Reexamination of Bargaining Power in the Distribution Channel under Possible Price Pass-through Behaviors of Retailers

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Abstract

This research aims to gain deeper insight into the determinants of relative power within the distribution channel. We formulate bilateral bargaining under the generalized Nash bargaining. However, when the retailers think retail price increase can be passed on to their customers, we expect them to engage less in vigorous bargaining. We thus allow for the possibility that the retailers can pass through the price increase negotiated with manufacturers to its customers and that the manufacturers are well aware of such behavior by the retailer. As a result, the parties' bargaining powers are determined endogenously not only from the substitution patterns of their customers but also from the willingness of their customers to accept the retail price increase triggered by the wholesale price increase negotiated between the retailer and the manufacturer. In this manuscript, we present the theoretical result on the barganing power in the distribution channel under this expanded framework.

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1 Introduction

The relationship between manufacturers and retailers has attracted significant attention in industrial organization and marketing science literature partly because of the purported power shift from manufacturers to retailers. Given this increase in the power of some of the retailers due to their increased size and willingness to introduce store brands aggressively as well as their willingness to invest in sophisticated information systems, [8] extended the framework of [3] and derived a theoretical formulation of market-level retailer Stackelberg game in analyzing a Japanese yogurt market.

The literature also tries to gain insight into the channel-by-channel strategic interaction of these firms, such as a degree of coordination or split of profit. [9] represents one approach: in their investigation of the influence of store brands on retailer bargaining power, they look for departures by manufacturers and retailers from the static profit-maximizing prices. To this end, they first formulated a demand model and derived the static profit-maximizing wholesale price and retail prices. They estimated the relationship of the deviations of the observed prices from the inferred static profit-maximizing price after store brand entry.

[7], [10], and [4] represent an alternative approach to measure bargaining power: they instead formulate wholesale prices as the outcome of the bargaining parametrized by $\lambda \in [0, 1]$ in each manufacturer-retailer pair via the generalized Nash bargaining model. For example, modeling consumer demand using a discrete-choice formulation, [4] solved the equilibrium conditions incorporating competition among multiple retailers and bargaining between retailers and manufacturers to determine wholesale prices under retail price unobservability.

However, in many consumer product categories such as grocery, consumer electronics, and appliances, manufacturers can and do observe those retail prices. It does make sense, therefore, to incorporate such behavior in modeling the distribution channel. We show that even if we assume that the retail price is observable, bilateral bargaining under the generalized Nash bargaining framework ([12]) is tractable if both the retailer and manufacturer understand and incorporate the retailer's price pass-through behavior so long as the negotiation between them over one product is independently conducted from other products.

2 Model

Consumer demand is modeled using a discrete-choice formulation. We model competition among multiple retailers and manufacturers. In addition to retailer and manufacturer competitions, we model the bargaining between retailers and manufacturers. We solve the equilibrium conditions and derive the expressions to be taken to the data.

2.1 Key assumptions

We adopt the standard random-coefficients discrete choice model and assume heterogeneous consumers select a product at a given retailer to maximize their utilities. We model retailer-brand combinations as the alternatives in the choice set. Thus the same products sold by different retailers can be considered distinct because their wholesale and retail prices can be different.

We assume that retailers compete in Bertrand-Nash fashion (see, e.g., [6]). In the vertical channel, R retailers and W manufacturers bargain over the wholesale prices of K products. In the case where one manufacturer bargains with two different retailers, we use the contract equilibrium as in [13], where contracts are negotiated secretly between each pair and, while negotiating, both parties have passive conjectures, which means that they take the other pair's terms of negotiations as given. Furthermore, we assume that in a negotiation over one product, both the retailer and the manufacturer do not consider the results of the negotiations underway between them over the other products.

We assume that, if, as a result of the Nash bargaining with the bargaining power parameter $\lambda \in [0, 1]$ of the retailer, the wholesale price of a product increases by a unit amount, then the retailer increases its retail price of the product by $\delta \in [0, 1]$. We also assume this parameter δ is decided product-by-product, and each δ is independently estimated. This way, δ measures the degree of retail price pass-through when the product's wholesale price changes. We further assume that every manufacturer understands and incorporates this behavior on the part of retailers when negotiating with them. Under these assumptions, we will show that manufacturers and retailers can anticipate the tractable equilibrium outcome using the generalized Nash bargaining framework.

A retailer engages in vigorous bargaining over the wholesale price when it expects to encounter a strong resistance against the retail price increase from the consumers. In such cases, we expect to observe low price pass-through parameter—δ close to 0—and strong negotiating stance—λ close to 1—by the retailer. These cases are perhaps the underlying scenario implicitly assumed by the literature such as [4] on the determinants of channel profitability.

However, in some industries such as energy, agriculture, and food, the share of raw material prices in the finished products is so large that those material price increases are observable and widely shared among manufacturers, retailers, and even among consumers. Retailers are then more willing to accept wholesale price increases triggered by the increase in raw material prices used for those products and consumers are more receptive to retail price increases of those products. If so, a retailer does not have to engage in vigorous bargaining—λ lower than the scenario described above—over the wholesale price when it can largely pass through—δ close to 1—the price increase to the consumer. The retailer, in such cases, conveys the message to the manufacturer that they are primarily price-takers. [1)]

It is conceivable that we observe a retailer engaging in substantial price pass-through behavior—δ closer to 1—while engaging in moderate bargaining—λ between the two cases described above— against the manufacturer. While accepting a tentative wholesale price

[1)] For example, gas stations routinely pass through the wholesale price increase of gasoline and diesel fuel to the consumers. Manufacturers of secondary processed products such as bread and noodles made from wheat increased the wholesale prices of these products in response to the two-fold price hike of imported wheat in 2007 in Japan. Claiming the declining numbers in dairy farmers and lower milk production, Japanese dairy product manufacturers have secured their wholesale price increases, according to [5].

increase from a manufacturer's product, the powerful retailer may choose to increase the retail price of the product just as much to maintain the retail margin. The powerful retailer knows that such a retail price increase will likely steer some consumers away from the product and thus hurt the manufacturer. With this kind of punitive behavior, a powerful retailer may be sending those manufacturers a signal to accept its strong bargaining position. Incorporating the price pass-through behavior of retailers and manufacturers' retail price observability when the generalized Nash bargaining framework is employed is therefore essential if we are to uncover how a particular industry segment is organized and operated.

2.2 Demand

Consumers are assumed to choose a product l in a product category that gives the highest indirect utility from a retailer r, but allowed to have an option of not purchasing any good in the category. Let us introduce a new index $k = k(l, r)$, $k = 0, \ldots, K$, corresponding to a product l and retailer r pair in the category with $k = 0$ being an outside good (no purchase) and K being the total number of products within the category. As we described previously, this notation reflects that the same products sold by different retailers are considered distinct because their wholesale and retail prices can be different and that every single retailer does not have to carry the same set of products in the category.

Let Ω^r and Ω^w be the set of products sold by retailer r, $r = 1, \ldots, R$, and made by manufacturer w, $w = 1, \ldots, W$, respectively, and Ω be the set of all products in the category.[2)] Let p_{kt} be the retail price of product k at time t, and α_{ik} captures intrinsic preference of heterogeneous consumer i for product k as in (3). Additional factors affecting the choice of product k such as retailer promotions, assortment depth, and manufacturer advertising at time t are denoted as $\vec{x}_{kt}$ in the form of vector. The indirect utility U_{ikt} of consumer i from purchasing product k at time t is thus

$$U_{ikt} = \alpha_{ik} - \beta_i p_{kt} + \vec{\gamma}_i^T \vec{x}_{kt} + \xi_{kt} + \epsilon_{ikt}. \tag{1}$$

To capture consumer heterogeneity in price response, we index the price coefficient β_i by i as in (4) below. The parameter $\vec{\gamma}_i$ is a heterogeneous coefficient vertical vector indexed by i as in (5) for $\vec{x}_{kt}$ whose length is the same as $\vec{x}_{kt}$. The term ξ_{kt} accounts for factors affecting the choice of product k at time t, and it is perceived by consumers, retailers, and manufacturers but not observed by the researcher ([1], [14]). The quantity ϵ_{ikt} captures idiosyncratic preference for consumer i for product k at time t, and we assume ϵ_{ikt} to distribute i.i.d. type I extreme value. To allow for category expansion or contraction, we define the indirect utility of not purchasing any in the category ($k = 0$) as

$$U_{i0t} = \epsilon_{i0t}. \tag{2}$$

To model consumer heterogeneity in those parameters, we assume that α_{ik}, β_i, and $\vec{\gamma}_i$

[2)] The collection of products Ω is defined as the collection of products sold by all retailers $\Omega = \cup_{r=1}^{R} \Omega^r$ or the collection of products made by all manufacturers $\Omega = \cup_{w=1}^{W} \Omega^w$. Therefore $\cup_{r=1}^{R} \Omega^r = \cup_{w=1}^{W} \Omega^w$.

independently vary across consumers according to

$$\alpha_{ik} = \alpha_k + \sigma_\alpha \cdot \nu_{i,\alpha}, \qquad \nu_{i,\alpha} \sim N(0,1), \tag{3}$$
$$\beta_i = \beta + \sigma_\beta \cdot \nu_{i,\beta}, \qquad \nu_{i,\beta} \sim N(0,1), \tag{4}$$
$$\vec{\gamma}_i = \vec{\gamma} + \Sigma_\gamma \cdot \vec{\nu}_{i,\gamma}, \qquad \vec{\nu}_{i,\gamma} \sim N(\vec{0}, I), \tag{5}$$

where α_k, β, σ_α, σ_β are parameters, $\vec{\gamma}$ is a parameter vector, and Σ_γ is a parameter matrix to be estimated. We assume that Σ_γ is diagonal, $\vec{0}$ is a zero vector, and I is an identity matrix of corresponding sizes. We rewrite the utility of consumer i for product k as

$$U_{ikt} = \zeta_{kt}(p_{kt}, \vec{x}_{kt}, \xi_{kt}; \alpha_k, \beta, \vec{\gamma}) + \mu_{ikt}(p_{kt}, \vec{x}_{kt}, \nu_{i,\alpha}, \nu_{i,\beta}, \vec{\nu}_{i,\gamma}; \sigma_\alpha, \sigma_\beta, \Sigma_\gamma) + \epsilon_{ikt}, \tag{6}$$

where ζ_{kt} is a fixed effect capturing the intrinsic preference for product k at time t, μ_{ikt} is the deviation from ζ_{kt} representing consumer i's heterogeneous preference for product k at time t.

We denote the joint distribution of the deviations from mean utility ζ_{kt} as $F(\mu)$. We obtain the market share of product k at time t by integrating the consumer-level choice probabilities as

$$s_{kt}(\vec{p}_t) = \int \frac{\exp\left(\zeta_{kt} + \mu_{ikt}\right)}{1 + \sum_{j\in\Omega} \exp\left(\zeta_{jt} + \mu_{ijt}\right)} dF(\mu), \tag{7}$$

where $\vec{p}_t = (p_{1t}, \ldots, p_{Kt})^T$ in s_{kt} emphasizes the fact that s_{kt}'s are determined by the supply and demand.

2.3 Retail margins

We assume retailers are myopic profit maximizers whose total profit from all products they sell are defined as

$$\pi_t^r = \sum_{k\in\Omega^r} (p_{kt} - p_{kt}^w - c_{kt}) M_t s_{kt}(\vec{p}_t) = \sum_{k\in\Omega^r} m_{kt} M_t s_{kt}(\vec{p}_t), \tag{8}$$

where $m_{kt} = p_{kt} - p_{kt}^w - c_{kt}$ is the margin of retailer r from product k, p_{kt} and p_{kt}^w are the retail and the wholesale prices, c_{kt} is the retailer's marginal cost for product k, and M_t is the size of the market for the product category, including outside goods, all at time t.

Assuming a pure-strategy Nash equilibrium in retail prices, the first-order condition for product j from (8) is

$$\frac{\partial \pi_t^r}{\partial p_{jt}} = \sum_{k\in\Omega^r} \left(\frac{\partial p_{kt}}{\partial p_{jt}} - \frac{\partial p_{kt}^w}{\partial p_{jt}} \right) M_t s_{kt}(\vec{p}_t) + \sum_{k\in\Omega^r} m_{kt} M_t \frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{jt}} = 0, \tag{9}$$

where we assume the marginal cost c_{kt} does not change with the retail price p_{jt}. However, unlike [4], the term $\partial p_{kt}^w / \partial p_{jt}$ remains in (9): The manufacturer can observe and respond to the retailer's price pass-through behavior by adjusting its wholesale price while remaining a myopic profit maximizer.

Since we assume that in a negotiation over one product, both the retailer and the manufacturer do not take into account the results of the negotiations underway over other products or $\partial p_{kt}/\partial p_{jt} = 0$ for $k \neq j$, expression (9) simplifies to

$$s_{jt}(\vec{p}_t) - \sum_{k\in\Omega^r} \frac{\partial p^w_{kt}}{\partial p_{jt}} s_{kt}(\vec{p}_t) + \sum_{k\in\Omega^r} m_{kt} \frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{jt}} = 0. \tag{10}$$

Stacking (10) for all products yields $K \times 1$ matrix

$$\vec{s}_t(\vec{p}_t) - T^r \odot \begin{pmatrix} \frac{\partial p^w_{1t}}{\partial p_{1t}} & \cdots & \frac{\partial p^w_{1t}}{\partial p_{Kt}} \\ \vdots & \ddots & \vdots \\ \frac{\partial p^w_{Kt}}{\partial p_{1t}} & \cdots & \frac{\partial p^w_{Kt}}{\partial p_{Kt}} \end{pmatrix}^T \vec{s}_t(\vec{p}_t) + T^r \odot \Phi_t(\vec{p}_t)^T \vec{m}^r_t = \vec{0}, \tag{11}$$

where

$$\begin{aligned} \vec{s}_t(\vec{p}_t) &= (s_{1t}(\vec{p}_t), \ldots, s_{Kt}(\vec{p}_t))^T, \\ \vec{m}^r_t &= (m_{1t}, \ldots, m_{Kt})^T, \\ \Phi_t(\vec{p}_t) &= \begin{pmatrix} \phi_{11t} & \cdots & \phi_{1Kt} \\ \vdots & \ddots & \vdots \\ \phi_{K1t} & \cdots & \phi_{KKt} \end{pmatrix} = \begin{pmatrix} \frac{\partial s_{1t}(\vec{p}_t)}{\partial p_{1t}} & \cdots & \frac{\partial s_{1t}(\vec{p}_t)}{\partial p_{Kt}} \\ \vdots & \ddots & \vdots \\ \frac{\partial s_{Kt}(\vec{p}_t)}{\partial p_{1t}} & \cdots & \frac{\partial s_{Kt}(\vec{p}_t)}{\partial p_{Kt}} \end{pmatrix}, \end{aligned}$$

T^r is a retailer ownership matrix whose (k, j) element $T^r_{kj} = 1$ if products k, j are sold by the retailer r, or $k, j \in \Omega^r$ and $T_{kj} = 0$ otherwise, and $\odot$ is Hadamard product (element-wise product) operator. Assuming $\left(T^r \odot \Phi_t(\vec{p}_t)^T\right)^{-1}$ exists and solving (11) for the retail margin vector for retailer r obtains, given wholesale prices,

$$\vec{m}^r_t = \left(T^r \odot \Phi_t(\vec{p}_t)^T\right)^{-1} \left[T^r \odot \begin{pmatrix} \frac{\partial p^w_{1t}}{\partial p_{1t}} & \cdots & \frac{\partial p^w_{1t}}{\partial p_{Kt}} \\ \vdots & \ddots & \vdots \\ \frac{\partial p^w_{Kt}}{\partial p_{1t}} & \cdots & \frac{\partial p^w_{Kt}}{\partial p_{Kt}} \end{pmatrix}^T - I \right] \vec{s}_t(\vec{p}_t). \tag{12}$$

Notice that, in expression (6) of [4], the first term within the brackets in (12) disappears because in their formulation, price pass-through behavior of the retailer is not allowed, and the retail price is unobservable to the manufacturer. Thus the manufacturer has no way of adjusting its wholesale price to respond to such behavior.

We need to infer $\partial p^w_{kt}/\partial p_{jt}$ in (12), or we need to infer how a profit-maximizing manufacturer w needs to adjust its wholesale prices of all the products $k \in \Omega^w$ it produces in response to changing the retail price of one of its products. In the following, we assume such a profit-maximizing manufacturer w carries the product indexed by j. We first define the manufacturer's total profit as

$$\pi^w_t = \sum_{k\in\Omega^w} (p^w_{kt} - c^w_{kt}) M_t s_{kt}(\vec{p}_t) = \sum_{k\in\Omega^w} m^w_{kt} M_t s_{kt}(\vec{p}_t), \tag{13}$$

where $m_{kt}^w = p_{kt}^w - c_{kt}^w$ is the margin of manufacturer w from product k and c_{kt}^w is the manufacturer's marginal cost for product k. The manufacturer's first-order condition for product j from (13) is

$$\frac{\partial \pi_t^w}{\partial p_{jt}^w} = \sum_{k\in\Omega^w} \frac{\partial p_{kt}^w}{\partial p_{jt}^w} M_t s_{kt}(\vec{p}_t) + \sum_{k\in\Omega^w} m_{kt}^w M_t \frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{jt}^w} = 0, \quad (14)$$

where we assume the marginal cost c_{kt}^w does not change with the wholesale price p_{jt}^w.

We assume that the wholesale price increase of a product can only be passed through to the retail price of that product, and that means $\partial p_{kt}/\partial p_{jt}^w = 0$ for $k \neq j$. As for the same product, we further assume that the degree of price pass-through is product-dependant, or $\partial p_{kt}/\partial p_{kt}^w = \delta_k$. Thus the following part of the second term on the right in (14) is

$$\frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{jt}^w} = \sum_{g\in\Omega} \frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{gt}} \frac{\partial p_{gt}}{\partial p_{jt}^w} = \delta_j \frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{jt}}. \quad (15)$$

By substituting expression in (15) for (14), we can simplify (14) to

$$s_{jt}(\vec{p}_t) + \delta_j \sum_{k\in\Omega} T_{jk}^w m_{kt}^w \frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{jt}} = 0. \quad (16)$$

Here we introduce manufacturer ownership matrix T^w whose (k, j) element $T_{kj}^w = 1$ if products k and j are produced by manufacturer w, or $k, j \in \Omega^w$ and $T_{jk}^w = 0$ otherwise, to signify the expression (16) is only meaningful when products k and j are produced by manufacturer w.

We now quantify the wholesale price response relative to the changing retail price $\partial p_{kt}^w/\partial p_{jt}$ while the manufacturer's myopic profit maximization behavior expressed in (16) is maintained. The total derivative of (16) for p_{gt} is

$$\frac{ds_{jt}(\vec{p}_t)}{dp_{gt}} + \delta_j \sum_{k\in\Omega} T_{jk}^w \frac{dp_{kt}^w}{dp_{gt}} \frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{jt}} + \delta_j \sum_{k\in\Omega} T_{jk}^w m_{kt}^w \frac{d}{dp_{gt}} \left(\frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{jt}} \right) = 0, \quad (17)$$

where the second term on the left-hand side is necessary because of p_{kt}^w in m_{kt}^w. Since we assume that the retailer and the manufacturer do not take into account the results of the negotiations underway over different products between them, the change in the retail price of one product is assumed not to affect retail prices of others. Hence, derivatives with respect to p_{gt} within the expression in (17) are calculated as follows:

$$\frac{ds_{kt}(\vec{p}_t)}{dp_{gt}} = \sum_{v\in\Omega} \frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{vt}} \frac{dp_{vt}}{dp_{gt}} = \frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{gt}},$$

$$\frac{dp_{kt}^w}{dp_{gt}} = \sum_{v\in\Omega} \frac{\partial p_{kt}^w}{\partial p_{vt}} \frac{dp_{vt}}{dp_{gt}} = \frac{\partial p_{kt}^w}{\partial p_{gt}},$$

$$\frac{d}{dp_{gt}} \left(\frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{jt}} \right) = \sum_{v\in\Omega} \frac{\partial}{\partial p_{vt}} \left(\frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{jt}} \right) \frac{dp_{vt}}{dp_{gt}} = \frac{\partial^2 s_{kt}(\vec{p}_t)}{\partial p_{gt} \partial p_{jt}}.$$

Substituting these expressions for (17) obtains

$$\frac{\partial s_{jt}(\vec{p}_t)}{\partial p_{gt}} + \delta_j \sum_{k\in\Omega} T^w_{jk} \frac{\partial p^w_{kt}}{\partial p_{gt}} \frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{jt}} + \delta_j \sum_{k\in\Omega} T^w_{jk} m^w_{kt} \frac{\partial^2 s_{kt}(\vec{p}_t)}{\partial p_{gt}\partial p_{jt}} = 0, \tag{18}$$

or in matrix notation

$$\Phi_t^T + \begin{pmatrix} \frac{\partial p^w_{1t}}{\partial p_{1t}} & \dots & \frac{\partial p^w_{1t}}{\partial p_{Kt}} \\ \vdots & \ddots & \vdots \\ \frac{\partial p^w_{Kt}}{\partial p_{1t}} & \dots & \frac{\partial p^w_{Kt}}{\partial p_{Kt}} \end{pmatrix}^T \Phi_t \Delta \odot T^w + H_t(\vec{m}^w_t)\Delta = 0, \tag{19}$$

where

$$\Delta = \begin{pmatrix} \delta_1 & \dots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \dots & \delta_K \end{pmatrix},$$

$$H_t(\vec{m}^w_t) = \begin{pmatrix} \sum_{j\in\Omega} T^w_{1j} m^w_{jt} \frac{\partial^2 s_{jt}(\vec{p}_t)}{\partial p_{1t}\partial p_{1t}} & \dots & \sum_{j\in\Omega} T^w_{Kj} m^w_{jt} \frac{\partial^2 s_{jt}(\vec{p}_t)}{\partial p_{1t}\partial p_{Kt}} \\ \vdots & \ddots & \vdots \\ \sum_{j\in\Omega} T^w_{1j} m^w_{jt} \frac{\partial^2 s_{jt}(\vec{p}_t)}{\partial p_{Kt}\partial p_{1t}} & \dots & \sum_{j\in\Omega} T^w_{Kj} m^w_{jt} \frac{\partial^2 s_{jt}(\vec{p}_t)}{\partial p_{Kt}\partial p_{Kt}} \end{pmatrix},$$

$$\vec{m}^w_t = (m^w_{1t}, \dots, m^w_{Kt})^T.$$

Solving (19) obtains

$$\begin{pmatrix} \frac{\partial p^w_{1t}}{\partial p_{1t}} & \dots & \frac{\partial p^w_{1t}}{\partial p_{Kt}} \\ \vdots & \ddots & \vdots \\ \frac{\partial p^w_{Kt}}{\partial p_{1t}} & \dots & \frac{\partial p^w_{Kt}}{\partial p_{Kt}} \end{pmatrix}^T = -(\Phi_t^T + H_t(\vec{m}^w_t)\Delta)(\Phi_t\Delta \odot T^w)^{-1}. \tag{20}$$

Finally, substituting (20) for (12) obtains the price pass-through retailer margin as

$$\vec{m}^r_t = -\left(T^r \odot \Phi_t^T\right)^{-1} \left[T^r \odot (\Phi_t^T + H_t(\vec{m}^w_t)\Delta)(\Phi_t\Delta \odot T^w)^{-1} + I\right] \vec{s}_t(\vec{p}_t). \tag{21}$$

2.4 Wholesale margins

The generalized Nash bargaining solution over the wholesale price of product k obtains as the maximand of the so-called generalized Nash product

$$(\pi^r_{kt} - d^r_{kt})^{\lambda_k}(\pi^w_{kt} - d^w_{kt})^{1-\lambda_k}, \tag{22}$$

where π^r_{kt} and π^w_{kt} are respectively the profits of retailer r and manufacturer w if the negotiations succeed, d^r_{kt} and d^w_{kt} are respectively disagreement payoffs of retailer r and manufacturer w if the negotiations fail. Nash bargaining solution has the property that the outcome is more favorable to a party with higher disagreement payoff. In this sense, disagreement payoffs are an essential determinant of the parties' bargaining position.

The generalized Nash bargaining solution captures bargaining power between the parties in another way through the bargaining power parameter $\lambda_k \in [0,1]$. Note that the higher λ_k, the more favorable is the outcome of the bargaining process to the retailer.[3)]

If an agreement is reached and product k is sold to consumers, then the payoffs to the retailer r and manufacturer w are, respectively

$$\pi^r_{kt} = (p_{kt} - p^w_{kt} - c_{kt})M_t s_{kt}(\vec{p}_t) = m_{kt}M_t s_{kt}(\vec{p}_t), \tag{23}$$
$$\pi^w_{kt} = (p^w_{kt} - c^w_{kt})M_t s_{kt}(\vec{p}_t) = m^w_{kt}M_t s_{kt}(\vec{p}_t). \tag{24}$$

The wholesale price determines how the total channel profits $\pi^r_{kt} + \pi^w_{kt} = (p_{kt} - c_{kt} - c^w_{kt})M_t s_{kt}(\vec{p}_t)$ are split between the retailer and the manufacturer.

The set $\Omega^r \cap \Omega^w$ defines the set of products manufacturer w produces and retailer r sells.

We define the difference $\Delta s^{-k}_{jt}(p)$ in market shares for the jth product in the category, $j \neq k$, when the negotiation over product k is successful and when it is not as the disagreement profits:

$$\Delta s^{-k}_{jt}(\vec{p}_t) = \int \left[\frac{\exp(\zeta_{jt} + \mu_{ijt})}{1 + \sum_{l\in\Omega\setminus\{k\}} \exp(\zeta_{lt} + \mu_{ilt})} - \frac{\exp(\zeta_{jt} + \mu_{ijt})}{1 + \sum_{l\in\Omega} \exp(\zeta_{lt} + \mu_{ilt})} \right] dF(\mu). \tag{25}$$

With (23), (24), and (25), we define the disagreement payoffs of retailer r and manufacturer w respectively as

$$d^r_{kt} = \sum_{j\in\Omega^r\setminus\{k\}} m_{jt}M_t \Delta s^{-k}_{jt}(\vec{p}_t), \tag{26}$$
$$d^w_{kt} = \sum_{j\in\Omega^w\setminus\{k\}} m^w_{jt}M_t \Delta s^{-k}_{jt}(\vec{p}_t). \tag{27}$$

Note that indices j and k in $\Delta s^{-k}_{jt}(\vec{p}_t)$ in (25) means that the negotiation is taking place between retailer r and manufacturer w over product k because index k signifies not only who made the product but also who sold the product according to our indexing scheme. However, as seen from (26) and (27), the disagreement payoffs are calculated independently by retailer r using the products it sells and by manufacturer w using the products it manufactures, and these two sets of products are in principle not the same.

Taking the derivative of expression in (22) with respect to p^w_{kt} and setting it equal to zero yields the first-order condition:

$$\lambda_k(\pi^r_{kt} - d^r_{kt})^{\lambda_k - 1}(\pi^w_{kt} - d^w_{kt})^{1-\lambda_k} \left(\frac{\partial \pi^r_{kt}}{\partial p^w_{kt}} - \frac{\partial d^r_{kt}}{\partial p^w_{kt}} \right) + (1-\lambda_k)(\pi^r_{kt} - d^r_{kt})^{\lambda_k}(\pi^w_{kt} - d^w_{kt})^{-\lambda_k} \left(\frac{\partial \pi^w_{kt}}{\partial p^w_{kt}} - \frac{\partial d^w_{kt}}{\partial p^w_{kt}} \right) = 0. \tag{28}$$

[3)] [4] let the bargaining power parameter vary with manufacturer-retailer pair, but we vary them with products. Thus we indexed λ with k.

Note that the terms $\partial d_{kt}^r/\partial p_{kt}^w$ and $\partial d_{kt}^w/\partial p_{kt}^w$ involving partial derivatives of disagreement payoffs for both retailer r and manufacturer w in (28) do not disappear because the retail price of the product k is affected by the negotiation over its wholesale price. Dividing (28) throughout by $(\pi_{kt}^r - d_{kt}^r)^{\lambda_k - 1}(\pi_{kt}^w - d_{kt}^w)^{-\lambda_k}$ and by λ_k and rearranging, we obtain

$$(\pi_{kt}^w - d_{kt}^w)\left(\frac{\partial \pi_{kt}^r}{\partial p_{kt}^w} - \frac{\partial d_{kt}^r}{\partial p_{kt}^w}\right) = -\frac{1-\lambda_k}{\lambda_k}(\pi_{kt}^r - d_{kt}^r)\left(\frac{\partial \pi_{kt}^w}{\partial p_{kt}^w} - \frac{\partial d_{kt}^w}{\partial p_{kt}^w}\right). \tag{29}$$

Expression (29) shows how profit margins are allocated between retailer r and manufacturer w under our formulation as a result of bargaining over the wholesale price of product k.

In the following, we further derive $\partial \pi_{kt}^r/\partial p_{kt}^w$, $\partial \pi_{kt}^w/\partial p_{kt}^w$, $\partial d_{kt}^r/\partial p_{kt}^w$, and $\partial d_{kt}^w/\partial p_{kt}^w$ in (29) in terms of market primitives. For the first two partial derivatives of profits,

$$\frac{\partial \pi_{kt}^r}{\partial p_{kt}^w} = \left(\frac{\partial p_{kt}}{\partial p_{kt}^w} - 1\right) M_t s_{kt}(\vec{p}_t) + m_{kt} M_t \frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{kt}^w}, \tag{30}$$

$$\frac{\partial \pi_{kt}^w}{\partial p_{kt}^w} = M_t s_{kt}(\vec{p}_t) + m_{kt}^w M_t \frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{kt}^w}. \tag{31}$$

Invoking (15) again and with ϕ_{kkt} as (k,k)-component of matrix $\Phi_t(\vec{p}_t)$ of partial derivatives of the market share for the retail price, we rewrite (30) and (31) as

$$\begin{aligned}\frac{\partial \pi_{kt}^r}{\partial p_{kt}^w} &= (\delta_k - 1) M_t s_{kt}(\vec{p}_t) + m_{kt} M_t \delta_k \frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{kt}} \\ &= (\delta_k - 1) M_t s_{kt}(\vec{p}_t) + m_{kt} M_t \delta_k \phi_{kkt}, \end{aligned} \tag{32}$$

$$\begin{aligned}\frac{\partial \pi_{kt}^w}{\partial p_{kt}^w} &= M_t s_{kt}(\vec{p}_t) + m_{kt}^w M_t \delta_k \frac{\partial s_{kt}(\vec{p}_t)}{\partial p_{kt}} \\ &= M_t s_{kt}(\vec{p}_t) + m_{kt}^w M_t \delta_k \phi_{kkt}. \end{aligned} \tag{33}$$

Therefore, we have

$$\begin{aligned}\frac{\partial}{\partial p_{kt}^w}(\pi_{kt}^r + \pi_{kt}^w) &= \frac{\partial \pi_{kt}^r}{\partial p_{kt}^w} + \frac{\partial \pi_{kt}^w}{\partial p_{kt}^w} \\ &= \delta_k M_t \{s_{kt}(\vec{p}_t) + (m_{kt} + m_{kt}^w)\phi_{kkt}\} \\ &= \delta_k M_t \{s_{kt}(\vec{p}_t) + (p_{kt} - c_{kt} - c_{kt}^w)\phi_{kkt}\}. \end{aligned} \tag{34}$$

From (34), with a positive price pass-through parameter δ_k of product k, we recognize the intricate economic mechanism under which the channel profit $\pi_{kt}^r + \pi_{kt}^w$ from the product can increase or decrease when its wholesale price p_{kt}^w marginally increases.[4] In general, we know that the market share marginally decreases as its retail price marginally increases, or $\phi_{kkt} < 0$. Even so, expression (34) implies that, for product k with a large market share $s_{kt}(\vec{p}_t)$ combined with a small per-unit profit $m_{kt} + m_{kt}^w$, the combined profit $\pi_{kt}^r + \pi_{kt}^w$ of

[4] For [4] $\partial(\pi_{kt}^r + \pi_{kt}^w)/\partial p_{kt}^w = 0$ because an increase in the manufacturer's profit is compensated by the corresponding decrease in the retailer's profit and vice versa.

retailer r and manufacturer w can increase by a small amount when its wholesale price p^w_{kt} marginally increases: on the other hand, for a product k with a small market share combined with a sizable per-unit profit, the combined profit can decrease by a small amount as its wholesale price p^w_{kt} marginally increases.

For the partial derivative of disagreement payoff of the retailer in (26),

$$\begin{aligned}\frac{\partial d^r_{kt}}{\partial p^w_{kt}} &= M_t \sum_{j\in\Omega^r\setminus\{k\}} m_{jt}\frac{\partial \Delta s^{-k}_{jt}(\vec{p}_t)}{\partial p^w_{kt}}\\ &= M_t \sum_{j\in\Omega^r\setminus\{k\}} m_{jt}\sum_{v\in\Omega}\frac{\partial \Delta s^{-k}_{jt}(\vec{p}_t)}{\partial p_{vt}}\frac{\partial p_{vt}}{\partial p^w_{kt}}\\ &= \delta_k M_t \sum_{j\in\Omega^r\setminus\{k\}} m_{jt}\frac{\partial \Delta s^{-k}_{jt}(\vec{p}_t)}{\partial p_{kt}}. \qquad (35)\end{aligned}$$

In deriving (35), we invoke the same reasoning we employed in deriving (15). Because the first term in brackets in (25) does not contain p_{kt},

$$\begin{aligned}\frac{\partial \Delta s^{-k}_{jt}(\vec{p}_t)}{\partial p_{kt}} &= -\frac{\partial}{\partial p_{kt}}\int \frac{\exp\left(\zeta_{jt}+\mu_{ijt}\right)}{1+\sum_{l\in\Omega}\exp\left(\zeta_{lt}+\mu_{ilt}\right)}dF(\mu)\\ &= -\frac{\partial s_{jt}}{\partial p_{kt}} = -\phi_{jkt}. \qquad (36)\end{aligned}$$

Therefore, (35) is rewritten as

$$\frac{\partial d^r_{kt}}{\partial p^w_{kt}} = -\delta_k M_t \sum_{j\in\Omega^r\setminus\{k\}} m_{jt}\phi_{jkt}. \qquad (37)$$

Similarly, the partial derivative of disagreement payoff of the manufacturer in (27) is derived as

$$\frac{\partial d^w_{kt}}{\partial p^w_{kt}} = -\delta_k M_t \sum_{j\in\Omega^w\setminus\{k\}} m^w_{jt}\phi_{jkt}. \qquad (38)$$

From expressions (32), (33), (37), and (38), we obtain

$$\begin{aligned}\frac{\partial \pi^r_{kt}}{\partial p^w_{kt}} - \frac{\partial d^r_{kt}}{\partial p^w_{kt}} &= (\delta_k-1)M_t s_{kt}(\vec{p}_t) + \delta_k M_t m_{kt}\phi_{kkt} + \delta_k M_t \sum_{j\in\Omega^r\setminus\{k\}} m_{jt}\phi_{jkt}\\ &= (\delta_k-1)M_t s_{kt}(\vec{p}_t) + \delta_k M_t \sum_{j\in\Omega^r} m_{jt}\phi_{jkt}, \qquad (39)\\ \frac{\partial \pi^w_{kt}}{\partial p^w_{kt}} - \frac{\partial d^w_{kt}}{\partial p^w_{kt}} &= M_t s_{kt}(\vec{p}_t) + \delta_k M_t m^w_{kt}\phi_{kkt} + \delta_k M_t \sum_{j\in\Omega^w\setminus\{k\}} m^w_{jt}\phi_{jkt}\\ &= M_t s_{kt}(\vec{p}_t) + \delta_k M_t \sum_{j\in\Omega^w} m^w_{jt}\phi_{jkt}. \qquad (40)\end{aligned}$$

We rewrite the expression in (29) relating wholesale to retail margins from product k in terms of market primitives using (23), (24), (26), (27), (39), and (40) as

$$\left(m^w_{kt}s_{kt}(\vec{p}_t) - \sum_{j\in\Omega^w\setminus\{k\}} m^w_{jt}\Delta s^{-k}_{jt}(\vec{p}_t)\right)\left((\delta_k - 1)s_{kt}(\vec{p}_t) + \delta_k \sum_{j\in\Omega^r} m_{jt}\phi_{jkt}\right)$$
$$= -\frac{1-\lambda_k}{\lambda_k}\left(m_{kt}s_{kt}(\vec{p}_t) - \sum_{j\in\Omega^r\setminus\{k\}} m_{jt}\Delta s^{-k}_{jt}(\vec{p}_t)\right)\left(s_{kt}(\vec{p}_t) + \delta_k \sum_{j\in\Omega^w} m^w_{jt}\phi_{jkt}\right). \tag{41}$$

For the sake of brevity, we redefine the terms representing the retailer margins in (41) as

$$\psi_{kt}(\vec{m}^r_t) = (\delta_k - 1)s_{kt}(\vec{p}_t) + \delta_k \sum_{j\in\Omega^r} m_{jt}\phi_{jkt}, \tag{42}$$
$$\upsilon_{kt}(\vec{m}^r_t) = m_{kt}s_{kt}(\vec{p}_t) - \sum_{j\in\Omega^r\setminus\{k\}} m_{jt}\Delta s^{-k}_{jt}(\vec{p}_t). \tag{43}$$

With (42) and (43), the left-hand side of (41) is expressed as the term involving the manufacturer margin times the term involving the retailer margin, while the right-hand side is expressed as the term involving the retailer margin times the term involving the manufacturer margin.

In the following, we express the manufacturer margin with respect to the retailer margin. Let $\Psi_t(\vec{m}^r_t)$, $\Upsilon_t(\vec{m}^r_t)$, and Λ be the $K\times K$ diagonal matrices whose k-th diagonal components are ψ_{kt}, υ_{kt}, and λ_k respectively. We also define the matrix of shares and changes in shares as

$$S_t = \begin{pmatrix} s_{1t}(\vec{p}_t) & -\Delta s^{-1}_{2t}(\vec{p}_t) & \dots & -\Delta s^{-1}_{Kt}(\vec{p}_t) \\ -\Delta s^{-2}_{1t}(\vec{p}_t) & s_{2t}(\vec{p}_t) & \dots & -\Delta s^{-2}_{Kt}(\vec{p}_t) \\ \vdots & \vdots & \ddots & \vdots \\ -\Delta s^{-K}_{1t}(\vec{p}_t) & -\Delta s^{-K}_{2t}(\vec{p}_t) & \dots & s_{Kt}(\vec{p}_t) \end{pmatrix}.$$

Stacking (41) for all products with manufacturer ownership matrix T^w, we have

$$\Psi_t(\vec{m}^r_t)(T^w \odot S_t)\vec{m}^w_t = -(I-\Lambda)\Lambda^{-1}\Upsilon_t(\vec{m}^r_t)[\vec{s}_t(\vec{p}_t) + \Delta(T^w \odot \Phi^T_t)\vec{m}^w_t]. \tag{44}$$

Solving expression (44) for $\vec{m}^w_t$ obtains

$$\vec{m}^w_t = -\left[\Psi_t(\vec{m}^r_t)(T^w \odot S_t) + (I-\Lambda)\Lambda^{-1}\Upsilon_t(\vec{m}^r_t)\Delta(T^w \odot \Phi^T_t)\right]^{-1}(I-\Lambda)\Lambda^{-1}\Upsilon_t(\vec{m}^r_t)\vec{s}_t(\vec{p}_t), \tag{45}$$

assuming the inverse on the right-hand side of (45) exists.

3 Conclusion and Discussion

In this article, we show that incorporating the retailer ’ s price pass-through behavior under the generalized Nash bargaining framework is theoretically tractable if both the retailer and manufacturer understand and incorporate the retailer ’ s price pass-through behavior so long as the negotiations over one product are independently conducted from the other products.

There are at least two limitations and in this article. First, we assume that the retailer and the manufacturer negotiate over one product, facilitating these two models ’ derivation. In reality, however, retailers and manufacturers may be negotiating over multiple products simultaneously, and, if so, each negotiation is likely to affect how other negotiations will result. Retailers and manufacturers may negotiate wholesale price and other contract terms as well. Modeling such negotiation will require a more involved framework than what we present in this article. However, as more data on the contracts between manufacturers and retailers become available, we believe our bargaining model can be extended to capture the complete picture of their bargaining.

The second issue is inherent in the generalized Nash bargaining framework itself. For the expression in (9) of [4] and the corresponding expression in (25) in this article, we are keenly aware that market prices of product k could have been different when the negotiation between retailer r and manufacturer w over product j is successful and when it is not because the market equilibrium could have been different with and without product k. Unfortunately, however, these counter-factual prices are not available for econometricians or are not easily inferred in general.

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