Manufacturer-Retailer Pricing Competition Across Multiple Product Categories: An Equilibrium Framework

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This paper investigates pricing competition between manufacturers and a common retailer across multiple product categories using an equilibrium framework. Rather than assuming a standard Nash equilibrium outcome to the channel's pricing game, the model allows for dependencies in pricing behavior between channel members and is flexible enough to accommodate deviations from a Nash equilibrium. Results suggest that accounting for pricing behavior across multiple product categories affects competitive intensity and the distribution of channel profits, suggesting that manufacturer and retailer pricing decisions across the two categories are dependent and involve cross-category coordination. Implications of the results for managerial practice are discussed.

INTRODUCTION

The study of competitive interactions between channel members has received considerable attention in the marketing and economics literature. Issues such as the coordination of channel decisions, price competition among channel members, vertical contracting, and bargaining power between manufacturers and retailers, among others, have been studied. Much of the extant research on channel interactions has examined the issue for specific industries or within a single product category. The objective of this exploratory paper is to extend the existing research on channel competition by developing an empirical model that accounts for the effects of cross-category interactions between channel members competing in multiple product markets, within an equilibrium, game-theoretic framework. In particular, the paper examines whether manufacturers and retailers tend to coordinate their pricing decisions across different product categories and if doing so enables them to compete more effectively by realizing a higher percentage of channel profits. In addition, rather than assuming a standard Nash equilibrium outcome to the channel's pricing game, the model allows for dependencies in pricing decisions between the channel members via the estimation of a set of conduct parameters that capture the nature of the competitive interactions in the channel and allow these interactions to vary according to the data, making the model more flexible to possible deviations from a Nash equilibrium and more reflective of the actual nature of the channel competition.

In the theoretical literature, various issues pertaining to channel interactions have been studied. Jeuland and Shugan (1983) looked into the problem of coordinating of various decision variables among channel members within the context of managing and optimizing channel profits in a single-manufacturer, single-retailer channel, and McGuire and Staelin (1983) examined the extent to which the substitutability of a manufacturer's products may affect its distribution structure. Choi (1991) examined channel interactions between multiple competing manufacturers and a common retailer, and he demonstrates how an independent retailer can be a powerful player in the market, unlike company-owned retail stores or exclusive franchises or dealerships. Along the same lines, Lee and Staelin (1997) studied the issue of price leadership and product line pricing for various models of channel interactions involving multiple players, including a two-manufacturer, two-retailer model, while Iyer and Villas-Boas (2003) developed a theoretical model of bargaining power to examine its effects on vertical coordination between channel members. While these and similar studies have contributed significantly to our theoretical understanding of channel competition, they are generally confined within the context of a single product category, and do not consider firms' simultaneous marketing decisions across multiple product categories.

The empirical literature on channel interactions has also mainly looked into competition within a single product category: Besanko et al. (1998) studied the importance of treating prices as endogenous variables in an application of the Choi (1991) model of competitive pricing between two manufacturers and a common retailer, Kadiyali et al (2000) and Sudhir (2001) also used a two-manufacturer, single-retailer framework to build equilibrium models of competitive pricing behavior, and Villas-Boas (2002) studied different models of vertical contracting in a market with multiple manufacturers and multiple retailers. More recently, Villas-Boas and Zhao (2005) developed comprehensive equilibrium models to study the level of manufacturer competition, channel interactions, and the retailer's product-category pricing behavior in the ketchup market, and Draganska et al. (2010) examined the relative bargaining power between manufacturers and retailers by developing a model that explains why channel power has shifted from manufacturers to retailers in recent years. While these and other papers in the empirical literature have provided valuable insights on the nature of channel competition between manufacturers and retailers, one limitation of these studies - as with the theoretical literature - is that they are largely done within the context of individual product categories. In practice, firms may not make their marketing decisions in any one product category independently of their decisions in the other product categories that the firm is competing in, and if so, such cross-category effects need to be taken into account. In addition, with the exception of a few papers like Kadiyali et al. (2000), most game-theoretic studies on channel interactions assume a standard equilibrium outcome (such as a Nash or a Stackelberg equilibrium) to the competitive interactions. While such assumptions are based on sound economic theory and are generally adequate for many situations, in practice, deviations from these standard outcomes may occur which are not captured in these models. To account for this possibility, a more flexible model of channel interactions that specifically captures such deviations (based on the observed data) would be needed.

Along with the development of the literature on channel interactions, two other streams of literature have influenced the development of this paper. The first is the empirical literature on multi-market contact. Parker and Roller (1997) used a structural model of competition to study the effects of multi-market contact and cross-ownership in the mobile telephone industry, and their analysis suggested that a company's competitive behavior in one market may be a function of the characteristics of the other markets. Another example is Shankar (1999), who studied the effects of multi-market contact on a firm's new product introduction strategies and an incumbent firm's response strategies to a potential entrant to the market, and found that multi-market contact led to a lower spending on new product introduction as well as a milder response on the part of the incumbent firm. These papers suggest that multi-market contact between competing firms may affect their strategic behavior in each market because marketing decisions within any one market may affect the firm's performance in other related markets. Within the domain of channel interactions, it is thus reasonable to expect manufacturers to coordinate their marketing decisions across multiple product markets or categories.

The second stream of literature that has motivated the development of this paper is the consumer demand literature on household buying behavior across multiple product categories. For example, Ainslie and Rossi (1998) studied the sensitivity of households to marketing mix variables by looking at correlations in buying behavior across different categories, and they found that significant correlations do exist, even for products that are not complementary or related to each other. Manchanda et al. (1999) further showed the existence of cross-category dependencies in consumer purchase decisions, especially among complementary products or products that are purchased within a similar purchase cycle. These studies suggest that consumers' purchase decisions across different product categories are not independent, which in turn would further influence the way firms coordinate their marketing decisions across these product categories.

This paper attempts to integrate these streams of research and extend the literature on channel interactions in a unified framework. The existing literature on competitive channel interactions and multi-market contact is combined by studying channel interactions across two different product categories, and the impact of consumer demand on firms' strategic decisions is incorporated into the framework by building an equilibrium model of supply and demand that is flexible enough to accommodate a variety of channel interactions and capture empirical deviations from the Nash equilibrium outcome. Being an exploratory paper on cross-category channel competition, the interactions among channel members have been confined to their price-setting behavior. The study focuses on the pricing interactions between two national brand manufacturers of bathroom tissues and paper towels, P&G and Georgia-Pacific, and a local retailer in a major U.S. metropolitan area.

In the next section, the mathematical model for operationalizing the competitive pricing interactions between the channel members is presented. This is followed by a description of the data used to estimate the model and a discussion of the estimation results and managerial implications. The paper concludes by suggesting some areas for future research.

MODEL

The proposed model is developed within the context of an oligopolistic market consisting of two national brand manufacturers and a common retailer, competing across two product categories. The retailer carries both national brands and also has its own private label in both product categories. To examine the impact of cross-category effects on channel interactions, two empirical models will be estimated. The basic model is a single-category model that assumes no cross-category effects and is estimated separately for each product category. The second is a model that accounts for the possibility of cross-category coordination of pricing decisions across the two product categories. Although only the manufacturers' and retailers' pricing decisions will be modeled in this paper, the model can also be extended to incorporate other relevant marketing decisions such as advertising or distribution.

Basic Model

The basic model in this paper is developed using the approach in Kadiyali et al. (2000). By adopting an equilibrium modeling approach that takes into account both supply and demand considerations, both the manufacturers' and retailer's pricing behavior, as well as consumer demand, can be modeled and the relevant parameters estimated simultaneously. In order to obtain closed-form solutions to the manufacturers' and retailer's pricing problems, many studies on channel competition have typically had to restrict the interactions between the channel members to result in a particular form of equilibrium, most commonly a Nash equilibrium. In a Nash equilibrium, the channel members make their pricing decisions simultaneously under the assumption that each member has made the best decision possible in response to their expectations of the other players' strategies. Although intuitively and theoretically appealing, a Nash equilibrium may not always apply in practice because channel members may have an incomplete understanding of their competitors or the market and may thus under-react or over-react in their decisions. In this model, no simplifying restrictions on the interactions between the channel members are imposed so that it is flexible enough to accommodate a variety of pricing interactions, measured in the form of a set of "conduct parameters", which are estimated from the data and are used to determine if the nature of the interactions deviates from the basic Nash equilibrium outcome. The demand side of the model consists of linear consumer demand functions, as traditionally modeled in the consumer economics literature, aggregated across all the stores of the retail chain. On the supply-side, the manufacturers and retailers are assumed to maximize their profits within each product category, and the competitive pricing equations for the manufacturers and retailer are derived from the first-order conditions of their profit-maximizing behavior. For each product category, three brands will be studied, one from each manufacturer (the brand with the highest market share for that manufacturer), and the retailer's own private label. For expository purposes, the two manufacturer brands will be designated as brand 1 (P&G) and brand 2 (Georgia-Pacific), while the retailer's private label will be designated as brand 3.

Demand Specification

The demand facing the retailer for each brand is a linear, semi-logarithmic function of the sales of brand *i*, denoted by q_i, comprising of the price of the focal brand under study, p_i, the prices of the other two competing brands, a dummy demand shifter variable, *ddshifter*, that captures seasonal variations in demand, and a promotional variable for the brand, *deal*, that captures the in-store promotions occurring in any given week for the brand. The demand shifter and promotional variables are treated as exogenous variables in the model. For each brand *i*, *i* = 1, 2, 3, the demand specification is:

1. $$q_i = a_i + b_i * \ln(p_1) + c_i * \ln(p_2) + d_i * \ln(p_3) + g_i * ddshifter + h_i * deal_i + \varepsilon_i$$

where a_i, b_i, c_i, d_i, g_i, and h_i are parameters to be estimated and ε_i is the error term.

There are other functional forms available for the demand specification (such as a linear or a log-log model) that can provide comparable fit; the main reason that this specification was chosen was that it facilitated the identification of the conduct parameters used in analyzing the channel interactions. Another reason for the semi-log specification is that it does a good job of capturing the typically non-linear relationship between sales level and prices.

Manufacturer Pricing Equations

On the supply side, the profit function for each manufacturer *i*, *i* = 1, 2, is given by:

2. $$\pi_i = (mp_i - mc_i) * q_i$$

Each manufacturer is assumed to maximize its category profit for each product, π_i, with respect to the manufacturer's selling price (i.e. the wholesale price paid by the retailer), which is represented by mp_i. The manufacturer's marginal cost of production, denoted by the parameter mc_i, is estimated from the data.

To derive the optimal pricing function for the manufacturer, consider the profit function for P&G, the manufacturer of brand 1. Substituting equation 1 into 2, the following equation for the profit earned by brand 1 is obtained:

3. $$\pi_1 = (mp_1 - mc_1) * a_1 + b_1 * \ln(p_1) + c_1 * \ln(p_2) + d_1 * \ln(p_3) + g_1 * ddshifter + h_1 * deal_1$$

The manufacturer is assumed to maximize its profit for brand 1 with respect to its selling price to the retailer. These first-order conditions, obtained by taking the partial derivative of equation 3 with respect to mp_1, are given by:

4. $$(mp_1 - mc_1) * (\frac{b_1}{p_1} * \frac{\partial p_1}{\partial mp_1} + \frac{c_1}{p_2} * \frac{\partial p_2}{\partial mp_1} + \frac{d_1}{p_3} * \frac{\partial p_3}{\partial mp_1}) + q_1 = 0$$

Let the retail price of each brand *i* be the sum of the retailer's margin on brand *i*, r_i, and the manufacturer's selling price to the retailer, mp_i, i.e., $p_i = r_i + mp_i$. The partial derivative of the retail price of brand 1, p_1, with respect to mp_1, is given by $\partial p_1 / \partial mp_1 = 1 + \partial r_1 / \partial mp_1$ and that of brand 2, p_2, with respect to mp_1 is given by $\partial p_2 / \partial mp_1 = \partial mp_2 / \partial mp_1 + \partial r_2 / \partial mp_1$. Each channel member's price-setting behavior can thus be denoted by a vector of conduct parameters, which, in this case, is $\{1+\theta(r_1, mp_1), \theta(p_2, mp_1), \theta(p_3, mp_1)\}$, where the parameter, $\theta(x, y)$, denotes the partial derivative of variable *x* with respect to variable *y* ($\partial x / \partial y$) that captures the change in *x* with respect to *y*. The first-order conditions in equation 4, which represents manufacturer 1's optimal pricing function for the wholesale price, mp_1, that maximizes brand 1's profit, can thus be written as:

$$5. \quad mp_1 - mc_1 = \frac{-q_1}{\frac{b_1}{p_1} * (1 + \theta(r_1, mp_1)) + \frac{c_1}{p_2} * \theta(p_2, mp_1) + \frac{d_1}{p_3} \theta(p_3, mp_1)}$$

The optimal pricing function for manufacturer 1, as written in equation 5, is an expression of its margin, (mp_1- mc_1), as a function of the retail demand for brand 1, the demand parameters, as well as a set of conduct parameters that describe the retailer's pricing behavior in response to manufacturer 1's setting of the wholesale price, mp_1. By looking at how the estimated parameter $\theta(r_1, mp_1)$, affect manufacturer 1's margin, the game that the retailer plays with the manufacturer can be analyzed. For example, if the interaction between manufacturer 1 and the retailer is a Nash equilibrium (i.e. manufacturer 1 has responded in the "best" possible way given its expectations of the retailer's pricing behavior), all the conduct parameters would be equal to zero, and manufacturer 1's margin for this case can be calculated accordingly. If the estimated conduct parameters results in a manufacturer 1 margin that is smaller than the Nash case, it means that the retailer is pricing more competitively than Nash, because it is able to appropriate part of manufacturer 1's margin. Conversely, if the estimated conduct parameters results in a manufacturer 1 margin that is larger than the Nash case, it means that the retailer is pricing less competitively, or softer, than Nash. The latter does not imply cooperative behavior, as the manufacturer and retailer are not jointly maximizing channel profits but are still maximizing their profits individually. Pricing softer than Nash results from realizing the dependence of one's own profits on those of the other firms.

A similar optimal pricing function for mp_2 is obtained in a similar manner for manufacturer 2:

$$6. \quad mp_2 - mc_2 = \frac{-q_2}{\frac{b_2}{p_1} * (1 + \theta(r_2, mp_2)) + \frac{c_2}{p_2} * \theta(p_2, mp_2) + \frac{d_2}{p_3} \theta(p_3, mp_2)}$$

The same analysis of the retailer's pricing behavior towards manufacturer 2 can be performed by looking at the parameter $\theta(r_2, mp_2)$.

Retailer Pricing Equations

The retailer is assumed to maximize its profit across all the three brands that it is carrying with respect to each brand's retail margin (as determined by the retail prices that the retailer sets), and its profit function can be written as follows:

$$7. \quad \pi_{retailer} = \sum_{j=1}^{3} r_i * q_i$$

To derive the retailer's optimal pricing equation for each brand, consider the retailer's pricing behavior for brand 1. The first-order conditions for equation 7 with respect to the retailer's margin for brand 1, r_1, is given by:

$$8. \quad q_1 + \sum_{j=1}^{3} r_j * \left(\frac{b_j}{p_1} * \left(1 + \frac{\partial mp_1}{\partial r_1}\right) + \frac{c_j}{p_2}\left(\frac{\partial mp_2}{\partial r_1}\right)\right) = 0$$

Rewriting equation 8 in conduct parameter terminology, the retailer's margin for brand 1 can be written as:

$$9. \qquad r_1 = \frac{-q_1 - \sum_{j \neq 1} r_j \left(\frac{b_j}{p_1} * (1 + \theta(mp_1, r_1)) + \frac{c_j}{p_2} * \theta(mp_2, r_1)\right)}{\frac{b_1}{p_1} * (1 + \theta(mp_1, r_1)) + \frac{c_1}{p_2} * \theta(mp_2, r_1)}$$

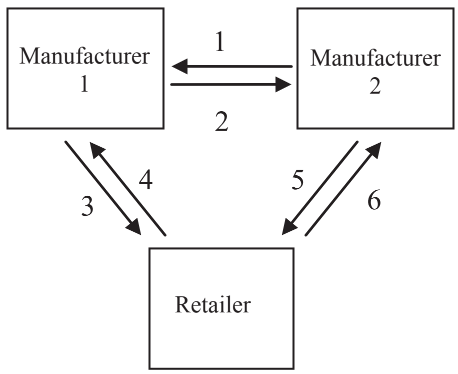
Equation 9 thus represents the retailer's optimal pricing equation for brand 1, expressed as a function of brand 1's retail margin, r_1. The conduct parameters in this pricing equation, which are also estimated from the data, describe the corresponding pricing game that manufacturer 1 plays with the retailer. In equation 9, the parameter $\theta(mp_1, r_1)$ represents manufacturer 1's price-setting behavior of its wholesale price, mp_1, in response to the retailer's retail price-setting behavior and the resulting retail margin, r_1. Under a Nash equilibrium assumption, r_1 is calculated by setting $\theta(mp_1, r_1) = 0$ (while keeping the other parameters at their estimated values). If the estimated value of $\theta(mp_1, r_1)$ results in a retail margin that is smaller than the Nash equilibrium margin, manufacturer 1 is pricing more competitively than Nash, and if the estimated value of $\theta(mp_1, r_1)$ results in a retail margin that is larger than the Nash margin, manufacturer 1 is pricing less competitively than Nash. Similar equations can be obtained for the optimal retailer pricing rules for brand 2 and the retailer's own private label, brand 3, and a similar analysis of manufacturer 2's games with the retailer can be conducted. The resulting optimal retailer pricing equations for brands 2 and 3 are:

$$10. \qquad r_2 = \frac{-q_2 - \sum_{j \neq 2} r_j \left(\frac{b_j}{p_1} * \theta(mp_1, r_2) + \frac{c_j}{p_2} * (1 + \theta(mp_2, r_1))\right)}{\frac{b_2}{p_1} * (\theta(mp_1, r_2)) + \frac{c_2}{p_2} * (1 + \theta(mp_2, r_1))}$$

$$11. \qquad r_3 = \frac{-q_3 - \sum_{j \neq 3} r_j \left(\frac{b_j}{p_1} * (\theta(mp_1, r_3)) + \frac{c_j}{p_2} * \theta(mp_2, r_3) + \frac{d_j}{p_3}\right)}{\frac{b_3}{p_1} * (\theta(mp_1, r_3)) + \frac{c_3}{p_2} * \theta(mp_2, r_3) + \frac{d_3}{p_3}}$$

The pricing interactions between the manufacturers and retailers as represented by the conduct parameters given in the optimal pricing equations can be represented in a schematic diagram as shown in Figure 1. Arrows 1 and 2 are the horizontal interactions between the manufacturers, i.e. $\theta(mp_i, mp_j)$. Arrow 3 captures manufacturer 1's response to the retailer's pricing behavior for brands 1, 2, and 3, given by $\theta(mp_1, r_1)$, $\theta(mp_1, r_2)$, and $\theta(mp_1, r_3)$, and arrow 4 captures the retailer's response to manufacturer 1's price-setting behavior of brand 1, given by $\theta(r_1, mp_1)$, $\theta(r_2, mp_1)$, and $\theta(r_3, mp_1)$. Arrows 5 and 6 describe the same interactions between manufacturer 2 and the retailer as arrows 3 and 4 do for manufacturer 1. Note that not all of the conduct parameters in the diagram are distinctly identifiable for estimation purposes. These include the horizontal interactions between the manufacturers, $\theta(mp_i, mp_j)$, and the response of the retailer on the pricing of one brand in response to the manufacturer's price-setting behavior for another brand, $\theta(r_i, mp_j)$ for $i \neq j$, as both these parameters are subsumed within $\theta(p_i, mp_j)$. However, since the focus of the paper is to study manufacturer-retailer interactions, being able to estimate $\theta(p_i, mp_j)$ is sufficient for this purpose. The estimation of the other parameters, however, will be a fruitful area for future research.

FIGURE 1
CONDUCT PARAMETERS REPRESENTING MANUFACTURER-RETAILER CHANNEL INTERACTIONS



Arrow	Conduct Parameters
1	$\theta(mp_2, mp_1)$
2	$\theta(mp_1, mp_2)$
3	$\theta(mp_1, r_1)$, $\theta(mp_1, r_2)$, $\theta(mp_1, r_3)$
4	$\theta(r_1, mp_1)$, $\theta(r_2, mp_1)$, $\theta(r_3, mp_1)$
5	$\theta(r_1, mp_2)$, $\theta(r_2, mp_2)$, $\theta(r_3, mp_2)$
6	$\theta(mp_2, r_1)$, $\theta(mp_2, r_2)$, $\theta(mp_2, r_3)$

Two-Category Model

The two-category model builds upon the basic model described in the previous section. If cross-category effects exist, it is reasonable to postulate that the conduct parameters describing the channel interactions in any one category may be a function of the market characteristics of the other categories. This idea is consistent with the multi-market study of the mobile telephone industry in Parker and Roller (1997). A pertinent market characteristic that can be used to represent cross-category effects is the market share, or a function of the market shares, of the products in each category because the relative size and market power that a firm has relative to the competition across different product categories can affect its pricing behavior in each category. This approach results in an analogous set of conduct parameters which can be estimated from the data and which describe the same manufacturer-retailer interactions for the two-category case as the conduct parameters for the single-category case. Specifically, to capture the market outcomes of the firms' marketing decisions in both product categories, the two-category model is developed with the conduct parameters as a function of the sum of the market shares of both product categories under study, as shown in equation 12. In this model, the conduct parameters are denoted by x's (to represent retailer interactions) and y's (to represent manufacturer interactions) to differentiate them from the θ's used in the single-category case, $MS_{i,\, cat\, 1}$ and $MS_{i,\, cat\, 2}$ represent the market shares of brand i in the two categories, while $MS_{j,\, cat\, 1}$ and $MS_{j,\, cat\, 2}$ denote the market shares of brand j in the two categories.

12.
$$\begin{aligned}
\theta(r_i, mp_i) &= x_{ii} * (MS_{i,\,cat\,1} + MS_{i,\,cat\,2}) \\
\theta(p_i, mp_j) &= x_{ij} * \frac{(MS_{i,\,cat\,1} + MS_{i,\,cat\,2})}{(MS_{j,\,cat\,1} + MS_{j,\,cat\,2})} \\
\theta(mp_i, r_i) &= y_{ii} * (MS_{i,\,cat\,1} + MS_{i,\,cat\,2}) \\
\theta(mp_i, r_j) &= y_{ij} * \frac{(MS_{i,\,cat\,1} + MS_{i,\,cat\,2})}{(MS_{j,\,cat\,1} + MS_{j,\,cat\,2})}
\end{aligned}$$

With this specification, the estimation results for the two-category model can be compared with the single-category model to see if accounting for cross-category effects result in differences in the channel members' pricing behavior in any one category.

EMPIRICAL ANALYSIS

Data and Estimation

The model is estimated using a data set consisting of weekly retail sales data of bathroom tissues and paper towels for Dominick's Finer Foods (DFF), a large retail chain in the Chicago area, aggregated across stores for approximately a five-year period from 1992 to 1997. This data set is publicly available at the website of the University of Chicago Booth School of Business. The two manufacturers, P&G and Georgia-Pacific, have the largest market shares in both the product categories of bathroom tissues and paper towels for the time period under consideration. Example of bathroom tissue and paper towel brands sold by these manufacturers include Charmin and Bounty for P&G, and Quilted Northern and Brawny for Georgia-Pacific. For each category, the top-selling brand sold by each manufacturer was selected for analysis. The retailer also has its own private label in both categories. The variables obtained from the data set include the retail price, the manufacturer's wholesale price to the retailer, unit sales, as well as the *deal* variable that captures information about weekly in-store promotions for a brand. In addition to the DFF data, supplemental data from the Bureau of Labor Statistics have also been obtained, including data on consumer and producer price indices (used to correct the retail and manufacturer prices for inflation over the five-year period), input costs, and the average weekly wages for the State of Illinois, which is used as the demand shifter variable in the demand functions.

The estimation of the model is carried out using the 3SLS (3-Stage Least Squares) procedure in the SAS programming language. The instrumental variables used for the estimation are a series of lagged dependent variables (such as prices, sales, and the *deal* variable), lagged values of the demand shifter variable, and prices of manufacturing input variables such as the cost of labor and materials. The complete set simultaneous equations for the single-category model consists of the three demand functions (equation 1 for i = 1, 2, 3), the two manufacturer pricing equations 5 and 6, and the three retailer pricing equations 9 through 11. The same equations are used for the two-category model, except that the conduct parameters in the manufacturer and retailer pricing equations are replaced by the multi-category conduct parameters given in equation 12.

Results and Discussion

Looking at the estimation results for both the basic and two-category models, it is interesting to note that none of the channel members are pricing less competitively than the Nash equilibrium, suggesting a high level of competition. In addition, a channel member's pricing strategy vis-a-vis its competitors' can change when multi-category effects are included in the analysis. The results for the basic model examine the channel interactions within a single product category are given in Table 1. For bathroom tissues, the own-price coefficients in the demand functions for all three brands are negative and significant, as expected. The estimated manufacturer marginal costs are also statistically significant and verified to be less than the manufacturer's wholesale prices, which provide face validity to the model. The same results are observed for the paper towel category.

The key results of interest, however, are the conduct parameters, which describe specific pairs of manufacturer-retailer interactions. For example, $\theta(r_1,mp_1)$ describes the retailer's competitive pricing response to its expectation of manufacturer 1's (P&G) pricing decision, while $\theta(mp_1,r_1)$ describes P&G's competitive pricing decision in response to its expectation of the retailer's prices. Between the retailer and Georgia-Pacific, the parameters $\theta(r_2,mp_2)$ and $\theta(mp_2,r_2)$ represent similar pricing interactions. In particular, it would be interesting to see whether these parameters deviate from a Nash equilibrium, which is the usual equilibrium outcome assumed in much of the game theoretic literature when no specific information on the nature of the competitive interactions are available. As operationalized in this model, a conduct parameter that is not significantly different from zero would imply a Nash equilibrium; otherwise, a level of competition that is more competitive or less competitive than a Nash equilibrium is implied.

TABLE 1
RESULTS FOR THE BASIC MODEL

		Bathroom tissues		Paper towels	
	Parameter	Estimate	Prob > |t|	Estimate	Prob > |t|
P&G (Brand 1)	Own price coefficient (unit/$)	-26.5	0.0001	-12.39	0.0001
	Marginal cost ($)	0.81	0.0011	0.93	0.0003
	Manufacturer margin ($)	0.09		0.29	
Georgia-Pacific (Brand 2)	Own price coefficient (unit/$)	-89.26	0.0001	-69.97	0.0001
	Marginal cost ($)	0.74	0.0040	0.35	0.0021
	Manufacturer margin ($)	0.24		0.16	
Private label (Brand 3)	Own price coefficient (unit/$)	-4.42	0.0001	-18.48	0.0001
	$\theta(r_1,mp_1)$	2.45	0.0077 (> Nash)	2.95	0.0021 (> Nash)
Conduct Parameters	$\theta(r_2,mp_2)$	1.68	0.0003 (> Nash)	0.98	0.7922 (Nash)
	$\theta(mp_1,r_1)$	2.27	0.0046 (> Nash)	3.63	0.0011 (> Nash)
	$\theta(mp_2,r_2)$	3.12	0.0063 (> Nash)	1.28	0.2053 (Nash)

Looking at the positive and significant estimates for $\theta(r_i, mp_i)$ and $\theta (mp_i, r_i,)$ for bathroom tissues in Table 1, both the retailer and the manufacturers are respectively pricing more competitively than a Nash equilibrium in their interactions with one another (denoted by the term "> Nash" in parentheses in Table 1). For the paper towel category, P&G and the retailer are pricing more competitively than Nash against each other as shown by the positive and significant estimates of $\theta(mp_1,r_1)$ of 3.63 and $\theta(r_1, mp_1)$ of 2.95, but the interactions between Georgia-Pacific and the retailer appear to be one-sided: while Georgia-Pacific is taking a more aggressive pricing stance against the retailer by pricing more competitively than Nash as denoted by the positive and significant estimate of $\theta(mp_2, r_2)$ of 1.28, the retailer is not doing the same and is in fact pricing at a Nash equilibrium ($\theta(r_2,mp_2)$ is non-significant for paper towels). As a whole, there appears to be a fair amount of manufacturer-retailer competition going on, which could be the result of the retailer having a significant private label in both categories. This is further supported by the positive signs on all the conduct parameters, which suggest that the channel players price their products in competitive tandem with each other (i.e. if one expects the other to lower price, one is likely to lower one's own prices as well). The more competitive interactions between P&G and the retailer in paper towels (as compared to Georgia-Pacific and the retailer) may be explained by the fact that P&G is the market leader in this category; hence it has a greater incentive to exert greater pricing pressure on the retailer to maintain its market leadership. Likewise, the retailer appears to view P&G as a greater threat to its private label brand for paper towels, hence its more competitive pricing decisions against P&G relative to Georgia-Pacific. As for Georgia-Pacific, it may be pricing more competitively against the retailer in paper towels but not in bathroom tissues because the retailer's paper towel label is more significant than its bathroom tissue label (about 20% of market share for paper towels vs. about 5% for bathroom tissues).

Table 2 presents the estimation results for the two-category model, with the conduct parameters specified as a function of the sum of the focal category's market share as well as the other category's market share. As before, the estimated own-price coefficients and marginal costs look reasonable and significant. However, there are a number of interesting differences in the estimates of the conduct parameters.

TABLE 2
RESULTS FOR THE TWO-CATEGORY MODEL

		Bathroom tissues		Paper towels	
	Parameter	Estimate	Prob > |t|	Estimate	Prob > |t|
P&G (Brand 1)	Own price coefficient (unit/$)	-31.91	0.0001	-15.67	0.0001
	Marginal cost ($)	0.802	0.0035	0.852	0.0021
	Manufacturer margin ($)	0.1		0.37	
Georgia-Pacific (Brand 2)	Own price coefficient (unit/$)	-13.42	0.0001	-55.22	0.0001
	Marginal cost ($)	0.917	0.0015	0.302	0.0009
	Manufacturer margin ($)	0.06		0.21	
Private label (Brand 3)	Own price coefficient (unit/$)	-49.21	0.0001	-16.73	0.0001
Conduct Parameters	$x(r_1, mp_1)$	5.04	0.0031 (> Nash)	6.14	0.0060 (> Nash)
	$x(r_2,mp_2)$	4.19	0.0076 (> Nash)	2.11	0.0002 (> Nash)
	$y(mp_1,r_1)$	1.17	0.0093 (> Nash)	2.54	0.0069 (> Nash)
	$y(mp_2,r_2)$	1.11	0.0854 (Nash)	1.29	0.7001 (Nash)

First, the positive and significant estimates of *x(r1,mp1)* of 5.04 (bathroom tissues) and 6.14 (paper towels) show that the retailer is pricing more competitively than Nash against P&G. Similarly, the positive and significant estimates of *y(mp1 r1)* of 1.17 (bathroom tissues) and 2.54 (paper towels) show that P&G is pricing more aggressively than the Nash equilibrium against the retailer. Although these results are directionally similar to those in the basic model, the magnitude of the parameters are different. Relative to the basic model (which examined pricing competition separately within each product category), the retailer appears to be pricing more aggressively against P&G, while P&G actually appears to be pricing less competitively against the retailer. This result is observed for both product categories. Second, Georgia-Pacific is observed to be pricing at a Nash equilibrium against the retailer for both the bathroom tissue and paper towel category, as shown by the two non-significant estimates of $y(mp_2,r_2)$ of 1.11 and 1.29, suggesting a reduction in competitive intensity in Georgia-Pacific's overall pricing strategy when cross-category effects are taken into account. Finally, in terms of the retailer's pricing decisions towards Georgia-Pacific, the larger and significant estimates of $x(r_2, mp_2)$ of 4.19 (bathroom tissues) and 2.11 (paper towels) suggest that, like its pricing strategy towards P&G, the retailer is also pricing more aggressively against Georgia-Pacific in both product categories, as compared to its pricing strategy in the basic model. The general message from these results seems to be that accounting for cross-category effects in the model results affects the observed level of competitive intensity in the channel, suggesting that channel members' pricing decisions involve cross-category coordination. In addition, this cross-category effect differs across manufacturers and retailer: while manufacturers tend to price less competitively across two related product categories, retailers tend to price more aggressively when coordinating their decisions across the two categories.

These findings can be due to a number of reasons and have a number of managerial implications. For related products such as bathroom tissues and paper towels, it is reasonable to expect the manufacturer to derive production efficiencies (such as economies of scale or sharing of production resources) from producing both products at the same time. These efficiencies may result in lower production costs and higher margins, resulting in a smaller push for manufacturers to compete aggressively with the retailer.

The retailer, on the other hand, does not get to enjoy such production efficiencies and is primarily competing on volume. As a result, it maintains a relatively aggressive pricing stance across both manufacturers across both product categories. Another reason why manufacturers appear to price their products less competitively when considering their pricing behavior across multiple product categories is that they may be coordinating their pricing strategies across the categories to fulfill a marketing objective and are hence less inclined to compete fiercely in any one category without considering its effects on the other product. For instance, if P&G bathroom tissues and paper towels are positioned as premium, high quality products relative to private labels and are also priced at a premium, a minimum price threshold is needed to maintain the products' positioning, and cutting prices excessively in one category may affect the product's brand image in the other category.

Finally, the difference in the observed results between the basic model and the two-category model have implications on the distribution of profits between manufacturer and retailer in the channel. Table 3 presents a comparison of the distribution of channel profits between the manufacturers and the retailer for the two models. In the interaction between P&G and the retailer in the basic model, 81.3% of the channel profits went to P&G for bathroom tissues, while the figure is at 67.1% for paper towels. Between Georgia-Pacific and the retailer, 76.2% of the channel profits for bathroom tissues went to Georgia-Pacific while the figure is at 52.7% for paper towels. The results for the two-category model show a similar pattern in the distribution of profits, except that a larger share of the channel profits are accrued to the manufacturers: 87.6% and 92% for bathroom tissues and paper towels respectively for P&G, and 78.1% and 59.1% for bathroom tissues and paper towels respectively for Georgia-Pacific. These profit estimates appear reasonable given that P&G is the market leader in both product categories and the retailer has a fairly significant market share in the paper towel category relative to bathroom tissues, and are quite consistent with the pricing strategies observed from the conduct parameter estimates. They also suggest that coordinating pricing strategies across related product categories can lead to channel higher profits for manufacturers, implying that manufacturers should engage in such pricing coordination across their products to maximize their profits.

TABLE 3
SHARE OF CHANNEL PROFITS

Bathroom tissue					
	Basic model	Two-category model		Basic model	Two-category model
P&G	81.3%	87.6%	Georgia-Pacific	76.2%	78.1%
Retailer	18.7%	12.3%	Retailer	23.8%	21.9%
Paper towels					
	Basic model	Two-category model		Basic model	Two-category model
P&G	67.1%	72.0%	Georgia-Pacific	52.7%	59.1%
Retailer	32.9%	28.0%	Retailer	47.3%	40.9%

CONCLUSION AND FUTURE RESEARCH

This paper has conducted an exploratory study of the nature of channel interactions across multiple product categories, which has received fairly little attention in the literature, and developed a flexible model of channel pricing competition that allows for deviations from the standard Nash equilibrium assumed in most game-theoretic papers on channel interactions. The model presented in the paper has formalized cross-category effects as a function of the market shares of the product categories under study. Initial estimation results suggest that cross-category effects result in decreased competition in the channel, suggesting that channel interactions across product categories are dependent and pricing decisions may involve cross-category coordination. In addition, coordination of pricing behavior across multiple product categories also affects the distribution of channel profits among channel members, which has implications for marketing managers. It is thus important for future studies on channel interactions to account for such cross-category effects, as studying the product categories independently of one another can result in results that do not truly reflect the true nature of the channel competition.

Further research on the topic can involve more detailed investigations of these effects. To begin with, the model can be extended to include other marketing mix elements besides price, such as advertising, distribution, and product design or packaging. Next, more analytically complex models can be developed that are able to estimate the conduct parameters representing the horizontal manufacturer interactions and cross-brand interactions in Figure 1, as they will provide further insights and a more complete picture of the overall nature of the channel interactions. In addition, the cross-category effects may be formalized by other different functional forms of the market shares or may involve the use of other relevant variables in addition to market shares. On the supply side, the way these cross-category effects may affect production considerations such as cost can be further investigated, while on the demand side, other functional forms of demand, such as a discrete choice model based on the random utility framework (McFadden, 1974), may also be used. Other interesting issues to look into would be the role of category captaincy, loss leaders, as well as product line pricing issues involving multiple brands in each product category, all of which may affect the nature of channel interactions and the manufacturers' and retailers' marketing strategies in the channel.

REFERENCES

Ainslie, A. and Rossi, P. E. (1998). Similarities in Choice Behavior Across Product Categories. Marketing Science, 17, (2), 91-106.

Besanko, D., Gupta, S. and Jain, D. (1998). Logit Demand Estimation Under Competitive Pricing Behavior: An Equilibrium Framework. Management Science, 44, (11), Part 1 of 2, 1533-1547.

Choi, S. (1991). Price Competition in a Channel Structure With a Common Retailer. Marketing Science, 10, (4), 271-296.

Draganska, M., Klapper, D., Villas-Boas, S. B. (2010). A Larger Slice or a Larger Pie? An Empirical Investigation of Bargaining Power in the Distribution Channel. Marketing Science, 29, (1), 57-77.

Iyer, G. and Villas-Boas, J. M. (2003). A Bargaining Theory of Distribution Channels. Journal of Marketing Research, 40, (1), 80-100.

Jeuland, A. P. and Shugan, S. M. (1983). Managing Channel Profits. Marketing Science, 2, (3), 239-272.

Kadiyali, V., Chintagunta, P. K. and Vilcassim, N. (2000). Manufacturer-Retailer Channel Interactions and Implications for Channel Power: An Empirical Investigation of Pricing in a Local Market. Marketing Science, 19, (2), 127-148.

Lee, E. and Staelin, R. (1997). Vertical Strategic Interaction: Implications for Channel Pricing Strategy. Marketing Science, 16, (3), 185-207.

Manchanda, P., Ansari, A., Gupta, S. (1999). The "Shopping Basket": A Model for Multicategory Purchase Incidence Decisions. Marketing Science, 18, (2), 95-114.

McFadden, Daniel (1974). Conditional Logit Analysis of Qualitative Choice Behavior, in P. Zarembka (ed.), Frontiers in Econometrics, 105-142 , New York: Academic Press.

McGuire, T. W. and Staelin, R. (1983). An Industry Equilibrium Analysis of Downstream Vertical Integration. Marketing Science, 2, (2), 161-190.

Parker, P. M. and Roller, L. H. (1997). Collusive Conduct in Duopolies: Multimarket Contact and Cross-ownership in the Mobile Telephone Industry. Rand Journal of Economics, 28, (2), 304-322.

Shankar, V. (1999). New Product Introduction and Incumbent Response Strategies: Their Interrelationship and the Role of Multimarket Contact. Journal of Marketing Research, 36, August, 327-344.

Sudhir K. (2001). Competitive Pricing Behavior in the Auto Market: A Structural Analysis. Marketing Science, 20, (1), 42-60.

Villas-Boas S. B. (2002). Vertical Contracts between Manufacturers and Retailers: An Empirical Analysis. Working Paper, University of California, Berkeley.

Villas-Boas J. M. and Zhao Y. (2005). Retailer, Manufacturers, and Individual Consumers: Modeling the Supply Side in the Ketchup Marketplace. Journal of Marketing Research, 42 (1), 83-95.