

# Estimating Bargaining Games in Distribution Channels

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# Estimating Bargaining Games in Distribution Channels

## Abstract

The issue of power in distribution channels remains a topic of interest among both practitioners and researchers of marketing. This interest has, no doubt, been fueled by the growing power of retailers and the emergence of retail powerhouses such as Walmart. Power, in a distribution channels context, is often defined as the ability to appropriate a larger share of the total channel surplus. Since wholesale prices determine the profit share a given channel member appropriates, power is directly related to the process of wholesale price setting. In most of the previous studies of channel interactions, it is assumed that the wholesale price is set by the manufacturer unilaterally, i.e. the manufacturers make a take-it or leave-it offer to the retailer. A few notable exceptions are the theoretical works of Villas Boas and Iyer (2002) and Shaffer and O'Brien (2004) who examine channel relations and price setting in a formal bilateral bargaining framework. There is also enough anecdotal evidence to suggest that wholesale prices are indeed set via a bargaining process rather than by unilateral mandates issued by manufacturers.

This paper relies on basic Nash bargaining theory to propose and implement an econometric framework to ascertain channel power. In a supermarket/ retail store setting, we assume that the wholesale prices are negotiated between competing manufacturers and a common retailer. We model the bargaining process as a modified Nash bargaining process with asymmetric bargaining powers. The wholesale prices that emerge as an outcome of bargaining process are a function of anticipated profits and relative bargaining powers. The theoretical solution suggests that gains from trade be split in proportion to the bargaining powers of the trading parties. We contrast our proposed model with some of the standard models used in the Empirical Industrial Organization literature (e.g. Manufacturer Stackelberg) by calibrating each model to data from two different product categories. We find that in terms of fit, our proposed model performs better than extant models of channel interactions and hence provides empirical evidence to support bargaining as the more plausible pricing mechanism in distribution channels. While our results continue to support notions of power obtained in previous studies (e.g. a manufacturer with a high market share has relatively more power) they also shed light on nuances that were hitherto unexplored. Particular among these are the factors that influence bargaining power such as cost advantages and brand equity.

# 1 Introduction

In a typical distribution channel setting conflict is an accepted and forgone conclusion. A basic examination of the underlying economics reveals that the goals (read profits) of channel members are often orthogonal to each other. Imagine a simple channel structure with a manufacturer and a retailer. Quite simply, in such a channel, the orthogonality manifests itself in manufacturers seeking to sell their products at higher wholesale prices and the retailer (channel members) looking to lower those very prices. This wholesale price, and associated payments if any, determine the ratio in which profits are shared between the manufacturer and the retailer in a distribution channel. The retail price, on the other hand, determines the demand and hence the total channel profit. Since the wholesale price plays such a critical role in the determination channel member profits, it would seem only natural that channel members attempt to influence it to their advantage. It is rather implausible then that any one member of the distribution channel would have complete authority in the setting of these wholesale prices. The following excerpt illustrates this point...

*“Even though Barnes & Noble is the biggest bookstore chain in the country, Mr. Leonard Riggio (of Barnes & Noble) has recently complained that publishers offer better wholesale deals to other kinds of retailers, like warehouse or specialty stores. For the last decade, independent bookstores have filed a series of antitrust lawsuits against publishers and the national chains Barnes & Noble and Borders, arguing that the chains shake down publishers for unfair deals that are not made available to small stores. The independents’ continuing litigation kept both publishers and the national chains on tiptoe in their price talks. In April, however, Barnes & Noble and Borders reached a favorable settlement to end the independents’ most recent suit, and now both publishers and booksellers have returned to the bargaining table with renewed determination.”*

The New York Times, November 26, 2001

Manufacturers and retailers are acutely aware of each other's contribution towards the functioning of the channel. In most cases the sources of power are also known or revealed as part of the bargaining process. The following is a continuation of the article excerpted earlier.

*“Mr. Riggio’s principal source of leverage is the potential promotion of other, more profitable merchandise, including the many books published by Barnes & Noble itself, at the expense of other publishers’ products. But the company is totally dependent on publishers for the most important titles.”*

The above is only one of a plethora of examples that can be found in the popular press. There is widespread acceptance of the notion of channel power and the fact that it is the exercise of this power appropriates rents in a channel context. Even so, the academic literature on distribution channels often assumes that power is concentrated in the hands of one party (typically the manufacturer) and ignores the impact of bargaining power on the wholesale price setting process. There are, however, a selection of theoretical pieces that either explicitly or implicitly acknowledge the role of power in distribution channels. The analysis of Jeuland and Shugan (1983) is a good example. While the focus, for most part in their paper is on the characterization of a channel coordinating quantity discount schedule, they do point out that ultimately the channel surplus will need to be distributed among the channel members and will be done via some bargaining mechanism. They go as far as to show how the contract parameters could be determined in an equal power environment. Choi (1991) examines the a number of vertical interactions including the Vertical Nash game and Retailer and Stackelberg leader-follower games (with either the manufacturer or the retailer being the leader). Each of these channel interactions reflects an alternative assumption on the distribution of “power” and therefore results in different prices and profits for each player. Krishnan and Soni (1997) construct a theoretical framework to study the ability of retailers to extract a “guarantee of margins” contract

from manufacturers and provide new insights into the power shift to retailers in the grocery channel. They specifically model the ability of retailers to play one manufacturer against another and to use the private label brands as a lever to extract more profits. Perhaps the most relevant (to our analysis) is the work of Iyer and Villas-Boas (2001) who point out that firms are often unable to commit to take it or leave it offers and cite real world examples to support this claim. They model wholesale prices as the outcome of a modified Nash bargaining game in which manufacturer and retailer both exert their bargaining powers. In their game the final wholesale price reflects the relative strengths of the two negotiating parties. The bargaining approach adopted by the authors is also realistic as our earlier example demonstrates. Following this, there has been more theoretical work that explicitly models the bargaining process in vertical relations (see e.g. Shaffer and O'Brien 2004; Dukes, Gal-Or and Srinivasan 2004).

Recent years have seen a growing in the study of channel interactions using Empirical Industrial Organization (EIO) framework (See e.g. Sudhir(2001), Cotterill and Putsis (2001), Besanko, Dube and Gupta (2003), Berto-Villas-Boas (2004) and Kadyali et. al. (2000)). The first three studies assume specific forms of games (e.g. Manufacturer Stackelberg or Vertical Nash) between the players and determine the nature of the interactions within the channel by examining the fit of data to different kinds of games. Berto-Villas-Boas (2004) takes a similar “menu” approach and examines manufacturer collusion, among other games. In contrast, Kadiyali et al. (2000) take a “conduct parameters” approach wherein various games are combined as parameter restricted versions of a super-game which is then estimated. The key advantage of using a conduct parameter approach is that it allows dependence in decisions made by channel members since it does not assume a fixed form of strategic game between the players. While this approach seems more appealing because of the inherent flexibility built into it, the method is limited on the theoretical front since the construction of the super-game depends in large part on the researcher’s priors.

In addition, interpreting the conduct parameters turns out to be a challenging task.

In this paper, we approach channel interactions from a bargaining theory perspective. Following Villas-Boas and Iyer (2001), we assume that wholesale prices are the result of a bargaining game played by the members of a distribution channel. As one would expect, the outcome of this bargaining process is a function of the anticipated profits of the two parties and their respective bargaining powers. We then use this theoretical framework to construct a flexible econometric specification which allows us to estimate the model parameters from aggregate data. A key contribution of our approach is that the bargaining framework acts as a supergame which nests a number of models (e.g. the Manufacturer Stackelberg) and thereby offers the same benefits of the conduct parameters approach without sacrificing parsimony.

The estimation procedure we implement treats bargaining power as a vector of additional parameters that are then estimated, along with other model parameters, from the data. As is well known in the literature now, the interactions between the players strategic choices and the existence of unobserved brand characteristics create simultaneity and endogeneity related issues. The prices that firms charge are functions of the expectation of their rivals' reactions. At the same time, these very prices also determine the demand for a firm's product. In other words the prices (supply) and quantities (demand) are simultaneously determined. Failing to account for this creates what is known as the simultaneity bias. In most cases it is also true that the demand specification is incomplete. In other words, all relevant marketing variables are rarely observed and measured (e.g. shelf space allocation) and consequently, are left out of the demand specification. As a result, these unobserved marketing variables are subsumed into the demand error which then causes it to be correlated with prices. This correlation induces a bias in the estimates of the price effect and is typically referred to as the endogeneity bias in the literature. Our estimation procedure addresses both these issues by constructing an econometric framework based on ideas laid out in Nevo (2001) and Berry, Levinsohn and Pakes

(1995). The basic idea is to use the contraction mapping approach suggested by BLP to obtain brand-time intercepts, then follow Nevo's suggestion of using these intercepts to construct a GMM objective function which includes the supply side moment conditions. A minimization of this objective function gives us the parameters of interest.

We implement our model and estimation methodology on 2 product categories - refrigerated fruit juice and bathroom tissue. The data reflect retail sales of Dominick's Finer Foods, one of the largest retail chains in the Chicago area. We also contrast our model with other models that have been tested previously in the literature. We find that in terms of fit the bargaining model performs better than the standard models of channel interactions. As in some previous studies, we find that the relative retailer power is lower for supplier with high market share and high for those manufacturers that have smaller market shares. The results also lend new insights into the impact of supply side specification on parameter estimates. We find that under a full bargaining specification, the price effect is significantly lower than in other games.

Rest of the paper is organized as follows: In the next section we provide a brief overview of bargaining theory. In section 3, we propose the bargaining model in the context of distribution channel. We also discuss other standard models that have been used to study channel interactions in the past studies. In section 4 we discuss the data used to estimate the models and in section 5 we discuss estimation issues. In sections 6 we present the results and related discussions. We conclude in section 7.

## **2 Bargaining Theory**

Bargaining can be thought of as the process of distributing the gains obtained from trade among the participants of the trade. In the present context, the gains from trade (between the manufacturer and the retailer) are the total channel profits, i.e.

revenue generated from sales at the retail level less the total costs incurred by the manufacturer. Since the wholesale price determines the proportion in which the gains from the trade (total channel profit) is split between the channel members, this wholesale price turns into the decision variable that is bargained over by channel members.

There are two solution concepts for the above-mentioned bargaining problem - the cooperative approach and the non-cooperative approach<sup>2</sup>. The asymmetric Nash bargaining solution is the cooperative approach to bargaining problems in which the asymmetry in bargaining power between the parties is taken into consideration. The cooperative approach to bargaining focuses on the outcome of the bargaining process without regard to the actual bargaining process. This approach states that, the outcome of cooperative bargaining should satisfy three key axioms of (i) Invariance to utility representations (ii) Pareto efficiency, and (iii) independence of irrelevant alternatives. The first axiom implies that it is the players' preferences and not particular utility function that matters. The second axiom implies that the gains from the trade are fully exploited and the parties. The third axiom implies that the solution to a second game is the same as that of the first game, where the second game is constructed by removing some of the (irrelevant) alternatives from the first game, if the solution of the first game is also a possible payoff of the second game. It is shown that the unique solution of the bargaining problem is obtained by maximizing the weighted product of the two parties' payoffs where the weights are the respective bargaining power of the parties.

The second solution concept is the non-cooperative approach and was proposed by Rubenstein (1982). In the non-cooperative approach each of the parties make alternating offers to each other till a solution is reached. If we assume that the bargaining is frictionless (i.e. making offers and counter offers are costless) then the outcome is indeterminate. However, in most real world bargaining situations, parties

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<sup>2</sup>See Muthoo (1999)

incur some cost in making offers and counter offers (haggling). Thus, the players have an incentive to reach an agreement as soon as possible. A player’s bargaining power depends on the relative magnitude of the player’s respective cost of haggling. The higher the cost of haggling the lower is the power.

In spite of the differences in the two solution approaches to the bargaining problem, it has been shown by Muthoo (1999) that in the limit, both the cooperative and the non-cooperative solution concepts are similar. In this paper we will be agnostic about the exact process via which bargaining occurs and will concern ourselves with the equilibrium outcome. In other words we will approach the problem from a Nash bargaining standpoint.

We model the bargaining process in the present context based on the asymmetric Nash bargaining solution (Roth 1979; Muthoo 1999). The Nash outcome of the bargaining process involving two parties can be obtained from the following maximization problem,

$$\max_x \mathbb{N} \equiv [v_1(x)]^\theta [v_2(x)]^{1-\theta} \tag{1}$$

where,  $\mathbb{N}$  is the asymmetric Nash product,  $v_k(x)$  is the utility of party  $k$  from the bargaining process,  $\theta$  is the bargaining power of party 1 and  $(1 - \theta)$  is the bargaining power of party 2. What is apparent is that any solution will depend on the parameter  $\theta$ . This parameter is central to our approach and reflects relative bargaining power. We concede that in a distribution channel context the notion of power is multidimensional and is difficult to capture within the confines of one parameter. Nevertheless, as our subsequent analysis and estimation will show this approach allows the relation between channel members to be modeled more flexibly and captures the basic spirit of channel power.

In most consumer product categories a manufacturer’s inherent bargaining power is derived from factors such as brand equity, effective advertising, the ability to go “direct” (to the consumer) and the availability of alternate retailers among others. As a specific example, imagine a manufacturer with a product that has unique and

unsubstitutable attributes. Such a product might enjoy substantial loyalty among consumers and, consequently, a retailer is “forced” to stock this product. Similarly, from a retailer’s perspective, availability of substitute products, high customer service levels, store loyalty and other such factors increase bargaining power. Text books are replete with examples of how channel members add value and how such value addition ultimately translates into power. While we acknowledge that the underlying drivers of bargaining power may also be related to other constructs in our system (e.g. costs or brand equity) we will assume conditional independence. In other words we will assume that bargaining power is exogenous and consequently will have no impact on the system constructs except via the bargaining parameters.

### **3 The Economic Framework**

In this paper, we examine interactions in a channel wherein multiple manufacturers sell their products through a common retailer. The manufacturers within a product category compete against each other for market share in the retail store. The retailer on the other hand is assumed to maximize the category profits i.e. sum of profits from all the brands in the category. Hence, the retailer is assumed to behave as a monopolist. To analyze the channel structure in EIO framework, we need the demand and supply equations. The supply (retail and wholesale price) equations are derived from the competitive interactions between the retailer and the manufacturers in each product category. The retailer sets the retail prices to maximize category profits i.e. takes into account the impact of retail prices on the demand of each of the brands in the entire category. Similarly, while setting the wholesale prices, the concerned parties take the impact of the wholesale prices on the retail prices (and implicitly on the demand) into consideration.

### 3.1 Utility, Choices and Demand

Our demand specification entails a mixed logit model with normally distributed random coefficients. Because of its flexibility, the random coefficients logit model has been used for both individual level as well as aggregate data (Nevo 1997, Villas Boas 1999, Sudhir 2001). Apart from relaxing the IIA property, the mixed logit model enables us to get simple equations of channel interactions with relatively smaller number of parameters to deal with. Let us assume that in each period  $t$ , a consumer  $h$  has an option to choose either one of the available brands within a category or not to make a purchase within the category (i.e. choose an outside good denoted by 0). The full set of choice alternatives is denoted by  $\mathcal{J}$ . The utility of brand  $j$  in period  $t$  for consumer  $h$  is given by,

$$U_{hjt} = \alpha_{hj} + X'_{jt}\lambda_h - \beta_h p_{jt} + \xi_{jt} + \varepsilon_{hjt} \quad (2)$$

where,  $\alpha_{jh}$  is the brand specific constant for brand  $j$  and  $X_{jt}$  is  $[\mathcal{K} \times 1]$  vector of marketing mix elements (observable) of brand  $j$  affecting the consumer choice. Note that the brand specific constants ( $\alpha$ ) and response parameters to marketing elements ( $\lambda, \beta$ ) are individual specific.  $\xi_{jt}$  is an unobservable (to the researcher) demand shock for brand  $j$  in time period  $t$ <sup>3</sup>. Finally,  $\varepsilon_{hjt}$  is an i.i.d. error component. given this specification, a consumer  $h$  chooses brand  $k$  in period  $t$  if,

$$U_{hit} > U_{hjt} \quad \forall i \neq j; i \in \mathcal{J}$$

We assume that the individual specific random parameters are normally distributed and can be represented as

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<sup>3</sup>Some of unobservable components of utility function such as advertising, past experience etc. might be correlated with price. Hence, including  $\xi_{jt}$  and allowing it to be correlated with price takes care of the possible endogeneity problem. For details see BLP 1995, Nevo 2000 and Sudhir 2001.

$$\begin{bmatrix} \alpha_h \\ \lambda_h \\ \beta_h \end{bmatrix} \sim \mathcal{N} \left( \begin{bmatrix} \bar{\alpha} \\ \bar{\lambda} \\ \bar{\beta} \end{bmatrix}, \Omega \right). \quad (3)$$

In other words,

$$\begin{bmatrix} \alpha_h \\ \lambda_h \\ \beta_h \end{bmatrix} = \begin{bmatrix} \bar{\alpha} \\ \bar{\lambda} \\ \bar{\beta} \end{bmatrix} + \Omega^{\frac{1}{2}} \eta_h, \quad \eta_h \sim \mathcal{N}(0, I_{(\mathcal{J}+\kappa)}), \quad (4)$$

where  $\Omega^{\frac{1}{2}}$  is the lower triangular, Cholesky root matrix of the covariance matrix  $\Omega$ , and then the utilities can be written as,

$$u_{hjt} = \delta_{jt} + \mu_{hjt} + \varepsilon_{hjt} \quad (5)$$

$$\text{where, } \delta_{jt} = \bar{\alpha}_j + X'_{jt} \bar{\lambda} - \bar{\beta} p_{jt} + \xi_{jt} \quad \text{and, } \mu_{hjt} = [1, X'_{jt}, p_{jt}] \Omega^{\frac{1}{2}} \eta_h.$$

In (5), the  $\eta_h$ 's are draws from a standard normal. By including the option an outside good, we allow the product category to expand or contract based on the attractiveness of the entire product category (which in turn depends on the prices and other marketing variables of all the brands in the category). We normalize the utility of the outside good to 0 for all the periods. The aggregate market share (or the aggregate probability of purchase) for each brand in period  $t$  is given by,

$$s_{jt} = \int_{[(\eta_h, \varepsilon_{hjt}) | U_{hjt} \geq U_{hkt} \forall k \in \mathcal{J}]} d\mathcal{F}(\varepsilon) d\mathcal{F}(\eta). \quad (6)$$

where,  $\mathcal{F}(\varepsilon)$  and  $\mathcal{F}(\eta)$  are the cumulative distribution functions of  $\varepsilon$  and  $\eta$  respectively.

If we specifically assume that the  $\varepsilon$  are distributed i.i.d. Gumbel then, we have,

$$s_{jt} = \int \frac{\exp(\delta_{jt} + \mu_{hjt})}{1 + \sum_{k \in \mathcal{J}} \exp(\delta_{kt} + \mu_{hkt})} d\mathcal{F}(\eta). \quad (7)$$

As mentioned earlier, logit demand specifications (similar to 7) have been used for both individual level data as well as aggregate data (Nevo 1997, Sudhir 2001) and are well accepted in the literature on account of their flexibility, parsimony and analytical simplicity.

### 3.2 The Channel Structure

In this paper, we propose a bilateral bargaining model for the wholesale price setting. The decision processes unfold as follows. First the Retailer bargains with manufacturers over whole prices. Then using these wholesale prices as given, the retailer sets retail prices. consumers observe the market factors (including retail prices) and make purchases.

#### The Retailer's Problem

The category profit maximizing retailer maximizes the sum of profits from all relevant brands. Let  $p_{jt}$  and  $w_{jt}$  be the retail price and the wholesale price respectively of brand  $j$  in period  $t$ . The retailer's profit function for period  $t$ ,  $\Pi_t^{(R)}$ , can then be described as,

$$\Pi_t^{(R)} = \left( \sum_{j \in \mathcal{J}} (p_{jt} - w_{jt}) s_{jt} \right) Q_t \quad (8)$$

where,  $Q_t$  is the size of the total market. The first order condition for brand  $j$  yields,

$$s_{jt} + \sum_{k \in \mathcal{J}} (p_{kt} - w_{kt}) \frac{\partial s_{kt}}{\partial p_{jt}} = 0 \quad (9)$$

The first order conditions for all brands  $j \in \mathcal{J}$ , can be written in matrix notation as,

$$\mathbf{s}_t + \mathbf{\Phi}_t (\mathbf{p}_t - \mathbf{w}_t) = \mathbf{0} \quad (10)$$

where,  $\mathbf{p}_t$  and  $\mathbf{w}_t$  are retail and wholesale price vectors respectively,  $\mathbf{s}_t$  is the vector of market shares and  $\mathbf{\Phi}_t$  is a matrix with  $(\mathbf{\Phi}_t)_{ij} = \frac{\partial s_{it}}{\partial p_{jt}}$ . The solution to these first order conditions yields  $p_{jt}(\mathbf{w}_t)$ .

## Wholesale Prices and Bargaining

We assume that the retailer bargains with each manufacturer over the wholesale price. While bargaining, each party is driven by self interest and attempt to maximize their own payoffs. Each manufacturer's profit function is,

$$\Pi_{jt}^{(M)} = (p_{jt} - c_j) s_{jt} Q_t. \quad (11)$$

The Nash product for the bargaining process between manufacturer  $j$  and the retailer at time  $t$  can then be described as,

$$\mathbb{N}_{jt} = \left[ \Pi_{jt}^{(M)} - d_j^{(M)} \right]^{\theta_j} \left[ \Pi_t^{(R)} - d_j^{(R)} \right]^{1-\theta_j}. \quad (12)$$

In the above,  $\theta_j$ , depicts the bargaining power of manufacturer  $j$  (relative to the retailer),  $d_j^{(R)}$  is the retailer's disagreement profit when bargaining with manufacturer  $j$  and  $d_j^{(M)}$  is manufacturer  $j$ 's disagreement profits. Similar to Shaffer and O'Brien (2004), we normalize the disagreement profits to the manufacturers to zero ( $d_j^{(M)} = 0$ ) and assume that the retailer's disagreement profit (with respect to manufacturer  $j$ ) is the profit it could earn without that manufacturer ( $d_j^{(R)} = \sum_{k \neq j} \Pi_{kt}^{(R)}$ ).

## Characterizing the Equilibrium

Substituting the relevant disagreement payoffs and differentiating yields the relevant first order conditions,

$$\frac{\partial \mathbb{N}_{jt}}{\partial w_{jt}} = \theta_j \Pi_{jt}^{(R)} \frac{\partial \Pi_{jt}^{(M)}}{\partial w_{jt}} + (1 - \theta_j) \Pi_{jt}^{(M)} \frac{\partial \Pi_{jt}^{(R)}}{\partial w_{jt}} = 0. \quad (13)$$

In other words,

$$0 = \theta_j \Pi_{jt}^{(R)} \left[ s_{jt} + (w_{jt} - c_j) \sum_{k \in \mathcal{J}} \frac{\partial s_{jt}}{\partial p_{kt}} \frac{\partial p_{kt}}{\partial w_{jt}} \right] + \quad (14)$$

$$(1 - \theta_j) \Pi_{jt}^{(M)} \left[ (p_{jt} - w_{jt}) \sum_{k \in \mathcal{J}} \frac{\partial s_{jt}}{\partial p_{kt}} \frac{\partial p_{kt}}{\partial w_{jt}} + s_{jt} \left( \frac{\partial p_{jt}}{\partial w_{jt}} - 1 \right) \right].$$

To evaluate the above we need the derivative of the retail prices with respect to the wholesale prices. Note that,

$$\mathbf{p}_t = \mathbf{w}_t - \mathbf{\Phi}_t^{-1} \mathbf{s}_t. \quad (15)$$

Totally differentiating equation 15 with respect to  $\mathbf{w}_t$  and rearranging, we get,

$$\frac{\partial \mathbf{p}_t}{\partial \mathbf{w}_t} = -\mathbf{G}_t^{-1} \mathbf{\Phi}_t \quad (16)$$

where,  $\mathbf{\Phi}_t$  is as defined in equation 10 and the  $(ij)^{th}$  term of the matrix  $\mathbf{G}_t$  is given as,

$$(\mathbf{G}_t)_{ij} = \frac{\partial s_{it}}{\partial p_{jt}} + \frac{\partial s_{jt}}{\partial p_{it}} + \sum_{k \in \mathcal{J}} (p_{kt} - w_{kt}) \frac{\partial^2 s_{kt}}{\partial p_i \partial p_j}. \quad (17)$$

The first order conditions described by (13) offer an intuitive insight into the Nash bargaining process. The Nash bargaining first order conditions (FOCs) can be thought of as a weighted average of the FOCs of the two bargaining parties. The weights are determined by the relative bargaining power and the extent to which the exercise of such power is warranted. To see this note that if the manufacturer's FOCs  $\left( \frac{\partial \Pi_{jt}^{(M)}}{\partial w_{jt}} \right)$  are multiplied by  $\theta_j \Pi_{jt}^{(R)}$ . Clearly, as a manufacturer's power increases ( $\theta_j \uparrow$ ) or if the retailer is making large profits ( $\Pi_{jt}^{(R)} \uparrow$ ) a larger weight is placed on the manufacturers FOC. A similar logic applies to the retailers FOC.

An alternative depiction of Equation 13 allows us to examine channel interactions in terms of relative bargaining power. Note that equation 13 can be re-written as,

$$-\frac{\left( \frac{\partial \Pi_{jt}^{(R)}}{\partial w_{jt}} \right) \left( \Pi_{jt}^{(R)} \right)^{-1}}{\left( \frac{\partial \Pi_{jt}^{(M)}}{\partial w_{jt}} \right) \left( \Pi_{jt}^{(M)} \right)^{-1}} = \frac{\theta_j}{(1 - \theta_j)}. \quad (18)$$

Multiplying both the numerator and denominator by  $w_{jt}$  we obtain

$$-\frac{\left( \frac{\partial \Pi_{jt}^{(R)}}{\partial w_{jt}} \frac{w_{jt}}{\Pi_{jt}^{(R)}} \right)}{\left( \frac{\partial \Pi_{jt}^{(M)}}{\partial w_{jt}} \frac{w_{jt}}{\Pi_{jt}^{(M)}} \right)} = \frac{\theta_j}{(1 - \theta_j)}. \quad (19)$$

The reader will quickly recognize the numerator and denominator as the elasticity of the retailer's and manufacturer  $j$ 's profit with respect to whole sale price ( $w_{jt}$ ). Labeling these as  $\mathcal{E}_R^{(j)}$  and  $\mathcal{E}_M^{(j)}$  respectively we arrive at the following relation,

$$\frac{\mathcal{E}_R^{(j)}}{\mathcal{E}_R^{(j)} + \mathcal{E}_M^{(j)}} = \theta_j. \quad (20)$$

In other words, the bargaining power of manufacturer  $j$  is equal to the relative sensitivity of the retailer (evaluated at the equilibrium whole prices) to changes in wholesale prices. the Nash bargaining approach smoothly combines the interests of both parties in a continuous manner. It should, therefore, be obvious that as bargaining power become extreme limiting cases emerge. In what follows we examine two such cases.

### Special Case: Manufacturer Stackelberg

In the manufacturer Stackelberg game, a manufacturer sets the wholesale price first and then the retailer sets the retail price. When setting wholesale prices manufacturers take the reaction function of the retailer into account. As the manufacturers' power approaches unity ( $\theta_j \rightarrow 1$ ) an increasing amount of weight is placed on what would be the manufacturer's FOC. In the limit only the manufacturer's objective function matters. This implies that manufacturers can act as a leaders and set wholesale prices without any influence of the retailer. This is the very essence of a manufacturer Stackelberg game and leads to the following proposition:

**Proposition 1** *If manufacturers have complete power (relative to the retailer), i.e. if  $\theta_j = 1 \forall j \in \mathcal{J}$ , then the solution to the bargaining game is identical to a Manufacturer Stackelberg Game.*

**Proof.** If manufacturer  $j$  has all the power in the channel, then  $\theta_j = 1$ . Substituting  $\theta_j = 1$  in equation 9, we obtain

$$\Pi_{jt}^{(R)} \left[ s_{jt} + (w_{jt} - c_j) \sum_{k \in \mathcal{J}} \frac{\partial s_{jt}}{\partial p_{kt}} \frac{\partial p_{kt}}{\partial w_{jt}} \right] = 0$$

Assuming  $\Pi_{jt}^{(R)}$  to be strictly positive (since the retailer can always add a non-zero margin to the wholesale price in the next stage), above equation reduces to,

$$s_{jt} + (w_{jt} - c_j) \sum_{k \in \mathcal{J}} \frac{\partial s_{jt}}{\partial p_{kt}} \frac{\partial p_{kt}}{\partial w_{jt}} = 0$$

which is the first order condition under Manufacturer Stackelberg. ■

At this point, it might be beneficial to revisit the concept of bargaining. Bargaining solution is the solution achieved when none of the parties is able to make a take-it or leave-it offer. In Manufacturer Stackelberg game, the manufacturer makes a take-it or leave-it offer and the retailer accepts the offer. However, in a repeated game scenario, as is probably the case in reality, the manufacturer will not be able to make a take-it or leave-it offer. The retailer can threaten with non-participation in the game and force the manufacturer to come to the bargaining table. In other words, the bargaining model can be thought of as an approximation of dynamic (possibly non-linear) contract between the manufacturer and the retailer where the profit sharing is determined according to the bargaining power (which in turn is determined by factors like contribution to the channel strength, alternate options etc.).

### **Special Case: Two Part Tariffs**

Just as we have examined the case where all power rests with the manufacturers it is worthwhile examining the other extreme where the retailer is all powerful. Intuition suggests that if the retailer could set wholesale prices they would set it at the lowest levels possible. Of course, there is a constraint in the form of the manufacturer's cost function and hence the retailer could only lower wholesale prices to the marginal cost of the manufacturer. In such case, the retailer would act as a monopolist charge monopoly prices thereby implicitly coordinating the channel. Note, however, that observing wholesale prices equal to marginal cost does not inaccessibly imply the retailer has complete power. In fact, any two-part tariff structure that sets wholesales prices at marginal cost while charging a fixed fee will be indistinguishable (in equi-

librium) from a game with complete retailer power. This leads us to the following proposition:

**Proposition 2** *Full Retailer power ( $\theta_j = 0$ ), a special case of bargaining, results in wholesale and retail prices identical to those under a two-part tariff pricing scheme in which the variable component of the tariff is equal to the marginal cost.*

**Proof.** If the retailer  $j$  has all the power in the channel, then  $\theta_j = 0$ . Substituting  $\theta_j = 0$  in equation 11, we obtain

$$\Pi_{jt}^{(M)} \left[ (p_{jt} - w_{jt}) \sum_{k=1}^3 \frac{\partial s_{jt}}{\partial p_{kt}} \frac{\partial p_{kt}}{\partial w_{jt}} + s_{jt} \left( \frac{\partial p_{jt}}{\partial w_{jt}} - 1 \right) \right] = 0 \quad (21)$$

Thus, either (i)  $(p_{jt} - w_{jt}) \sum_{k=1}^3 \frac{\partial s_{jt}}{\partial p_{kt}} \frac{\partial p_{kt}}{\partial w_{jt}} + s_{jt} \left( \frac{\partial p_{jt}}{\partial w_{jt}} - 1 \right) = 0$  or, (ii)  $\Pi_{jt}^{(M)} = 0$

Let us examine the two conditions separately.

(i) The first condition states that,

$$(p_{jt} - w_{jt}) \sum_{k=1}^3 \frac{\partial s_{jt}}{\partial p_{kt}} \frac{\partial p_{kt}}{\partial w_{jt}} + s_{jt} \left( \frac{\partial p_{jt}}{\partial w_{jt}} - 1 \right) = 0 \quad (22)$$

Note that,  $\frac{\partial s_{jt}}{\partial p_{kt}}$  is strictly positive if  $j \neq k$  and is strictly negative if  $j = k$ . Similarly,  $\frac{\partial p_{kt}}{\partial w_{jt}}$  is strictly negative if  $j \neq k$  and is strictly positive if  $j = k$ . Further as shown in Sudhir (also see Besanko, Dube and Gupta 2005),  $\frac{\partial p_{jt}}{\partial w_{jt}}$  lies between 0 and 1. The above conditions imply that all the terms in the LHS of equation 22 are strictly negative. Hence, the condition i.e. equation 22 is not feasible.

(ii) This leaves us with the condition that  $\Pi_{jt}^{(M)} = 0$ .

This essentially means that the wholesale price is equal to the marginal cost of the manufacturer. This condition is equivalent to the two-part tariff scheme of payments wherein the wholesale price is equal to the marginal cost plus, there is a fixed fee from the retailer to the manufacturer<sup>4</sup>. ■

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<sup>4</sup>Note that the two part tariff under the bargaining scenario would also entail whole prices at marginal cost but the fixed fee would be a function of bargaining power.

The two extremes examined here only represent two of the many games that are possible within the bargaining framework. Importantly, the two nested extremes represent recognizable forms from the extant literature. As an aside we would like to point out that the Vertical Nash and Retailer Stackelberg models do not appear as special cases of our framework. These models suffer from an inherent lack of logical consistency (since they require a pre-commitment on the part of the retailer without any reason or penalty to enforce it). The bargaining framework can, however, accommodate an equal power scenario which we implement in our empirical analysis.

## 4 The Econometric Approach

### 4.1 Models Estimated

The retail and the wholesale prices are dependent on the expected demand in each period. On the other hand, the demand is determined by the retail price, which in turn is determined by the wholesale prices. Because of the interdependence of these decisions, we need to estimate this system of equations simultaneously. We estimate three versions of our bargaining framework. The system of equations to be estimated for each of these versions are as follows:

#### *Bargaining Model*

equations (7), (10) and (14)  $\forall j \in \mathcal{J}$

#### *Manufacturer Stackelberg*

Same equations as the Bargaining Model with  $\theta_j = 1, \forall j \in \mathcal{J}$

#### *Equal Power*

Same equations as the Bargaining Model with  $\theta_j = \frac{1}{2}, \forall j \in \mathcal{J}$

We initially started with the idea of estimating four models, the three listed above and a Retailer Power model ( $\theta_j = 0, \forall j \in \mathcal{J}$ ). Our analysis showed that the retailer power model resulted in parameter values that were contrary to theory and the model fit was poor. We therefore concentrate our attention to the models listed above.

## 4.2 Estimation Procedure

The demand side errors ( $\xi_{jt}$ ) enter non-linearly in the demand equations which makes the simultaneous estimation of the above-mentioned systems of equations rather difficult. We propose and implement the following three step procedure to estimate the systems of equations:

1. First, we make use of the instrumental variables approach suggested by BLP (1995) and Nevo (2000) to estimate the heterogeneity parameters (i.e.  $\Omega$ ) of the mixed logit demand system<sup>5</sup>. The market share  $s_{jt}$ , as derived in equation 7, is evaluated by numerical integration. Next, the  $\delta_{jt}$ 's are computed (as a function of  $\Omega$ ) by the following contraction mapping:

$$(e^{\delta_{jt}})^{n+1} = (e^{\delta_{jt}})^n \frac{S_{jt}}{s_{jt}}.$$

$S_{jt}$  and  $s_{jt}$  are the *observed* and *computed* market share of brand  $j$  respectively. Once the  $\delta_{jt}$ 's are obtained, we can compute the demand errors as,

$$\xi_{jt} = \delta_{jt} - (\bar{\alpha}_j + X'_{jt}\bar{\lambda} - \bar{\beta}p_{jt})$$

Finally, the parameters are estimated by minimizing the following GMM objective function:

$$\min (Z\xi)' \Psi^{-1}(Z\xi)$$

where,  $Z$  is the matrix of instruments and  $\Psi$  is an appropriate weighting matrix.

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<sup>5</sup>The reader is referred to Nevo (2000) for more details of the estimation procedure.

2. Next, we use the estimated covariance matrix  $\hat{\Omega}$  from the earlier step and estimate the systems of equations simultaneously by GMM.
3. Finally, we use the estimated mean parameters of the demand system ( $\bar{\alpha}_j$ 's,  $\bar{\lambda}$ 's and  $\bar{\beta}_k$ 's) to re-estimate the heterogeneity parameters.

## 5 Data

The data in the Dominick's Database (Kilts Center for Marketing Research, University of Chicago) is used to estimate the structural parameters of the two product categories. Dominick's Finer Foods is one of the largest retail chains in Chicago metropolitan area. The data are aggregated across all stores in the retail chain<sup>6</sup>. The two product categories examined were the refrigerated fruit juice category and the bathroom tissue category. While compiling the data, it was ensured that all brands had non-zero sales in each period (this ensures that all brands are competing in the market). In the refrigerated fruit juice market, top three manufacturers - Tropicana, Private Label and Minute Maid account for 77% of market share. In the bathroom tissue market, top three brands - Kleenex, Charmin and Quilted Northern account for 85% of market share. The variables in the data set are as follows:

- (i) Retail price ( $\phi$ /oz. or  $\phi$ /roll) - Calculated as a weighted average price across UPCs and sizes for any one manufacturer.
- (ii) Retailer's margin ( $\phi$ /oz. or  $\phi$ /roll) - Calculated as weighted average across UPCs and sizes for any one manufacturer.
- (iii) Wholesale Price ( $\phi$ /oz. or  $\phi$ /roll) - Calculated by subtracting the retailer's margin from the retail price.

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<sup>6</sup>We also estimated our model on a zone basis and found qualitatively similar results. These are available from the authors.

- (iv) Quantity (oz./rolls)- Aggregated across all UPCs for one manufacturer
- (v) Deal (indicator variable) - Calculated as a weighted average of “deal” across UPCs and sizes for any one manufacturer.
- (vi) Bonus (indicator variable) - Calculated as a weighted average of “deal” across UPCs and sizes for any one manufacturer.

Tables 1a and 1b provide summary descriptive statistics for the two datasets. The wholesale price is calculated by subtracting the retailer’s margin from the retail price. This is the Average Acquisition Cost<sup>7</sup> (AAC) used by Kadiyali et al. (2000) and Besanko, Dube and Gupta (2005). To estimate the demand equations (7), we also need data on the outside option available to consumers. We follow Nevo’s (1997) approach, which is based on store traffic and the average consumption, to calculate the potential total market size and thus impute the outside option<sup>8</sup>.

The estimation procedure outlined earlier requires a set of instruments that are correlated with prices but uncorrelated with the unobserved demand shock ( $\xi$ ). We use cost indices from the Bureau of Labor Statistics (BLS) as instruments. Table 2 contains descriptive statistics of the series. We found the series to be remarkably good instruments. The correlation between average monthly prices and the series was .63 for refrigerated fruit juice and .40 for toilet tissue. In addition we also use the two marketing variables - Bonus and Deal as instruments. It might be argued that coupon and deal are marketing variables that might be endogenous as well. However, arguably coupon and deal expenses are decided much ahead of time (usually once a year) and can therefore be treated as exogenous.

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<sup>7</sup>See Peltzman (2000) for details of this construct and Besanko, Dube and Gupta (2005) for a defence of its use as a measure of wholesale prices.

<sup>8</sup>It is ensured that the potential market calculated using this method is larger than the actual total sales of the product category in each period.

## 6 Results and Discussion

### 6.1 Model Comparison

Since we are using a GMM based methodology model comparison is difficult and past studies have relied on various approximate tests. A unique feature of the three models we estimate is that two of them (Manufacturer Stackelberg and Equal Power) are nested in the broader bargaining model. This facilitates direct comparison using Hansen's- $J$  statistic. Unfortunately, this approach does not account for the restrictions placed on the bargaining parameters. Instead, we use the Model and Moment Selection Criteria (MMSC-BIC) proposed by Andrews (1999) and Andrews and Lu (2001) to compare across models. The MMSC-BIC has been shown to be a consistent discriminator across models and relies on a penalty term similar to the Bayesian Information Criterion (BIC). We compute and present a version of this statistic  $\Delta$ MMSC-BIC which represents the difference in the criteria between a given model and the best fitting model. Our results generally support the fact that channel interactions in the two categories we study are consistent with Nash bargaining. In particular, we find that the full bargaining model outperforms the Manufacturer Stackelberg and Equal Power models.

### 6.2 Channel Interactions: Refrigerated Fruit Juice

Detailed results from our estimation procedure implemented on the Refrigerated Fruit Juice (RFJ) category are provided in Table 3a. The parameter estimates obtained from all models seem reasonable and make economic sense. As expected the price parameters are negative while the deal and bonus parameters are positive. The marginal costs are significant and positive and, in all cases, are lower than the wholesale prices. The results suggest that misspecification of the supply side game has an effect on the estimation results. In particular the price coefficient seems to be significantly lower in the full model than other models.

Table 4 reveals that the Tropicana brand enjoys the highest relative power ( $\theta_{Tropicana} = 0.716$ ) in the RFJ category. It is plausible that high brand equity (as measured by the brand constant) plays a role in contributing to this power. As expected, the Private Label has the lowest bargaining power, although it is only marginally lower than that of Minute Maid. This strong showing of the private label might be on account of substantially lower marginal costs. Moreover, as indicated by some of the earlier studies on channel interactions the retailer is dependent on the Private Label to a great extent to effectively bargain with the national label brands. Another interesting fact revealed by Table 4 is that a larger power parameter does not guarantee a larger proportion of the channel profits. Increased power gives the player greater ability to influence the wholesale price but since total channel profits depend on the retail prices as well, the relationship between power and profit share is not one-to-one. In fact, as our theory suggests that the ratio of bargaining power is related to the sensitivity (elasticity) of profits with respect to wholesale prices.

### 6.3 Channel Interactions: Bathroom Tissue

To be added.

## 7 Conclusion and Directions

In this paper, we have proposed and estimated a bargaining model of channel interactions. Specifically we assume that wholesale prices are determined via Nash bargaining between the manufacturer and the retailer. As a result no one party sets these prices unilaterally but rather “weigh in” on the final solution based on their respective bargaining powers. We offer a theoretical perspective that, compared to the extant models of channel interactions, is more realistic.

Our econometric approach allows us to estimate the relative bargaining power of the channel members and compare alternative game-forms within a single enveloping framework. Our findings reveal that a bargaining model with asymmetric power outperforms some of the standard models of channel interactions in existing literature.

There are several logical extensions of this paper. The treatment of the marginal cost could be improved, especially if better data on factor inputs were available. In this paper we have assumed that a static game is played in each week. It would be interesting to examine the problem from a longer term perspective treating firms as forward looking and incorporating bargaining costs.

## 8 References

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**Table 1a: Descriptive Statistics for Refrigerated Fruit Juice**

<b>Brands</b>	<b>Variable</b>	<b>Weekly Mean</b>	<b>Std. Dev.</b>
<b>Tropicana</b>	Quantity (1000 oz.)	55,232	49,637
	Retail Price (cents/oz.)	3.97	0.61
	Wholesale price (cents/oz.)	2.82	0.30
	Bonus (avg.)	0.37	0.31
	Deal (avg.)	0.11	0.24
	Market Share	32.8%	
<b>Minute Maid</b>	Quantity (1000 oz.)	33,687	50,283
	Retail Price (cents/oz.)	3.42	0.57
	Wholesale price (cents/oz.)	2.40	0.32
	Bonus (avg.)	0.39	0.35
	Deal (avg.)	0.10	0.25
	Market Share	20%	
<b>Private Label</b>	Quantity (1000 oz.)	41,519	45,827
	Retail Price (cents/oz.)	2.53	0.44
	Wholesale price (cents/oz.)	1.69	0.27
	Bonus (avg.)	0.43	0.38
	Deal (avg.)	0.05	0.19
	Market Share	24.7%	

*Note: Coupon and Deal are indicator variables and are calculated as the weighted average across UPCs and sizes for any one manufacturer*

**Table 1b: Descriptive Statistics for Toilet Tissue**

<b>Brands</b>	<b>Variable</b>	<b>Weekly Mean</b>	<b>Std. Dev.</b>
<b>Kleenex</b>	Quantity (oz.)	3,626	3,615
	Retail Price (cents/oz.)	44.22	7.16
	Wholesale price (cents/oz.)	38.20	5.92
	Bonus (avg.)	0.274	0.289
	Deal (avg.)	0.117	0.236
	Market Share	37.3%	
<b>Charmin</b>	Quantity (oz.)	3,057	5,830
	Retail Price (cents/oz.)	36.30	5.77
	Wholesale price (cents/oz.)	29.95	4.33
	Bonus (avg.)	0.176	0.268
	Deal (avg.)	0.068	0.196
	Market Share	31.4%	
<b>Quilted Northern</b>	Quantity (oz.)	1,659	2,171
	Retail Price (cents/oz.)	32.55	4.08
	Wholesale price (cents/oz.)	25.93	2.75
	Bonus (avg.)	0.256	0.342
	Deal (avg.)	0.057	0.190
	Market Share	17.1%	

*Note: Coupon and Deal are indicator variables and are calculated as the weighted average across UPCs and sizes for any one manufacturer*

**Table 2: BLS Series Instruments**

PPI Series Title	Mean	Std. Dev.	Min	Max	$\rho^9$
Frozen juices and ades	119.52	10.71	102.20	149.10	.63
Toilet tissue and stock <sup>10</sup>	136.41	7.62	127.90	152.80	.40

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<sup>9</sup>Correlation with average prices (all brands) in a given month.

<sup>10</sup>The BLS series seemed to have a scale shift in the towards the end of our data. We use a smooth extrapolation for the last few months in this series rather than the actual data.

**Table 3a: Parameter Estimates for Refrigerated Fruit Juice**

Parameter	Bargaining		Manufacturer		Equal	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Price	-115.62	1.287	-130.20	2.851	-133.97	0.594
Bonus	0.75	0.013	0.57	0.064	0.67	0.011
Reduction	0.81	0.026	0.71	0.098	0.62	0.012
Brand Constants					0	0
Tropicana	2.29	0.054	3.251	0.126	2.73	0.017
Minute Maid	1.05	0.050	1.840	0.107	1.87	0.010
Private Label	0.47	0.040	0.811	0.092	0.86	0.012
Marginal Cost						
Tropicana	0.017	0.001	0.017	0.003	0.016	0.002
Minute Maid	0.015	0.000	0.014	0.002	0.014	0.003
Private Label	0.010	0.000	0.007	0.001	0.010	0.002
Bargaining Power						
Tropicana	0.72	0.014				
Minute Maid	0.50	0.002				
Private Label	0.44	0.002				
Hansen's $J$ -Statistic	584.52		633.73		614.93	
$\Delta$ MMS-C-BIC	-		33.25		14.45	

**Table 3b: Parameter Estimates for Toilet Tissue**

Parameter	Bargaining		Manufacturer		Equal	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Price	-11.759	0.079	-13.269	0.678	-13.045	.021
Bonus	0.009	0.001	-0.346	0.076	1.168	0.019
Reduction	0.552	0.029	-0.368	0.118	1.513	0.018
Brand Constants						
Kleenex	2.594	0.036	4.620	0.352	1.513	0.019
Charmin	1.947	0.042	3.348	0.281	0.334	.015
Quilted Northern	0.936	0.045	2.487	0.261	-0.272	0.021
Marginal Cost						
Kleenex	0.306	0.005	0.275	0.007	0.260	0.001
Minute Maid	0.240	0.001	0.203	0.006	0.230	0.011
Quilted Northern	0.207	0.001	0.173	0.004	0.109	0.003
Bargaining Power						
Kleenex	0.602	.0011				
Charmin	0.454	0.005				
Quilted Northern	0.211	0.010				
Objective Function	750.65		845.02		784.79	
$\Delta$ MMS-C-BIC	-		77.86		17.83	

**Table 4: Profit Share and Bargaining Power**

<b>Refrigerated fruit juice</b>			
	Tropicana	Minute Maid	Private Label
Retail Margin (cents/oz.)	1.15	1.02	0.84
Wholesale Margin (cents/oz.)	1.14	1.17	0.68
Estimated Marginal Cost (cents/oz.)	1.68	1.51	1.01
Retailer Profit Share	50.70%	53.10%	54.90%
Manufacturer Profit Share	49.30%	46.90%	45.10%
Manufacturer Bargaining Power	0.716	0.501	0.442
Market Share	32.8%	20.0%	24.7%
Brand Equity (Constants)	2.299	1.056	0.477

  

<b>Toilet Tissue</b>			
	Kleenex	Charmin	Quilted Northern
Retail Margin (cents/roll)	3.21	3.79	5.22
Wholesale Margin (cents/roll)	3.49	2.25	3.15
Estimated Marginal Cost (cents/roll)	3.06	2.48	2.07
Retailer Profit Share	44.20%	51.60%	55.90%
Manufacturer Profit Share	55.80%	48.40%	44.10%
Manufacturer Bargaining Power	0.602	0.454	0.210
Market Share	37.3%	31.4%	17.1%
Brand Equity (Constants)	2.594	1.947	0.936