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Role of Bargaining in Marketing Channel Games of Quality Choice and Profit Share

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Abstract: Since the 1980s, increased concentrations across marketing channels have changed bargaining relationships between retailers and manufacturers both in North America and in Europe. At the same time contract mechanisms within the marketing channels have become more complex and private label market share have grown rapidly. This paper first investigates the implications of bargaining between manufacturers and retailers. The analysis applies to an arbitrary number of manufacturers and retailers, and holds under general technology and product differentiation conditions, assuming that each retailer acts as a monopolist on its own market. Under Nash bargaining, we show that two widely used types of contracts (quantity forcing contracts and two-part-tariff contracts) are sufficient to obtain efficiency in the channel conditionnally on products specifications but importantly generate a different sharing of surplus. We then investigate the implications for non cooperative quality choices made before the bargaining stage. We examine how the bargaining power of retailers and manufacturers affect the quantity, pricing and quality decisions. This provides useful insights into the changing relationships between manufacturers and retailers. Our analysis helps explain the recent growth of private labels, exclusive products for retailers designed by national brand manufacturers, the growing use of side payments and other emerging trade practices.

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1 Introduction

With the advent of powerful retailers and manufacturers in different marketing channels understanding the intricacies of channel relationships is becoming more and more important. Increase in concentrations and market powers of channel players have also led to increase in tensions and trade skirmishes between suppliers and retailers. Recent skirmishes and tense negotiation between Apple and music producers is an example.[1] These rising strategic tensions between manufacturers and retailers have raised questions about the relative power of channel members and its implication on market outcomes. In this paper our goal is to explore the role of cost structures of suppliers and quality provisions by the channel players in the negotiated equilibrium outcomes, with implications for consumers, retailers and manufacturers.

This paper is also motivated by the growing policy concerns regarding the rise in bargaining power of retailers both in Europe and in North America (e.g., see Inderst and Wey, 2004; Innes and Hamilton, 2006)), with implications for quality choices and economic efficiency in the marketing channel. So, in this paper we try to address the following three critical emerging questions:

[1] How is total channel profit shared between channel members given shifting bargaining powers from manufacturers to retailers? For example, questions are being asked whether retailers may be driving manufacturers to bankruptcy by demanding more and more of the channel profit from the suppliers. Our approach here addresses this question in the context of a general bargaining model involving multiple retailers and manufacturers.

[2] What are the critical drivers of negotiation between powerful channel players? Here our focus will be on the role of production costs in the negotiation process between channel players. The reason for this focus is that it is not obvious why powerful retailers like WalMart

[1] "Universal in Dispute with Apple over iTunes" New York Times July 2^{nd} 2007.

are so obsessed about the cost structure of their suppliers.

It is also alleged that increase in retail market power may be leading to a “race to the bottom” by a relentless push for suppliers to reduce their cost. Retailers are demanding more information from manufacturers in terms of their cost and plant structures.[2] For example, to become a supplier from China, WalMart requires suppliers to provide detailed information on their manufacturing process, numbers of workers employed and also their supply history to WalMart's competitors. From the perspective of marketing and supply chain management, it is not clear how shifting focus from cost of procurement to cost structures of the suppliers help powerful retailers. If WalMart is purely interested in getting the lowest wholesale price, then such 'obsession' with the cost structures of its supplier is somewhat baffling. Surely, a few decades back when mom and pop retailers dominated the world, they also wanted the lowest price available from their suppliers but they hardly bothered about the cost structures of their suppliers.

[3] After exploring characteristics of the bargaining outcomes we then ask another important and critical question: what will be the nature of the equilibrium in terms of quality of products given rising bargaining power of retailers and increasing market share of private labels in most marketing channels? This is important in terms of consumer welfare. Does the overall quality of products in the marketing channel increase or decrease due to shifting market power in the marketing channel? And how does this affect consumer welfare? Choice of quality issue is also related with the recent growth of private labels in the marketing channel (Inderst and Shaffer, 2007; Shaffer, 2005; Avenel and Caprice, 2006). Indeed, in the case of private label, the choice of quality is typically made by the retailer (Sayman, Hoch and Raju, 2002). In this context, we explore the quality choice equilibriums to provide insights into the links between quality choice and private labels.

Regionally Europeans and North American retailers significantly diverge in terms of pri-

[2] This is exemplified by Walmart's focus on suppliers cost structures. See the discussion in the following two documenteries: "Is Wal-Mart Good for America" http://www.pbs.org/wgbh/pages/frontline/shows/walmart/ (produced by Frontline PBS) and "The Age of Wal-Mart - Inside America's Most Powerful Company," (Produced by CNBC).

vate label strategies (Cotterill, 1997). According to Cotterill, powerful retailers in Europe (such as Carrefour in Europe) have relied more on the private labels to grow their business compared to some of the US counterparts (such as Wal-Mart). On average, Hoch et al. (2002) found that in 86 % of the 225 categories sold in their large sample of retail outlets private label share had trended upward at 1% point per year during the period 1987-1990, while national brand share stagnated. And according to Steiner (2004) this upward trend in overall private label dollar share continued from 1994–2000 in all three classes of retailers (Private Label Manufacturers Association, 2001) and in supermarkets and drug chains. The private label's dollar market share in these three classes of retailers for the 52 weeks ending August 12, 2000 was 14.4%, and private label's volume market share had reached 28.1% (Private Label Magazine, 2000). The increasing importance of private labels is affecting the relationship between suppliers and retailers. Even for branded products more and more quality on the store shelves are negotiated rather than taken as given by the retailers. For example, recently HP and Best Buy in the US market has introduced an exclusive laptop for Best Buy stores whose quality was determined through negotiations.[3] Similarly WalMart's insistence on quality has led to introduction of store brands by leading national brand manufacturers like: Starter sneakers by Nike, Levis Strauss jeans by Levis Inc., Slice carbonated soft drinks by Pepsi.[4]

To address these questions, this paper develops an analytical model of a marketing channel that relies on a two-stage game, where quality choices are made non-cooperatively in the first stage, and in the second stage bilateral bargaining between pairs of manufacturers and retailers determine profit maximizing quantity and pricing. The analysis applies to an arbitrary number of manufacturers and retailers, and holds under general technology and product differentiation conditions. We focus however on the case where each retailer is independent and acts as a monopoly on its final market. This is a reassonable assumption as Slade (1995)

[3] How HP Reclaimed Its PC Lead Over Dell (Wall Street Journal, June 4^{th}, 2007).

[4] For some interesting and detailed discussions on how Wal-Mart influenced quality choices for branded products: Fast Company Magazine (http://www.fastcompany.com/magazine/77/walmart.html).

argued that in the empirical settings retailers do not compete directly with each other for a given product or product category on price. Note that this assumption does not rule out the possibility of non-price competition. This assumption has been also retained in recent literaure to explore the impacts of increasing buyer power (see e.g. Inderst and Wey (2003), Inderst and Shaffer (2007), Inderst and Wey (2005)). By abstracting away from downstream price competition allows us to focus on how the equilibrium qualities and shares of surplus depend on bargaining power, technologies, and demands specification.

We first show that, two simple and often used forms of contracts, namely *quantity forcing contracts* (hereafter QF) with fixed transfer payments and *two-part tariff contracts* (hereafter TPT) (which allow for slotting fees and other forms of side payments), are sufficient to reach efficiency from the channel's perspective.[5] However, the nature of contracts has an influence on the sharing of total surplus in the channel. In particular, when all bilateral bargaining takes place over TPT with retailers holding the right to order any quantities they need, the latter are able to extract more surplus from manufacturers than under QF contracts.

The findings of this paper also shed lights on how the changing bargaining power of retailers and manufacturers affect the quantity and pricing. We provide rationale for the excessive focus of powerful retailers on the cost structures of the suppliers. We show how information on the cost structure of the suppliers become critical as the bargaining power of the retailers increase to optimize retail profits. Also, our analysis provides useful insights on the role of quality choice decisions on market outcomes. It shows why under different bargaining conditions and decision processes it may not be possible for channel intermediaries to agree on quality choices. By endogenizing the quality choice process, we provide insights into the role of private labels, exclusive deals between retailers and national brand manufacturers, the growing use of slotting fees and other forms of side payments (e.g., trade and

[5] If there is competition between retailers on the same market, then the complexity of contracts needed to reach efficiency inside the channel raises. For instance, consider the case of a monopolist supplier dealing with two competing retailers. If manufacturer has all the bargaining power, public two-part tariffs entail efficiency. This contrasts with the opposite situation where retailers have all the bargaining power. Indeed, Marx and Shaffer (2005) have shown that public two-part tariffs is no longer sufficient and Rey et al. (2006) have shown that three-part-tariffs contingent on the market structure (exclusivity or common agency) are needed.

promotional allowances), the choice of retail contracts, and other emerging trade practices in market channels.

The paper is organized as follows. The model is presented in section 2. We provide the equilibrium solution to the bargaining game in section 3. Section 4 presents the analysis of payment schemes, with a focus on the role of contract type, bargaining power, role of cost structures of the manufacturers. The quality choice issues are investigated in section 5. Section 6 presents simulation results illustrating our analysis. Finally, section 7 concludes.

2 The Model

The model involves a two-stage game. The quality decisions are made in a first stage. And in the second stage each retailer and each manufacturer using bilateral negotiation decides on quantities and payments for products. Using backward induction, we start with the analysis of stage-two decisions. For modeling purpose, it will be convenient to assume that all negotiations are simultaneous and to use an asymmetric Nash bargaining approach.[6] However, our analysis can still apply in situations where each bargaining session involves an iterative process. Then our model would represent the outcome of this process.[7] As such, we believe that our investigation can provide a good approximation of the actual bargaining taking place between retailers and manufacturers.[8]

Furthermore, each retailer is a local monopoly in the market it is operating, which means that consumers compare prices within a store but not across stores. It also means that it is still possible to have non-price competition among retailers. However, manufacturers compete with each other within a retail chain. Retailers also compete when bargaining with a common provider.[9]

[6] To model simultaneous negotiations between manufacturers and retailers, we assume that each manufacturer employs I sale agents and each retailer employs J buyers. Each sale agent negotiates independently with his corresponding buyer while anticipating fruitful outcomes in all other negotiations.

[7] An example is the iterative bargaining scheme proposed by Zeuthen (1930). As shown by Harsanyi (1977), the Zeuthen iterative scheme converges to the Nash bargaining outcome.

[8] The CNBC produced documentary mentioned in section 1 provides useful insights into the negotiation process at Wal-Mart.

[9] The model can be modified to incorporate non-price competition between retailers, but this will signifi-

To provide insights into negotiation/bargaining outcomes in a marketing channel we first need to decide on the on design of the contracts. We consider two types of contracts: (i) *Quantity forcing contracts (QF)* where, for given quality, each retailer and each manufacturer bargain over a pair of quantities and payments. If expressed per unit basis this types of contracts are observationally equivalent to wholesale price contracts. In other words, our paper do take into account wholesale pricing contracts provided the contracts are negotiated. And (ii) *Two-part Tariff (TPT)* which is the most widely used form of non-linear pricing mechanism. In this case, again for a given quality, each retailer and each manufacturer bargain over a fixed transfer payment and a wholesale price. We assume that a retailer keeps the right to order any desired quantity. This type of contracts can lead to slotting allowances now widely used in marketing channels. Note that TPT contract as presented does not rule out the possibilities of in kind (i.e. non-monetized) side payments between retailers and manufacturers like sharing information on consumer demand, inventories etc.

We present our analysis under both types of contracts. A number of results and insights hold under both types of contracts. Such results are presented first. For example, both contracts eliminate double marginalization problems in the marketing channel. In the absence of direct externalities between retailers and/or manufacturers, it follows that quantity choices are the monopoly outcomes on each independent markets. The main difference between the two contracts is that the two-part tariff outcome leaves more flexibility to retailers than the quantity forcing contracts in situations of bargaining failure. As we will see, this affects the relative bargaining position of retailers versus manufacturers as well as the distribution of profit and hence the quality choices at the second stage. In particular, we will consider quality choices that can be made either by manufacturers in the case of branded products or by retailers in the case of store brands or private labels.

cantly decrease analytical tractability of the paper without adding much to the focus of our analysis.

2.1 Assumptions and notations

We consider a set I of n retailers that buy goods from a set J of m manufacturers. Retailers will be denoted by $i \in I = \{1, 2, ...n\}$ and manufacturers by $j \in J = \{1, 2, ..., m\}$. The quantity of the products purchased by the i-th retailer from the j-th manufacturer is denoted by the vector $q_{ij} \geq 0$. The goods q_{ij} have quality attributes denoted by the vector α_{ij}. The i-th retailer also pays the amount T_{ij} to the j-th manufacturer. The vector $q_i = \{q_{ij} : j \in J\}$ denotes all quantities bought (and sold on its final market) by the i-th retailer with products characteristics $\alpha_i = \{\alpha_{ij} : j \in J\}$, and the vector $q_j = \{q_{ij} : i \in I\}$ denotes all quantities produced by the j-th manufacturer with products characteristics $\alpha_j = \{\alpha_{ij} : i \in I\}$. Also, we let $q = \{q_{ij} : i \in I, j \in J\}$ and $\alpha = \{\alpha_{ij} : i \in I, j \in J\}$.

The i-th retailer faces the following price-dependent demand for q_{ij} :

$$p_{ij} = P_{ij}(q_i, \alpha_i) \text{ for } i \in I,\ j \in J.$$

For simplicity we normalize retailers retailing cost to be zero. It means that the only costs paid by retailers are the costs of procuring products from the manufacturers. The profit made by the i-th retailer is then given by:

$$\pi_i = R_i(q_i, \alpha_i) - \sum_{j \in J} T_{ij}. \tag{1}$$

where $R_i(q_i, \alpha_i) = \sum_{j \in J} P_{ij}(q_i, \alpha_i) q_{ij}$ denotes the i-th retailer's revenue. The profit made by the j-th manufacturer is:

$$\pi_j = \sum_{i \in I} T_{ij} - C_j(q_j, \alpha_j), \tag{2}$$

where $C_j(q_j, \alpha_j)$ is the cost of production for the j-th manufacturer. Aggregate profit is given by:

$$\Pi(q, \alpha) = \sum_{i \in I} R_i(q_i, \alpha_i) - \sum_{j \in J} C_j(q_j, \alpha_j). \tag{3}$$

Throughout, we assume that $\Pi(q, \alpha)$ is concave in (q, α). Also, we assume that $R_i(q_i, \alpha_i)$ depends on the attribute α_{ij} only when $q_{ij} \neq 0$, $i \in I$, and that $C_j(q_j, \alpha_j)$ depends on α_{ij} only when $q_{ij} \neq 0$, $j \in J$.

As discussed above, two types of contracts are investigated: quantity forcing and two-part tariff contracts. In the quantity forcing (QF) contracts between the i-th retailer and the j-th manufacturer, the instruments are the quantities q_{ij} and the payments T_{ij}, $i \in I$, $j \in J$. Under two-part tariff, we have $T_{ij} = F_{ij} + w_{ij}q_{ij}$, where w_{ij} is the vector of wholesale prices for q_{ij} sold to the i-th retailer by the j-th manufacturer, and F_{ij} is the fixed payment made by the i-th retailer to the j-th manufacturer, $i \in I$, $j \in J$.[10] In the two-part tariff (TPT) contracts between the i-th retailer and the j-th manufacturer, the instruments are the prices w_{ij} and the fixed payments F_{ij}, $i \in I$, $j \in J$.

3 Bargaining Equilibrium

Starting with stage two, consider the decisions about quantities and payments made among retailers and manufacturers, conditional on quality α. Assume that the bilateral bargaining between the i-th retailer and the j-th manufacturer is represented by the following asymmetric Nash bargaining game:

$$\max\{\lambda_i^j \ln(\pi_i - \pi_i^j) + \lambda_j^i \ln(\pi_j - \pi_j^i)\} \tag{4}$$

where $\lambda_i^j > 0$ is the bargaining weight for the i-th agent when bargaining with the j-th agent, π_i^j is the threat point for the i-th agent when bargaining with the j-th agent, and the bargaining weights are normalized such that $\lambda_i^j + \lambda_j^i = 1, i \in I, j \in J$. The threat points π_i^j and π_j^i represent profits obtained when negotiations fail between agents i and j. As discussed below, the characterization of the threat points in general depends on the nature of the contracts.

Bilateral Nash bargaining being a cooperative game, it implies that decisions are made so as to maximize the total channel profit $\pi_i + \pi_j$ made by the j-th manufacturer and the i-th retailer. As we will show here that in our context with indirect externalities between players, this is consistent with choosing quantities q so as to maximize aggregate profit $\Pi(q, \alpha)$.

[10] In our notation, $w_{ij}q_{ij}$ denotes the inner product of the two vectors w_{ij} and q_{ij}, with $w_{ij}q_{ij}$ being the total variable payment made by the i-th retailer to the j-th manufacturer.

Proposition 1 *Under bilateral bargaining represented by the asymmetric Nash bargaining game (4), for a given quality* α*, the optimum quantity choice is* $q^*(\alpha) \in \arg\max_{q \geq 0}\{\Pi(q, \alpha)\}$*, where* $\Pi(q, \alpha)$ *is aggregate profit given in (3). This result applies to quantity-forcing contracts as well as two-part tariffs where the prices are* $w_i^*(\alpha_i) = \partial R_i(q_i^*(\alpha), \alpha_i)/\partial q_i, i \in I$*.*

Proof: See appendix A. ∎

Proposition 1 implies that, conditional on quality α, the bargaining outcome will lead to monopoly outputs. By maximizing aggregate profit, this eliminates any double marginalization problems in the marketing channel. Note the generality of this result: it allows for an arbitrary number of manufacturers, an arbitrary number of retailers, a general technology, and arbitrary possibilities of substitution among products within a retail chain. And this result applies to QF as well as TPT contracts (with wholesal price $w_i^*(\alpha_i) = \partial R_i(q_i^*(\alpha), \alpha_i)/\partial q_i, i \in I$ in the case of TPT contracts).

Next we derive the generalized profit sharing rule under the Nash bargaining solution:

Proposition 2 *Under bilateral bargaining represented by the asymmetric Nash bargaining game (4), retailer* i *and manufacturer* j*'s profits are equal to their threat point profit plus a weighted share of the joint bargaining gain* $(\Pi_{ij} - \pi_i^j - \pi_j^i)$*:*

$$\pi_i = \pi_i^j + \lambda_i^j \cdot \left(\Pi_{ij} - \pi_i^j - \pi_j^i\right), \quad i \in I, \tag{5}$$

and

$$\pi_j = \pi_j^i + \lambda_j^i \cdot \left(\Pi_{ij} - \pi_i^j - \pi_j^i\right), \quad j \in J, \tag{6}$$

where $\Pi_{ij} = \pi_i + \pi_j$ *is the joint profit of the* i*-th retailer and the* j*-th manufacturer.*

Proof: Using the definitions of π_i and π_j given in (1) and (2), note that the objective function in (4) is differentiable and strictly concave in T_{ij} (or F_{ij} under two-part tariffs). For retailer i and manufacturer j, the associated first-order condition for a maximum is

$$-\frac{\lambda_i^j}{\pi_i - \pi_i^j} + \frac{\lambda_j^i}{\pi_j - \pi_j^i} = 0 \tag{7}$$

Rewriting (7) and using the normalization rule $\lambda_i^j + \lambda_j^i = 1$ give the desired results. ■

Proposition 2 show that each agent's profit depends on both the level of threat point profits (π_i^j, π_j^i) and on the value of the bargaining parameter $\lambda_i^j = 1 - \lambda_j^i$. The threat point profits reflect available outside options in the case of negotiation failure. And the bargaining parameters $\lambda' s$ represent relative bargaining skills. Proposition 2 implies that agents with high threat points and good negotiating skills will grab a large portion of total profit. Alternatively, agents with low threat points and low bargaining skills will obtain only a small portion of total profit. In general, small stores can be expected to have fewer resources, more limited options and thus lower threat points. In other words, in a world of efficient mega-retailers, some small retailers may still be able to do well provided that they have good negotiating skills.

4 Threat Points, Cost and Payment Schemes

The results obtained above apply for quantity-forcing as well as two-part tariff contracts. And they apply for generic threat points. We now investigate how threat points, conditional on quality α, can vary with the type of contracts, with implications for payment schemes and the distribution of profits.

4.1 The case of Quantity Forcing (QF) Contracts

Under QF contracts between the i-th retailer and the j-th manufacturer, decisions are made about quantities q_{ij} and payments $T_{ij}, i \in I$, $j \in J$. Consider that a bargaining failure between the i-th retailer and the j-th manufacturer corresponds to $q_{ij} = 0$ and $T_{ij} = 0$. In addition, under bilateral bargaining failure between the i-th and j-th agent and QF contracts, we assume that the quantities chosen with other agents $\{q_{lk} : l \in I, k \in J, (l, k) \neq (i, j)\}$ and the payments involving other agents $\{T_{lk} : l \in I, k \in J, (l, k) \neq (i, j)\}$ remain unaffected by the (i, j)-th bargaining failure. In this context, denote the revenue of the i-th retailer when it does not contract with the j-th manufacturer by $R_i^{-j} = R_i(q_i^{-j}, \alpha_i)$ where $q_i^{-j} = \{q_{ik} : k \in$

$J; q_{ij} = 0\}$. Similarly, define $C_j^{-i} = C_j(q_j^{-i}, \alpha_j)$ where $q_j^{-i} = \{q_{lj} : l \in I; q_{ij} = 0\}$. Note that this implies that R_i^{-j} and C_j^{-i} do not depend on q_{ij}. The threat points under QF contracts become:

$$\pi_i^j|_{QF} = R_i^{-j} - \sum_{k \in J \backslash j} T_{ik}, \quad i \in I, \tag{8}$$

and

$$\pi_j^i|_{QF} = \sum_{l \in I \backslash i} T_{lj} - C_j^{-i}, \quad j \in J, \tag{9}$$

evaluated at $\{q_{lk}^*(\alpha) : l \in I, k \in J, (l,k) \neq (i,j)\}$, where $J\backslash j = \{k : k \in J, k \neq j\}$, $I\backslash i = \{k : k \in I, k \neq i\}$. Under an (i,j)-th bargaining failure, treating $\{T_{lk} : l \in I, k \in J, (l,k) \neq (i,j)\}$ as fixed and using equations (1), (2) and (5) yield the following result:

Proposition 3 *Under QF contracts, the payment T_{ij} can be expressed as a function of incremental cost to the j-th manufacturer, $\left(C_j - C_j^{-i}\right)$, and incremental revenue from the i-th retailer, $\left(R_i - R_i^{-j}\right)$:*

$$T_{ij} = \left(1 - \lambda_i^j\right)\left(R_i - R_i^{-j}\right) + \lambda_i^j \left(C_j - C_j^{-i}\right), \quad i \in I, j \in J. \tag{10}$$

Equation (10) shows how the bargaining weights λ's affect the transfer payments T. If the i-th retailer has little bargaining power while negotiating with the j-th manufacturer ($\lambda_i^j \simeq 0$), then $T_{ij} \simeq R_i - R_i^{-j}$. This means that the j-th manufacturer will receive all the benefits of the incremental revenue $(R_i - R_i^{-j})$ obtained from selling its product to the i-th retailer. However, the j-th manufacturer will face the entire incremental cost $(C_j - C_j^{-i})$. On the other hand, if retailer i has all the bargaining power ($\lambda_i^j \simeq 1$), then $T_{ij} \simeq C_j - C_j^{-i}$. This means that the j-th manufacturer will be totally compensated for the incremental cost $(C_j - C_j^{-i})$ of selling its product to the i-th retailer. But the i-th retailer will keep the entire incremental revenue $(R_i - R_i^{-j})$. In intermediate situations where $\lambda_i^j \in (0,1)$, then incremental cost and incremental revenue will be shared between manufacturers and retailers, with a sharing rule that depends on their relative bargaining skills (as represented by λ_i^j).

Using equations (1), (2) and (10), the profits under QF contracts can be expressed as follows:

Proposition 4 *Under QF contracts, the i-th retailer's profit is*

$$\pi_i|_{QF} = R_i - \sum_{j \in J}(1-\lambda_i^j)(R_i - R_i^{-j}) - \sum_{j \in J} \lambda_i^j \left(C_j - C_j^{-i} \right), \quad i \in I, \tag{11}$$

and the j-th manufacturer's profit is

$$\pi_j|_{QF} = \sum_{i \in I}(1-\lambda_i^j) \left(R_i - R_i^{-j} \right) + \sum_{i \in I} \lambda_i^j \left(C_j - C_j^{-i} \right) - C_j, \quad j \in J. \tag{12}$$

Proposition 4 provides useful insights into the relationships between manufacturers and retailers. Given $\lambda_i^j \in (0,1)$, equation (11) implies that the profit of the i-th retailer $\pi_i|_{QF}$ is positively related to the threat revenue R_i^{-j}, and negatively related to the incremental costs $\left(C_j - C_j^{-i} \right)$. Noting that $\partial \pi_i / \partial R_i|_{QF} = 1 - \sum_{j \in J}(1-\lambda_i^j) = 1 - \sum_{j \in J} \lambda_j^i$, the effect of revenue R_i on π_i's depends on the relative bargaining weights: it is positive (negative) when $\sum_{j \in J} \lambda_j^i < (>) 1$. Similarly, equation (12) implies that the profit of the j-th retailer $\pi_j|_{QF}$ is negatively related to the threat cost C_j^{-i}, and positively related to the incremental revenue $\left(R_i - R_i^{-j} \right)$. Noting that $\partial \pi_j / \partial C_j|_{QF} = \sum_{i \in I} \lambda_i^j - 1$, the effect of cost C_j on π_j's depend on the relative bargaining weights: it is positive (negative) when $\sum_{i \in I} \lambda_i^j > (<) 1$.

Proposition (4) identifies the role of bargaining power among agents under QF contracts. To illustrate, consider the case where the i-th retailer is a poor negotiator with $\sum_{j \in J}(1-\lambda_i^j) > 1$. This corresponds to a situation where the λ_i^j's tend to be small. Then any increase in R_i will have a negative impact on profit $\pi_i|_{QF}$. Intuitively, a decline in the negotiating power of the i-th retailer is associated with manufacturers extracting more of any increased revenue. In such cases, perversely, the i-th retailer would benefit from a strategy that reduces its revenue R_i.

In the extreme case of a very weak retailer (or very strong manufacturers), we have $\lambda_i^j \simeq 0$ for all j. Then, equation (11) implies that the i-th retailer's profit becomes $\pi_i|_{QF} \simeq R_i - \sum_{j \in J}(R_i - R_i^{-j})$. In such a situation, profit $\pi_i|_{QF}$ depends only on the revenue patterns, and the cost of manufacturing ceases to play a role in determining the i-th retailer's profit.

Alternatively, consider the case where the j-th manufacturer is a poor negotiator with $\sum_{i \in I} \lambda_i^j > 1$. This corresponds to a situation where the λ_i^j's tend to be large (or equivalently the λ_j^i's tend to be small). Then any decrease in C_j will have a negative impact on profit $\pi_j|_{QF}$. Intuitively, a decline in the negotiating power of the j-th manufacturer is associated with retailers extracting more of the reduced cost. In such cases, perversely, the j-th manufacturer would benefit from a strategy that increases its cost C_j. In the extreme case where the i-th retailer has very strong bargaining power, we have $\lambda_i^j \simeq 1$ for all j. Then, from equation (11), the i-th retailer's profit becomes $\pi_i|_{QF} \simeq R_i - \sum_{j\in J}\left(C_j - C_j^{-i}\right)$. This implies that the i-th retailer with high negotiating power pays the manufacturers only the incremental cost $\sum_{j\in J}(C_j - C_j^{-i})$.

The present analysis can help explain why powerful retailers like WalMart are so sensitive about every aspects of costs of production. With better negotiating power and high threat points, they can extract all the surplus from the marketing channel and pay their suppliers only the incremental cost of production. In this context, growth in retail profit comes in large part from squeezing the costs of the suppliers. Also, using equation (12), note that $\lambda_i^j \simeq 1$ for all i implies that the j-th manufacturer's profit becomes $\pi_j|_{QF} = \sum_{i\in I}\left(C_j - C_j^{-i}\right) - C_j$. Thus, in the presence of powerful retailers, profit $\pi_j|_{QF}$ depends only on the manufacturing cost, and patterns of revenue cease to play a role in determining manufacturers' profit. Note that if the retailers only provide for the incremental cost of production then they have major incentives either to push suppliers to build larger plants or look for suppliers with more flatter average cost functions. Also, because of the importance of the cost structures of the suppliers, retailers have incentives to ask suppliers to relocate to cheaper locations with larger plants thereby leading to the phenomenon of race to the bottom. The qualitative results presented here also hold under TPT contract, as it will be clear in the next section.

4.2 The Case of Two-Part Tariffs (TPT)

Under TPT contracts, the payments made by the i-th retailer to the j-th manufacturer take the form $T_{ij} = F_{ij} + w_{ij}q_{ij}, i \in I,\ j \in J$. Again, consider that a bargaining failure between the i-th retailer and the j-th manufacturer corresponds to $q_{ij} = 0$ and $F_{ij} = 0$

(implying that $T_{ij} = 0$). Under bilateral bargaining between the i-th and j-th agent and TPT contracts, we assume that the prices facing other agents $\{w_{lk} : l \in I, k \in J, (l, k) \neq (i, j)\}$ and the fixed payments involving other agents $\{F_{lk} : l \in I, k \in J, (l, k) \neq (i, j)\}$ remain unaffected by the (i, j)-th bargaining failure. To compare, QF contracts keep the payments $\{T_{lk} : l \in I, k \in J, (l, k) \neq (i, j)\}$ and quantities $\{q_{lk} : l \in I, k \in J, (l, k) \neq (i, j)\}$ constant when the i-th and j-th agents fail to reach an agreement. In contrast, TPT contracts keep the fixed payments $\{F_{lk} : l \in I, k \in J, (l, k) \neq (i, j)\}$ and the prices $\{w_{lk} : l \in I, k \in J, (l, k) \neq (i, j)\}$ constant. But bargaining failure under TPT allows some adjustments in the quantities $\{q_{lk} : l \in I, k \in J, (l, k) \neq (i, j)\}$ and this affects threat points and profit sharing. We assume that these quantity adjustments are decided by the retailers. Implicitly, this means that, under contract failure, the retailers make decisions that remain consistent with their own interest. In other words, for given prices w, each retailer retains the right to choose the quantities to order from manufacturers and keeps on behaving as a profit maximizer when bilateral negotiations fail.

In the context of an (i, j)-th bargaining failure, again define $R_i^{-j} = R_i(q_i^{-j}, \alpha_i)$ where $q_i^{-j} = \{q_{ik} : k \in J; q_{ij} = 0\}$. From Proposition 1, let TPT prices be $w_i^*(\alpha) = \partial R_i(q_i^*(\alpha), \alpha_i)/\partial q_i$, $i \in I$, where $q^*(\alpha) \in \arg\max_{q \geq 0}\{\Pi(q, \alpha)\}$. This implies that $q_l^*(\alpha) \in \arg\max_{q_l \geq 0}\{R_l(q_l, \alpha_l) - \sum_{j \in J} w_{lj}^*(\alpha) q_{lj}\}$ for $l \in I \backslash i$. For given prices $w_i^*(\alpha)$, it means that, under TPT contracts, the quantity decisions involving "other retailers" (besides the i-th one) remain unaffected by an (i, j)-th bargaining failure. However, with retailers behaving as profit maximizers, when negotiations fail with the j-th manufacturer, the i-th retailer's decisions become

$$\hat{q}_i^{-j}(\alpha) \in \arg\max_{q_i^{-j} \geq 0}\{R_i^{-j} - \sum_{k \in J \backslash j} w_{ik}^*(\alpha) q_{ik}\}, \quad i \in I.$$

In general $\hat{q}_{ik}^{-j}(\alpha) \neq q_{ik}^*(\alpha)$, implying quantity adjustments for $q_{ik}, k \in J \backslash j$. Under TPT contracts, the threat-point profit for the i-th retailer is thus defined as:

$$\begin{aligned}\pi_i^j|_{TPT} &= \max_{q_i^{-j}\geq 0}\{R_i^{-j} - \sum_{k\in J\backslash j} w_{ik}^*(\alpha)q_{ik}\} - \sum_{k\in J\backslash j} F_{ik}, \\ &= \hat{R}_i^{-j} - \sum_{k\in J\backslash j} w_{ik}^*(\alpha)\hat{q}_{ik}^{-j}(\alpha) - \sum_{k\in J\backslash j} F_{ik}, \quad i\in I,\end{aligned} \tag{13}$$

where $\hat{R}_i^{-j} = R_i(\hat{q}_i^{-j}(\alpha), \alpha_i)$ is R_i^{-j} evaluated at $\hat{q}_i^{-j}(\alpha)$. A comparison of equations (8) and (13) shows that the threat points differ between QF and TPT contracts. Intuitively, TPT contracts give the retailers the rights to choose the quantities ordered and sold to consumers. As discussed below, this added flexibility in procurement gives an advantage to the retailers under TPT contracts (compared to QF contracts).

Next, consider the case of manufacturers in the context of an (i,j)-th bargaining failure. As just discussed, under TPT prices $w_i^*(\alpha) = \partial R_i(q_i^*(\alpha), \alpha_i)/\partial q_i, i\in I$, the quantity decisions involving "other retailers" remain unaffected when the i-th retailer fails to agree with the j-th manufacturer. This implies that $q_{lj} = q_{lj}^*(\alpha)$ for $l\in I\backslash i$ and $j\in J$ with or without bargaining failure. Thus in case of bargaining failure with the i-th retailer, the j-th manufacturer produces $q_{ij} = 0$. But it also produces the same quantities $\{q_{lj}^*(\alpha) : l\in I\backslash i\}$ that it would have produced under a successful negotiation. Note that this is the same threat-point characterization obtained under QF contracts and given by $\pi_j^i|_{QF}$ in equation (9). It follows that, under TPT, the threat point profit for the j-th manufacturer is:

$$\pi_j^i|_{TPT} = \sum_{l\in I\backslash i} [F_{lj} + w_{lj}q_{lj}] - C_j^{-i}, \tag{14}$$

evaluated at $\{w_{lk}^*(\alpha) : l\in I, k\in J, (l,k)\neq (i,j)\}$ and $\{q_{lk}^*(\alpha) : l\in I, k\in J, (l,k)\neq (i,j)\}$, where $C_j^{-i} = C_j(q_j^{-i}, \alpha_j)$ and $q_j^{-i} = \{q_{kj} : k\in I; q_{ij} = 0\}, j\in J$.

Under an (i,j)-th bargaining failure, treating $\{F_{lk} : l\in I, k\in J, (l,k)\neq (i,j)\}$ as fixed, and using equations (1), (2) and (5) yield the following result.

Proposition 5 *Under TPT contracts where $w_i^*(\alpha) = \partial R_i(q_i^*(\alpha), \alpha_i)/\partial q_i, i\in I$, the payment* *from the i-th retailer to the j-th manufacturer is:*

$$F_{ij} + w_{ij}^*(\alpha)q_{ij} = \left(1 - \lambda_i^j\right)\left(R_i - \hat{R}_i^{-j}\right) + \lambda_i^j\left(C_j - C_j^{-i}\right) + \left(1 - \lambda_i^j\right)\sum_{k \in J \backslash j}\left[w_{ik}^*(\alpha)(\hat{q}_{ik}^{-j}(\alpha) - q_{ik})\right], \tag{15}$$

evaluated at $q = q^*(\alpha)$.

Comparing the payment scheme (15) under TPT contracts with the payment scheme (10) under QF contract is instructive. The first term in (15) is similar to the first term in (15): they both involve a weighted change in the i-th retailer's revenue associated with negotiation failure with the j-th manufacturer. However, $\hat{R}_i^{-j}$ in (15) differs from R_i^{-j} in equation (10). As discussed above, the former allows for quantity adjustments that are not present in the latter. The second terms in (15) and (10) are identical. They measure the effect of a negotiation failure with the i-th retailer on the j-th manufacturer's cost. Finally, the third term in (15) does not appear in (10). Since the second terms are identical, the differences in payments between TPT and QF contracts are due entirely to the first and third terms in (15). To examine these differences, note that equation (13) implies

$$\hat{R}_i^{-j} - \sum_{k \in J \backslash j} w_{ik}^*(\alpha)\hat{q}_{ik}^{-j}(\alpha) \geq R_i^{-j} - \sum_{k \in J \backslash j} w_{ik}^*(\alpha)q_{ik}. \tag{16}$$

Combining equations (10), (15) and (16) gives the following result.

Proposition 6 *The payments made by the i-th retailer to the j-th manufacturer satisfy*

$$F_{ij} + w_{ij}^*(\alpha)q_{ij} \leq T_{ij}, \tag{17}$$

implying that the i-th retailer tends to pay less under TPT than under QF contracts.

Proposition 6 shows that retailers tend to be better off under TPT than under QF contracts. This is a very general result which applies under general technology, bargaining skills and market conditions. This result is intuitive. While QF contracts keep quantities constant under bargaining failure, TPT gives some flexibility to the retailers in adjusting quantities when negotiation fails. This flexibility affects their threat points and their payment schemes.

Using equations (1), (2) and (15) yields the following results under TPT contract.

Proposition 7 *Under TPT contracts, the i-th retailer's profit is*

$$\begin{aligned}\pi_i|_{TPT} = {} & R_i - \sum_{j\in J}(1-\lambda_i^j)(R_i - \hat{R}_i^{-j}) - \sum_{j\in J}\lambda_i^j\left(C_j - C_j^{-i}\right) \\ & - \sum_{j\in J}\sum_{k\in J\backslash j}(1-\lambda_i^j)w_{ik}^*(\alpha)\left(\hat{q}_{ik}^{-j} - q_{ik}\right), \quad i\in I,\end{aligned} \tag{18}$$

and the j-th manufacturer's profit is

$$\begin{aligned}\pi_j|_{TPT} = {} & \sum_{i\in I}(1-\lambda_i^j)\left(R_i - \hat{R}_i^{-j}\right) + \sum_{i\in I}\lambda_i^j\left(C_j - C_j^{-i}\right) \\ & + \sum_{i\in I}\sum_{k\in J\backslash j}(1-\lambda_i^j)w_{ik}^*(\alpha)\left(\hat{q}_{ik}^{-j} - q_{ik}\right) - C_j, \quad j\in J.\end{aligned} \tag{19}$$

The TPT results stated in Proposition 7 are similar to those obtained in Proposition 4 under QF contracts, except for two important differences. First, the revenue term R_i^{-j} under QF contract is replaced by $\hat{R}_i^{-j}$ under TPT. Second, the term $\sum_{k\in J\backslash j}(1-\lambda_i^j)w_{ik}^*(\alpha)\left(\hat{q}_{ik}^{-j} - q_{ik}\right)$ is present under TPT but not under a QF contract. As discussed above, both differences reflect the fact that, compared to QF contracts, TPT gives some additional flexibility for retailers to adjust quantities under bargaining failure. Except for these two differences, similar results are obtained. Again, equations (18) and (19) show how the distribution of bargaining power among agents affects the distribution of profit in the marketing channel.

Next, we explore the effects of the type of contract on manufacturers' and retailers' profits. These profits are defined in equations (11) and (12) under QF contracts and in equation (18) and (19) under TPT. Using equations (1), (2), and (17), we obtain the following result.

Proposition 8 *The profits made by retailers and manufacturers satisfy*

$$\pi_i|_{TPT} \geq \pi_i|_{QF}, \quad i\in I,$$

and

$$\pi_j|_{TPT} \leq \pi_j|_{QF}, \quad j\in J.$$

Proposition 8 shows that TPT contracts tend to benefit retailers at the expense of manufacturers. As discussed above, this reflects the fact that retailers gain added flexibility using TPT when negotiations fail. This tends to increase their threat points and improve their position in claiming a larger share of profit.

Finally, in the context of TPT contracts, we explore the determinants of the fixed payments F_{ij}. When positive, these payments involve retailers paying manufacturers a fixed amount of money. But when negative, they are fixed payments from manufacturers to retailers. As such, when negative, F_{ij} represents slotting fees. Such slotting fees have become more commonly used over the last few years. This raises the issue: what are the determinants of slotting fees? And when are they likely to arise?

In general, the fixed fees F_{ij} are determined as given in equation (15). This shows that the determinants of the F_{ij}'s can be complex: they depend on the cost and revenue structure and on the distribution of bargaining power. Here, we look for sufficient conditions under which we can determine the sign of F_{ij}.

Proposition 9 *Sufficient conditions for a slotting fee, $F_{ij} < 0$, between the i-th retailer and the j-th manufacturer are:*

(i) *the incremental average revenue $[R_i(kq_{ij}) - \hat{R}_i^{-j}]/k$ is increasing in k (where k is a positive scalar representing a proportional rescaling of q_{ij}), and*

(ii) $\sum_{i \in I} \sum_{k \in J \backslash j} w_{ik}^*(\alpha)(\hat{q}_{ik}^{-j} - q_{ik}) \leq 0$, *evaluated at $q = q^*(\alpha)$.*

Proof: Using (13) and at the optimum, we have, $\pi_i - \pi_i^j = R_i - \hat{R}_i^{-j} - F_{ij} - w_{ij}^*(\alpha) q_{ij} + \sum_{i \in I} \sum_{k \in J \backslash j} w_{ik}^*(\alpha) \left(\hat{q}_{ik}^{-j} - q_{ik} \right)$. Since $\pi_i - \pi_i^j \geq 0$, and using $w_{ij}^*(\alpha) = \partial R_i / \partial q_{ij}$, it follows that $R_i - \hat{R}_i^{-j} - [\partial R_i / \partial q_{ij}] \, q_{ij} + \sum_{i \in I} \sum_{k \in J \backslash j} w_{ik}^*(\alpha) \left(\hat{q}_{ik}^{-j} - q_{ik} \right) \geq F_{ij}$. Note that the incremental average revenue $[R_i(kq_{ij}) - \hat{R}_i^{-j}]/k$ being increasing in the scalar $k > 0$ implies that $R_i - \hat{R}_i^{-j} - [\partial R_i / \partial q_{ij}] \, q_{ij} < 0$ (evaluated at $k = 1$). This gives the desired results. ■

Proposition 9 presents sufficient conditions for slotting fees to arise between the i-th retailer and the j-th manufacturer, with $F_{ij} < 0$. These conditions are that the incremental average revenue $[R_i(kq_{ij}) - \hat{R}_i^{-j}]/k$ is increasing in k, and that $\sum_{i \in I} \sum_{k \in J \backslash j} w_{ik}^*(\alpha)(\hat{q}_{ik}^{-j} - q_{ik}) \leq 0$. Condition (i) reflects local economies of scale in retail sales. It is satisfied when a proportional increase in q_{ij} generates a more than proportional increase in incremental revenue $[R_i - \hat{R}_i^{-j}]$. This could happen in situations where consumer response exhibit "minimum thresholds" with respect to quantities q_{ij}. Condition (ii) means that setting $q_{ij} = 0$ tends to decrease the demand for other products sold by the j-th retailer $\{q_{ik} : k \in J \backslash j\}$, i.e. that q_{ij} and $\{q_{ik} : k \in J \backslash j\}$ behave as complements. This complementarity relationship can induce the j-th manufacturer to pay a fixed fee to the i-th retailer. In other words, Proposition 9 states that slotting fees are likely to arise when local economies of scale in retail sales exists with respect to q_{ij}, and when the commodities q_{ij} tends to be complement with other products sold by the i-th retailer. These results appear to be new. They provide valuable insights about scenarios where slotting fees are expected to arise.

5 Product positioning

So far, we have investigated the second stage bargaining process over product quantities and payments among manufacturers and retailers, conditionally on quality attributes α. In this section, we investigate the first stage alternative decision rules related to the quality choices/attributes α defining product positioning in the marketing channel. In this paper, we consider cases where products are vertically differentiated. Note that in the case of costless horizontal differentiation product positioning becomes trivial. So, in rest of the analysis an increase in α will imply improvement in product quality.

5.1 Optimal product positioning from the total channel perspective

For reference, we start by analyzing the optimal product positioning from the total channel perspective as a benchmark case to which we will compare manufacturers and retailers qualities choices. From proposition 1, the total channel profit can be written as $\Pi^*(\alpha) = \Pi(q^*(\alpha), \alpha)$, where $\Pi(q, \alpha)$ is defined in equation (3) and $q^*(\alpha) \in \arg\max_{q \geq 0}\{\Pi(q, \alpha)\}$ is the monopoly quantities conditional on α. Let A represent the feasible set for α, $\alpha \in A$. Therefore, the monopoly quality choices are consistent with the profit maximizing problem:

$$\alpha^* \in \arg\max_{\alpha \in A} \{\Pi^*(\alpha)\}. \tag{20}$$

Letting $q^* = q^*(\alpha^*)$, this can be alternatively written as $(\alpha^*, q^*) \in \arg\max_{\alpha \in A, q \geq 0} \{\Pi(\alpha, q)\}$.

5.2 Optimal positioning in a two-stage game

We focus our attention on two cases: (i) the case where each manufacturer chooses the quality of the products it produces; and (ii) the case where retailers make the quality choice similar to the most cases of quality choice for private labels. In either case, we investigate how changes in the relative bargaining power of market participants affects quality choices. This analysis will provide us insights into how changes in bargaining power and who makes the quality choice decisions will impact market outcomes and social welfare.

Case (i) corresponds to situations where manufacturers choose the product type/quality. We focus our attention on the situation where the quality produced by each manufacturer is uniform for all retailers.[11] Thus, for the j-th manufacturer, we assume that $\alpha_{ij} = \alpha_{\cdot j}, i \in I$. Let the feasible set for $\alpha_{\cdot j}$ be $A_j,\ j \in J$. Using equation (6), the quality choice made by the j-th manufacturer for $\alpha_{\cdot j}$ is given by the optimization problem

$$\alpha_j^m(\lambda_j^I, \alpha_{J \setminus j}) \in \arg\max_{\alpha \cdot j \in A_j} \{\sum_{i \in I} \left(\pi_j^i + \lambda_j^i \cdot B_{ij}(\alpha.)\right)\}, \tag{21}$$

where $\alpha. = \{\alpha_{\cdot j} : j \in J\}$, $B_{ij}(\alpha.) = [\pi_i(q_i^*(\alpha.), \alpha.) + \pi_j(q_j^*(\alpha.), \alpha_{\cdot j}) - \pi_i^j - \pi_j^i]$ is the bargaining gain obtained jointly by the i-th retailer and j-th manufacturer, $\lambda_j^I = \{\lambda_j^i : i \in I\}$ and $\alpha_{J \setminus j} = \{\alpha_{\cdot k} : k \in J \setminus j\}$. Equation (21) defines $\alpha_j^m(\lambda_j^I, \alpha_{J \setminus j})$ as the reaction function representing the j-th manufacturer's decision for $\alpha_{\cdot j}$ conditional on the bargaining weights λ_j^I and on other quality decisions $\alpha_{J \setminus j}$.

Case (ii) corresponds to the situation where retailers make the quality choice. For the i-th retailer, using equation (5), this means that the choice of α_{ij} is made as follows

[11] The case where each manufacturer sells different product qualities to different retailers is presented in Appendix B.

$$\alpha_{ij}^{r}(\lambda_i^j, \alpha_{I\backslash i,J\backslash j}) \in \arg\max_{\alpha_{ij}\in A_{ij}} \{\pi_i^j + \lambda_i^j \cdot B_{ij}(\alpha)\}, \tag{22}$$

where $B_{ij}(\alpha) = [\pi_i(q_i^*(\alpha), \alpha_i) + \pi_j(q_j^*(\alpha), \alpha_j) - \pi_i^j - \pi_j^i]$ is the bargaining gain obtained jointly by the i-th retailer and j-th manufacturer, and $\alpha_{I\backslash i,J\backslash j} = \{\alpha_{lk} : l \in I\backslash i, k \in J\backslash j\}$. Equation (22) defines $\alpha_{ij}^{r}(\lambda_i^j, \alpha_{I\backslash i,J\backslash j})$ as the reaction function representing the i-th retailer's decision for α_{ij} conditional on the bargaining weight λ_i^j and on other quality decisions $\alpha_{I\backslash i,J\backslash j}$.

Equations (21) and (22) differ from equation (20). This implies that the non-cooperative quality decisions made at stage one in general differ from the optimal product positioning α^* given in (20). This is because the j-th manufacturer does not internalize all the effects of its quality decision. Two sets of factors play a role. First, in general, the threat points π_i^j and π_j^i depend on the quality choice α_{ij}. To see that, it suffices to note that, under bilateral bargaining failure, both C_i^j and C_i^j depend on α_{ij} (through q_i^{-j}) under either a QF contract or a TPT contract. Second, equations (21) and (22) imply that the relative bargaining weight $\lambda' s$ play a role in the quality decision.

Equations (21) and (22) also differ from each other. This shows that the quality decisions depend on who makes these decisions. There are two reasons for this difference. First, while $\alpha_j^m(\lambda_j^I, \alpha_{J\backslash j})$ in (21) depends on the bargaining weights of the j-th manufacturer with respect to *all* retailers $\lambda_j^I = \{\lambda_j^i : i \in I\}$, note that $\alpha_{ij}^{r}(\lambda_i^j, \alpha_{I\backslash i,J\backslash j})$ in (22) depends only on the bargaining weight λ_i^j specific to the i-th retailer. Second, the strategic effects involved in quality choices differ in (21) versus (22). Indeed, while $\alpha_j^m(\lambda_j^I, \alpha_{J\backslash j})$ in (21) depends on $\alpha_{J\backslash j}$, $\alpha_{ij}^{r}(\lambda_i^j, \alpha_{I\backslash i,J\backslash j})$ in (22) depends $\alpha_{I\backslash i,J\backslash j}$, reflecting our assumption that the quality produced by each manufacturer (in case (i)) is uniform for all retailers.

The market determination of product quality is analyzed in details below, with a focus on two issues: 1/ the role of changing bargaining power; and 2/ the effects of control on product positioning.

5.2.1 Optimal positioning from the manufacturer's perspective

When each manufacturer chooses product quality that is uniform across all retailers, equation (21) provides the relevant characterization of the quality choice $\alpha_{\cdot j}, j \in J$. In this context, the strategic effects of $\alpha_{J\backslash j}$ on α_j^m in $\alpha_j^m(\lambda_j^I, \alpha_{J\backslash j})$ are relevant. Define the qualities $\alpha_{\cdot k}$ and $\alpha_{\cdot j}$ to be *m-strategic substitutes* (*m-strategic complements*) when $\alpha_j^m(\lambda_j^I, \alpha_{J\backslash j})$ is decreasing (increasing) in $\alpha_{\cdot k}, k \in J\backslash j$. For simplicity, we limit our discussion to the case where $\alpha_{\cdot j}$ is a scalar and where the optimization problem (21) has a unique interior solution. In this context, the next proposition investigates the effects of changing relative bargaining power (as captured by the $\lambda' s$) on product positioning.

Proposition 10 *Assume that the manufacturers choose quality according to (21). Then, ceteris paribus,*

(i) *an increase in λ_i^j implies a decrease (increase) in quality $\alpha_{\cdot j}$ when $\frac{\partial B_{ij}(\alpha.)}{\partial \alpha_{\cdot j}} > 0$ (< 0), $i \in I$;*

(ii) *an increase in λ_i^k implies a decrease (increase) in quality $\alpha_{\cdot j}$ when $\frac{\partial \alpha_j^m}{\partial \alpha_{\cdot k}} \frac{\partial B_{ik}(\alpha.)}{\partial \alpha_{\cdot k}} > 0$ (< 0), $k \in J\backslash j$, where $\frac{\partial \alpha_j^m}{\partial \alpha_{\cdot k}} > 0$ (< 0) when $\alpha_{\cdot k}$ and $\alpha_{\cdot j}$ are m-strategic complements (substitutes).*

Proof: Given $\lambda_j^i = 1 - \lambda_i^j$ and assuming differentiability, applying comparative statics analysis to (21) gives

$$\frac{\partial \alpha_j^m}{\partial \lambda_i^j} = sign\{-\frac{\partial B_{ij}(\alpha.)}{\partial \alpha_{\cdot j}}\}. \tag{23}$$

Thus, a ceteris paribus increase in λ_i^j tends to increase (decrease) α_j^m when $\frac{\partial B_{ij}(\alpha.)}{\partial \alpha_{\cdot j}}$ is negative (positive). This yields result (i). Note from (21) that a ceteris paribus change in λ_k^i (or equivalently $(1 - \lambda_i^k)$) has no direct impact on α_j^m when $k \in J\backslash j$. Under differentiability and for $k \in J\backslash j$, it follows that the impact of λ_i^k on $\alpha_{\cdot j}$ reduces to its strategic impact: $\frac{\partial \alpha_j^m}{\partial \alpha_{\cdot k}} \frac{\partial \alpha_k^m}{\partial \lambda_i^k}$. Using (23), this yields result (ii). ■

Proposition 10 shows the impact of bargaining weights on the j-th manufacturer's quality decision $\alpha_{\cdot j}$. Result (i) states that increasing the bargaining power of any retailer relative to the j-th manufacturer (through an increase in λ_i^j) implies a decrease (increase) in quality $\alpha_{\cdot j}$ when $\frac{\partial B_{ij}(\alpha_{\cdot})}{\partial \alpha_{\cdot j}}$ is positive (negative), $i \in I$. This identifies the role of the bargaining gain $B_{ij}(\alpha_{\cdot})$ and its properties with respect to a change in $\alpha_{\cdot j}$. However, note that, in general, the effects of $\alpha_{\cdot j}$ on $B_{ij}(\alpha_{\cdot\cdot})$ can be complex: they depend on the properties of manufacturing cost C_j, revenue R_i, as well as the threat points π_i^j and π_j^i. They will be further evaluated below.

Result (ii) shows the effect on $\alpha_{\cdot j}$ (the quality produced by the j-th manufacturer) of a change in the bargaining power of retailers with respect to other manufacturers (as measured by λ_i^k, $k \in J \backslash j$). It states that the quality produced by the j-th manufacturer decreases (increases) with a rise in λ_i^k when $\frac{\partial \alpha_j^m}{\partial \alpha_{\cdot k}} \frac{\partial B_{ik}(\alpha_{\cdot})}{\partial \alpha_{\cdot k}} > 0$ (< 0), $k \in J \backslash j$. Again, this identifies the role of the bargaining gain $B_{ij}(\alpha_{\cdot})$ and its properties with respect to a change in $\alpha_{\cdot j}$. It also shows the role of strategic behavior, as captured by the strategic effect $\frac{\partial \alpha_j^m}{\partial \alpha_{\cdot k}}$. For example, in the case where increasing quality contributes to increasing the bargaining gain $B_{ik}(\alpha_{\cdot})$ (i.e., where $\frac{\partial B_{ik}(\alpha_{\cdot})}{\partial \alpha_{\cdot k}} > 0$), then a rise in the bargaining power of retailers with respect to the k-th manufacturer (as measured by $\lambda_i^k, k \in J \backslash j$) implies an increase (decrease) in the quality $\alpha_{\cdot j}$ chosen by the j-th manufacturer when $\alpha_{\cdot k}$ and $\alpha_{\cdot j}$ are m-strategic substitutes (complements). This illustrates the effects of strategic behavior on product positioning.[12]

5.2.2 Optimal positioning from the retailer's perspective

We now turn our attention to the case where the quality choice is made by retailers in the first stage of the game. This reflects the changing role of retailers over the last few years. In particular, this is motivated by the growing importance of large retailers in product positioning. Equation (22) provides the relevant characterization of the quality choice for this analysis. In this context, the strategic effects of $\alpha_{I \backslash i, J \backslash j}$ on α_{ij}^r in $\alpha_{ij}^r(\lambda_i^j, \alpha_{I \backslash i, J \backslash j})$ are relevant.

[12] The case where manufacturers offer different product quality to different retailers gives similar qualitative results. This case is presented in Appendix A.

Define the qualities α_{ij} and α_{lk} to be *r-strategic substitutes* (*r-strategic complements*) when $\alpha_{ij}^r(\lambda_i^j, \alpha_{I\backslash i, J\backslash j})$ is decreasing (increasing) in $\alpha_{lk}, l \in I\backslash i, k \in J\backslash j$. For simplicity, we limit our discussion to the case where α_{ij} is a scalar and where the optimization problem (22) has a unique interior solution. In this context, the next proposition investigates the effects of changing relative bargaining power (as captured by the $\lambda' s$) on product positioning.

Proposition 11 *Assume that the i-th retailer chooses quality α_{ij} according to (22). Then, ceteris paribus,*

(i) *an increase in λ_i^j implies an increase (decrease) in quality α_{ij} when $\frac{\partial B_{ij}(\alpha.)}{\partial \alpha_{ij}} > 0$ (< 0), $i \in I, j \in J$;*

(ii) *an increase in λ_l^k implies an increase (decrease) in quality α_{ij} when $\frac{\partial \alpha_{ij}^r}{\partial \alpha_{lk}} \frac{\partial B_{lk}(\alpha.)}{\partial \alpha_{lk}} > 0$ (< 0), $l \in I\backslash i, k \in J\backslash j$, where $\frac{\partial \alpha_{ij}^r}{\partial \alpha_{lk}} > 0$ (< 0) when α_{ij} and α_{lk} are r-strategic complements (substitutes).*

Proof: Assuming differentiability, applying comparative statics analysis to (22) gives

$$\frac{\partial \alpha_{ij}^r}{\partial \lambda_i^j} = sign\{\frac{\partial B_{ij}(\alpha)}{\partial \alpha_{ij}}\}. \tag{24}$$

Thus, a ceteris paribus increase in λ_i^j tends to increase (decrease) α_{ij}^r when $\frac{\partial B_{ij}(\alpha)}{\partial \alpha_{ij}}$ is positive (negative). This yields result (i). Note from (22) that a ceteris paribus change in λ_l^k has no direct impact on α_{ij}^r when $l \in I\backslash i, k \in J\backslash j$. Under differentiability and for $l \in I\backslash i, k \in J\backslash j$, it follows that the impact of λ_l^k on α_{ij} reduces to its strategic impact: $\frac{\partial \alpha_{ij}^r}{\partial \alpha_{lk}} \frac{\partial \alpha_{lk}^r}{\partial \lambda_l^k}$. Using (24), this yields result (ii). ■

Proposition 11 shows the impact of bargaining weights on the quality decision α_{ij} made by the i-th retailer for products obtained from the j-th manufacturer. Result (i) states that increasing the bargaining power of the i-th retailer relative to the j-th manufacturer (through an increase in λ_i^j) implies an increase (decrease) in quality α_{ij} when $\frac{\partial B_{ij}(\alpha)}{\partial \alpha_{ij}}$ is positive (negative), $i \in I, j \in J$. Again, this identifies the role of the bargaining gain $B_{ij}(\alpha)$ and its properties with respect to changes in α_{ij}.

Result (ii) shows the effect on α_{ij} (the quality chosen by the i-th retailer for products obtained from the j-th manufacturer) of a change in the relative bargaining power of other retailers and manufacturers (as measured by λ_l^k, $l \in I\backslash i, k \in J\backslash j$). It states that the quality α_{ij} increases (decreases) with a rise in λ_l^k when $\frac{\partial \alpha_{ij}^r}{\partial \alpha_{lk}} \frac{\partial B_{lk}(\alpha.)}{\partial \alpha_{lk}} > 0$ (< 0), $l \in I\backslash i, k \in J\backslash j$. Again, this identifies the role of the bargaining gain $B_{ij}(\alpha)$ and its properties with respect to a change in α_{ij}. It also shows the role of strategic behavior, as captured by the strategic effect $\frac{\partial \alpha_{ij}^r}{\partial \alpha_{lk}}$. For example, in the case where increasing quality contributes to increasing the bargaining gain $B_{lk}(\alpha)$ (i.e., where $\frac{\partial B_{lk}(\alpha)}{\partial \alpha_{lk}} > 0$), then a rise in the bargaining power of the l-th retailer with respect to the k-th manufacturer (as measured by $\lambda_l^k, l \in I\backslash i, k \in J\backslash j$) implies a decrease (increase) in the quality α_{ij} when α_{lk} and α_{ij} are r-strategic substitutes (complements).

Comparing the results stated in Propositions 10 and 11 is instructive. In particular, result (i) of each proposition shows that changing the bargaining weight λ_i^j tends to have opposite effects on the quality choice α_{ij} depending on who has control of the quality decision and product positioning. For example, in the case where increasing quality α tends to increase the bargaining gain B_{ij}, then a rise in the bargaining power of the i-th retailer (as measured by λ_i^j) would *decrease* product quality α_{ij} when the quality decision is made by the j-th manufacturer, but it would *increase* product quality α_{ij} when the quality decision is made by the i-th retailer. This shows the presence of important trade-offs between bargaining power, control, and quality management. Further explorations of these tradeoffs are presented next.

6 Bargaining Outcomes using Simulation

Given the complexity of quality choices, this section explores the determinants of product quality in a marketing channel using simulation techniques. We consider quality choices in the context of a vertically differentiated product market.[13] To keep the analysis tractable, we simulate a market with two retailers and two manufacturers with manufacturer A producing

[13] Note that, under purely horizontally differentiated products where the cost of differentiation is zero, the choice of quality is trivial.

and selling high quality α_A to both retailers and manufacturer B producing low quality α_B for both retailers with $\alpha_A > \alpha_B$. Following Mussa and Rosen (1978) we specify the consumer's utility function as $U_m = \theta_m \alpha_j - p_{ij}$ where θ_m is the income of consumer m, α_j is the quality product produced by manufacturer j and p_{ij} is the price charged by retailer i for product of quality α_j. For simplicity, we assume that consumer's income (θ) is uniformly distributed over the region $[0, 1]$. The demands for manufacturers A and B from the i-th retailer are:

$$q_{iA} = 1 - \frac{p_{iA} - p_{iB}}{\alpha_A - \alpha_B} \text{ and } q_{iB} = \frac{p_{iA} - p_{iB}}{\alpha_A - \alpha_B} - \frac{p_{iB}}{\alpha_B} \tag{25}$$

On the cost side, we use the following specification:

$$C_j = c \sum_i \alpha_j^2 q_{ij} \tag{26}$$

which implies that the quality choice influences the marginal cost of production. It is easy to compute the optimal qualities from the channel's perspective: $(\alpha_A^*, \alpha_B^*) = (\frac{2}{5c}, \frac{1}{5c})$.

6.1 Existence of equilibria in qualities: QF versus TPT

As mentioned before, we formalize the quality choice as a two-step process: in the first stage, manufacturers or retailers choose quality of the product; and in the second stage, they bargain over the total channel profit using either a quantity forcing contract (QF) or a two part tariff contract (TPT). For simplicity, we only consider pure strategy equilibria in quality. Using our specification, the following proposition shows how existence of equilibrium under QF contracts depend on who makes the quality choice decision.

Proposition 12 *Under quantity forcing (QF) contracts, there is no pure strategy Nash equilibrium if quality choice decisions are made non cooperatively by the manufacturers.*

Proof: Without loss of generality assume that the distribution of bargaining power is symmetric such that $\lambda_1^A = \lambda_1^B = \lambda_2^A = \lambda_2^B = \lambda$ is the common bargaining power of both retailers. Using envelope theorem on optimum profit specification in equations (1) and (2) we obtain: $\frac{d\Pi_A}{d\alpha_A} = -1/2(c\alpha_B - 1 + 3c\alpha_A)(c\alpha_A - 1 + c\alpha_B)(\lambda - 1)$, and $\frac{d\Pi_B}{d\alpha_B} = -(1/2)\alpha_A^2 c^2(\lambda - 1)$. It follows that there is no interior solution with $\alpha_A > 0$, $\alpha_B > 0$, and $c > 0$. ■

Proposition 12 implies that, in our simulation context, leaving the quality choice decisions to the manufacturers will generate conflicts among market participants. This can be seen by looking at equation (2). Intuitively, the channel conflict arises because the lower quality manufacturer can get a larger share of the channel profit by increasing quality as much as possible. She will prefer a quality that is higher or equal to the quality of higher quality manufacturer. Such "leap frogging" strategy to quality by the low quality manufacturer will lead to higher joint revenue (R_i) and lower threat point revenue ($\hat{R}_i^{-j}$) in equation (2), thereby increasing profits of the low quality manufacturer.

On the other hand, when a retailer makes the quality choice decisions it can be easily shown that she can internalize all the externalities such that quality is optimally spaced within the store. It is also interesting to investigate the situation where a retailer chooses one of the quality and a manufacturer the other one (this will be similar to a case of competition between a private label and a national brand). In this case we can again show that there exists no pure strategy equilibrium. If retailer 1 makes the high quality choice and manufacturer B makes the low quality choice, we still have that $\frac{d\Pi_B}{d\alpha_B} = -(1/2)\alpha_A^2 c^2(\lambda - 1) > 0$ as $\lambda \leq 1$ and $c > 0$ and for $\alpha_A > 0$. This implies that the low quality manufacturer will have the incentive to leap frog the high quality product. This condition also holds when manufacturer A chooses α_A and the retailer chooses α_B.[14]

Compared to QF contract, under TPT contract there exists an equilibrium with two products when quality choice decisions are made by the manufacturers.

Proposition 13 *Under two-part tariff (TPT) contracts, feasible equilibria exist with two manufacturers when quality decisions are made by them. In addition, manufacturers always*

[14] In this case, we get four solution candidates: $\{\alpha_A = 0, \alpha_B = \frac{1}{c}\}$, $\{\alpha_B = 0, \alpha_A = \frac{1}{c}\}$, $\{\alpha_B = \frac{2}{c(\lambda+2)}, \alpha_A = \frac{\lambda}{c(\lambda+2)}\}$, $\{\alpha_B = \frac{4-3\lambda}{c(10-3\lambda)}, \alpha_A = \frac{2}{c(10-3\lambda)}\}$. Under the first two solutions, only one product exists at equilibrium. The fourth solution yields $\alpha_A < \alpha_B$, which is inconsistent with our underlying assumption of our demand specification. Finally, the third solution is feasible, but equilibrium implies $q_{iA} = 0$.

choose the channel profit maximizing qualities.

Proof: Using the envelope theorem, we get: $\frac{d\Pi_A}{d\alpha_A} = \frac{1}{2}\left(1 + c\left(\alpha_B - 3\alpha_A\right)\right)\left(c\left(\alpha_B + \alpha_A\right) - 1\right)(\lambda - 1)$ and $\frac{d\Pi_B}{d\alpha_B} = \frac{1}{2}c^2\alpha_A\left(2\alpha_B - \alpha_A\right)(\lambda - 1)$. There are four possible solutions: $\{\alpha_A = 0, \alpha_B = -\frac{1}{c}\}$, $\{\alpha_A = 0, \alpha_B = \frac{1}{c}\}$, $\{\alpha_B = \frac{1}{3c}, \alpha_A = \frac{2}{3c}\}$, $\{\alpha_B = \frac{1}{5c}, \alpha_A = \frac{2}{5c}\}$. The first two solutions involve only one product in the market. The third solution leads to zero profit for manufacturer A. The fourth solution is the only equilibrium with two products. Note that when $\lambda = 1$, the equilibrium is indeterminate as manufacturers do not make any profits. So in such situation we assume that manufacturers will act in the interest of the retailers. ■

Intuitively under TPT contract retailers can compensate manufacturers adequately with side payments to neutralize any opportunistic behavior from them. In fact, the side payments are so efficient that the proposition 13 also implies that the equilibrium quality will be independent of the bargaining power. Hence, under TPT, the manufacturers' profits are proportional to the total channel profit implying that their quality choice of manufacturers (at the Nash equilibrium) are efficient. In other words, TPT are sufficiently sophisticated contracts here so that the issue of maximizing channel profit (with manufacturers choosing qualities) and sharing the surplus can be perfectly disentangled. This outcome contrasts strongly with the QF contracts situation where there exists no Nash equilibrium when manufacturers control qualities.

6.2 Simulated Market Outcomes under QF and TPT Contracts

Using the demand (25) and the cost specifications (26), we simulate the outcomes in the marketing channel.[15] It should be noted here that in this market, some scenarios involve situations where some market participants would decide to exit (i.e., they would not survive the bargaining process). We only present results of scenarios where all market participants are present in equilibrium at the end of the bargaining process. This means that the bargaining outcomes presented in this section have the following properties: $(\alpha_A > \alpha_B > 0)$, $(p_{iA}, p_{iB} >$

[15] We also impose that $c = 0.025$.

0), $(q_{iA}, q_{iB} > 0)$, $(\Pi_i, \Pi_A, \Pi_B \geq 0)$. By focusing outcomes where all the players survive we will be able replicate scenarios where both private labels and national brand products coexist, one of the major focus of this research.[16] Tables 1-8 present simulation results under QF and TPT contracts. Under each contract type, we simulate bargaining outcomes under the following situations: [1] retailer i makes both quality choices[17]; [2] manufacturers makes both quality choices; [3] retailer makes the high quality α_A and manufacturer makes low quality α_B choice; and [4] retailer makes the α_B decision and manufacturer A controls its quality α_A. In terms of bargaining power, we simulate two situations: [1] retailer i has equal bargaining power with the manufacturers (i.e., $\lambda_i^A = \lambda_i^B$); [2] retailer i has unequal bargaining power with the manufacturers (i.e., $\lambda_i^A \neq \lambda_i^B$). Finally, to make the simulation outcomes comparable, we present the results only for selected combinations of bargaining power. In the case of $\lambda_i^A = \lambda_i^B$ we present results for the following combinations of λ_i^A and λ_i^B: (0, 0), (0.25, 0.25), (0.5, 0.5), (0.75, 0.75) and (1, 1). And in the case of $\lambda_i^A \neq \lambda_i^B$ we present results for the following combinations of λ_i^A and λ_i^B: (0, 0.25), (0.25, 0), (0.25, 0.75), (0.75, 0.25), (1, 0) and (0, 1).[18]

Retailers' choices Table 1 and 2 present equilibrium outcomes where retailers make the quality choices under equal and unequal bargaining power. Note that in Table 1 under equal bargaining power when the retailer's bargaining power is low (i.e. $\lambda_{ij} < 0.5$) and under TPT we fail to find any equilibrium. This is because with low bargaining power, retailers fail to extract enough surplus to make the side payments and deal with both manufacturers. Under equal bargaining power, equilibrium outcomes also suggest that an increase in the retailers' bargaining power tends to increase retailers' profit (as expected) while the difference between high and low quality products widens. This is because, under low bargaining power,

[16] The process of eliminating one of the products in the bargaining outcome is an interesting research question. Exploring this issue is a good topic for future research.

[17] Recall that due to symmetry between the retailers, they both agree on the optimal choice of qualities.

[18] Of these different permutations and combinations of bargaining and quality choices, we focus our attention on scenarios where a pure-strategy equilibrium exists with two products.

the retailer uses quality as bargaining chip, implying that qualities are chosen close to each other to extract more surplus from the manufacturers. On the other hand, under higher bargaining power, retail profit depends less and less on threat points. This implies that the retailer positions product qualities with increasing distance to cater to a larger customer base. However, the effect varies across consumers: consumers of high quality products gain when retailers become very powerful, while the consumers of low quality products loose. The effects on consumer welfare are due to both price and quality changes. For example, both the price and the quality of product B (low-quality) are always negatively affected by a rise in retailers' bargaining power. However, the effects on the quality and price of product A (high quality) are not uniform: the quality and price of product A first increase and then decrease with rise in retailers' power.

Table 2 presents simulated results when the bargaining power is heterogeneous or unequal between retailers and manufacturers and retailers make the quality choices. Note that with TPT and unequal bargaining power between retailers and manufacturers, no equilibrium exists. Here under the QF contracts, the strategic role of bargaining power is more pronounced. When the bargaining power of the retailer i is low (i.e. $\lambda_{ij} < 0.25$), the retailer pushes for higher quality of α_B from the low quality manufacturer and lower quality from the high quality manufacturer. Although different consumer groups gain differently from the differences in bargaining power, relative retail bargaining power is positively correlated with consumer welfare. As retailers' bargaining power increases against the high quality manufacturer A, then high quality consumers gain (compare scenarios 3 and 4). On the other hand, low quality consumers gain when retailers' bargaining power increases against the low quality manufacturer B.

In summary, as the bargaining power of one of the retailer increases against any of the manufacturers, retailer can extract more of the surplus from the manufacturers, while attracting the marginal consumer who benefits from higher quality of the products. This leads to a situation where a rise in retailers' bargaining power is beneficial to consumers overall.

This is an example of Galbraith's (1954) notion of countervailing marketing power, where powerful retailers generate better deal for consumers than smaller less powerful retailers.

Manufacturers' choices Table 3 and 4 present simulated results where manufacturers make all quality choices either under equal (2F), and unequal (2G) bargaining power. Unlike the case of QF contract, under TPT contract it is possible to have equilibrium where manufacturers make the quality choices. Following proposition 13, the quality choice is independent of the bargaining power and coincides with the channel profit maximizing one. As the equilibrium price, quality, and quantity remain the same under different scenarios, consumer welfare is not affected by changes in bargaining power.

Asymmetric situations Table 5 presents results where retailer i makes the low quality decision α_B and manufacturer A chooses α_A under equal bargaining powers. This would represent the competition between a national brand and a private label of lower quality. It follows that this implies some increase in quality in the marketing channel for both products (compare to the scenarios in Table 3 with the same bargaining power). In this case, a retailer would choose a higher quality α_B to increase their threat points and thus their bargaining position. This in turn pushes α_A to higher levels. On the consumer side, improvement in the low quality product helps low quality consumers but improvement in the high quality product hurts high quality consumers.

Table 6 presents results similar to 5 but under unequal bargaining power. Note that with positive bargaining powers, channel quality choice becomes stable (i.e. scenarios 6, 10, and 12). Under such scenarios, each manufacturer is induced to produce optimal channel profit maximizing quality. This is driven by the fact that under TPT, quality choices by manufacturers are independent of the channel bargaining power. And a retailer can take advantage of this condition only when it has positive bargaining powers against both the manufacturers.

Table 7 presents results with retailers now choosing α_A while manufacturer B controls

α_B under equal bargaining powers. This would represent a situation where a national brand competes with a private label of higher quality. Compared to scenarios in Tables 3 and 4 under TPT, both qualities are now lower. In this case, retailers has an incentive to lower quality to increase the threat points against manufacturer B and thereby improve its bargaining position. And the optimal strategy for manufacturer B is to move away from α_A by also lowering quality. With lower qualities, prices are also lower. The net effect is an increase in channel profit, a slight increase in aggregate consumer surplus. And this gain in consumer surplus mainly comes from low quality consumers as high quality consumers suffer. Compared to outcomes in Table 5, this means an increase in overall efficiency (as reflected by an increase in total surplus).

Table 8 presents results similar to Table 7 but under unequal bargaining power. Note that under both scenarios as long as the bargaining power of the retailers are greater than zero, social welfare do not change, and the choices of quality remain the same. This outcome is similar to the one obtained under TPT when manufacturer makes the quality choices (see Table 3 and 4). From Tables 6 and 8, as long as the bargaining power of the retailers is greater than zero (scenario 6, 8 and 12 in Table 6, and scenario 6, 8 and 10 in Table 8), note that total social welfare does not change with changing bargaining power. Interestingly this is not the case when retailers have equal bargaining power as in Table 5 and 7. This implies with unequal bargaining power retailers get back the power to compensate the manufacturers to bring back stable quality choices as bargaining power changes.

For comparison, we also estimated the market outcomes when the two products are produced by two manufacturers and sold directly to consumers. Under such a scenario, the two firms would have made the following quality choices: $\alpha_A = 14.76$ and $\alpha_B = 11.71$. Compared to the best case scenario presented in the tables, firms would have chosen quality closer to each other. But this choice of quality significantly hurts high quality consumers compared to low quality consumers.

Overall our simulation results conform to the analytical results presented in the paper.

It should be noted here that when retailers make the quality choices the channel profit maximizing outcome is never reached except in the trivial case when retailers have all the bargaining power. It should also be mentioned here that once we move from QF to TPT contracts under the same bargaining power structure not only channel profit increases but also consumer surplus and social welfare also rise. This is not surprising because by increasing the complexity of the contracts we provide more flexibility to increase channel efficiency. This increase in efficiency inside the channel also benefits consumers.

7 Concluding Remarks

In this paper, we develop a general bargaining model of a marketing channel with bilateral negotiations between retailers and manufacturers. We analyze the equilibrium outcomes under two types of channel contracts: quantity forcing and two part tariff contracts. Both contracts eliminate double marginalization problems in a marketing channel in the absence of direct competition between retailers. We show that, compared to quantity forcing contracts, two part tariff allows for more flexibility with respect to off-equilibrium path decisions for retailers. The nature of contracts hence influences the way surplus is shared between all parties in the channel.

Our bargaining model suggest that with the increase in bargaining power of the retailers, total profit becomes correlated with the total costs of the manufacturers. As a result, retailers will become more sensitive to manufacturers costs as their bargaining power in the channel improves. This also implies that powerful retailers like Wal-Mart will ask for more cost related information from their suppliers than neighborhood mom and pop stores. In fact if a retailer has all the bargaining power, then it only pays manufacturers for the incremental cost of its products. But it is still possible for large manufacturers to make profits even with limited bargaining power. This is because incremental cost payments by the retailers will be based on average costs of producing products for all the retailers. As a result, a manufacturer will be able to profit from the average cost differences between producing for the retailer and producing for rest of the retailers. This implies there is a benefit of having large plants producing for all the retailers in a market. It is probable that this may be the reason why giant production plants in China can flourish even under tremendous pressures to reduce cost from retailers like Wal-Mart and Target. In other words, powerful retailers do have interest in location, plant size and plant management decisions of the manufacturers.

Similarly, retailers can have positive profit even when retail bargaining power is limited. In this case, retailer's profit comes from internalization of cross price effects. This profit is analogous to gate keeping fees paid by the manufacturers to retailers. Also, a retailer with weak bargaining power will be less sensitive to cost changes of the manufacturers. And with limited bargaining power, retailers' profit will come from the difference between threat point payoffs and joint profit maximizing revenues. Here the retailer that maximizes profit will play each of the manufacturers against the other without taking into account the cost structures of the manufacturers. This may explain why sometimes weaker retailers (such as K-Mart during its bankruptcy period) develop such contentious relationships with its suppliers.

Our analysis also illustrates the complexity of the quality choices that can play dual roles in the marketing channel: on the one hand appropriate quality choice will optimize revenue on the demand side but on the supply side quality choice will help to determine the threat points of the channel players thereby influencing the share of the channel profits. In the case of retailers, the difference between the chosen product qualities and bargaining power is positively correlated. This is because with low bargaining power retailers can increase the threat points by choosing qualities with minimum difference. And as the bargaining power increases, influence of the threat points in profit diminishes and as a result a retailer can choose qualities to maximize profit and serve larger consumer base. Our analytical and simulation results also show how contract designs (QF vs. TPT) influences quality choice outcomes. Under QF contracts, it is not possible to have equilibrium, in the context of vertically differentiated market, with manufacturers making the quality choices. This is driven by the fact under QF contracts manufacturers have incentives to leapfrog each other, because by raising the quality level they increase the threat points thereby increase their share of the pie. This is not true in the case of TPT contracts. Under TPT contract, side payments by the retailers remove the incentive to leapfrog each other by the manufacturers. In fact, in the context of our simulation model, choice of quality by the manufacturers can be independent of the bargaining power in the channel. The richness of the outcomes presented in this paper does correlate well with the anecdotal real world evidence. Of the powerful retailers, Wal-Mart is not known for aggressive private label strategy although they are known for insisting on specific qualities from the suppliers. On the other hand, Target has been very aggressive with their private label strategy. Our findings also complements the findings of Sayman, Hoch and Raju (2002) regarding product positioning, where they show how store brands position will be influenced by the demand strengths of the national brands. By deviating from the standard principal agent model we show that choice of qualities thereby positioning of brands in the stores will also be influenced by the bargaining powers of the channel players. From the retailers perspective the decision to introduce private labels will depend on whether manufacturers are willing to provide the optimal quality contingent on bargaining power. A weak retailer will prefer products to be positioned as close to each other to increase threat points but on the other hand powerful retailer will prefer products to be positioned further apart.

Our present analysis points to a need for further research. It would be useful to extend our investigation to take into account direct retail level competition. Finally, our present model only considers quality choice in a vertically differentiated product market. Future explorations of quality choice are needed in markets where products are both horizontally and vertically differentiated and both complementary and substitute products exist.

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Appendix

A Proof of proposition 1

First, consider the case of quantity forcing contracts. Let the aggregate profit-maximizing decision rule for quantities be $q^*(\alpha) \in \arg\max_{q \geq 0}\{\Pi(q, \alpha)\}$. Consider some alternative decision rule $q^a(\alpha)$ satisfying $q^a(\alpha) \notin \arg\max_{q \geq 0}\{\Pi(q, \alpha)\}$. Given aggregate profit $\Pi(q, \alpha) = \sum_{i \in I} R_i(q_i, \alpha_i) - \sum_{j \in J} C_j(q_j, \alpha_j)$, it follows that $\sum_{i \in I} R_i(q_i^*(\alpha), \alpha_i) - \sum_{j \in J} C_j(q_j^*(\alpha), \alpha_j) > \sum_{i \in I} R_i(q_i^a(\alpha), \alpha_i) - \sum_{j \in J} C_j(q_j^a(\alpha), \alpha_j)$. This implies $R_i(q_i^*(\alpha), \alpha_i) - C_j(q_j^*(\alpha), \alpha_j) > R_i(q_i^a(\alpha), \alpha_i) - C_j(q_j^a(\alpha), \alpha_j)$ for some $i \in I$ and $j \in J$. Since the objective function in (4) is an increasing function of π_i and π_j, it follows that the i-th and j-th agent would never choose $q_{ij}^a(\alpha)$, a contradiction. Thus, conditional on α, bilateral bargaining represented by (4) will necessarily lead to choosing $q^*(\alpha)$, the aggregate profit-maximizing quantity choice.

Second, consider the case of two-part tariffs where $T_{ij} = F_{ij} + w_{ij} q_{ij}$, $i \in I$, $j \in J$. Noting that $q_{ij}^*(\alpha) \in \arg\max_{q_{ij} \geq 0}\{\Pi(q, \alpha)\} = \arg\max_{q_{ij} \geq 0}\{\pi_i + \pi_j\}$, the associated Kuhn-Tucker conditions are $\partial R_i(q_i^*(\alpha), \alpha_i)/\partial q_{ij} \leq \partial C_j(q_j^*(\alpha), \alpha_j)/\partial q_{ij}$, and $[\partial R_i(q_i^*(\alpha), \alpha_i)/\partial q_{ij} - \partial C_j(q_j^*(\alpha), \alpha_j)/\partial q_{ij}] q_{ij} = 0$. It follows that the prices $w_{ij}^*(\alpha) = \partial R_i(q_i^*(\alpha), \alpha_i)/\partial q_i$ are consistent with profit-maximizing quantity decisions for the i-th retailer as well as the j-th manufacturer, $i \in I, j \in J$. Such prices are therefore consistent with the maximization problem (4).

B The case of specific qualities for retailers

Proposition 10 analyzes the case where each manufacturer sells the same quality to all retailers. This Appendix considers an alternative scenario where each manufacturer can choose different qualities α_{ij} for different retailers. Let A_{ij} denote the feasible set α_{ij}, with $\alpha_{ij} \in A_{ij}$. Using equation (6), it follows that choice of α_{ij} satisfies

$$\alpha_{ij}^m(\lambda_j^i, \alpha_{I \backslash i, J \backslash j}) \in \arg\max_{\alpha_{ij} \in A_{ij}} \{\pi_j^i + \lambda_j^i \cdot B_{ij}(\alpha)\}, \tag{27}$$

where $B_{ij}(\alpha) = \pi_i(q_i^*(\alpha), \alpha_i) + \pi_j(q_j^*(\alpha), \alpha_j) - \pi_i^j - \pi_j^i$ is the bargaining gain obtained jointly by the i-th retailer and j-th manufacturer. Comparative static analysis applied to (27) yields

$$\frac{\partial \alpha_{ij}^m}{\partial \lambda_i^j} = sign\{-\frac{\partial B_{ij}(\alpha)}{\partial \alpha_{ij}}\}. \tag{28}$$

Noting the similarities between (28) and (23) and following the same reasoning presented in Proposition 10, we obtain the following results.

Assuming that the manufacturers choose quality according to (27), then

1. an increase in λ_i^j implies a decrease (increase) in the quality α_{ij} when $\frac{\partial B_{ij}(\alpha.)}{\partial \alpha_{\cdot j}} > 0$ (< 0), $i \in I$;

2. an increase in λ_l^k implies a decrease (increase) in the quality α_{ij} when $\frac{\partial \alpha_{ij}^m}{\partial \alpha_{lk}} \frac{\partial B_{lk}(\alpha.)}{\partial \alpha_{ik}} > 0$ (< 0), $l \in I \backslash i, k \in J \backslash j$, where $\frac{\partial \alpha_{ij}^m}{\partial \alpha_{lk}} > 0$ (< 0) when α_{lk} and α_{ij} are m-strategic complements (substitutes).

Table 1: Market outcomes with Quality Choice by Retailer *i* and Equal Bargaining Power

Scenario	Contract (Bargaining Power)	α_A	α_B	q_{iA}	q_{iB}	p_{iA}	p_{iB}	Π_i	π_A	π_B	Channel Profit	Consumer Surplus from HQ	Consumer Surplus from LQ	Total Consumer Surplus	F_{iA}	F_{iB}	Social Surplus
1	QF (0, 0)	No solutions with two brands															
2	*TPT (0, 0)*	*No solutions with two brands*															
3	QF (0.25, 0.25)	14.775	11.866	0.167	0.185	10.116	7.693	0.936	0.618	0.607	3.097	0.572	0.202	1.55			4.65
4	*TPT (0.25, 0.25)*	*No solutions with two brands*															
5	QF (0.5, 0.5)	15.745	10.709	0.169	0.197	10.971	6.788	1.147	0.451	0.415	3.160	0.583	0.207	1.58			4.74
6	*TPT (0.5, 0.5)*	*No solutions with two brands*															
7	QF (0.75, 0.75)	16.227	9.623	0.177	0.203	11.405	5.969	1.368	0.254	0.198	3.188	0.599	0.198	1.59			4.78
8	*TPT (0.75, 0.75)*	*15.261*	*10.983*	*0.172*	*0.191*	*10.542*	*6.999*	*1.512*	*0.063*	*0.056*	*3.143*	*0.586*	*0.200*	1.57	*0.032*	*0.028*	*4.71*
9	QF (1, 1)	16.000	8.000	0.200	0.200	11.200	4.800	1.600	0.000	0.000	3.200	0.640	0.160	1.60			4.80
10	*TPT (1, 1)*	*16.000*	*8.000*	*0.200*	*0.200*	*11.200*	*4.800*	*1.600*	*0.000*	*0.000*	*3.200*	*0.640*	*0.160*	1.60	*0.000*	*0.000*	*4.80*

Table 2: Market outcomes with Quality Choice by Retailer *i* and Unequal Bargaining Power

Scenario	Contract (Bargaining Power)	α_A	α_B	q_{iA}	q_{iB}	p_{iA}	p_{iB}	Π_i	π_A	π_B	Channel Profit	Consumer Surplus from HQ	Consumer Surplus from LQ	Total Consumer Surplus	F_{iA}	F_{iB}	Social Surplus
1	QF (0, 0.25)	15.238	13.333	0.143	0.190	10.522	8.889	0.847	0.622	0.726	3.041	0.518	0.242	1.52			4.56
2	*TPT (0, 0.25)*	*No solutions with two brands*															
3	QF (0.25, 0)	13.333	11.429	0.190	0.167	8.889	7.347	0.847	0.726	0.635	3.054	0.605	0.159	1.53			4.58
4	*TPT (0.25, 0)*	*No solutions with two brands*															
5	QF (0.25, 0.75)	19.864	12.886	0.091	0.248	14.864	8.519	1.217	0.245	0.397	3.075	0.372	0.397	1.54			4.61
6	*TPT (0.25, 0.75)*	*No solutions with two brands*															
7	QF (0.75, 0.25)	13.873	6.613	0.244	0.173	9.342	3.853	1.228	0.413	0.298	3.168	0.692	0.099	1.58			4.75
8	*TPT (0.75, 0.25)*	*No Solutions with Two Brands*															
9	QF (1, 0)	No Solutions with Two Brands															
10	*TPT (1, 0)*	*No Solutions with Two Brands*															
11	QF (0, 1)	No Solutions with Two Brands															
12	*TPT (0, 1)*	*No Solutions with Two Brands*															

Table 3: Market outcomes with Quality Choice by Manufacturers and Equal Bargaining Power

Scenario	Contract (Bargaining Power)	α_A	α_B	q_{iA}	q_{iB}	p_{iA}	p_{iB}	Π_i	π_A	π_B	Channel Profit	Consumer Surplus from HQ	Consumer Surplus from LQ	Total Consumer Surplus	F_{iA}	F_{iB}	Social Surplus
1	QF (0, 0)	No solutions with two brands															
2	*TPT (0, 0)*	*16.000*	*8.000*	*0.200*	*0.200*	*11.200*	*4.800*	*1.120*	*0.640*	*0.320*	*3.200*	*0.160*	*0.640*	1.60	*0.320*	*0.160*	*4.80*
3	QF (0.25, 0.25)	No solutions with two brands															
4	*TPT (0.25, 0.25)*	*16.000*	*8.000*	*0.200*	*0.200*	*11.200*	*4.800*	*1.240*	*0.480*	*0.240*	*3.200*	*0.160*	*0.640*	1.60	*0.240*	*0.120*	*4.80*
5	QF (0.5, 0.5)	No solutions with two brands															
6	*TPT (0.5, 0.5)*	*16.000*	*8.000*	*0.200*	*0.200*	*11.200*	*4.800*	*1.360*	*0.320*	*0.160*	*3.200*	*0.160*	*0.640*	1.60	*0.160*	*0.080*	*4.80*
7	QF (0.75, 0.75)	No solutions with two brands															
8	*TPT (0.75, 0.75)*	*16.000*	*8.000*	*0.200*	*0.200*	*11.200*	*4.800*	*1.480*	*0.160*	*0.080*	*3.200*	*0.160*	*0.640*	1.60	*0.080*	*0.040*	*4.80*
9	QF (1, 1)	No solutions with two brands															
10	*TPT (1, 1)*	*No solutions with two brands*															

Table 4: Market outcomes with Quality Choice by Manufacturers and Unequal Bargaining Power

Scenario	Contract (Bargaining Power)	α_A	α_B	q_{iA}	q_{iB}	p_{iA}	p_{iB}	Π_i	π_A	π_B	Channel Profit	Consumer Surplus from HQ	Consumer Surplus from LQ	Total Consumer Surplus	F_{iA}	F_{iB}	Social Surplus
1	QF (0, 0.25)	No solutions with two brands															
2	*TPT (0, 0.25)*	*16.000*	*8.000*	*0.200*	*0.200*	*11.200*	*4.800*	*1.160*	*0.640*	*0.240*	*3.200*	*0.160*	*0.640*	1.60	*0.320*	*0.120*	*4.80*
3	QF (0.25, 0)	No solutions with two brands															
4	*TPT (0.25, 0)*	*16.000*	*8.000*	*0.200*	*0.200*	*11.200*	*4.800*	*1.200*	*0.480*	*0.320*	*3.200*	*0.160*	*0.640*	1.60	*0.240*	*0.160*	*4.80*
5	QF (0.25, 0.75)	No solutions with two brands															
6	*TPT (0.25, 0.75)*	*16.000*	*8.000*	*0.200*	*0.200*	*11.200*	*4.800*	*1.320*	*0.480*	*0.080*	*3.200*	*0.160*	*0.640*	1.60	*0.240*	*0.040*	*4.80*
7	QF (0.75, 0.25)	No solutions with two brands															
8	*TPT (0.75, 0.25)*	*16.000*	*8.000*	*0.200*	*0.200*	*11.200*	*4.800*	*1.400*	*0.160*	*0.240*	*3.200*	*0.160*	*0.640*	1.60	*0.080*	*0.120*	*4.80*
9	QF (1, 0)	No solutions with two brands															
10	*TPT (1, 0)*	*No solutions with two brands*															
11	QF (0, 1)	No solutions with two brands															
12	*TPT (0, 1)*	*No solutions with two brands*															

Table 5: Market outcomes with HQ Choice by the Manufacturer A, LQ Choice by the Retailer i and Equal Bargaining Power

Scenario	Contract	α_A	α_B	q_{iA}	q_{iB}	p_{iA}	p_{iB}	Π_i	π_A	π_B	Channel Profit	Consumer Surplus from HQ	Consumer Surplus from LQ	Total Consumer Surplus	F_{iA}	F_{iB}	Social Surplus
1	QF (0, 0)	No solutions with two brands															
2	*TPT (0, 0)*	*No solutions with two brands*															
3	QF (0.25, 0.25)	No solutions with two brands															
4	*TPT (0.25, 0.25)*	*18.46*	*15.38*	*0.077*	*0.231*	*13.491*	*10.651*	*1.359*	*0.027*	*0.205*	*2.949*	*0.410*	*0.328*	1.47	*0.014*	*0.102*	*4.42*
5	QF (0.5, 0.5)	No solutions with two brands															
6	*TPT (0.5, 0.5)*	*17.778*	*13.333*	*0.111*	*0.222*	*12.840*	*8.889*	*1.427*	*0.055*	*0.165*	*3.073*	*0.329*	*0.439*	1.54	*0.027*	*0.082*	*4.61*
7	QF (0.75, 0.75)	No solutions with two brands															
8	*TPT (0.75, 0.75)*	*17.072*	*11.215*	*0.146*	*0.213*	*12.179*	*7.180*	*1.502*	*0.063*	*0.088*	*3.155*	*0.255*	*0.533*	1.58	*0.031*	*0.044*	*4.73*
9	QF (1, 1)	No solutions with two brands															
10	*TPT (1, 1)*	*No solutions with two brands*															

Table 6: Market outcomes with HQ Choice by the Manufacturer A, LQ Choice by the Retailer i and Unequal Bargaining Power

Scenario	Contract	α_A	α_B	q_{iA}	q_{iB}	p_{iA}	p_{iB}	Π_i	π_A	π_B	Channel Profit	Consumer Surplus from HQ	Consumer Surplus from LQ	Total Consumer Surplus	F_{iA}	F_{iB}	Social Surplus
1	QF (0, 0.25)	No solutions with two brands															
2	*TPT (0, 0.25)*	*18.620*	*15.859*	*0.069*	*0.233*	*13.643*	*11.073*	*1.349*	*0.026*	*0.191*	*2.915*	*0.299*	*0.430*	1.46	*0.013*	*0.096*	*4.37*
3	QF (0.25, 0)	No solutions with two brands															
4	*TPT (0.25, 0)*	*No solutions with two brands*															
5	QF (0.25, 0.75)	No solutions with two brands															
6	*TPT (0.25, 0.75)*	*17.78*	*13.33*	*0.11*	*0.22*	*12.84*	*8.89*	*1.45*	*0.08*	*0.08*	*3.073*	*0.33*	*0.44*	1.54	*0.04*	*0.04*	*4.61*
7	QF (0.75, 0.25)	No solutions with two brands															
8	*TPT (0.75, 0.25)*	*17.78*	*13.33*	*0.11*	*0.22*	*12.84*	*8.89*	*1.40*	*0.03*	*0.25*	*3.073*	*0.33*	*0.44*	1.54	*0.01*	*0.12*	*4.61*
9	QF (1, 0)	No solutions with two brands															
10	*TPT (1, 0)*	*No solutions with two brands*															
11	QF (0, 1)	No solutions with two brands															
12	*TPT (0, 1)*	*17.778*	*13.33*	*0.111*	*0.222*	*12.840*	*8.889*	*1.481*	*0.110*	*0.000*	*3.073*	*0.330*	*0.440*	1.54	*0.055*	*0.000*	*4.61*

Table 7: Market outcomes with LQ Choice by the Manufacturer B, HQ Choice by the Retailer i and Equal Bargaining Power

Scenario	Contract	α_A	α_B	q_{iA}	q_{iB}	p_{iA}	p_{iB}	Π_i	π_A	π_B	Channel Profit	Consumer Surplus from HQ	Consumer Surplus from LQ	Total Consumer Surplus	F_{iA}	F_{iB}	Social Surplus
1	QF (0, 0)	No solutions with two brands															
2	*TPT (0, 0)*	*No solutions with two brands*															
3	QF (0.25, 0.25)	No solutions with two brands															
4	*TPT (0.25, 0.25)*	*11.17*	*5.58*	*0.291*	*0.140*	*7.144*	*3.182*	*1.111*	*0.707*	*0.082*	*3.010*	*0.054*	*0.698*	1.51	*0.354*	*0.041*	*4.52*
5	QF (0.5, 0.5)	No solutions with two brands															
6	*TPT (0.5, 0.5)*	*13.333*	*6.667*	*0.250*	*0.167*	*8.889*	*3.889*	*1.319*	*0.417*	*0.093*	*3.148*	*0.093*	*0.694*	1.57	*0.208*	*0.046*	*4.72*
7	QF (0.75, 0.75)	No solutions with two brands															
8	*TPT (0.75, 0.75)*	*14.776*	*7.388*	*0.223*	*0.185*	*10.117*	*4.376*	*1.472*	*0.184*	*0.063*	*3.190*	*0.126*	*0.671*	1.59	*0.092*	*0.032*	*4.78*
9	QF (1, 1)	No solutions with two brands															
10	*TPT (1, 1)*	*No solutions with two brands*															

Table 8: Market outcomes with LQ Choice by the Manufacturer B, HQ Choice by the Retailer i and Unequal Bargaining Power

Scenario	Contract	α_A	α_B	q_{iA}	q_{iB}	p_{iA}	p_{iB}	Π_i	π_A	π_B	Channel Profit	Consumer Surplus from HQ	Consumer Surplus from LQ	Total Consumer Surplus	F_{iA}	F_{iB}	Social Surplus
1	QF (0, 0.25)	No solutions with two brands															
2	*TPT (0, 0.25)*	*No solutions with two brands*															
3	QF (0.25, 0)	No solutions with two brands															
4	*TPT (0.25, 0)*	*10.519*	*5.259*	*0.303*	*0.131*	*6.642*	*2.975*	*1.067*	*0.723*	*0.091*	*2.948*	*0.692*	*0.045*	1.47	*0.362*	*0.045*	*4.42*
5	QF (0.25, 0.75)	No solutions with two brands															
6	*TPT (0.25, 0.75)*	*13.333*	*6.667*	*0.250*	*0.167*	*8.889*	*3.889*	*1.238*	*0.625*	*0.046*	*3.148*	*0.093*	*0.694*	1.57	*0.312*	*0.023*	*4.72*
7	QF (0.75, 0.25)	No solutions with two brands															
8	*TPT (0.75, 0.25)*	*13.333*	*6.667*	*0.250*	*0.167*	*8.889*	*3.889*	*1.400*	*0.208*	*0.139*	*3.148*	*0.093*	*0.694*	1.57	*0.104*	*0.069*	*4.72*
9	QF (1, 0)	No solutions with two brands															
10	*TPT (1, 0)*	*13.333*	*6.667*	*0.250*	*0.167*	*8.889*	*3.889*	*1.481*	*0.000*	*0.185*	*3.148*	*0.694*	*0.093*	1.57	*0.000*	*0.093*	*4.72*
11	QF (0, 1)	No solutions with two brands															
12	*TPT (0, 1)*	*No solutions with two brands*															