Estimating Bargaining Games in Distribution Channels

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First version June, 2004.
Current version July, 2006.
January 3, 2008

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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. In a simple manufacturer-retailer setting wholesale prices determine the profit share a given channel member appropriates and consequently, power is directly related to the process of wholesale price setting. In most previous studies of channel interactions, it is assumed that the wholesale price is set by the manufacturer unilaterally, i.e. the manufacturer makes 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 Nash bargaining theory to propose and implement an econometric framework to investigate channel structure and 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 negotiation process using a modified Nash bargaining framework with asymmetric bargaining powers. The wholesale prices that emerge as an outcome of the 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 there 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."*

<div align="center">The New York Times, November 26, 2001</div>

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

<div align="center">1</div>

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 re-

tailer 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 (RFJ) and Toilet Tissue (TTI). 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. For example, we find that under a full bargaining specification, the price effect is significantly lower than in other game forms.

This paper contributes to the marketing literature on theoretical, methodological and substantive fronts. First, we extend the current theory on distribution channels by modeling channel interactions via an asymmetric Nash bargaining game with multiple manufacturers and a common retailer. We further show that this bargaining game nests other strategic game forms and outline new interpretations of the bargaining power construct. On the methodological front we propose an iterative estimation procedure that allows us to calibrate the complex theoretical model using real data. Finally, our results offer substantive insights into the nature of channel interactions in two product categories. In particular, our analysis and related discussions allow researchers and managers to grasp the notion of power better and relate it to constructs such as brand equity, costs and market share.

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) are 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 co-operative approach and the non-cooperative approach[2]. The asymmetric Nash bargaining solution is the cooperative approach to bargaining problems in which the asymmetry in bar-

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[2]See Muthoo (1999)

gaining 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 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,

$$\max_{x} \mathbb{N} \equiv [v_1(x) - d_1]^\theta [v_2(x) - d_2]^{1-\theta} \tag{1}$$

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where, $\mathbb{N}$ is the asymmetric Nash product, d_k is the disagreement payoff of party k if the bargaining process breaks down, $v(x)$ is the utility party k derives from an allocation of x, θ 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 θ. 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 models more flexibly and captures the basic spirit of channel power.

In most 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

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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 set of brands is denoted by $\mathcal{J}$, while the full set of choice alternatives is denoted by $\mathcal{I} = \{\mathcal{J}, 0\}$. The utility of brand j in period t for consumer h is given by,

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

where, α_{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 (α) and response parameters to marketing elements (λ, β) are individual specific. ξ_{jt} is an unobservable (to the researcher) demand shock for brand j in time period t[3]. Finally, ε_{hjt} is an i.i.d. error component. We also normalize the utility from the outside good to zero $(U_{0t} = 0)$. Given this specification, a consumer h chooses alternative k in period

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[3]Some unobservable components of the utiltity function such as advertising, past experience etc. might be correlated with price. Including ξ_{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.

t if,

$$U_{hit} \geqslant U_{hjt} \quad \forall \; i, j \in \mathcal{I}$$

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

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

In other words,

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

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

$$
\begin{aligned}
u_{hjt} &= \delta_{jt} + \mu_{hjt} + \varepsilon_{hjt} \\
\text{where,} \; \delta_{jt} &= \bar{\alpha}_j + X'_{jt}\bar{\lambda} - \bar{\beta}p_{jt} + \xi_{jt} \quad \text{and,} \quad \mu_{hjt} = \left[1, X'_{jt}, p_{jt} \right] \Omega^{\frac{1}{2}} \eta_h.
\end{aligned}
\tag{5}
$$

In (5), the η_h's are draws from a standard normal. By including the option of 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). The aggregate market share (or the aggregate probability of purchase) for each brand in period t is given by,

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

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

If we specifically assume that the ε are distributed i.i.d. Gumbel then, we have,

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

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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,

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

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

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

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

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

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,

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

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

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

In the above, θ_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 $\left(d_{jt}^{(M)} = 0 \right)$ and assume that the retailer's disagreement profit (with respect to manufacturer j) is the maximum profit it could earn should manufacturer j be removed from the game. In other words, $d_{jt}^{(R)} = \max \Pi_{-jt}^{(R)}$. Note that this outside option is a fixed value for a specific manufacturer and can be treated as a constant.

Characterizing the Equilibrium

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

$$\frac{\partial \mathbb{N}_{jt}}{\partial w_{jt}} = \theta_j \left(\Pi_t^{(R)} - d_j^{(R)} \right) \frac{\partial \Pi_{jt}^{(M)}}{\partial w_{jt}} + (1 - \theta_j)\, \Pi_{jt}^{(M)} \frac{\partial \Pi_t^{(R)}}{\partial w_{jt}} = 0. \tag{13}$$

In other words,

$$\begin{aligned}
0 = \;& \theta_j \left(\Pi_t^{(R)} - d_j^{(R)} \right) \left[s_{jt} + (w_{jt} - c_j) \sum_{k \in \mathcal{J}} \frac{\partial s_{jt}}{\partial p_{kt}} \frac{\partial p_{kt}}{\partial w_{jt}} \right] + \\
& (1 - \theta_j) \Pi_{jt}^{(M)} \left[\sum_{k \in \mathcal{J}} \left\{ s_{kt} \frac{\partial p_{kt}}{\partial w_{jt}} + (p_{kt} - w_{kt}) \sum_{l \in \mathcal{J}} \frac{\partial s_{kt}}{\partial p_{lt}} \frac{\partial p_{lt}}{\partial w_{jt}} \right\} - s_{jt} \right].
\end{aligned} \tag{14}$$

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

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

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

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

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

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

The first order conditions described by (13) offer an intuitive insight into the Nash bargaining process and 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 selfish FOCs $\left(\frac{\partial \Pi_{jt}^{(M)}}{\partial w_{jt}}\right)$ are multiplied by $\theta_j \left(\Pi_t^{(R)} - d_j^{(R)}\right)$. Clearly, as a manufacturer's power increases $(\theta_j \uparrow)$ or if the retailer is making large profits $\left(\Pi_t^{(R)} \uparrow\right)$ a larger weight is placed on the manufacturer's FOC. Alternatively, if the retailer has a better outside option $\left(d_j^{(R)} \uparrow\right)$ then the manufacturer's FOC matters less. A similar logic applies to the retailer's 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,

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

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

$$-\frac{\left[\frac{\partial\left(\Pi_t^{(R)} - d_j^{(R)}\right)}{\partial w_{jt}} \frac{w_{jt}}{\left(\Pi_t^{(R)} - d_j^{(R)}\right)}\right]}{\left[\frac{\partial\left(\Pi_{jt}^{(M)} - d_j^{(M)}\right)}{\partial w_{jt}} \frac{w_{jt}}{\left(\Pi_{jt}^{(M)} - d_j^{(M)}\right)}\right]} = \frac{\mathcal{E}_R^{(j)}}{\mathcal{E}_M^{(j)}} = \frac{\theta_j}{(1 - \theta_j)}. \tag{19}$$

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

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

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 powers 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 taking wholesale prices as given. This game assumes that when setting wholesale prices, manufacturers are forward looking, and take the reaction function of the retailer into account. The bargaining game proposed earlier nests the manufacturer Stackelberg game as a special case. To see this, note that as the manufacturers' power approaches unity ($\theta_j \to 1$) an increasing amount of weight is placed on what would be the manufacturer's profit maximizing 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 active 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

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

Now if $\left(\Pi_t^{(R)} - d_j^{(R)}\right) = 0$ then there are no gains to be made (for the retailer) from trade and the manufacturer will be excluded from the game. In other words in any equilibrium containing manufacturer j the term $\left(\Pi_t^{(R)} - d_j^{(R)}\right)$ has to be strictly positive. In such case,

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the 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. A bargaining solution is achieved when none of the parties is able to make unilateral take-it or leave-it offers. The Manufacturer Stackelberg game, however, relies on the assumption that manufacturers are capable of making credible take-it or leave-it offers and that a retailer has no choice but to accept such offers. Most anecdotal evidence, however, suggests that, contrary to the Stackelberg assumptions, manufacturers are unable to make such unilateral offers. Retailers are often able to threaten non-participation and, hence, force the manufacturer to come to the bargaining table. While our bargaining model is a static depiction of reality, it nevertheless can be thought of as an approximation of dynamic contract negotiations between manufacturers and the retailer where the profit sharing is determined according to the bargaining power. The fact that the Stackelberg game is an extreme case of the bargaining framework suggests that, at best, it has limited applicability to real-world channel relations.

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 co-ordinating the channel. Note, however, that observing wholesale prices equal to marginal cost does not necessarily imply that 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 equilibrium) 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

$$\Pi_{jt}^{(M)} \frac{\partial \Pi_t^{(R)}}{\partial w_{jt}} = 0 \tag{21}$$

Thus, either (i) $\frac{\partial \Pi_t^{(R)}}{\partial w_{jt}} = 0$

or, (ii) $\Pi_{jt}^{(M)} = 0$

Let us examine the two conditions separately.

(i) The first condition states that,

$$\frac{\partial \Pi_t^{(R)}}{\partial w_{jt}} = 0 \tag{22}$$

Note, however, that $\Pi_t^{(R)} = \Pi_t^{(R)}(\mathbf{p}^*)$, i.e. it contains the optimal price response. Then, since $\frac{d\Pi_t^{(R)}}{dp_k^*} = 0, \forall\ k \in \mathcal{J}$, by the envelope theorem $\frac{\partial \Pi_t^{(R)}}{\partial w_{jt}} = -Q_{jt}^*$. 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[4]. ∎

The two extremes examined here only represent two of a continuum of games that are possible within the proposed bargaining framework. Importantly, the two nested extremes represent recognizable forms from the extant literature. The bargaining framework can also accommodate an equal power scenario by setting $\theta_j = \frac{1}{2}$. This is corresponds exactly to the Nash bargaining solution originally proposed by Nash (1950). As an aside we would like to point out that the Vertical Nash and Retailer Stackelberg models do not appear as special

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[4]Note that the two part tariff, under a bargaining scenario, would also entail wholesale prices at marginal cost but the fixed fee would now be a function of relative bargaining powers of the two parties.

cases of our framework. These models suffer from an inherent lack of logical consistency (since they require a credible pre-commitment on the part of the retailer without any reason or penalty to enforce it).

4   The Econometric Approach

4.1   Structural 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. The presence of heterogeneity and nonlinearities in the system require a customized estimation framework which we discuss in the next section. 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. In addition, as a benchmark, we also estimated a simple logit demand model for both datasets.

Before we move on we need to address a key issue pertaining to the identification of the disagreement payoffs faced by the retailer. As mentioned earlier the manufacturer's disagreement payoffs have been normalized to zero. A similar assumption for the retailer is, however, economically untenable. This is because the theoretically maximum profits obtainable by the retailer is smaller if one removes a given manufacturer from the analysis. In other words $\left[\left(\max \Pi_t^{(R)}\right) - \Pi_{jt}^{(R)}\right] > \left[\max \Pi_{-jt}^{(R)}\right]$. In addition, from an econometric standpoint estimating the disagreement payoffs is infeasible. To work around this problem we assume that the disagreement payoffs $\left(d_{jt}^{(R)}\right)$ are equal to the theoretical maximum attainable without manufacturer j under the same parameter values. We also tried scaling this value and found that there was little impact on our estimation results.

4.2 Estimation Procedure

The demand side errors (ξ_{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. Ω) of the mixed logit demand system[5]. The market share s_{jt}, as derived in equation 7, is evaluated by numerical integration. Next, the δ_{jt}'s are computed (as a function of Ω) 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 δ_{jt}'s are obtained, we can compute the demand errors as,

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

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[5] The reader is refered to Nevo (2000) for more details of the estimation procedure.

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

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

where, Z is the matrix of instruments and Ψ is a weighting matrix.

2. Next, we use the estimated heterogeneity parameter matrix $\hat{\Omega}$ from the earlier step and estimate the systems of equations simultaneously using a simulated GMM approach. At this stage the moment conditions include the demand and (relevant) supply side equations. Note that the demand side parameters are re-estimated in this step.

3. Finally, we use the mean parameters of the demand system ($\bar{\alpha}_j$'s, $\bar{\lambda}$'s and $\bar{\beta}_k$'s) to re-estimate the heterogeneity parameters (i.e. Ω).

One pass through the estimation procedure outlined above ensures consistent estimates of the parameters of interest. Obviously, our approach lends itself naturally to an iterated GMM approach (similar to the continuous updated GMM approach of Hanson, Heaton and Yaron 1996) which involves cycling through the steps until a pre-specified stopping criterion has been met. This iterated version of the GMM procedure specified above improves the efficiency of the estimates while retaining consistency.

5   Refrigerated Fruit Juice: An Empirical Illustration

5.1   Data

The data in the Dominick's Database (Kilts Center for Marketing Research, University of Chicago) is used to estimate the structural parameters of two product categories. The two product categories examine were the refrigerated fruit juice category and the bathroom tissue category. 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[6]. While compiling the data, it was ensured that all brands had non-zero sales in each period (this ensures that

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[6]We also estimated our model on a zone basis and found qualitatively similar results.

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 ($\not c$/oz. or $\not c$/roll) - Calculated as a weighted average price across UPCs and sizes for any one manufacturer.

(ii) Retailer's margin ($\not c$/oz. or $\not c$/roll) - Calculated as weighted average across UPCs and sizes for any one manufacturer.

(iii) Wholesale Price ($\not c$/oz. or $\not c$/roll) - Calculated by subtracting the retailer's margin from the retail price.

(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[7] (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[8].

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[7]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.

[8]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.

The estimation procedure outlined earlier requires a set of instruments that are correlated with prices but uncorrelated with the unobserved demand shock (ξ). We use cost indices from the Bureau of Labor Statistics (BLS) as instruments. Table 1c 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 that bonus and deal are marketing variables that might be endogenous as well. However, arguably bonus and deal expenses are decided ahead of time (usually once a year) and can therefore be treated as exogenous.

5.2 Model Specification

The estimation procedure requires us to spell out the particulars or our demand and cost functions. The random coefficients demand model we estimate is captured by the following utility specification,

$$U_{hjt} = \alpha_{hj} + \lambda_{1h}BONUS_{jt} + \lambda_{2h}DEAL_{jt} - \beta_h p_{jt} + \xi_{jt}. \tag{23}$$

Note also that we normalize the utility from the outside option to zero, i.e. $U_{0t} = 0$. As a benchmark we also estimated a naive logit model without any heterogeneity or endogeneity correction.

On the cost side we adopted a rather simple specification. We allowed the marginal cost (c_{jt}) (for each manufacturer) to vary over time as a function of the producer's price index[9] (PPI_t). This gives us,

$$c_{jt} = c_{0j} + c_{1j}PPI_t. \tag{24}$$

As a specification check we also tried a constant marginal cost specification and found the above equation to fit the data better. Using the cost and demand systems as specified by (23) and (24) we implemented the estimation procedure described earlier.

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[9]Note also that in the estimation procedure, the PPI indices were scaled (by a constant) to make the estimated coefficients more presentation friendly.

5.3 Robustness Checks

While the model and econometric framework adopted in this paper are designed to aptly reflect institutional details and theory, they do, to a certain extent, rely on a set of key assumptions. To ensure the consistency and credibility of our results and to assess the sensitivity of our findings to these assumptions, we conducted a series of robustness checks. These are briefly discussed below.

Seasonality: We tested for seasonality by including time related (month, quarter or season) effects. We found no impact of such factors in the TTI category. While the RFJ category did exhibit some seasonality the results presented in this paper are qualitatively similar to those which included season fixed effects.

Retail Costs: An implicit assumption in our framework is that there are zero retail costs. This is potentially a problematic assumption. Unfortunately, we were unable to find adequate proxies for these retail costs. Our attempts to include wages, electricity rates and other such market level factors did not provide any significant results. Also, assuming constant retail costs did not have any impact on our findings.

Marginal Cost Function: We tried a number of different specification for the marginal cost function. As mentioned earlier we tried a constant marginal cost formulation which was dominated by the specification reported in this paper. In addition, we also tried higher order (quadratic, cubic) terms in the function but found no significant effects. Given that we do not have inventory data on raw-materials used by manufacturers, we were unable to ascertain at what time points the PPI indices become relevant to costs. To check whether this issue made a difference, we allowed the marginal cost functions to contains lags of the PPI index. Again, we found no significant differences from those that we present here.

Instruments: While the instruments used in the estimation procedure work well we tired other instruments to assess the sensitivity of parameter estimates to the choice of instruments. Our checks revealed that without the PPI series the parameters are only slightly different. One key issue we faced was whether we should use wholesale prices as instruments in the first stage of our estimation procedure. Our experiments showed again that using wholesale prices as instruments in addition to the PPI had only a small impact on the final

demand parameters. In any case, since we reestimated demand parameters using a system of equations in the later steps of the estimation routine this issue is irrelevant. Another choice of instruments we tested was lagged prices. Again, results were similar but we chose to refrain from using these as instruments.

Starting Values: A final check we performed was to conduct a grid search over some of the parameters to ensure that we had reached a global optima. In a few cases we found that the GMM procedure was trapped in a local minima and the grid search allowed us to hone in on the true estimates by re-specifying appropriate starting values.

The purpose of the robustness checks outlined above was to ensure the validity and sensitivity of our parameter estimates to perturbations in our assumptions, functional forms and data. We are satisfied that this is the case and we now move to a discussion of our results.

6 Results and Discussion

6.1 Model Fit and Comparison

GMM based methodologies do not naturally lend themselves to model comparison. In most cases (for example in menu approaches to testing vertical structures) the differences in moment conditions result in an inherent non-nestedness which consequently make it difficult to compare across models. Past studies have relied on various adaptations and approximations to compare models. A unique feature of the models we estimate is that two of the three (Manufacturer Stackelberg and Equal Power) are nested in the broader bargaining model. This facilitates a direct comparison using Hansen's-J statistic. Unfortunately, this statistic does not account for the restrictions placed on the bargaining parameters. To account for the differences in parameters, we use the Model and Moment Selection Criteria (MMSC-BIC) proposed by Andrews (1999) and Andrews and Lu (2001). 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 ΔMMSC-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. While an improvement in fit should be expected (given the nesting structure) the ΔMMSC-BIC reveals that after taking into account parameter restrictions the Bargaining model continues to do better. It is also noteworthy that the equal power model fits the data better than the manufacturer Stackelberg game and that it seems "closer" to the full bargaining model. This finding might be coincidental (i.e. a function of the product categories) or structural (in that the bargaining powers are likely not going to be extreme). In either case future research that applies our modeling framework to other product categories might investigate this issue further.

6.2 Parameter Estimates

Tables 2a and 2b present results from a naive logit demand estimation for the Refrigerated Fruit Juice (RFJ) and Toilet Tissue (TTI) datasets. The estimated parameters obtained via this simple model are intuitive and statistically significant. Given that neither heterogeneity nor endogeneity has been corrected for we should expect the structural models to reveal strong differences from these naive estimates. This is borne out by the results presented in tables 3a and 3b. Each table contains three sets of estimates pertaining to (a) Demand (b) Cost and (c) Structure and we discuss these in order.

Demand

A quick comparison of tables 2 and 3 reveal that the incorporation of heterogeneity and the correction for endogeneity results in the price coefficients being more negative. This is consistent with results obtained in previous studies and reflects the reduction in the endogeneity bias. For the RFJ category the price coefficient moves from -90.09 to -115.62 in the full bargaining model. A similar increase is found in the TTI category (-5.94 to -11.76). A closer look at Table 3a and 3b reveals some interesting differences in the demand parameters

across the three structural models. First, we note that the full bargaining model tends to have a lower price sensitivity than the other two models. As one would expect, since the Equal power model is closer to the Full Model in terms of fit, the parameter estimates are similar. We note, however, that the differences across models are statistically significant. What is noteworthy here is that the differences in price effect estimates (and also estimates of other demand related factors) are emerge only on account of the supply side restrictions in place since the demand specification is inherently the same across models. Interpreting these differences from a supply standpoint might offer some interesting insights into how structural assumptions and restrictions impact parameter estimates.

To examine this further we focus our attention to a comparison of the price parameter differences between the manufacturer Stackelberg and Bargaining models. In both product categories the price sensitivity is higher [10] under the Stackelberg framework. To understand why this might happen, note that, under the Stackelberg game manufacturers set wholesale prices to maximize their own profits, without any active influence from the retailer. These wholesale prices act as key ingredients in the retail price setting process adopted by the retailer. Now, if manufacturer's act selfishly, the wholesale prices, and consequently, retail prices will be higher than if the retailer had some say in the matter on account of his/her bargaining clout. Assume, for a second, that the Bargaining model reflects the truth, then, the *observed* prices will seem too low when compared to theoretical Stackelberg prices. To compensate for this difference the estimation procedure adjusts the estimates so that observed and theoretical prices match up. This ends up making the consumer seem more price sensitive than they might truly be. We would like to point out that a similar logic might explain why the price sensitivity is lower in the Bargaining game if one were to assume Stackelberg to be the truth. In either case, the discussion highlights the role that structural assumptions play in determining parameter estimates. While the other demand side parameters are all significant there seems to be no obvious discernable pattern in the promotion variables or in the brand constants across the various models.

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[10]We also compared elasticites and found the same pattern. These elasticities, while not presented here, are available on request.

Costs and Auxiliary Measures

Perhaps the truest test of structural models is their ability to recover reasonable, intuitive and acceptable measures of economic interest. The past literature has found that model misspecification often results in negative or insignificant estimates of cost and margin type constructs. All models estimated within the broader bargaining framework results in cost and margin estimates that were economically intuitive. In particular the estimates resulted in positive cost and margin estimates. In what follows we discuss these constructs in some detail.

The cost parameters (both c_0 and c_1) are significant for the RFJ category across models. The private label brand has the lowest cost intercept (in all models) and seems to be more strongly in line with the variation in the PPI index. This seems intuitive, since the national label brands possibly have other costs (packaging, advertising etc.) which gets captured by the cost intercept but not by the PPI.

For the TTI category the cost intercepts (c_0) are significant but the cost slope parameters (c_1) are statistically non-significant for two (Charmin and Quilted Northern) of the three brands. This might be because the variation in the toilet tissue PPI did not correspond to changes in costs for those brands or because these brands have a constant marginal cost of production. In both product categories the average marginal costs (and estimated marginal costs at each time period) are well below the wholesale prices for the bargaining model and the equal power models. In case of the Stackelberg specification, the average marginal cost lies below wholesale price for all brands but in both categories there are instances, where the estimated costs for one or more brands fall above the wholesale price of that brand, for that week.

Overall, we found the estimated cost parameters to provide us with intuitive and economically viable projections of the marginal cost of production across models. These are reflected in the fact that the margins were estimated to be positive and of reasonable magnitude. In later sections we focus our attention to the bargaining model in particular and present estimates of margins and average marginal costs for each brand along with other related measures and assess their relation to bargaining power and profit shares. These

margins and cost estimates are contained in Table 4.

Structure

The final set of estimates in Tables 3a and 3b correspond to the bargaining parameters. Obviously, the Stackelberg and Equal power models require us to fix these parameters and they are therefore not estimated. The results reveal a different spread of bargaining power in the two product categories. In the RFJ category Tropicana is the dominant brand and has a relative (to the retailer) bargaining power of 0.72. Surprisingly, Minute Maid (0.50) and the Private Label (0.44) brands seems to have similar power parameters. In the TTI category the spread is more pronounced with Quilted Northern having a bargaining power estimate of only 0.21. Kleenex is the most powerful (0.60) followed by Charmin (0.45). In both categories the estimates are significant and are also (jointly) statistically different from $0, 1$ or $\frac{1}{2}$. In the next section we discuss the drivers and implications of these parameters in more detail.

7   What drives Channel Power?

Table 4 presents a related set of constructs that make it easier to compare and understand the results from the full bargaining model. In particular we present, for all brands in both product categories, average margins (wholesale and retail), average marginal costs, share of manufacturer profits (own channel and system), bargaining power estimates, market share, brand specific constants (reflecting brand equity), own price elasticity, clout and vulnerability[11].

7.1   Refrigerated Fruit Juice

The first panel in Table 4 presents the mentioned constructs for the Refrigerated Fruit Juice category. A quick glance reveals that Tropicana has the largest bargaining power and also

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[11]The clout and vulnerability measures are as defined in Kamakura and Russell (1989) and reflect the sum of cross price elasticities. Clout measures the impact of a focal brand's price change on all other brands while Vulnerability is assesses the impact that other brands have on the focal brand.

has a higher brand specific constant (Brand Equity), market share and clout. In spite of what looks like a large bargaining power estimate, Tropicana only manages to extract about half the channel surplus as measured by the split in profit shares for its own channel and manages about a quarter (24.7%) of the total system profits. There might a number of issues at play here. Kadiyali et al. (2000) analyze the same data set and conjecture that the retailer's market share might have a role to play here. They also suggest that strong competition between the manufacturers might give the retailer more power. There appears to be some truth to their argument as Table 4 suggests. The clout and vulnerability measures are strongly related to power, suggesting that favorable asymmetry in cross price effects can help generate power for manufacturers. Interestingly, Tropicana does not have a cost advantage. In fact, as one would expect, it is the private label manufacturer that has the lowest costs. This might help explain why even with a weak position on brand equity, clout and vulnerability the private label manufacturer still manages to extract a reasonable proportion of the own channel surplus. The retailer by virtue of a significant power share vis-a-vis each manufacturer manages to garner over half (52.3%) of the total system profits. Overall it seems like bargaining power is strongly related to the other constructs presented in the table. Looking across brands, there seems to be a strong (but not proportional) relation between power and the own channel profit share extracted. This is depicted graphically in Figure 1.

7.2   Toilet Tissue

Compared to the RFJ category the manufacturers manage to cumulatively appropriate a larger proportion of system-wide profits (51%) but not by much. In terms of own channel splits, Kleenex emerges ahead with 55.8% but Charmin (48.40%) and Quilted Northern (44.10%) relinquish a larger proportion of their surplus to the retailer. This is consistent with the estimates of power in this category. Figure 2 depicts the relation graphically. What is striking is that in contrast to the RFJ category the relation between the two constructs seems to be less pronounced. Nevertheless, once again bargaining power and profit shares are positively related. A key question here is how Quilted Northern with a weak bargaining

power estimate manages to extract a reasonable proportion of its own channel profits. The answer to this lies perhaps in a mix of demand and cost arguments. A quick look at the clout and vulnerability numbers shows that the values are less dispersed and that the own price elasticities are close to each other. Additionally, Quilted Northern seems to have a slight cost advantage and consequently, even though it fails to influence the wholesale prices much, it still does reasonably well. Overall, as in the RFJ category, bargaining power seems to be strongly related to constructs such as clout, market share, low vulnerability and brand equity.

8   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. This work build on the early works of Kadiyali et al. (2000) and demonstrates the complex patterns of power that exist in the retail sector.

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 the manufacturer Stackelberg game of channel interactions which is the popular choice in existing literature.

There are a number of avenues for future studies to adapt and extend this line of research. One such avenue would be endogenizing the bargaining power parameters. This could be done in a reduced form manner by relating the bargaining power parameters to other key constructs such as marginal cost, brand equity (as measured by brand constants) or other brand specific factors. A more ambitious attempt would entail moving to a Rubenstein-esque non-cooperative theoretical framework which inherently makes bargaining power endogenous.

Another obvious line of inquiry would be the incorporation of retail competition. We note,

however, that the development of a coherent bargaining game involving multiple retailers and manufacturers turns out to be a challenging task. While are the beginnings of some theoretical work on enriching retailer side issues (Dukes A., E. Gal'Or and K. Srinivasan 2004) the move to an econometrically viable framework might be difficult.

Finally, data and methods related issues might also offer avenues for incremental improvements to this research. The treatment of the marginal cost could be bettered, especially if better data on factor inputs were used. Similarly the availability of retailer costs might also help. In addition, there could be methodological improvements that make estimation more robust. For example, the severe nonlinearities might be better tackled by using global optimizers such as simulated annealing or genetic optimization methods.

In summary, our study is a first attempt to calibrate a bargaining model in a channel setting using real data. Despite the complexity of the theoretical framework we have been able to show that an econometric implementation is feasible and offers some new and intuitive results. In particular, our results show that a bargaining approach to channel relations is more appropriate than those found in the extant literature.

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Table 1a: Descriptive Statistics for Refrigerated Fruit Juice

Brands	Variable	Weekly Mean	Std. Dev.
Tropicana	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%	
Minute Maid	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%	
Private Label	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: Bonus 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

Brands	Variable	Weekly Mean	Std. Dev.
Kleenex	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%	
Charmin	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%	
Quilted Northern	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: Bonus and Deal are indicator variables and are calculated as the weighted average across UPCs and sizes for any one manufacturer

Table 1c: BLS Series Instruments

PPI Series Title	Mean	Std. Dev.	Min	Max	ρ[12]
Frozen juices and ades	119.52	10.71	102.20	149.10	.63
Toilet tissue and stock[13]	136.41	7.62	127.90	152.80	.40

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[12]Correlation with average prices (all brands) in a given month.

[13]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 2a:

Logit Demand Estimates for Refrigerated Fruit Juice

(No Heterogeneity/Endogeneity Corrections)

Parameter	Estimate	S.E.
Price (β)	-90.09	2.861
Bonus (λ_1)	0.57	0.048
Deal (λ_2)	0.85	0.065
Brand Constants (α)		
Tropicana	1.11	0.129
Minute Maid	0.91	0.111
Private Label	0.32	0.087

Table 2b:

Logit Demand Estimates for Toilet Tissue

(No Heterogeneity/Endogeneity Corrections)

Parameter	Estimate	S.E.
Price (β)	-6.28	0.424
Bonus (λ_1)	0.73	0.082
Deal (λ_2)	1.42	0.115
Brand Constants (α)		
Kleenex	1.01	0.213
Charmin	0.22	0.172
Quilted Northern	-0.51	0.161

Table 3a: Structural Parameter Estimates for Refrigerated Fruit Juice

Parameter	Bargaining Model Estimate	S.E.	Manufacturer Stackelberg Estimate	S.E.	Equal Power Estimate	S.E.
Price $(\bar{\beta})$	-115.62	1.287	-130.20	2.851	-123.97	0.594
Bonus $(\bar{\lambda}_1)$	0.75	0.013	0.57	0.064	0.67	0.011
Deal $(\bar{\lambda}_2)$	0.81	0.026	0.71	0.098	0.62	0.012
Brand Constants $(\bar{\alpha})$						
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
Cost Intercept (c_0)						
Tropicana	0.019	0.001	0.019	0.003	.018	.001
Minute Maid	0.014	0.002	0.011	0.002	.012	.003
Private Label	0.004	0.001	0.003	0.001	.004	.002
Cost Intercept (c_1)						
Tropicana	0.811	0.134	0.778	0.113	0.801	0.143
Minute Maid	0.808	0.141	0.712	0.167	0.774	0.129
Private Label	1.032	0.115	0.921	0.318	1.109	0.232
Bargaining Power (θ)						
Tropicana	0.72	0.014	1.0	fixed	0.5	fixed
Minute Maid	0.50	0.002	1.0	fixed	0.5	fixed
Private Label	0.44	0.002	1.0	fixed	0.5	fixed
Hansen's J-Statistic	584.52		643.73		624.93	
ΔMMSC-BIC	-		43.25		24.45	

Table 3b: Structural Parameter Estimates for Toilet Tissue

Parameter	Bargaining Model Estimate	Bargaining Model S.E.	Manufacturer Stackelberg Estimate	Manufacturer Stackelberg S.E.	Equal Power Estimate	Equal Power S.E.
Price $(\bar{\beta})$	-11.759	0.079	-13.269	0.678	-13.045	.0210
Bonus $(\bar{\lambda}_1)$	0.109	0.001	0.346	0.076	.168	0.019
Deal $(\bar{\lambda}_2)$	0.552	0.029	0.368	0.118	.513	0.018
Brand Constants $(\bar{\alpha})$						
Kleenex	2.594	0.036	4.620	0.352	1.513	0.019
Charmin	1.947	0.042	3.348	0.281	1.334	.0151
Quilted Northern	0.936	0.045	2.487	0.261	0.272	0.021
Cost Intercept (c_0)						
Kleenex	0.127	0.051	0.109	0.048	0.122	0.042
Charmin	0.296	0.039	0.241	0.025	0.280	0.051
Quilted Northern	0.251	0.024	0.195	0.038	0.247	0.036
Cost Slope (c_1)						
Kleenex	1.242	0.371	1.350	0.322	1.138	0.296
Charmin	-0.384	0.282^{ns}	-0.299	0.246^{ns}	-0.353	0.277^{ns}
Quilted Northern	-0.309	0.196^{ns}	-0.301	0.414^{ns}	-0.308	0.211^{ns}
Bargaining Power (θ)						
Kleenex	0.602	.0011	1.0	fixed	0.5	fixed
Charmin	0.454	0.005	1.0	fixed	0.5	fixed
Quilted Northern	0.211	0.010	1.0	fixed	0.5	fixed
Objective Function	750.65		845.02		774.79	
ΔMMSC-BIC	-		77.86		27.83	

Table 4: Bargaining Power and Related Constructs

Refrigerated Fruit Juice			
	Tropicana	Minute Maid	Private Label
Retail Margin (cents/oz)	1.15	1.02	0.84
Wholesale Margin (cents/oz)	1.14	0.89	0.68
Estimated Marginal Cost (cents/oz)	1.68	1.51	1.01
Manufacturer Profit Share (Total System)	24.7%	11.8%	11.1%
Manufacturer Profit Share (Own Channel)	49.8%	46.6%	44.7%
Manufacturer Bargaining Power	0.716	0.501	0.442
Market Share	32.8%	20.0%	24.7%
Brand Equity (Relative)	2.29	1.05	0.47
Own Price Elasticity	-3.98	-3.67	-2.62
Clout	1.04	0.46	0.54
Vulnerability	0.52	0.75	0.79

Toilet Tissue			
	Kleenex	Charmin	Quilted Northern
Retail Margin (cents/roll)	6.02	6.35	6.62
Wholesale Margin (cents/roll)	7.60	5.95	5.23
Estimated Marginal Cost (cents/roll)	30.60	24.00	20.70
Manufacturer Profit Share (Total System)	25.8%	17.1%	8.1%
Manufacturer Profit Share (Own Channel)	55.8%	48.4%	44.1%
Manufacturer Bargaining Power	0.602	0.454	0.211
Market Share	37.3%	31.4%	17.1%
Brand Equity (Relative)	2.594	1.947	0.936
Own Price Elasticity	-3.94	-3.48	-3.35
Clout	1.02	0.85	0.36
Vulnerability	0.57	0.71	0.95