products are highly substitutable,[14] both manufacturers may benefit from decentralization. However, Zhao *et al*. (2009) determined that, when firms can choose quality and pricing, neither manufacturer can benefit from decentralization.

Our results confirm those of Zhao *et al*. (2009). Although our model satisfies the necessary condition, a manufacturer cannot benefit from decentralization. Only one common-dealing channel at the retail level exists in this model; the retailer (integrator) maximizes the joint profits, and focuses on coordination rather than competition. The effects of strategic interaction between firms are dominated by the effect of the $2M1R$ channel configuration. Therefore, the profits of a decentralized manufacturer are inevitably lower than those under integration.

Proposition 2. *Decentralization reduces the consumer's surplus, producer's surplus, and social welfare.*

[13] Under $2M2R$ and the exclusive dealing channels, McGuire and Staelin (1983) and Moorthy (1988) used an essentially horizontal differentiation model, but Zhao *et al*. (2009) adopted a vertical differentiation model to examine how channel structures may influence a firm's profits.

[14] Moorthy (1988) specified the demand function for the manufacturer i ($i=1,2$) as $\lambda_i = 1 - p_i + \theta \cdot p_j$, where $\theta \in [0,1]$ is a substitutability parameter between two products. Decentralization is a better choice than integration for both manufacturers when θ is greater than 0.931.

The numerical outcomes regarding **Proposition 2** are shown in Table 6.

Table 6: Table of Welfare Variations from Integration to Decentralization

Consumer's Surplus (CS)										
Low Quality Firm Unilateral Decentralization			Low Quality Firm Decentralization		High Quality Firm Unilateral Decentralization		High Quality Firm Decentralization		Enforced Decentralization	
n	$II \to DI$		$ID \to DD$		$II \to ID$		$DI \to DD$		$II \to DD$	
2	20.00	18.83	18.78	11.77	20.00	18.78	18.83	11.77	20.00	11.77
3	37.47	36.12	35.82	23.91	37.47	35.82	36.12	23.91	37.47	23.91
4	49.88	48.41	48.26	33.04	49.88	48.26	48.41	33.04	49.88	33.04
5	58.67	57.43	57.39	39.85	58.67	57.39	57.43	39.85	58.67	39.85
6	65.63	64.35	64.53	44.97	65.63	64.53	64.35	44.97	65.63	44.97
7	70.39	69.77	69.62	48.93	70.39	69.62	69.77	48.93	70.39	48.93
8	75.17	74.31	75.65	52.02	75.17	75.65	74.31	52.02	75.17	52.02
9	78.65	78.65	77.27	54.47	78.65	77.27	78.65	54.47	78.65	54.47
Producer's Surplus (PS)										
2	40.00	38.90	38.06	37.76	40.00	38.06	38.90	37.76	40.00	37.76
3	75.02	73.79	73.13	71.76	75.02	73.13	73.79	71.76	75.02	71.76
4	98.52	98.20	97.52	95.47	98.52	97.52	98.20	95.47	98.52	95.47
5	117.90	116.10	115.30	112.50	117.90	115.30	116.10	112.50	117.90	112.50
6	129.80	129.70	128.70	125.70	129.80	128.70	129.70	125.70	129.80	125.70
7	141.30	140.70	139.70	135.80	141.30	139.70	140.70	135.80	141.30	135.80
8	151.60	149.40	147.70	144.00	151.60	147.70	149.40	144.00	151.60	144.00
9	160.10	156.30	157.30	150.50	160.10	157.30	156.30	150.50	160.10	150.50

Note: All values are expressed as 1/1000's.

Well-being outcomes are the same as in Zhao *et al*. (2009). Regardless of exclusive or common dealings, when a manufacturer (unilaterally) decentralizes, the consumer's surplus decreases because of a lower total demand. Moreover, decentralization reduces the sum of the profits of both manufacturers, which is unfavorable to the producer's surplus. Because decentralization afflicts the well-being of consumers and producers, social welfare also declines.

Proposition 3. *Both low- and high-quality manufacturers have no incentives to deviate from integration.*

The numerical outcomes regarding **Proposition 3** are shown in Table 7.

Table 7: Table of Manufacturers' Profits under Different Channel Structures

	Low Quality Manufacturer's Profit (π_{M1})				High Quality Manufacturer's Profit (π_{M2})			
n	π_{M1}^{DI}	π_{M1}^{DD}	π_{M1}^{II}	π_{M1}^{ID}	π_{M2}^{ID}	π_{M2}^{DD}	π_{M2}^{II}	π_{M2}^{DI}
2	1.28	6.07	16.00	37.18	0.88	8.22	24.00	37.62
3	1.54	9.52	30.01	72.08	1.05	14.42	45.24	72.25
4	1.50	10.59	39.65	96.50	1.02	18.50	59.78	96.70
5	1.40	11.48	46.71	114.30	0.96	21.49	70.59	114.70
6	1.29	11.62	52.03	127.80	0.88	24.02	78.77	128.40
7	1.19	11.54	56.63	138.90	0.81	26.25	85.59	139.50
8	1.10	11.39	60.04	146.90	0.76	28.47	90.58	148.30
9	1.02	11.20	62.89	156.60	0.70	30.66	95.22	155.30

Several papers in the previous literature, such as McGuire and Staelin (1983), Bonanno and Vickers (1988), Moorthy (1988) and Coughlan and Wernerfelt (1989), have suggested that DD can be an equilibrium strategy. Regardless of the number of competitors at the manufacturing or retailing level, their models are all exclusive dealing channels at the retail level, and are horizontally differentiated in nature.[15]

By contrast, Zhao *et al*. (2009) used exclusive dealing channels coupled with a vertically differentiated model. Strategic interaction with another manufacturer is insufficient, making decentralization a Nash equilibrium strategy.

This study also obtains II as the unique Nash equilibrium strategy. Using $2M1R$ and the common-dealing channel, the profit sequence of the low-quality manufacturer is $\pi_{M1}^{DI} < \pi_{M1}^{DD} < \pi_{M1}^{II} < \pi_{M1}^{ID}$, and that of the high-quality manufacturer is $\pi_{M2}^{ID} < \pi_{M2}^{DD} < \pi_{M2}^{II} < \pi_{M2}^{DI}$. Neither manufacturer has the incentive to deviate from integration, regardless of whether decisions are made simultaneously or sequentially.

In addition, the consumer's surplus, producer's surplus, and social welfare are the largest under II, but the smallest under the DD channel structure. This shows that the private incentives of manufacturers may benefit consumers, but do not

[15]McGuire and Staelin (1983), Bonanno and Vickers (1988), and Moorthy (1988) used the 2M2R channels, while Coughlan and Wernerfelt (1989) used the $2MnR$, $nM2R$ and $2M2R$ cases, where $n \geq 2$.

conform to the preferences of the authorities for decentralization.

4 Conclusion

This study primarily refers to the concepts of Zhao *et al*. (2009), with the exception of using a $2M1R$ rather than a $2M2R$ channel configuration. Two manufacturers produce low- and high-quality products, respectively, and sell their products through a common retailer. Therefore, the retailer has strong incentives to coordinate the sales of the two varieties. We assume that firms can choose quality and pricing endogenously, and that consumer preference exhibits the form of a power utility function. This study examines how channel structures may influence a firm's strategies and social welfare. The outcomes in terms of the manufacturer's quality and pricing strategies are different from in Zhao *et al*. (2009).

We first consider the impact of the power n. It is found that the manufacturer's qualities and wholesale prices decrease, but the retail prices, total demand, retailer's profits, the sum of the profits of both manufacturers, consumer's surplus, producer's surplus and social welfare increase with the power n. We then examine the impact created when a firm chooses decentralization. It is found that when the low- (high-) quality manufacturer chooses decentralization, the low- (high-) quality level and its price decrease (increase). When a manufacturer chooses decentralization, its own demand and profits decrease. Decentralization reduces the consumer's surplus, producer's surplus, and social welfare. Moreover, low- and high-quality manufacturers have no incentives to deviate from integration. Relevant outcomes are summarized in Appendix 2.

In this study, even though we met the necessary condition for a manufacturer to benefit from decentralization, because our model is focused on coordination rather than competition, the effects of strategic interaction are dominated by the $2M1R$ channel configuration. The profits of a decentralized manufacturer are inevitably lower than those under integration.

We also found that the consumer's surplus, producer's surplus and social welfare are the largest under II, but the smallest under the DD channel structure. The private incentives of manufacturers may benefit consumers, but do not conform to the preferences of the authorities for decentralization. This new perspective may

enable the authorities to have fairer evaluations of integration.

Finally, this study provides recommendations for future studies. If integration incurs costs, manufacturer's profits under integration are not necessarily higher than those under decentralization, even in the $2M1R$ channel configuration. Moreover, when integration costs are linked with quality, the firm's quality strategy is influenced. These issues require further investigation, but this type of model could be more complicated and therefore beyond the scope of this study.

Appendix 1: Numerical Outcomes of the Impact of n

1. The qualities and quality-differences decrease with n *, as shown in Table A1.*

Table A1: Equilibrium Quality When Power $n = 2,3,...,9$

	II Channel			*ID* Channel			*DI* Channel			*DD* Channel		
n	q_1	q_2	Δq	q_1	q_2	Δq	q_1	q_2	Δq	q_1	q_2	Δq
2	40.00	160.00	120.00	101.80	193.30	91.50	29.70	118.80	89.10	39.74	167.90	128.20
3	33.46	127.40	93.94	82.63	151.70	69.07	25.00	95.21	70.21	24.77	137.20	112.40
4	28.42	105.80	77.38	69.23	125.20	55.97	21.30	79.34	58.04	15.84	115.20	99.36
5	24.65	90.66	66.01	59.59	106.80	47.21	18.51	68.08	49.57	10.27	98.92	88.65
6	21.76	79.38	57.62	52.34	93.28	40.94	16.36	59.68	43.32	6.66	86.27	79.61
7	19.48	70.66	51.18	46.69	82.89	36.20	14.66	53.17	38.51	4.26	76.14	71.88
8	17.64	63.72	46.08	42.17	74.65	32.48	13.28	47.97	34.69	2.66	67.84	65.18
9	16.12	58.05	41.93	38.47	67.94	29.47	12.14	43.72	31.58	1.61	60.92	59.31

Note: All values are expressed as 1/1000's.

The larger n is, the lower ε is and the higher $|\eta|$ is, and thus both manufacturers have the incentive to decrease their quality level. Furthermore, increases in n lead to greater high-quality declines compared to low-quality declines.

2. The retail prices increase with n, as shown in Table A2.

Table A2: Equilibrium Retail Price When Power $n = 2,3,...,9$

	II Channel		*ID* Channel		*DI* Channel		*DD* Channel	
n	p_1	p_2	p_1	p_2	p_1	p_2	p_1	p_2
2	120.0	280.0	210.3	323.5	108.5	231.7	137.1	318.1
3	178.0	315.6	259.6	350.0	167.6	276.0	182.6	366.9
4	219.4	337.7	291.0	366.5	210.5	304.9	212.8	394.7
5	250.7	354.7	313.9	378.5	242.9	326.0	234.1	413.8
6	274.6	367.3	331.1	387.8	267.8	342.2	249.9	428.2
7	295.6	378.8	346.2	396.2	288.2	355.3	261.4	439.7
8	310.9	386.4	354.4	400.2	304.8	365.8	269.9	449.2
9	324.7	394.0	368.6	410.2	317.5	373.5	275.4	457.7

Note: All values are expressed as 1/1000's.

There are two primary forces influencing the retail price when n increases. The consumer's willingness to pay will be raised since the perceived utility is enhanced (the utility enhancement effect: $\partial u/\partial n > 0$), but it will be lowered because the quality decreases with n (the quality effect: $(\partial q/\partial n)\cdot(\partial u/\partial q) < 0$). Because the utility enhancement effect dominates, the retail prices will increase with n ($du/dn = (\partial u/\partial n) + (\partial q/\partial n)\cdot(\partial u/\partial q) > 0$).[16]

From an intuitive point of view, $u = \sqrt[n]{q}$ is the CRRA utility function, and the risk coefficient is $-q\cdot u''(q)/u'(q) = 1-(1/n)$. That is, the consumer becomes more risk-averse (or more pressed to purchase) when n increases. Therefore, the consumer is willing to pay higher prices to purchase now, even if the quality is lower.

3. The wholesale prices decrease with n, as shown in Table A3.

[16] Because $\partial u/\partial n = -u\cdot\ln q/n^2 > 0$, $\partial q/\partial n = q\cdot\ln u < 0$, and $\partial u/\partial q = (1/n)\cdot q^{(1-n/n)} > 0$, the utility enhancement effect is positive ($\partial u/\partial n > 0$) and the quality effect is negative ($(\partial q/\partial n)\cdot(\partial u/\partial q) < 0$).

Table A3: Equilibrium Wholesale Price When Power $n = 2,3,...,9$

	n	2	3	4	5	6	7	8	9
ID Channel	w_2	207.80	166.00	138.20	118.40	103.70	92.30	83.30	75.90
DI Channel	w_1	44.57	42.98	39.20	35.49	32.23	29.45	27.06	25.02
DD Channel	w_1	75.01	73.91	70.92	68.11	65.83	64.05	62.81	61.92
	w_2	226.70	217.70	207.00	198.20	191.50	187.00	184.30	183.00

Note: All values are expressed as 1/1000's.

Quality positioning also represents the firm's marginal cost, causing a decline in wholesale prices with a fall in n.

4. The total demand increases with n, as shown in Table A4.

Table A4: Equilibrium Market Share When Power $n = 2,3,...,9$

	II Channel			*ID* Channel			*DI* Channel			*DD* Channel		
n	λ_1	λ_2	λ	λ_1	λ_2	λ	λ_1	λ_2	λ	λ_1	λ_2	λ
2	0.2000	0.2000	0.4000	0.2798	0.0602	0.3400	0.08608	0.2845	0.3706	0.1722	0.1396	0.3118
3	0.2077	0.2404	0.4481	0.3322	0.0733	0.4055	0.08555	0.3410	0.4266	0.1938	0.1794	0.3732
4	0.2076	0.2578	0.4654	0.3533	0.0791	0.4324	0.08365	0.3650	0.4486	0.1986	0.2014	0.4000
5	0.2067	0.2674	0.4741	0.3652	0.0824	0.4476	0.08218	0.3785	0.4607	0.1984	0.2165	0.4149
6	0.2058	0.2736	0.4794	0.3725	0.0845	0.4570	0.08115	0.3868	0.4680	0.1963	0.2278	0.4241
7	0.2051	0.2778	0.4829	0.3779	0.0858	0.4637	0.08035	0.3928	0.4732	0.1931	0.2370	0.4301
8	0.2047	0.2807	0.4854	0.3815	0.0869	0.4684	0.07980	0.3970	0.4768	0.1895	0.2445	0.4340
9	0.2038	0.2834	0.4872	0.3849	0.0877	0.4726	0.07918	0.4005	0.4797	0.1856	0.2511	0.4367

Since an agent has higher utility with a larger n, left-side consumers have a greater desire to consume, thereby increasing the total demand.

5. The retailer's profits and the sum of the profits of both manufacturers increase with n, as shown in Table A5.

Table A5: Table of Equilibrium Profits When Power $n = 2,3,...,9$

	II Channel			*ID* Channel		
n	π_{M1}	π_{M2}	π_M	$\pi_{M1}{}^*$	π_{M2}	π_M
2	16.00	24.00	40.00	37.18	0.88	38.06
3	30.01	45.24	75.25	72.08	1.05	73.13
4	39.65	59.78	99.43	96.50	1.02	97.52
5	46.71	70.59	117.30	114.30	0.96	115.30
6	52.03	78.77	130.80	127.80	0.88	128.70
7	56.63	85.59	142.20	138.90	0.81	139.70
8	60.04	90.58	150.60	146.90	0.76	147.70
9	62.89	95.22	158.10	156.60	0.70	157.30

	DI Channel			*DD* Channel			
n	π_{M1}	$\pi_{M2}{}^{**}$	π_M	π_{M1}	π_{M2}	π_M	π_R
2	1.28	37.62	38.90	6.07	8.22	14.28	23.48
3	1.54	72.25	73.79	9.52	14.42	23.94	47.82
4	1.50	96.70	98.20	10.95	18.50	29.45	66.02
5	1.40	114.70	116.10	11.48	21.49	32.97	79.50
6	1.29	128.40	129.70	11.62	24.02	35.64	90.05
7	1.19	139.50	140.70	11.54	26.25	37.79	97.92
8	1.10	148.30	149.40	11.39	28.47	39.86	104.10
9	1.02	155.30	156.30	11.20	30.66	41.86	108.60

Note: All values are expressed as 1/1000's, * $\pi_{M1}^{DI} = \pi_{m1} + \pi_{r2}$, ** $\pi_{M2}^{DI} = \pi_{r1} + \pi_{m2}$.

As n rises, increases in the consumers' willingness to pay, retail prices, total demand, together with the decrease in marginal cost, lead to an expansion of retailer profits and the sum of the profits of both manufacturers.

6. The consumer's surplus, producer's surplus and social welfare increase with n, as shown in Table A6.

Table A6: Table of Equilibrium Welfare When Power $n = 2,3,...,9$

	II Channel			*ID* Channel			*DI* Channel			*DD* Channel		
n	*CS*	*PS*	*SW*	*CS*	*PS*	*SW*	*CS*	*PS*	*SW*	*CS*	*PS*	*SW*
2	20.00	40.00	60.00	18.78	38.06	56.84	18.83	38.90	57.73	11.77	37.76	49.53
3	37.47	75.02	112.50	35.82	73.13	109.00	36.12	73.79	109.90	23.91	71.76	95.67
4	49.88	98.52	148.40	48.26	97.52	145.80	48.41	98.20	146.60	33.04	95.47	128.50
5	58.67	117.90	176.60	57.39	115.30	172.70	57.43	116.10	173.50	39.85	112.50	152.40
6	65.63	129.80	195.40	64.53	128.70	193.20	64.35	129.70	194.00	44.97	125.70	170.70
7	70.39	141.30	211.70	69.62	139.70	209.30	69.77	140.70	210.50	48.93	135.80	184.70
8	75.17	151.60	226.80	75.65	147.70	223.40	74.31	149.40	223.70	52.02	144.00	196.00
9	78.65	160.10	238.80	77.27	157.30	234.60	78.65	156.30	235.00	54.47	150.50	205.00

Note: All values are expressed as 1/1000's.

The CS increases with n, because an agent obtains higher utility with n, thereby causing more consumers to enter the market. The PS increases with n, because the sum of the profits of both manufacturers increase.

Appendix 2: Summary of the Outcomes of this Study

Table A7: The Impact of the Power n on Equilibrium Variables

	Quality	Retail Price	Wholesale Price
Low Quality Market	q_1 decreases	p_1 increases	w_1 decreases
High Quality Market	q_2 decreases	p_2 increases	w_2 decreases
	Δq decreases		
	Quantity Demand	**Firm's Profit**	**Welfare**
Low Quality Market	λ_1 indefinite	π_{M1} indefinite	CS_1 increases
High Quality Market	λ_2 increases	π_{M2} indefinite	CS_2 increases
	λ increases	π_M increases, π_R increases	CS, PS and SW increase

Table A8: The Impact on Equilibrium Variables Under Decentralization

		Quality	Retail Price	Quantity Demanded
Low Quality Firm (Unilateral) Decentralization	$II \to DI$ $ID \to DD$	q_1 decreases	p_1 decreases	λ_1 decreases
High Quality Firm (Unilateral) Decentralization	$II \to ID$ $DI \to DD$	q_2 increases	p_2 increases	λ_2 decreases
Enforced Decentralization	$II \to DD$	q_1 decreases q_2 increases	p_1 decreases p_2 increases	λ_1 decreases λ_2 decreases more
		Manufacturer's Profit	Consumer's Surplus	Social Welfare
Low Quality Firm (Unilateral) Decentralization	$II \to DI$ $ID \to DD$	π_{M1} decreases	CS decreases	SW decreases
High Quality Firm (Unilateral) Decentralization	$II \to ID$ $DI \to DD$	π_{M2} decreases	CS decreases	SW decreases
Enforced Decentralization	$II \to DD$	π_{M1} decreases π_{M2} decreases more	CS decreases	SW decreases

References

Bonanno, G. and J. Vickers, (1988), "Vertical Separation," *The Journal of Industrial Economics*, 36, 257-266.

Chambers, C., P. Kouvelis, and J. Semple, (2006), "Quality-Based Competition, Profitability, and Variable Costs," *Management Science*, 52, 1884-1895.

Chen, Y., (2001), "On Vertical Mergers and the Competitive Effects," *The Rand Journal of Economics*, 32, 667-685.

Choi, C. J. and H. S. Shin, (1992), "A Comment on a Model of Vertical Product Differentiation," *The Journal of Industrial Economics*, 40, 229-231.

Choi, S. C., (1991), "Price Competition in a Channel Structure with a Common Retailer," *Marketing Science*, 10, 271-296.

Choi, S. C., (1996), "Price Competition in a Duopoly Common Retailer Channel," *Journal of Retailing*, 72, 117-134.

Chung, G. L., (1995), "A Game Theoretical Analysis of Slotting Allowance," *NTU Management Review*, 6, 61-81.

Chung, G. L., (1997), "A Channel Competition Analysis of Retailer's Private Brand Strategy," *Journal of Management*, 14, 457-477.

Coughlan, A. T. and B. Wernerfelt, (1989), "On Credible Delegation by Oligopolists: A Discussion of Distribution Channel Management," *Management Science*, 35, 226-239.

Jacobson, J. M., (2003), *Antitrust Law Developments*, American Bar Association Section of Antitrust Law: ABA Publishing.

Jeuland, A. and S. Shugan, (1983), "Coordination in Marketing Channels, Productivity and Efficiency in Distribution," In: Gautschi, D. A. (ed.), North Holland, New York, 17-32.

Liao, C. H. and P. L. Tseng, (2008), "Strategic Selection of Direct Selling and Private Brand in Retail Market under Manufacturer Stackelberg," *Journal of Management*, 25, 467-485.

McFetridge, D. G., (1994), "The Economics of Vertical Integration," *Canadian Journal of Agricultural Economics*, 42, 525-531.

McGuire, T. W. and R. Staelin, (1983), "An Industry Equilibrium Analysis of Downstream Vertical Integration," *Marketing Science*, 2, 161-191.

Moorthy, K. S., (1988), "Strategic Decentralization in Channels," *Marketing Science*, 7, 335-355.

Motta, M., (1993), "Endogenous Quality Choice: Price vs. Quantity Competition," *The Journal of Industrial Economics*, 41, 113-131.

Raju, J. S., R. Sethuraman, and S. K. Dhar, (1995), "The Introduction and Performance of Store Brands," *Management Science*, 41, 957-978.

Riordan, M. H., (2008), "Competitive Effects of Vertical Integration," *Handbook of Antitrust Economics*, In: Buccirossi, P. (ed.), MIT Press.

Shaked, A. and J. Sutton, (1982), "Relaxing Price Competition through Product Differentiation," *The Review of Economic Studies*, 49, 3-13.

Spengler, J. J., (1950), "Vertical Integration and Antitrust Policy," *Journal of Political Economy*, 58, 347-352.

Wauthy, X., (1996), "Quality Choice in Models of Vertical Differentiation," *The Journal of Industrial Economics*, 44, 345-353.

Zhao, X., D. Atkins, and Y. Liu, (2009), "Effects of Distribution Channel Structure in Markets with Vertically Differentiated Products," *Quantitative Marketing and Economics*, 7, 377-397.