WAL-MART AS A LEADING RETAILER IN THE SUPPLY CHAIN

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ABSTRACT

The Wal-Mart effect has a dramatic impact on upstream manufacturers in a supply chain. This study applies a game-theoretic approach to analyze the effects of the leading retailer in a supply chain. We propose three models relating to the interactions between upstream duopolistic manufacturers and a downstream retailer: The first model represents that both manufacturers react simultaneously and independently to the retailer's price decision. The second model describes both manufacturers reacting to the retailer's decision in a leader-follower price competitive condition. The third model is a traditional upstream-dominating situation, which will be employed to contrast with the first two downstream-dominating models. By changing the degree of substitutability of the two products made by these two manufacturers, there are some findings: (i) As a downstream leader in the supply chain, the retailer profit is more than the sum of the two duopolistic manufacturers. (ii) If the duopolistic manufacturers also play the leader-follower game, the leader manufacturer's profit is greater than the follower manufacturer's profit. (iii) When comparing to the manufacturer-dominating model, the retailer-dominating models have the lower retail price and an increase in sale quantities. (iv) Compared to the manufacturer-dominating model, the retailer-dominating models' producer surplus, consumer surplus, and social welfare are improved.

Keywords: Supply chain, Leading retailer, Wal-Mart effect, Game theory

1. INTRODUCTION

Who in the market sets the price? And how is it set? This paper discusses these simple but complicated questions. As a profit-maximizing agency, it is taught that the oligopolistic and monopolistic firm pursuits to raise the market price by means of restricting the supply volume. The monopoly theory illustrates the price behavior of the dominant manufacturer and induces a production chain view, predicting the lead of the upstream producer price over the downstream retail price. The empirical results of production chain view studies are inconsistent. For instance, Caporale et al. (2002) report evidence to support the causality relationship of the production chain view by examining the producer price index (PPI) and the consumer price index (CPI) of G7 countries. On the other hand, Clark (1995) goes against it by carefully testing the predicting power of PPI to CPI with the historical data of the United States. It is noteworthy that the argument against the production chain view is based upon the macro observation of aggregate firm behaviors. It might be difficult to say that this is the best way to explore the individual firm behavior from the macro data.

In a remarkable article in the *American Economic Review* over half a century ago, Mason (1939) indicates the importance of analyzing the oligopolistic and monopolistic firm behavior with a consideration of the influence of market structure and the interaction of every participant within the market. In other words, Mason (1939) points out the potential contribution of our work in approaching the oligopolistic and monopolistic firm behavior from the supply chain management view with the tool of game theory. Ayers's (2001) definition of supply chain management as: "Life cycle processes comprising physical, information, financial, and knowledge flows whose purpose is to satisfy end-user requirements with products and services from multiple linked suppliers." By this viewpoint, we consider the process of physical products from the upstream manufacturer to the downstream retailer and their interaction in the supply chain under the game structure.

Wal-Mart, the retailer giant running nearly 6,500 stores across 14 countries with a remarkable revenue record of U$351.1 billion in 2007, is the most famous case of a monopolistic firm reaching and retaining its success by a totally price reduction policy (Hesterly, 2010). Wal-Mart has strong impacts on a community and country in many wide aspects. Hicks (2006) concludes the so-called Wal-Mart effect in 3 types: (1) The income effect states that the lower retail prices may allow consumers to increase purchases, hence leading to higher employment and income in the retailer sector. Goetz and Swaminathan (2006) indicate that there exists a statistically significant increase effect of each Wal-Mart store on the United States' countywide family-poverty rate with an average of 0.099%. However, a smaller reduction in the family-poverty rate, which might possibly be derived from the policy of minimizing the worker's wage, is also found in places that had no stores. The estimate of the overall income effect must offset the above two effects. (2) The cluster effect refers to the geographic firm network naturally formed to share a common labor market, transportation, and the technologies of Wal-Mart, which bring a net increase of employment, wages, and firms as a consequence. (3) The productivity effect refers to the overall economic growth resulting from the new inputs (more workers, more natural resources, and more machinery) and the more intensive production process for workers to produce more goods or services with the same inputs. It is found that Wal-Mart's price policy does not remain only in its store, but spills over to bring domestic retail prices down in the product markets it enters. Masker (2005) shows evidence that price decline is economically large, 1.5-3.0%, in the short run and four times as much in the long run and is statistically significant.

The building of an advantageous retailer supply chain, or a dominant downstream supply chain, is a key factor to Wal-Mart's success. Fishman (2006) points out that with its enormous bargaining power Wal-Mart forces vendors to meet its low price policy. Wal-Mart provides big sales/purchasing volume to attract suppliers to accept the contract with little profit. Many cases show that businesses have declared bankruptcy after their long-term relationship is over with Wal-Mart (Norman, 2004). Reports show that in countries where Wal-Mart failed to establish advantageous bargaining power over manufacturers, such as in Germany and Japan with manufacturer-oriented cultures, Wal-Mart lost the competition war against local retailers (Christopherson, 2007; Aoyama, 2007). The competition game that the monopolistic retailer, represented by Wal-Mart in the present paper, plays against its manufacturers will be demonstrated in the following sections to theoretically examine the income effect and productivity effect. We exclude the cluster effect from examination, because it is beyond the scope of our design of a single retailer game.

The rest of this article is organized as follows: Section 2 presents some previous researches utilizing game theory in supply chain issues. Section 3 proposes the basic two-level models in this work, including two retailer-dominating models as well as one manufacturers-dominating model. Section 4 reveals some preliminary numerical results of these models. Conclusions and managerial insights are made in Section 5.

2. LITERATURE REVIEW

The supply chain represents a product moving from suppliers to manufacturers to distributors to retailers to customers along a chain (Chopra and Meindl, 2001). It consists of manufacturers, distributors or wholesalers, retailers, and then selling the final products to the consumers. The goal of supply chain management helps a firm to increase throughput while simultaneously reducing both inventory and operating expenses, keeping the overall supply chain profitability. As globalization and multinational corporations emerge, supply chain management is wildly adopted by managers and applied in diverse industries.

Studies in supply chain have demonstrated that in many industries retailers have increased their power relative to the manufacturers' power over the last two decades (Messinger and Narasimhan, 1995). Manufacturers that had dominating their retailers in the past are finding that many retailers now hold the upper hand (Li et al, 2002). Retailers, with an enormous scale relative to their upstream suppliers, require the suppliers to coordinate in related operations, such as inventory level, quantity discount, advertisement, terms of payment, or slotting fees. If the products do not sell well as expected, the suppliers face the threat of moving products to poor shelf location or even to be dropped.

A considerable amount of research has been done in the area of supply chain from different points of view. Some researchers are interested in the inventory topic in a supply chain. Parlar and Wang (1994) focus on the gaming nature of the discount problem and demand consideration to analyze the discounting decisions made by a supplier with a group of homogeneous customers. They show that the seller has to set up its quantity discount schedule such that the buyer orders more than its economic ordering quantity. Through this, the seller can gain more from a quantity discount. Cachon (1999, 2001) studies the competitive and cooperative selection of inventory policies in a two-echelon supply chain with a supplier and N retailers. Via using the theory of super-modular games, he shows that Nash equilibria exist in reorder point policies. However, from a numerical result, the supply chain reorder point is frequently not a Nash equilibrium. Three cooperation strategies are presented to help improve supply chain performance: change incentives, change equilibrium, or change control. Among these, change control means allowing the vendor to choose all reorder points. By this strategy, it achieves optimal supply chain performance.

Agrawal et al. (2002) consider that a retailer faces the uncertain product demand and vendors' differences in lead times, costs, and production flexibility. They develop an optimization model to choose the production commitments that maximize the retailer's profit, given demand forecasts and vendors' capacity and flexibility constrains. This helps the retailer to manage capacity, inventory, and shipments of products produced by multiple vendors. Minner (2003) reviews inventory models with multiple supply options and their contributions to supply chain management. The strategic aspects of supplier competition and the role of operational flexibility in global sourcing are emphasized. Some inventory problems from reverse logistics and multi-echelon supply chains are also mentioned.

There are also many studies on supply chain from a market economics view. Kaihara (2001) proposes a supply chain management with market economics. His work takes the whole supply chain as a distributed resource allocation system, based on the general equilibrium theory and competitive mechanism. By defining production functions and introducing a budget constraint as an agent's profit maximization strategy, supply chain management could lead to efficient resource allocations. Ertek and Griffin (2002) develop and analyze the case where the supplier has dominant bargaining power and the case where the buyer has dominant bargaining power. The buyer's pricing scheme involves both a constant markup and a multiplier. They conclude that a buyer using only a multiplier pricing scheme leads to a higher market price and sensitivity when operational costs exist. The sensitivity of the market price increases non-linearly as the wholesale price increased.

In the multi-echelon supply chain, some researchers argue the real world situation and then modify demand functions in supply chain models. They suggest that different demand functions cause diverse research results. Lau and Lau (2003) argue that a downward sloping demand curve is only valid for a single echelon structure. Assuming different demand curve functions in a multi-echelon supply chain leads to very different results.

A lot of researchers study the supply chain from the view of game theory. Choi (1991) analyzes a channel structure with two competing manufacturers and a powerful retailer under a non-cooperative game. Some results depend critically on the form of demand functions. With a linear demand function, a manufacturer is better off by maintaining exclusive dealers while a retailer has an incentive to interact with several vendors. All channel members are better off when no one dominates the market. With a non-linear demand function, an exclusive dealer channel provides higher profits to all members than a common retailer. The conclusion also emphasizes the importance of properly choosing the demand function. Parlar and Wang (1994) take an all-unit quantity-discounting scheme into a two-echelon system with a single vendor and a single retailer. They show that both parties could gain significantly from a quantity discount policy under the manufacturer-Stackelberg structure. Weng (1995) further extends Parlar and Wang's work to cover the two-echelon system with a single supplier and a group of homogeneous buyers. Both all-unit and incremental quantity discount policies are considered. The result shows that both discounting policies have equal benefits to supplier and retailers.

Li et al. (2002) work with a supply chain from a marketing view. They focus on cooperative advertising in marketing programs. A two-level supply chain is assumed and the Stackelberg equilibrium is discussed. The results present different sharing rules in cooperative advertising expenditure. Yue et al. (2006) study the coordination of cooperative advertisement in a manufacturer-retailer supply chain when the manufacturer offers price deductions to customers. The manufacturer acts as leader and the Stackelberg equilibrium is obtained for the decision on national advertisement, local advertisement, and the manufacturer's share of local advertising allowance. The optimal price deduction is also determined. Yang and Zhou (2006) consider the pricing and quantity decisions of a two-echelon supply chain system with a manufacturer that produces a single product to two competitive retailers. The Stackelberg structure is assumed in this situation: the manufacturer acts as leader and duopolistic retailers act as followers. Their analysis focuses on the competitive behaviors of duopolistic retailers, finding that the degree of competitive situation is influential to the pricing decision. The total profits of the retailers exceed the manufacturer only under the situation when each retailer's market demand is highly dissimilarity.

Most of the quantitative models related to supply chain management issues are dominated by the framework of multi-echelon systems or logistics/distribution systems. Their backgrounds consider the relationship between a single vendor and a single buyer or a single vendor and several buyers. The situation of multiple upstream manufacturers with downstream single retailer has received less attention. In this study we develop some supply chain models to analyze the behavior of supply chain members. We begin with a two-level supply chain model. By applying the leader-follower interactive mechanism, there is certainly something to be explored. The focus is in comparing the supply chain with the retailer-dominating (retailer as leader) model to the manufacturer-dominating (manufacturer as leader) model. We acquire the results on a retailer's selling price, the price that the manufacturer charges to the retailer, and the selling volume from different models. The profit of each member is also considered. Moreover, the producer surplus, consumer surplus, and social welfare are also of concern.

3. THE TWO-LEVEL SUPPLY CHAIN MODELS

This section develops three supply chain models. The first model assumes that both manufacturers react independently and simultaneously to the retailer. The second model represents two manufacturers having a leader-follower relationship. Both models represents the retailer dominates in the supply chain. In contrast to the first two models, the third model is the so-called traditional manufacturer-dominating model. That is, the upstream manufacturer acts as the leader in the supply chain. The backward induction approach is applied to solve these models.

3.1 Model of Duopolistic Manufacturers Reacting Simultaneously (R-S Model)

In this subsection we consider a two-level supply chain that consists of duopolistic manufacturers and a common retailer. The products produced by the two manufacturers exist to some extent with substitutability to the customers. The interaction mechanism between two-level supply chains is assumed to be the process in which the retailer acts as a leader and two manufacturers act as followers. The retailer sets its market price based on the wholesale price (w_i) plus required margins (m_i); that is, $p_i = m_i + w_i$.

The demand function of the market is assumed to be a downward-sloping type:

$$q_i = a - bp_i + \theta p_j, \quad i, j = 1,2, \quad a > b > 0, \quad 0 < \theta < b. \tag{1}$$

Where θ is the degree of substitutability between two products. Here, q_i denotes the deterministic market demand and p_i is the retail price in the market. The retailer first sets the product prices p_1, p_2 to the duopolistic manufacturers, and then both manufacturers simultaneously and independently respond with wholesale prices w_1, w_2. Both manufacturers' profit functions can be expressed as below:

$$\pi_{M1} = (w_1 - c_1)q_1 = (w_1 - c_1)(a - bp_1 + \theta p_2), \tag{2}$$

$$\pi_{M2} = (w_2 - c_2)q_2 = (w_2 - c_2)(a - bp_2 + \theta p_1). \tag{3}$$

In (2) and (3), π_{Mi} represents each manufacturer's profit and w_i is the wholesale price per unit charged to the retailer and c_i is the unit manufacturing cost. Thus, manufacturers 1 and 2 will maximize their profits with respect to w_1 and w_2, respectively. Optimal wholesale prices for the two are obtained by solving $\partial \pi_{M1} / \partial w_1 = 0$ and $\partial \pi_{M2} / \partial w_2 = 0$. Therefore, we have

$$w_1 = \frac{a - bm_1 + \theta p_2 + bc_1}{2b}, \tag{4}$$

$$w_2 = \frac{a - bm_2 + \theta p_1 + bc_2}{2b}. \tag{5}$$

From the retailer's point of view, it knows the manufacturers' reaction function and will also maximize its own profit π_R. The profit comes from how many quantities of these two products that the retailer will sell, and so the retailer's profit function can be expressed below:

$$\pi_R = (p_1 - w_1)q_1 + (p_2 - w_2)q_2. \tag{6}$$

Substituting (4) and (5) into (6) and solving $\partial \pi_R / \partial p_1 = 0$ and $\partial \pi_R / \partial p_2 = 0$ simultaneously, we obtain the retailer's optimal sale prices p_1^* and p_2^*:

$$p_1^* = \frac{a(3b - 2\theta)}{2(b - \theta)(2b - \theta)} + \frac{b(2b(c_1 - m_1) + \theta(c_2 - m_2))}{2(2b - \theta)(2b + \theta)}, \tag{7}$$

$$p_2^* = \frac{a(3b-2\theta)}{2(b-\theta)(2b-\theta)} + \frac{b(2b(c_2-m_2)+\theta(c_1-m_1))}{2(2b-\theta)(2b+\theta)}. \tag{8}$$

By applying (7) and (8) into (4) and (5), each manufacturer's wholesale price is:

$$w_1^* = \frac{a(4b-3\theta)}{4(b-\theta)(2b-\theta)} + \frac{(8b^2-\theta^2)(c_1-m_1)+2b\theta(c_2-m_2)}{4(2b-\theta)(2b+\theta)}, \tag{9}$$

$$w_2^* = \frac{a(4b-3\theta)}{4(b-\theta)(2b-\theta)} + \frac{(8b^2-\theta^2)(c_2-m_2)+2b\theta(c_1-m_1)}{4(2b-\theta)(2b+\theta)}. \tag{10}$$

The quantity each manufacturer produces can also be solved by substituting (7) and (8) into (1):

$$q_1^* = \frac{b(a(2b+\theta)-(2b^2-\theta^2)(c_1-m_1)+b\theta(c_2-m_2))}{2(2b+\theta)(2b-\theta)}, \tag{11}$$

$$q_2^* = \frac{b(a(2b+\theta)-(2b^2-\theta^2)(c_2-m_2)+b\theta(c_1-m_1))}{2(2b+\theta)(2b-\theta)}. \tag{12}$$

As we get (7)-(12), it is now possible to find the profit functions of the two manufacturers π_{M1}, π_{M2}, and the retailer's profit π_R. Since it is rather complicated to present analytical results about each member's profit, we will directly show some numerical examples in later section.

3.2 Model of Duopolistic Manufacturers in a Leader-Follower Structure (L-F Model)

In the second model we assume that one of the two manufacturers (e.g., manufacturer 1) acts as a leader and the other (e.g., manufacturer 2) acts as a follower. For any given p_1, p_2, and w_1, the follower (manufacturer 2) observes its reaction function by $\partial\pi_{M2}/\partial w_2 = 0$ and we get w_2:

$$w_2 = \frac{a - bm_2 + \theta p_1 + bc_2}{2b}. \tag{13}$$

Just as (5) in the previous subsection, manufacturer 1 maximizes its profit, given the wholesale price decision of its rival. Substitute (5) into (2) and set $\partial\pi_{M1}/\partial w_1 = 0$. We can get w_1 as below:

$$w_1 = \frac{a(2b+\theta)+(2b^2-\theta^2)(c_1-m_1)+b\theta(c_2+m_2)}{4b^2-2\theta^2}. \tag{14}$$

Again, the retailer knows the manufacturers' decisions and will maximize its own profit. By applying (13) and (14) into the retailer's profit function (6) and solving $\partial\pi_R/\partial p_1 = 0$ and $\partial\pi_R/\partial p_2 = 0$, we get the retailer's best decision on market prices p_1^* and p_2^*. Due to the complexity of the closed-form solution, we are not going to show the rest of equations here. The numerical example will be presented in the next section.

3.3 Model of Duopolistic Manufacturers in Domination (M-D Model)

The third model is to represents the manufacturers as the leaders and the retailer as the follower. The profit functions of manufacturer 1, manufacturer 2, and the retailer are the same as (2), (3), and (6), respectively. The retailer's reaction function is obtained by differentiating (6) with respect to p_1 and p_2. Set the equations to zero and solve simultaneously. We achieve:

$$p_1 = \frac{w_1}{2} + \frac{a}{2(b-\theta)}, \tag{15}$$

$$p_2 = \frac{w_2}{2} + \frac{a}{2(b-\theta)}. \tag{16}$$

By substituting (1), (15), and (16) into manufacturers' profit functions (2) and (3), and then differentiating (2) and (3) and setting to zero, the optimal wholesale price is:

$$w_1^* = \frac{2ab + a\theta + 2b^2c_1 + b\theta c_2}{4b^2 - \theta^2}, \tag{17}$$

$$w_2^* = \frac{2ab + a\theta + 2b^2c_2 + b\theta c_1}{4b^2 - \theta^2}. \tag{18}$$

Putting (17) and (18) into (15) and (16), the retail prices are as follows:

$$p_1^* = \frac{1}{2}\left(\frac{a}{b-\theta} + \frac{2ab + a\theta + 2b^2c_1 + b\theta c_2}{4b^2 - \theta^2}\right), \tag{19}$$

$$p_2^* = \frac{1}{2}\left(\frac{a}{b-\theta} + \frac{2ab + a\theta + 2b^2c_2 + b\theta c_1}{4b^2 - \theta^2}\right). \tag{20}$$

Replacing the demand function with optimal retailer prices (19) and (20), the level of output can also be obtained. Therefore, we get the quantities as below:

$$q_1^* = \frac{b(a(2b+\theta) + (\theta^2 - 2b^2)c_1 + b\theta c_2)}{8b^2 - 2\theta^2}, \tag{21}$$

$$q_2^* = \frac{b(a(2b+\theta) + (\theta^2 - 2b^2)c_2 + b\theta c_1)}{8b^2 - 2\theta^2}. \tag{22}$$

Like the previous models, the profits of supply chain members can be induced by (17)-(22). This model is taken as a benchmark to examine when the dominating situation shifts from upstream to downstream, influencing the decisions of supply chain members. In the next section we are going to discuss some numerical results.

4. NUMERICAL EXAMPLES

4.1 Prices Decision of Supply Chain Members under Different Domination

In order to examine the effect from the variation of the degree of substitutability (θ) between two products on the models mentioned above, here we adjust the θ value (0.1 to 0.9) to observe the results. The parameters of the demand functions remain unchanged and both manufacturers are assumed to have the same manufacturing cost. The basic numerical setting mainly comes from Yang and Zhou (2006), their work demonstrates the two-echelon supply chain model with one manufacturer dominating in upstream and two retailers in downstream.

[Table 1. Inserts Here]

Table 1 shows the numerical results of the retailing price (p_1^* , p_2^*) and the wholesale price (w_1^*, w_2^*) of the three models. In R-S model, both manufacturers react to retailer's decision independently and simultaneously; the retail prices and wholesale price are equal under the same substitutability. However, in L-F model, we can find the result that the leader manufacturer takes advantage of the follower manufacturer. The leader manufacturer sets the higher wholesale price (w_1^*) than the follower manufacturer (w_2^*) to the retailer. Besides, its retail price set by the retailer is lower than the follower manufacturer. Such a consequence will make the leader manufacturer's product more competitive than the follower manufacturer in the market. Except the discussion to the retailer-dominating models, the third model is the upstream manufacturer-dominating model. When compared to the first two models, the retail prices, wholesale prices determined by the supply chain members in M-D model are higher than the previous two models. That is, if the retailer owns the domination in a supply chain, it will price low to the consumers. Moreover, if the upstream manufactures also play the leader-follower game structure, the retailer will sell the leader manufacturer's product at lower price than the follower manufacturer. The results of relating price decisions are also depicted in Figures 1 and 2.

[Figure 1 Inserts Here.]

[Figure 2 Inserts Here.]

Due to the low retail price, the upstream supply chain members have to decrease their wholesale price. As retailer sets a low price in the market and requires the vendors to keep on supplying, it will impact the cost of the upstream manufacturers. The upstream manufacturers face the problem of saving costs to meet the retailer's requirement in price strategy or they will lose their position in the supply chain.

As soon as the price decisions are made, the relevant sale volumes can be obtained in our models straightforward. The numerical results of the three models on sale volumes are listed in Table 2. In R-S model, that reveals no difference to the two products. In contrast to R-S model, the sale volumes of L-F model show that the leader manufacturer sells more than the follower manufacturer. As figure 3 illustrates, the sale volumes gap between two manufacturers in L-F model appears to increase due to the substitutability. In other words, if consumers suppose that both products are less different, the consumers will choose the cheaper one. We can observe such a shopping behavior when consumers are purchasing the commodities in the retail store. As to the M-D model, the numerical results of the sale quantity are lower than the retailer-dominating models. What we get from the change of the role of supply chain members in domination is that the more power the downstream members possess, the lower the retail price they will set. The first two models explain that the powerful retailer would like to set the retail price low enough to attract the consumers buying something they feel is cheap, even though they do not need such a product immediately.

[Table 2 Inserts Here.]

[Figure 3 Inserts Here.]

4.2 Profits Distribution of Supply Chain Members

Next the distribution of profits of the supply chain members will be concerned. In Table 3, profits are expressed for each member (π_R, π_{M1}, and π_{M2}), total supply chain profit (π_T), and the percentage each member shares ($\pi_R\%$, $\pi_{M1}\%$, and $\pi_{M2}\%$). The last column indicates the ratio of retailer profit to the sum of both manufacturers' profit (π_R / π_M).

From Table 1 in last subsection, we can find that for each model, the retail prices charged to customers by the retailer and the wholesale price offered to the retailer by two manufacturers increase as the values of substitutability increase. Profits of both parties and the total supply chain profits (π_T) are influenced by that result.

In R-S and L-F model, the interaction mechanism of the supply chain structure is that the retailer dominates the entire situation. We observe in Table 3 that the retailer owns the biggest part of the profit. Although its profit drops as the substitutability value increases, it takes up over half of the pie than the sum of the two duopolistic manufacturers. To each substitutability level, the whole supply chain profit and the profit share that earned by the retailer does not show distinct difference in both model. However, in L-F model, the result of the upstream manufacturers' interaction reveals the leader has more benefits than the follower.

In M-D model, as the substitutability value increases, the wholesale prices are going up, so the upstream manufacturers' profits rise. In opposite to the first two models, the retailer does not dominate in the supply chain, its profit take only one-third of the pie. If we check the profit ratio of the downstream retailer to upstream manufacturers, it ranges from 1.15 to 1.45 times across the substitutability level in the first two models. On the contrary, the ratios just range from 0.51 to 0.61 times to the M-D models. Moreover, the results reveal that the retailer-dominating models earn more supply chain profits than the manufacturer-dominating models.

[Table 3 Inserts Here.]

4.3 The Welfare Distribution under Different Domination

From the above, the retailer-dominating model with lower retail prices and the higher sale volumes is beneficial to the whole supply chain members. The relevant producer surplus based on the previous numerical results is given in Figure 4. The producer surplus here is the sum of the whole supply chain members' profits. Three models appear to have a consistent upward trend and the first two models seem to yield higher producer surplus than the M-D model. This means that the supply chain members in the M-D model receive less profit than that in retailer-dominating models. Between the first two retailer-dominating models, the results indicate that the R-S model displays a higher surplus than the L-F models.

[Figure 4 Inserts Here.]

The consumers also get advantages from the retailer-dominating supply chain. Low prices in the market causes the consumer surplus of the first two models to be larger than the M-D model. The rising trend curves of the consumer surplus in Figure 5 are almost the same as the producer surplus. In the retailer-dominating models, the consumer surplus has the same ranking as the producer surplus.

[Figure 5 Inserts Here.]

Figure 6 presents the social welfare trend curves for these three models. The first two retailer-dominating models increase social welfare more than the traditional M-D model. From the analysis above, it shows that the retailer-dominating models demonstrate a better welfare than the manufacturer-dominating model. In the supply chain view, the further of the power moves to the downstream member, the more the social welfare will improve. In other words, it will probably help to distribute the resources more efficient. The retailer, who stands in the long end of the supply chain and plays as a probe of the supply chain, can acquire the valuable information from the consumers. This voice of consumers will be a good feedback to the upstream manufacturer, and affect their production decision deeply. As we apply the game structure in the supply chain to explore the relationship, such a phenomenon can be explained frankly.

[Figure 6 Inserts Here.]

5. CONCLUDING REMARKS

This paper extends the existing two-level supply chain models by considering the duopolistic manufacturers and their common retailer. An interactive game structure is applied to the supply chain participants and their responses are discussed. By changing the degree of substitutability of the two products that produced by manufacturers in upstream supply chain and the domination scenarios of the supply chain members, some numerical results are presented. The supply chain members' decisions on pricing, the profits they earn as well as the welfare issues are analyzed. From this study we find that: (i) As the downstream retailer owns the domination in the supply chain, the retailer's profit will be more than the sum of two duopolistic manufacturers. (ii) If the duopolistic manufacturers also play the leader-follower game, the leader manufacturer's profit is better than the follower manufacturer's. (iii) When comparing to the manufacturer-dominating model, the retail-dominating models (R-S and L-F) demonstrate the lower retail prices and more in sale quantities. Here, the Hicks (2006) income effect can be explained. (iv) The overall welfare of retailer-dominating models is superior to those of manufacturer-dominating model. This outcome is consistent with the productivity effect that Hicks proposed.

The power structure of the supply chain has gradually shifted from upstream to downstream members. To the supply chain issues, we cannot ignore the emergence of the downstream power. In some cases, it is possible for retailers to price products directly from the voice of consumers, rather than on a wholesale price basis. Such a situation would impact deeply on the vendors. The manufacturers in upstream have to control the production budget wisely and improve their efficiency in order to maintain the position in the supply chain. That is totally different from the past of their roles in supply chain. However, it contributes to the allocation of resources and benefits the society according to the previous analysis. Besides, most of the downstream retailers favor multi-vendors instead of single-vendor to avoid the risk of shortage. In our models settings, the similarity of goods that produced by upstream manufacturers will influence on the supply chain members' decision.

In contrast, the upstream manufacturers should find their way out to cope with the emerging retailer-dominating condition. To gather more information from the market and devote innovation in the product or manufacturing process will improve its weak spot in a supply chain. Fishman (2006) points out the case that Snapper Inc. to disconnect with Wal-Mart by devoting product differentiation and improving product quality.

In this study, we assume a two-level structure in discussing the supply chain model. Some future work can extend the two-level supply chain to three-level or multi-level supply chain model. Moreover, the demand curve in this study is assumed to be linear, some other demand curve's shapes should be adopted in future work to represents different kind of consumer's demands.

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Table 1

Retail and wholesale price of the three models

	R-S model				L-F model				M-D model			
θ	p_1^*	p_2^*	w_1^*	w_2^*	p_1^*	p_2^*	w_1^*	w_2^*	p_1^*	p_2^*	w_1^*	w_2^*
0.1	3.3034	3.3034	2.5330	2.5330	3.3047	3.3073	2.5331	2.5331	3.5560	3.5560	3.0303	3.0303
0.3	3.4163	3.4163	2.6025	2.6025	3.4204	3.4283	2.6029	2.6026	3.6741	3.6741	3.0928	3.0928
0.5	3.5380	3.5380	2.6769	2.6769	3.5451	3.5588	2.6779	2.6773	3.8012	3.8012	3.1579	3.1579
0.7	3.6697	3.6697	2.7569	2.7569	3.6801	3.7003	2.7590	2.7576	3.9385	3.9385	3.2258	3.2258
0.9	3.8127	3.8127	2.8431	2.8431	3.8268	3.8542	2.8469	2.8444	4.0874	4.0874	3.2967	3.2967

Note: a =20, b =5, and $c_1 = c_2$ =2

Table 2

Sales quantity of the three models

	R-S model		L-F model		M-D model	
θ	q_1^*	q_2^*	q_1^*	q_2^*	q_1^*	q_2^*
0.1	3.8131	3.8131	3.8071	3.7942	2.5758	2.5758
0.3	3.9433	3.9433	3.9267	3.8848	2.7320	2.7320
0.5	4.0789	4.0789	4.0540	3.9784	2.8947	2.8947
0.7	4.2204	4.2204	4.1897	4.0745	3.0645	3.0645
0.9	4.3681	4.3681	4.3350	4.1729	3.2418	3.2418

Note: a =20, b =5, and $c_1 = c_2$ =2

Table 3

Profits distribution of the three models

	θ	π_R	π_{M1}	π_{M2}	π_T	π_R%	π_{M1}%	π_{M2}	π_R / π_M
R-S model	0.1	5.875	2.033	2.033	9.940	59.11	20.45	20.45	1.445
	0.3	6.418	2.376	2.376	11.170	57.46	21.27	21.27	1.351
	0.5	7.025	2.761	2.761	12.547	55.99	22.01	22.01	1.272
	0.7	7.705	3.194	3.194	14.093	54.67	22.67	22.67	1.206
	0.9	8.470	3.683	3.683	15.836	53.49	23.26	23.26	1.150
L-F model	0.1	5.875	2.030	2.023	9.927	59.18	20.44	20.37	1.450
	0.3	6.418	2.367	2.341	11.126	57.68	21.28	21.04	1.363
	0.5	7.023	2.748	2.694	12.465	56.34	22.05	21.61	1.290
	0.7	7.700	3.180	3.087	13.967	55.13	22.77	22.10	1.229
	0.9	8.462	3.671	3.524	15.657	54.05	23.45	22.51	1.176
M-D model	0.1	2.708	2.654	2.654	8.016	33.78	33.11	33.11	0.510
	0.3	3.176	2.985	2.985	9.147	34.72	32.64	32.64	0.532
	0.5	3.724	3.352	3.352	10.428	35.71	32.14	32.14	0.556
	0.7	4.368	3.757	3.757	11.881	36.76	31.62	31.62	0.581
	0.9	5.126	4.204	4.204	13.534	37.88	31.06	31.06	0.610

Note: a =20, b =5, and $c_1 = c_2$ =2

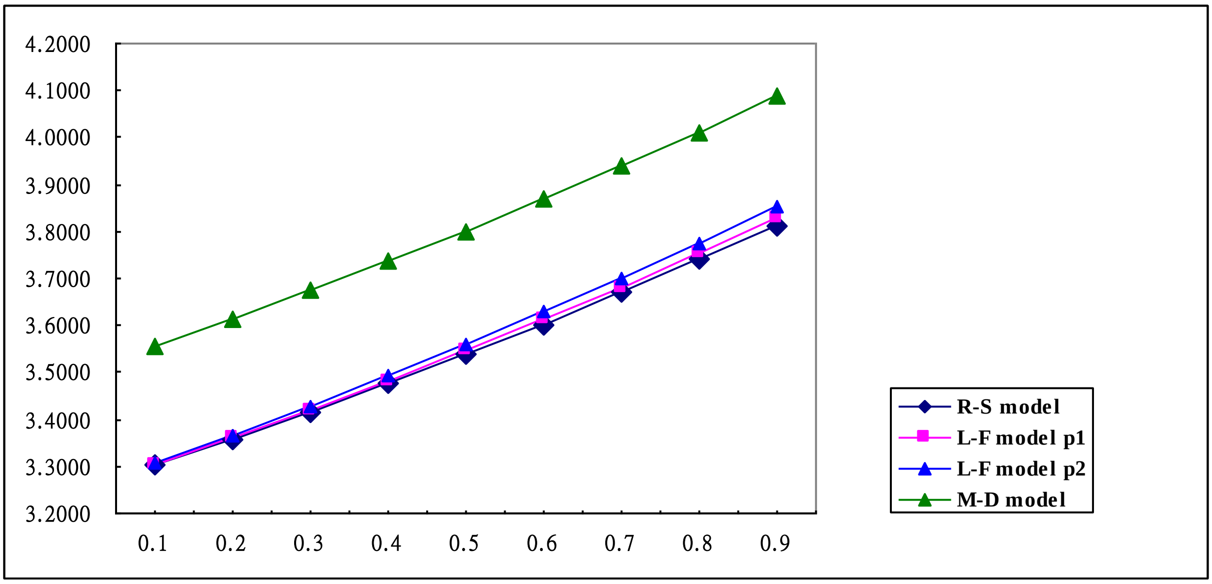

Figure 1. *Retail prices of the three models*

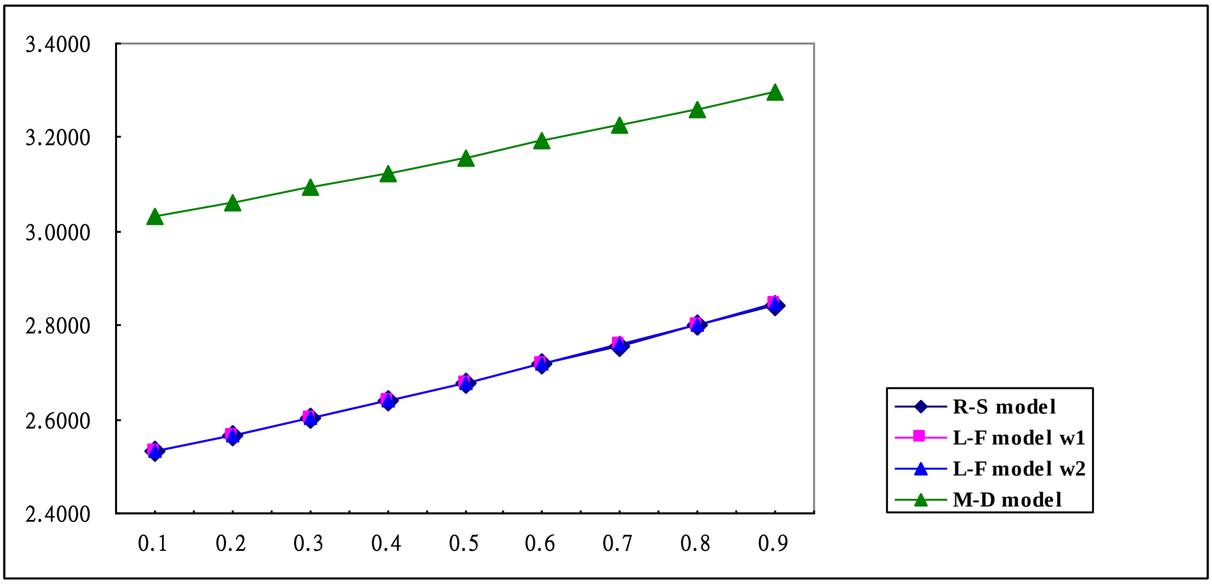

Figure 2. *Wholesale prices of the three models*

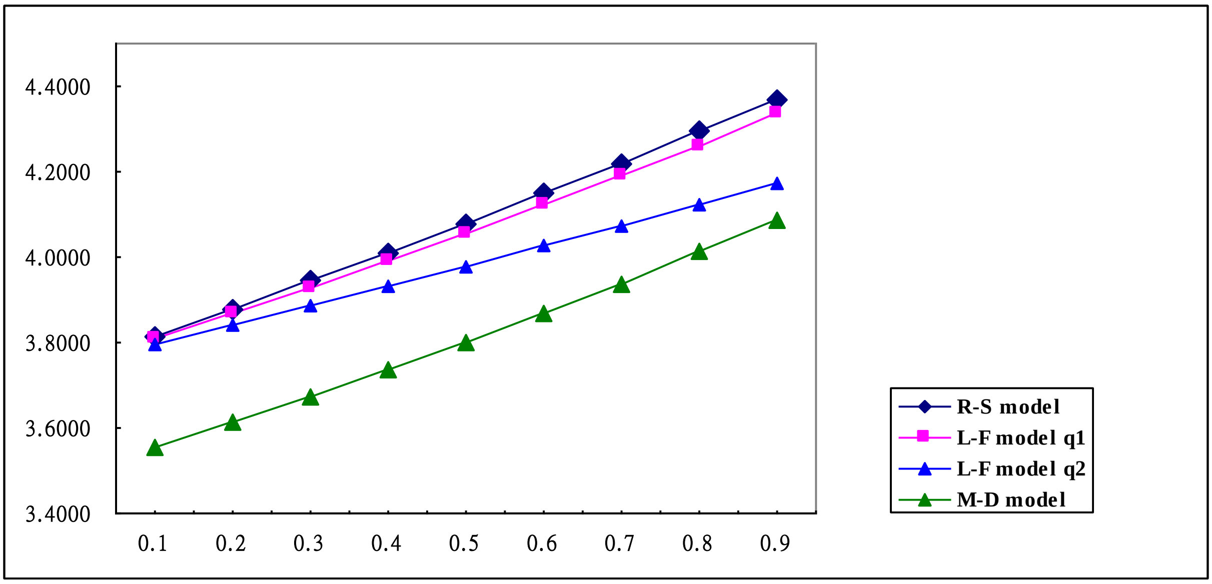

Figure 3. *Sales quantities of the three models*

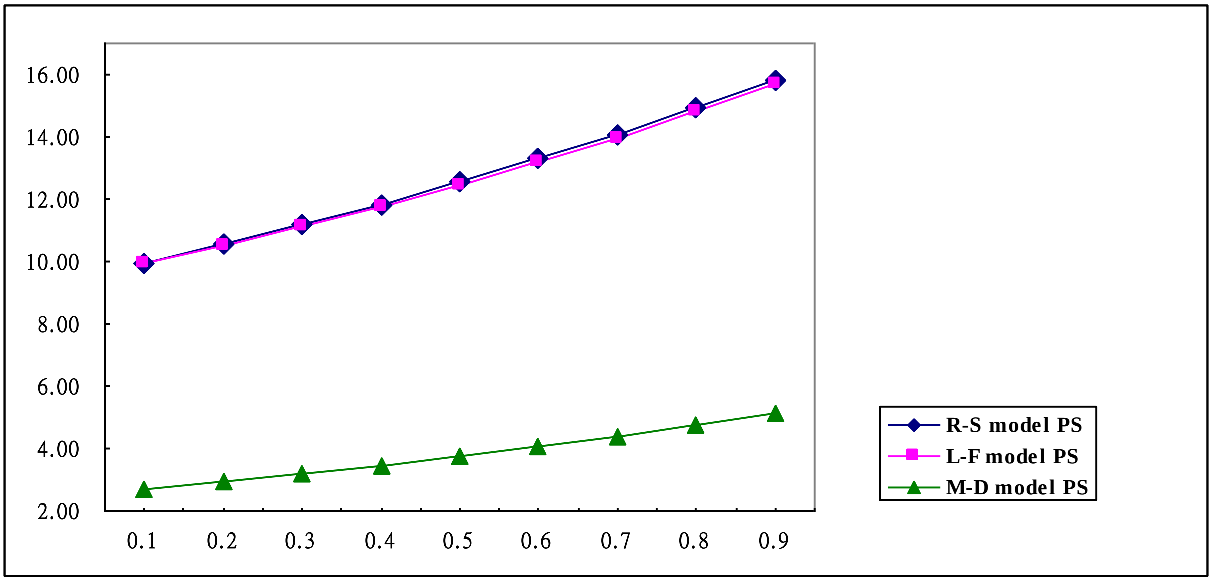

Figure 4. *Producer surpluses of the three models*

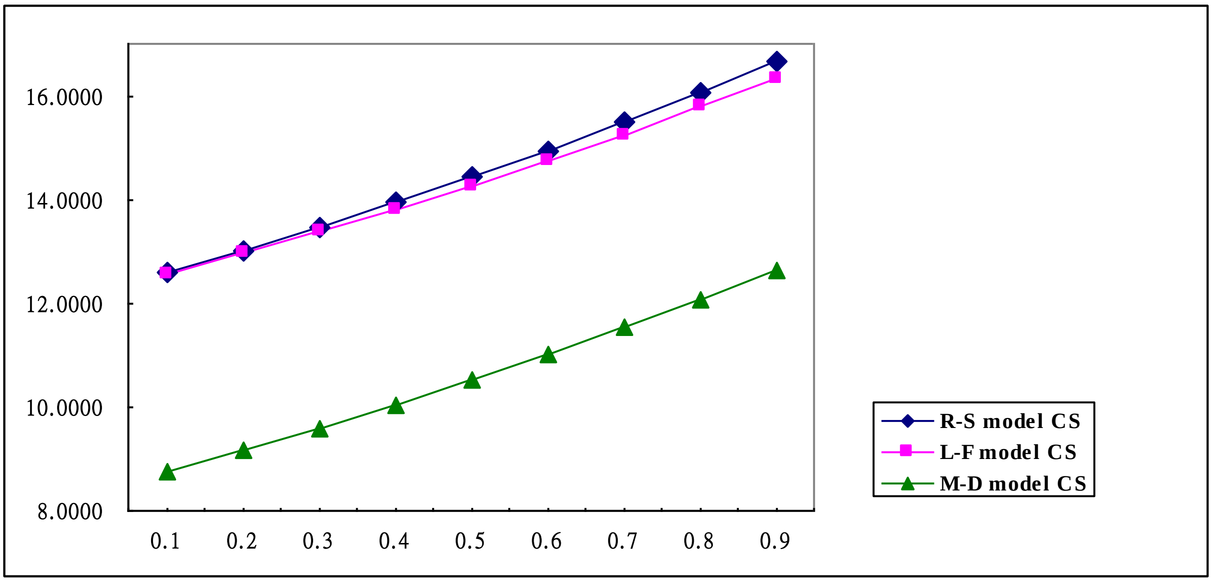

Figure 5. *Consumer surpluses of the three models*

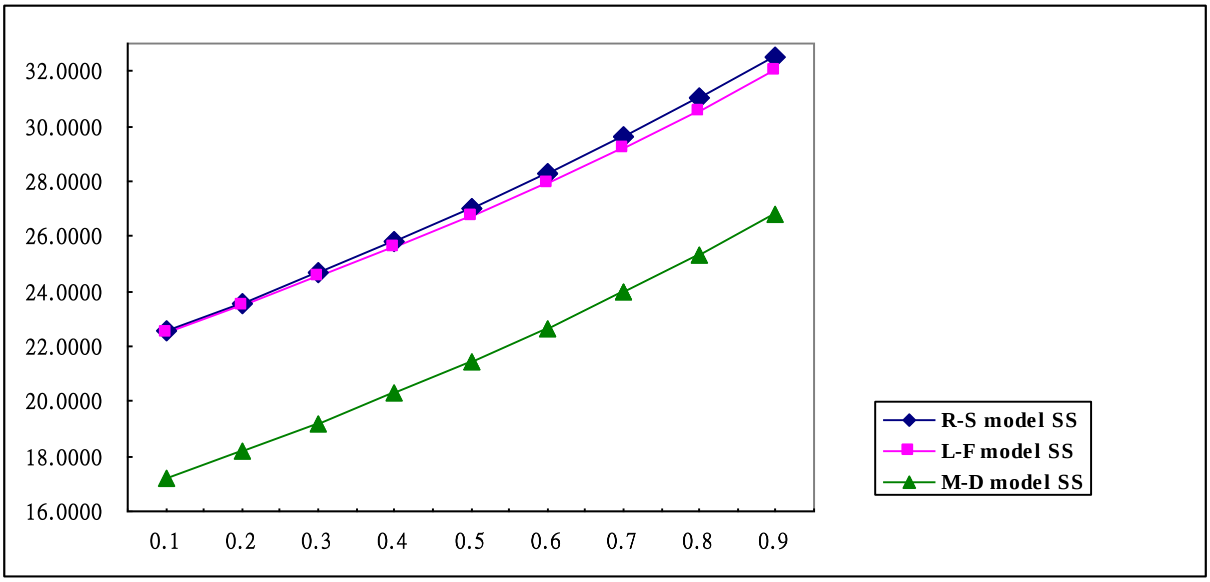

Figure 6. *Social welfare levels of the three models*