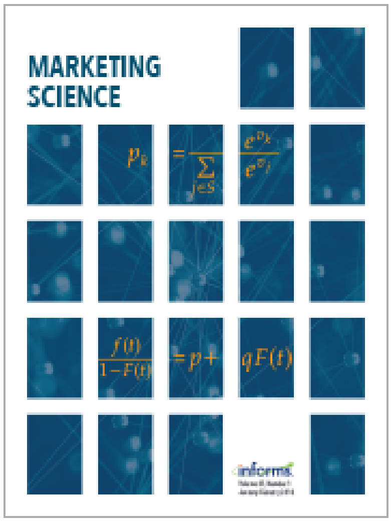


Marketing Science

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

Outsourcing Retail Pricing to a Category Captain: The Role of Information Firewalls

Vincent R. Nijs, Kanishka Misra, Karsten Hansen

MARKETING SCIENCE
Vol. 33, No. 1, January–February 2014, pp. 66–81
ISSN 0732-2399 (print) | ISSN 1526-548X (online)

http://dx.doi.org/10.1287/mksc.2013.0822

Outsourcing Retail Pricing to a Category Captain: The Role of Information Firewalls

Vincent R. Nijs
Rady School of Management, University of California, San Diego, La Jolla, California 92093, vnijs@ucsd.edu

Kanishka Misra
Stephen M. Ross School of Business, University of Michigan, Ann Arbor, Michigan 48109, kanishka@umich.edu

Karsten Hansen
Rady School of Management, University of California, San Diego, La Jolla, California 92093, k4hansen@ucsd.edu

It has been argued that retailers lack both the resources and capabilities to maximize category performance. Retailers may seek category management (CM) advice from a manufacturer, referred to as a category captain (CC). A CC's recommendations affect all brands in the category, not just her own. Despite an increase in the number of CC collaborations, retailers are still concerned about manufacturer opportunism and militant behavior by manufacturers not selected as CCs, whereas government agencies are worried about anticompetitive behavior that could harm consumers. The Federal Trade Commission recommends strictly enforced information firewalls within a CC's organization as a best-practice guideline. In this study we develop an empirical model and use policy simulations to quantify the impact of CC arrangements with information firewalls on retailers, manufacturers, and consumers. We show how these effects could be influenced by the (de)activation of vertical and horizontal information firewalls within the CC's organization.

Key words: category captains; information firewalls; public policy; retail pricing; price coordination; consumer welfare; competition; category management

History: Received: February 1, 2012; accepted: October 3, 2013; Preyas Desai served as the editor-in-chief and Scott Neslin served as associate editor for this article. Published online in *Articles in Advance* November 19, 2013.

1. Introduction

Category management (CM) is used to manage product categories as individual business units in order to enhance consumer benefits (Blattberg and Fox 1995). It shifts retailers' focus from product- to category-level goals. Both retailers and manufacturers involved in CM expect improved trading relationships and profitability (Dewsnap and Hart 2004). Although CM has been practiced for well over a decade by companies both large and small, it is still often employed inefficiently (Hofstetter 2006). "Win-win-win" scenarios in which retailers, manufacturers, and consumers all benefit have proven hard to realize in practice (Lindblom and Olkkonen 2008).

Coordinating prices across all products in a category, a key component of CM, requires significant retailer investment. Changing prices is costly (Zbaracki 2004, Srinivasan et al. 2008), and with the ever-increasing number of UPCs, retailers have insufficient resources to apply CM principles in many categories (Subramanian et al. 2010, Kurtuluş and Toktay 2011). In fact, Morgan et al. (2007) argued that most retailers not only lack the resources but also lack the capabilities to maximize category performance.

The Federal Trade Commission (FTC 2001) suggests that even the most successful retailers could benefit from manufacturers' expertise. Retailers can leverage suppliers' resources and capabilities by seeking advice from a manufacturer referred to as a *category captain* (CC) (Kurtuluş and Toktay 2004, 2011; Morgan et al. 2007). A CC could be asked to analyze category-level data, assist in setting category goals, and develop and implement category plans, among other tasks (Dussart 1998, Basuroy et al. 2001). Because of the level of coordination involved, retailers generally choose a single CC (Webster 1992, Lindblom and Olkkonen 2008) whose recommendations affect all brands in the category, not just her own (Subramanian et al. 2010).

Industry reports (e.g., *Progressive Grocer* 2008) suggest that both manufacturers and retailers can benefit from CC arrangements. For example, Gooner et al. (2011) interviewed retailers and found that expanding the size of the "category pie" is a key benefit retailers expect from a CC relationship. When data, insights, and knowledge are pooled in an effective retailer–supplier collaboration, both parties can benefit (Blattberg and Fox 1995). For example, the CM experts at the J.M. Smucker Company assist retail partners in setting optimal price gaps for all products, including private label brands, in the peanut butter and fruit spread categories. The Kellogg Co. offers retail partners pricing tools to calculate the impact of price changes on category sales and profitability (*Progressive Grocer* 2008). Although the economic benefits to manufacturers are unknown, it has been argued that some manufacturers take on the role of CC to increase their influence on category decisions (Raskin 2003) and offset the perceived power imbalance between retailers and manufacturers (Corstjens and Corstjens 1995).

Even though Subramanian et al. (2010) suggested that the number of CC collaborations is increasing, many retailers are still concerned about latent manufacturer opportunism and doubt successful alliances can be forged (Morgan et al. 2007). Opportunistic behavior on the part of the CC could lead to "retaliation from other suppliers that may withhold promotional support, market information, or other resources required to effectively manage the category" (Gooner et al. 2011, p. 23), and it could harm both retailer and manufacturer performance. Desrochers et al. (2003) hypothesized that CC arrangements might limit some suppliers' ability to compete, resulting in higher prices and reduced consumer welfare. Others are concerned that CCs may promote anticompetitive behavior, such as collusion between retailers (FTC 2001, Desrochers et al. 2003).

The existing literature on CC arrangements is scarce. A small set of papers developed predictions from theoretical models in settings with linear demand and without retail competition (Wang et al. 2003, Subramanian et al. 2010, Kurtuluş and Toktay 2011). However, tools for weighing the costs and benefits of CCs are missing, and the empirical consequences of CC arrangements are unknown (Kurtuluş and Toktay 2004, 2011; Morgan et al. 2007; Lindblom and Olkkonen 2008). The motivation for our research is provided by Gooner et al. (2011, p. 32):

> [G]iven the public policy concerns surrounding the impact of [CC arrangements] on competition and consumer welfare, retailer–supplier CM relationships are clearly an area in which further research is required. For example, researchers should examine the impact of using category captains on the wholesale prices of both the lead and other suppliers' brands—and the subsequent retail prices charged to consumers.

In this paper we investigate the impact CC arrangements focused on category pricing have on social welfare and market participants' prices and profits. Because data on CC arrangements are not available as a result of antitrust concerns, we develop a structural model and use policy simulations to evaluate their impact on manufacturers, retailers, and consumers.

The current lack of research and empirical insights is one reason federal regulations do not exist for CC arrangements (Desrochers et al. 2003). The FTC does, however, recommend strictly enforced information firewalls within a CC's organization as a best-practice guideline. The firewalls restrict the information available to the category captain. However, it is unclear if this will benefit consumers as intended. Although (legal) scholars have speculated on the importance of these firewalls, their influence has, to the best of our knowledge, been investigated neither empirically nor analytically (Herderschee-Hunter 2003). We distinguish (1) vertical information firewalls between the teams that set manufacturer wholesale prices and the CC teams that recommend retail prices and (2) horizontal information firewalls between CC teams that recommend prices for competing retailers. We study the influence of these firewalls in four different scenarios; in each we determine the impact of deactivating one or more firewalls for retailers, manufacturers, and consumers. This allows us to draw inferences about the importance of information firewalls and provide implications for policy makers focused on the social welfare benefits of CC arrangements. Without (empirical) insight into the importance of these firewalls, policy makers are, in essence, "flying blind." Furthermore, without clear guidance from the FTC, manufacturers and retailers may engage in practices that are detrimental to social welfare.

We specify a model of competition in vertical channels that is realistic enough to be estimated using market data. Although the (mixed) logit demand model is ubiquitous in empirical research, the analytical channels literature in marketing generally assumes linear demand for tractability (e.g. Subramanian et al. 2010, Kurtuluş and Toktay 2011). Because our model is too complex to solve analytically, we derive price equilibria computationally using parameters estimated on a unique data set. As the effect magnitudes are derived from real-world data, the resulting insights on CC arrangements and information firewalls are both theoretically and empirically relevant. Following Thomadsen (2007), we classify our approach as computational theoretic.

Our empirical results demonstrate that CC arrangements focused on category pricing are socially inefficient when both vertical and horizontal information firewalls are activated; i.e., retailers, manufacturers, and consumers are worse off. Specifically, we find that category price coordination can reduce retailer profits when manufacturers endogenize the retailer's use of a CC and increase wholesale prices. In contrast to concerns commonly expressed by policy makers, CC arrangements can enhance social welfare when vertical information firewalls are deactivated. Manufacturers not selected as CCs, however, could see a substantial drop in profitability. Finally, we demonstrate that horizontal information firewalls are needed to ensure the welfare benefits of CC arrangements are fully realized. Our findings are relevant not only to retailers and manufacturers but also to the policy makers that provide recommendations on the use of information firewalls in CC organizations.

The remainder of this paper is organized as follows. In §2 we describe the data used in the empirical analysis. The econometric model is specified in §3. Sections 4 and 5 report the main empirical results and the policy simulations, respectively. In the final section of the paper, we discuss implications and provide suggestions for future research.

2. Data

The unique data set we assembled for this study contains information on quantities, prices, and costs for a distribution channel in 2003–2004. We observe both weekly wholesale prices charged to retailers for every UPC sold by one manufacturer and retail transactions for all UPCs sold in a major product category in a Midwest market. Whereas these data are generally not available to researchers, they are commonly accessible to manufacturers in the industry.

We collected data for the two major retail chains (R1 and R2) that account for 60% of dollar volume sales in supermarkets and drugstores in this market. The top 14 brands in the category represent 80% of dollar volume in the geographical market. These brands are owned by the top three players in the category (M1, M2, and M3). We focus on a set of 48 UPCs that cover 95% of brand sales.

In our econometric model, consumer choice is specified at the UPC level. A consumer chooses the *outside good* if she does not buy in the category or does not buy any of the products included in our analysis. We calibrate the outside option using the population living in the zip-code areas covered by chains R1 and R2 and multiply the number of potential consumers by the consumption rate of a heavy user in the category. Given this specification, the outside good has an average share of 92.81%. Table 1 shows the relative shares for the brands and chains studied. Manufacturer M1 is the largest player (66.4%), followed by M2 (29.5%) and M3 (4.1%). Brand 1 has the biggest market share in both chains.

Average brand prices are reported in Table 2.[1] Brands 6 and 7 are priced highest. M1 and M2 have brands in both the higher and lower price tiers, whereas M3's products are only in the highest price tier.

In addition, our database contains information on chain-level feature or display support for a UPC in a given week. Because category demand may be correlated with temperature, we also gathered weekly weather data for the region. We used instruments for demand estimation that are correlated with price changes but not with demand. Note that we cannot use wholesale prices because we observe them for only one of the manufacturers. We collected data on possible marginal cost shifters at the national, regional, and local levels: prices for key materials used to manufacture products in this industry, prices for electricity, and prices for gas used in production. In addition, we obtained data on retail prices in cities on the East Coast and West Coast (Nevo 2001). Any changes in supply conditions should induce a common price shock in multiple cities. In §4.1 we use a Sargan test to evaluate whether our instruments adequately address price endogeneity. The test

Table 1 **Brand Market Shares**

Brand	Manufacturer	R1 (%)	R2 (%)	Total
Brand 1	M1	24.7	5.2	29.9
Brand 2	M1	10.7	1.9	12.6
Brand 3	M1	3.0	0.4	3.4
Brand 4	M1	4.9	1.0	5.8
Brand 5	M3	3.4	0.8	4.1
Brand 6	M1	1.5	0.3	1.8
Brand 7	M1	4.2	0.9	5.1
Brand 8	M2	0.9	0.2	1.1
Brand 9	M2	2.9	0.5	3.4
Brand 10	M2	8.7	1.9	10.7
Brand 11	M2	2.8	0.5	3.3
Brand 12	M2	3.0	0.3	3.3
Brand 13	M2	6.3	1.4	7.7
Brand 14	M1	6.5	1.2	7.8
Total		83.3	16.7	100.0

Table 2 **Average Retail Prices**

Brand	Manufacturer	R1	R2
Brand 1	M1	17.33	17.60
Brand 2	M1	17.22	17.39
Brand 3	M1	12.83	12.82
Brand 4	M1	12.84	12.87
Brand 5	M3	17.09	17.04
Brand 6	M1	20.06	20.16
Brand 7	M1	20.06	20.21
Brand 8	M2	18.26	18.31
Brand 9	M2	12.35	12.29
Brand 10	M2	17.16	17.35
Brand 11	M2	10.18	10.11
Brand 12	M2	10.03	10.00
Brand 13	M2	10.10	10.09
Brand 14	M1	11.14	11.13

[1] For confidentiality reasons, prices are standardized by 1/10th of the lowest-priced good (brand 12 in chain R2).

determines whether the residuals from our demand model are uncorrelated with the instruments, as they should be.

Our data set allows us to contribute to the extant literature in three distinct ways. First, in contrast to prior studies that focus on only one retail chain (e.g., Choi 1991, Kadiyali et al. 2000), we are able to address the impact of retail competition, as our data cover transactions from multiple supermarkets. Second, whereas researchers previously did not have access to manufacturer data (e.g., Sudhir 2001, Villas-Boas 2007), we observe actual supplier costs and wholesale prices. Empirical work on channel interaction has commonly relied on accounting measures, such as average acquisition cost (AAC), as a proxy for wholesale prices (Kadiyali et al. 2000, Chintagunta 2002, Besanko et al. 2005, Meza and Sudhir 2006). Because these measures do not represent economic marginal cost, they have been described as "a limitation to be lived with" (Meza and Sudhir 2006, p. 354). Nijs et al. (2010) showed, however, that using a measure of AAC introduces both an endogeneity problem (see also Peltzman 2000) and a significant bias in trade deal pass-through estimates. Having access to cost data allows us to establish whether our model accurately uncovers retailer and manufacturer margins. Finally, we estimate the implications of information firewalls in CC relationships at the chain level. None of the publicly available data sets contains accurate information at this level of aggregation. Our data, however, are based on a census of stores in the market studied. Publicly available sources such as the academic IRI data set (Bronnenberg et al. 2008) provide information on a sample of stores from each chain in a market. The induced sampling variability could lead to under- or overestimation of the effects of CC arrangements. As an illustration, we calculated chain-level market shares for the leading manufacturers in a geographical market covered by both the IRI data set and our own. Although the smallest differences are only a single share point, the average difference across brands and chains equals 4.7% market share points. Because IRI's projection tools are not available to researchers, the sampling variability in the academic IRI data set makes it inappropriate for the purpose of estimating the influence of information firewalls in CC arrangements.

It is important to note that there are no CCs in our data set.[2] Furthermore, even in markets in which CCs do play an active role, archival data on CC arrangements, responsibilities, and actions in retail stores are unlikely to be made available to researchers because of antitrust concerns (Morgan et al. 2007). In general, CC arrangements have limited visibility beyond the boundaries of a specific retail organization. To illustrate this point, note that retailers are not mentioned by name in *Progressive Grocer*'s overview of the best CCs of the year (e.g., *Progressive Grocer* 2007, 2008). To establish the importance of information firewalls in CC arrangements, we develop a model of competition in vertical channels in the next section.

3. Econometric Model

In this section, we develop a structural model to study the impact of information firewalls in CC arrangements on manufacturers, retailers, and consumers. The ability to estimate the impact of strategic or regulatory changes in the marketplace is an important advantage of such models. As Chintagunta and Nair (2011, p. 979) argued,

> The promise of ''structural models,'' derived from theoretical microfoundations of consumer behavior, is built on the premise that these counterfactuals can be more credibly simulated by re-solving the model explicitly for agents' policies given estimates of policy-invariant parameters that index primitive consumer preferences.... In essence, the approach involves estimating deep parameters indexing consumer behavior and then building up to a "new demand" structure under the counterfactual conditional on these primitives. In some sense, the models use theory to navigate the unknown, and in several contexts they have been shown to provide surprisingly good predictions of radically different counterfactuals and underlying primitives.

Estimating the welfare implications of CC arrangements requires a system based on individual-level utility. Consistent with previous research, we assume prices result from a weekly game between retailers and manufacturers (e.g., Chintagunta 2002, Chintagunta 2003; Dubé 2004; Villas-Boas 2007). Since individual consumer choices are not observed in our data, we parameterize unobserved heterogeneity. From the utility model, we derive an aggregate demand system (Berry et al. 1995) and impose a supply-side model to infer price-cost margins. We then conduct policy simulations using estimated marginal costs and demand parameters to trace out response functions and quantify the effects of CC arrangements in scenarios with different information firewall configurations (see §5).

3.1. Demand

We use a random coefficients logit model (Berry et al. 1995) of weekly discrete choice estimated on aggregate data (Nevo 2000). Formally stated, we assume each consumer i chooses either a UPC j ($j \in \{1, 2, \ldots, J\}$) from a retail chain r ($r \in \{1, \ldots, R\}$) or the

[2] In the next section, we describe our empirical strategy to determine the benefits of CC arrangements for retailers, manufacturers, and consumers.

outside option in each week t ($t \in \{1, 2, \ldots, T\}$). Every UPC–retail chain combination (j, r) has characteristics $(x_{jrt}, \xi_{jrt}, p_{jrt})$; x_{jrt} includes (a) UPC fixed effects, (b) retail chain fixed effects, (c) weekly market characteristics (i.e., holidays and temperature), (d) a time trend, and (e) attributes that vary by brand, UPC, and time (e.g., feature advertising). Weekly product characteristics that are observable to consumers and firms but unobservable to the researcher are denoted by ξ_{jrt}; e.g., shelf space and coupons (Berry et al. 1995, Nevo 2000, Chintagunta 2003). The price for UPC j at chain r in week t is denoted by p_{jrt}. The individual utility specification is as follows:

$$u_{ijrt} = (Y_i - p_{jrt})\beta_i + \alpha_i + \gamma x_{jrt} + \xi_{jrt} + \epsilon_{ijrt}, \qquad (1)$$

where Y_i is the income of consumer i, β_i is the marginal utility of income, and α_i captures preference for the category; γ captures the influence of product characteristics and the intrinsic preference for a retail chain; and ϵ_{ijrt}, which is distributed i.i.d. extreme value, captures consumer i's idiosyncratic utility for each alternative. We specify consumer preference heterogeneity as

$$(\beta_i, \alpha_i) \sim \mathrm{N}((\beta, \alpha), \Sigma), \qquad (2)$$

where the parameters β and α reflect the average marginal utility of income and the mean preference for the category, respectively. We assume heterogeneity is normally distributed with variance Σ. For tractability we assume Σ is a diagonal matrix (Nevo 2000). We further assume that the inherent preference for the outside option is equal to zero and constant over time. The utility for the outside option is given by

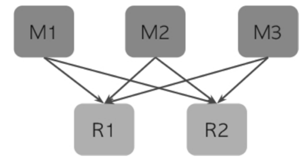
$$u_{i0t} = Y_i\beta_i + \epsilon_{i0t}. \qquad (3)$$

We use simulated method of moments with the instruments described in §2 (Berry et al. 1995, Nevo 2000). To ensure a global minimum, we use 10 random starting points, select the lowest objective function value, and then take 100 random perturbations from this value as a new starting point. We employ the Newey–West algorithm to obtain consistent standard errors of the parameter estimates.

3.2. Supply

3.2.1. Market Structure. As described in §2, we consider a market with three manufacturers and two retailers. Each manufacturer sells one or more brands and each brand has multiple UPCs. Manufacturers set UPC wholesale prices for both chains, and retailers set UPC retail prices. The vertical channel structure is depicted in Figure 1.

Figure 1 **Vertical Channel Structure**



In line with a large body of research on weekly price setting in supermarkets, we assume a static Bertrand pricing game for both manufacturers and retailers and include information on feature and display activity as control variables (e.g., Chintagunta 2002, Dubé 2005, Villas-Boas 2007). The retailers studied do not carry a private label product in the category. We evaluate alternative supply models in which vertical competition is specified either as manufacturer Stackelberg or vertical Nash. For both structures we then investigate whether retailers set prices at the category, manufacturer, brand, or UPC level (Basuroy et al. 2001, Sudhir 2001). To determine the most appropriate structure for our data, we apply the test of nonnested models proposed by Rivers and Vuong (2002). See Bonnet and Dubois (2010) for a recent application of an equivalent testing procedure.

3.2.2. Retailer Pricing. Retailer profits are given by

$$\pi_{rt} = \sum_{j \in S_r} [p_{jrt} - w_{jrt}] D_{jrt}(p), \qquad (4)$$

where p_{jrt} refers to the price charged to consumers by retail chain r for product j in week t, w_{jrt} refers to the wholesale price charged by the manufacturer to retail chain r for product j in week t, and S_r defines the set of products that retailer r sells in week t. The demand for UPC j at chain r in week t as a function of all retail prices in the time period is denoted by $D_{jrt}(p)$. Demand, or share, for each UPC is derived using Equation 1.

We assume a retailer's objective is to maximize profits and examine four organizational structures that differ in the delegation of decision-making rights. At the category level, we assume retail prices are coordinated and solve the global optimization problem for all UPCs; therefore,

$$\{p^*_{jrt} \colon j \in S_r\} = \arg\max \sum_{j \in S_r} [p_{jrt} - w_{jrt}] D_{jrt}(p).$$

At the manufacturer level, we assume retail prices are set to maximize retailer profits for each manufacturer's products separately. Define S_r^m as the set of UPCs that manufacturer m sells through retailer r. Retail prices for m's UPCs are determined by $\{p^*_{jrt}\colon j \in S_r^m\} = \arg\max \sum_{j \in S_r^m} [p_{jrt} - w_{jrt}] D_{jrt}(p)$. For brand-level optimization, we assume retail prices are set to maximize profits for each brand's products separately; i.e., there are 14 unique (sub)optimization problems, one for each brand. Define S_r^b as the set

Table 3 **Retailer Pricing Structures**

Level	Retail prices
Category optimization	$\{p^*_{jrt}: j \in S_r\} = \arg\max \sum_{j\in S_r} [p_{jrt} - w_{jrt}] D_{jrt}(p)$
Manufacturer optimization	$\{p^*_{jrt}: j \in S^m_r\} = \arg\max \sum_{j\in S^b_r} [p_{jrt} - w_{jrt}] D_{jrt}(p)$ $\forall\, m \in \{1, 2, 3\}$
Brand optimization	$\{p^*_{jrt}: j \in S^b_r\} = \arg\max \sum_{j\in S^b_r} [p_{jrt} - w_{jrt}] D_{jrt}(p)$ $\forall\, b \in \{1, \ldots, 14\}$
UPC optimization	$p^*_{jrt} = \arg\max [p_{jrt} - w_{jrt}] D_{jrt}(p)\ \forall\, j \in \{1, \ldots, 48\}$

of UPCs for brand b sold by retailer r. Retail prices for m's UPCs are determined by $\{p^*_{jrt}: j \in S^b_r\} = \arg\max \sum_{j\in S^b_r} [p_{jrt} - w_{jrt}] D_{jrt}(p)$. Finally, we examine the limit case, UPC maximization, where retail prices are set to maximize profits for each UPC separately. The retail price for UPC j is given by $p^*_{jrt} = \arg\max [p_{jrt} - w_{jrt}] D_{jrt}(p)$. We summarize the retail pricing structures in Table 3.

In each case, we solve for the optimal price using

$$P_t - W_t = -(T_r \times \Delta_{rt})^{-1} D_t, \tag{5}$$

where P_t is a vector of prices charged to consumers by both retail chains at time t and W_t is a vector of wholesale prices charged to the retailers at time t. The matrix of own- and cross-price demand derivatives is denoted by Δ_{rt}, where $\Delta_{rt}(j, k) = \partial D_{krt}/\partial p_{jrt}$. If retailer r maximizes joint profits over UPCs i and j, $T_r(i, j) = 1$; otherwise, it takes a value of 0. D_t is a vector of UPC demand shares.

3.2.3. Manufacturer Pricing. The profit function for each manufacturer m is given by

$$\pi_{mt} = \sum_{r=1}^{2} \sum_{j\in S^m_r} \left[w_{jrt} - c^m_{jrt} \right] D_{jrt}(p(w)), \tag{6}$$

where c^m_{jrt} is the marginal cost for manufacturer m to produce product j and deliver it to retailer r at time t, S^m_r defines the set of products that manufacturer m sells to retailers at time t, and $p(w)$ are the retail prices charged to consumers when the manufacturer charges wholesale prices w. Manufacturers are assumed to set wholesale prices that maximize profits over their entire product line and across retail chains. We infer manufacturer price-cost margins using

$$w_t - c^m_t = -(T_m \Delta_{mt})^{-1} D_t(p(w)), \tag{7}$$

where T_m is an ownership matrix indicating which UPCs are produced by each manufacturer. If the same manufacturer sells UPCs j and k, $T_m(j, k) = 1$; otherwise, it takes a value of 0. The matrix of own- and cross-price derivatives is denoted by Δ_{mt}, where element (j, k) is $\partial D_{krt}/\partial p^w_{jrt}$ as in Villas-Boas (2007). Moreover, $\Delta_{mt} = \Delta'_{pt} \Delta_{rt}$, where Δ_{rt} is the matrix of the own- and cross-price demand derivatives with respect to retail price, as in the retailer's first-order conditions; and Δ_{pt} is the matrix of retailer reaction functions. If manufacturers are Stackelberg leaders, we estimate Δ_{pt} by applying the implicit function theorem to the retailer's first-order conditions. If competition between manufacturers and retailers is vertical Nash, Δ_{pt} is the identity matrix.

4. Estimation Results

4.1. Demand

Estimates from a random coefficients logit model with UPC fixed effects are reported in Table 4. The table shows mean effects, standard errors, and heterogeneity coefficients for price and the constant (i.e., standard deviations). For comparison we also include estimates for a homogeneous logit model with endogenous prices. Except for price and the mean UPC fixed effect, the estimates are similar across the two models.

On average, price has a negative effect on utility, and price sensitivity varies significantly across consumers. Although the mean of the UPC fixed effects suggests a portion of consumers do not buy in the category, there is strong heterogeneity in preferences. The positive coefficient for R1, the market's leading retailer, confirms that consumers prefer to shop at this chain. As expected, we find that demand increases with feature and display support, during the holiday season, and with higher temperatures. There is also a slight positive trend in demand. We apply a Sargan test to evaluate the instruments used in estimation (see §2). The p-value for the test was equal to 0.36, suggesting our instruments adequately address price endogeneity for the random coefficients logit model. Table 5 shows mean own- and cross-price elasticities by manufacturer. The average own-price elasticities vary from −3.35 for manufacturer M2 to −4.12 for manufacturer M3. Previous studies implementing

Table 4 **Demand Estimates**

	Logit IV		RC logit IV	
Variable	Estimate	S.E.	Estimate	S.E.
Mean UPC fixed effect	−6.92*	—	−5.170*	—
Price	−0.409*	0.127	−0.872*	0.208
Chain R1	1.831*	0.010	1.824*	0.010
Feature/display	0.705*	0.046	0.630*	0.053
Holiday	0.210*	0.013	0.279*	0.028
Temperature	0.002*	0.000	0.001*	0.000
Trend	0.001*	0.000	0.003*	0.001
Standard deviation price			0.180*	0.038
Standard deviation constant			0.750*	0.208

Note. IV, instrumental variables; RC, random coefficient.
$^* p < 0.01$.

Table 5 Mean Price Elasticities by Manufacturer

Manufacturer	Own price	Cross price
M1	−3.90	0.42
M2	−3.35	0.14
M3	−4.12	0.02

similar demand models report own-price elasticities in the same range (Nevo 2001) or higher (Villas-Boas 2009, Bonnet and Dubois 2010). Manufacturer M3 has the most elastic demand but also has the most limited ability to draw demand from other manufacturers. Manufacturer M1 has the highest cross-price elasticity. The retailers' average own-price elasticities are similar: −3.69 for R1 and −3.71 for R2. Furthermore, on average, a price change in R1 has a greater impact on demand in R2 (0.48) than vice versa (0.10).

4.2. Supply

Recall that we use the Rivers and Vuong (2002) nonnested model specification test to determine the best-fitting channel cost model for our data set without a CC. Specifically, we evaluate eight alternative models—four in which vertical competition is specified as manufacturer Stackelberg (MS) and four in which it is specified as vertical Nash (VN). For both MS and VN, we then consider a case in which retailers price at either the category (C), manufacturer (M), brand (B), or UPC (U) level. Our testing procedure follows Bonnet and Dubois (2010).

In the best-fitting model, the estimated marginal costs should be most strongly correlated with variables that affect marginal costs. The test determines which cost equation has the best statistical fit given the observed cost shifters W_{jt}, which are independent of the conjectured supply model. For each model h, we use nonlinear least squares to minimize the lack of fit:

$$Q_t^h = \sum_{j,r}\left[\log(p_{jrt} - \Gamma_{jrt}^h - \gamma_{jrt}^h) - \omega_{jr}^h - W_{jt}'\lambda_h\right]^2,$$

where p_{jrt} is the retail price for product j in retail chain r at time t, Γ_{jrt}^h is the manufacturer price-cost margin for model h, γ_{jrt}^h is the retailer price-cost margin, ω_{jr}^h is an unknown product- and chain-specific parameter, and W_{jt} are observable shocks to the marginal cost of product j at time t. Two competing models, h and h', are asymptotically equivalent if

$$H_0\colon \lim_{T\to\infty}\{\bar{Q}^h - \bar{Q}^{h'}\} = 0,$$

where $\bar{Q}^h$ ($\bar{Q}^{h'}$) is the expectation of the lack-of-fit measure Q_t^h ($Q_t^{h'}$) for model h (h'). We consider two alternative hypotheses:

$$H_1\colon \lim_{T\to\infty}\{\bar{Q}^h - \bar{Q}^{h'}\} < 0,$$

$$H_2\colon \lim_{T\to\infty}\{\bar{Q}^h - \bar{Q}^{h'}\} > 0,$$

where in H_1, model h is asymptotically better than model h', and H_2 indicates that h' is asymptotically better than h. The test statistic of interest is

$$Z_{hh'} = \frac{\sqrt{T}}{\hat{\sigma}^{hh'}}\sum_t(\hat{Q}_t^h - \hat{Q}_t^{h'}),$$

where $\hat{\sigma}^{hh'}$ is the estimated variance of the difference in lack of fit. Values of $Z_{hh'}$ are compared to critical values of the standard normal distribution to determine statistical significance. Results are reported in Table 6. A significantly negative (positive) value indicates that the column (row) model has a higher lack of fit. Because all values of $Z_{hh'}$ in row MS-U are significantly smaller than zero, we find empirical support for a supply-side model where (1) manufacturers set wholesale prices first and retailers then set retail prices, and (2) retail prices are set to maximize profits from each UPC separately as $p_{jrt}^* = \arg\max[p_{jrt} - w_{jrt}]D_{jrt}(p)$. To check the validity of this result, we compare the actual manufacturer costs and wholesale prices for the UPCs produced by one manufacturer with those estimated from the MS-U model. We find that the correlation between the estimated and observed wholesale prices is 0.96. The correlation between estimated and actual manufacturer costs is equal to 0.93.

Table 6 Nonnested Model Comparisons

$H_1 \backslash H_2$	MS-C	MS-M	MS-B	MS-U	VN-C	VN-M	VN-B	VN-U
MS-C		11.81	11.94	12.09	−2.16	4.15	6.19	6.43
MS-M	−11.81		10.19	10.56	−4.74	−1.77	0.48	0.76
MS-B	−11.94	−10.19		13.64	−6.81	−7.24	−6.13	−5.93
MS-U	−12.09	−10.56	−13.64		−6.98	−7.63	−6.64	−6.45
VN-C	2.16	4.74	6.81	6.98		5.87	6.53	6.63
VN-M	−4.15	1.77	7.24	7.63	−5.87		10.32	10.63
VN-B	−6.19	−0.48	−13.64	6.64	−6.53	−10.32		12.61
VN-U	−6.43	−0.76	5.93	6.45	−6.63	−10.63	−12.61	

Note. Cell values are estimates of $Z_{hh'}$.

Because our model is static, we try to determine empirically whether omitting dynamics is likely to affect our results. (Villas-Boas 2009, p. 26) stated that "the implications of assuming a static framework are shown in Hendel and Nevo (2006): ignoring dynamic demand stockpiling behavior results in upward-biased own price elasticities and, thus, in estimated price-cost margins that are too low." Since our data contain price-cost margins for the UPCs produced by one manufacturer, we are able to evaluate whether the margins are indeed too low as argued by Hendel and Nevo (2006). Using the best-fitting supply model (MS-U), we find our estimated margins are, on average, the same size as those observed in the data.

5. Policy Simulations

The key benefit of a structural model lies in its ability to describe outcomes following a change in the industry; i.e., in our application, a retailer entering into a CC arrangement with a manufacturer. Recall from §4.2 that in the structure most consistent with the available data, retailers set prices at the UPC level and manufacturers are Stackelberg leaders. Based on this structure, we recover the key primitives of the model, i.e., the estimated demand parameters and marginal costs. Given these primitives we solve for wholesale and retail prices under different CC configurations. This allows us to evaluate the impact of a change in the industry and consider the implications for retailers, manufacturers, and consumers. Because our model is built on a consumer utility formulation, we derive consumer welfare implications of industry structure changes. The welfare differential between two scenarios—say, S1 and S2—for consumer i at time t can be calculated as

$$\mathrm{CV}_{it} = \frac{\log(\sum_{r=1}^{R}\sum_{j=0}^{J}\exp(V_{ijrt}^{S1})) - \log(\sum_{r=1}^{R}\sum_{j=0}^{J}\exp(V_{ijrt}^{S2}))}{\beta_{it}}, \tag{8}$$

where V_{ijrt} is the expected utility for consumer i from UPC j in store r at time t (e.g., Small and Rosen 1981, Chintagunta 2003, Dubé 2005). The denominator captures the marginal utility of income and therefore converts utils to a dollar measure. The total change in consumer welfare is estimated by integrating over heterogeneous consumers.

Figure 1 illustrates the current market structure that we refer to as Scenario 0. A manufacturer (e.g., M1) has teams that set wholesale prices for products sold to retailers R1 and R2. These teams coordinate wholesale prices for their products across retailers. The same structure applies for other manufacturers that sell to both retailers (i.e., M2 and M3 in our data). Retailers observe the wholesale prices charged by all manufacturers and then set retail prices.

In the discussion that follows, the CC recommends retail prices for all UPCs jointly to maximize category profits; the retailer then charges the recommended prices to consumers. The effects of CC arrangements can differ depending on the information firewalls a CC implements. First, vertical information firewalls between the team that sets wholesale prices and the team that recommends retail prices implies that the CC and retailer will act as separate profit-maximizing agents. Second, horizontal information firewalls can be implemented between the CC's pricing teams, which ensures the CC's recommendations to one retailer are independent of those to a competing retailer (i.e., the CC does not coordinate recommendations across retailers). Horizontal information firewalls play an important role in maintaining retail competition when a manufacturer is the CC in both retail chains. One of our primary research objectives is to evaluate the (relative) importance of these two types of firewalls in the scenarios described below to derive policy implications.

For each of the scenarios, we assume the identity of the CC is known to all agents and prices are set conditional on which manufacturer is CC. We avoid specific assumptions about contracts between retailers and the CC. Based on surveys and interviews with managers, Gooner et al. (2011) argued that the CC–retailer relationship is a form of relational governance that allows the CC and the retailer to "cooperate without formal agreements or contracts, which are deliberately avoided because of antitrust concerns" (p. 21). They explained that partners can develop mutually beneficial relationships "even in a context that our fieldwork revealed uses no formal contracts to safeguard the ability to claim value from their joint efforts" (p. 31).

5.1. Scenario 0: No CC

As established in §4.2, in the current market setting manufacturers are Stackelberg leaders and set wholesale prices to maximize their product line profits across retail chains:

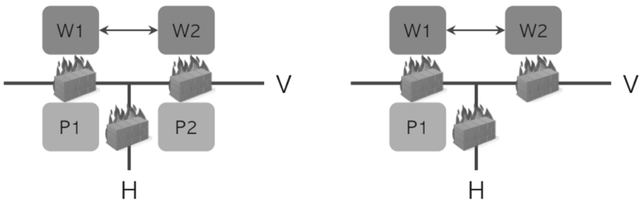
$$\{w_{jrt}^{*}\colon r \in \{1,2\},\, j \in S_r^m\} = \arg\max \sum_{r=1}^{2}\sum_{j\in S_r^m}[w_{jrt} - c_{jrt}^{m}]D_{jrt}(p(w)).$$

Retailers observe wholesale prices and charge consumers prices that maximize UPC profits, or $p_{jrt}^{*} = \arg\max[p_{jrt} - w_{jrt}]D_{jrt}(p)\ \forall\, j \in \{1, \ldots, 48\}$.

5.2. Vertical Information Firewalls Activated

5.2.1. Scenario 1: Horizontal Information Firewalls Activated. In this scenario, vertical information firewalls are activated and a CC, engaged as

Figure 2 **Pricing Teams in the CC's Organization When Horizontal and Vertical Information Firewalls Are Activated**



Note. The graph illustrates the positioning of information firewalls when a firm is CC for both retailers (left panel) or only for retailer R1 (right panel). Horizontal information firewall H blocks the (horizontal) flow of information between P1 and P2. Vertical information firewall V blocks the (vertical) flow of information between the wholesale and retail price teams.

Table 7 **Difference in Retail Profits Compared with Scenario 0 (i.e., UPC-Level Retail Pricing) When Vertical and Horizontal Information Firewalls Are Activated**

	CC for chain R2			
CC for chain R1	None		CC	
None	0	0	−0	−2
CC	−17	−0	−17	−1

Note. The first number in each cell represents the payoff change ($000) for chain R1; the second number represents that for chain R2.

an independent consultant, recommends retail prices that maximize category profits. All manufacturers, including the CC, are Stackelberg leaders and first set wholesale prices to maximize their product line profits across retail chains as in Scenario 0. Figure 2 illustrates the positioning of information firewalls in the CC's organization when she is the CC for both retailers (left panel) or only for retailer R1 (right panel). In the left panel, the CC has four pricing teams. The two teams that set wholesale prices to retailers R1 and R2 (i.e., W1 and W2, respectively) coordinate. The two teams that recommend retail prices to R1 and R2 (i.e., P1 and P2, respectively) receive information on manufacturer wholesale prices from the respective retailers but cannot coordinate because of the presence of a horizontal information firewall (H). In Figure 2, the horizontal information firewall *blocks* the (horizontal) flow of information between P1 and P2. The presence of a vertical information firewall (V) implies that the teams that set wholesale prices (i.e., W1 and W2) cannot communicate with the retail price recommendation teams (i.e., P1 and P2) and will act independently. Moreover, vertical information firewalls *block* the (vertical) flow of information between wholesale and retail price teams within the CC's organization. In the right panel, the CC has three pricing teams, and similar to the left panel, the two teams that set wholesale prices to retailers R1 and R2 (i.e., W1 and W2, respectively) can coordinate. Team P1 recommends retail prices to R1 and receives information on all manufacturer wholesale prices charged to that retailer.

When vertical information firewall V is activated, the CC and non-CCs have identical objective functions; i.e.,

$$\sum_{r=1}^{2}\sum_{j\in S_r^m}[w_{jrt}-c_{jrt}^m]D_{jrt}(p(w)).$$

Retailers observe wholesale prices and set retail prices to either (1) maximize UPC profits when no CC is used as in Scenario 0 or (2) maximize category profits as $\{p^*_{jrt}\colon j\in S_r\}=\arg\max\sum_{j\in S_r}[p_{jrt}-w_{jrt}]D_{jrt}(p)$ when a CC provides price recommendations. Note that in this scenario, the specific manufacturer used as the CC does not impact the results because each recommends retail prices that maximize category profits for the retailer(s). Based on this structure and the estimated market primitives, we derive equilibrium prices and payoffs.[3]

Table 7 shows the change in payoffs for both retailers when they choose (not) to use a CC to support pricing decisions. We find it interesting that R1 and R2 would be worse off with a CC than in the status quo. When both vertical and horizontal information firewalls are activated, retailer profits are higher using UPC-level retail pricing than coordinated category pricing. If both retailers decide to use a CC, the losses for R1 would amount to $17,000 per week (approximately 6% of the retailer's average profits from the category in Scenario 0), and R2 would lose $1,000 per week (approximately 2% of the retailer's average profits from the category in Scenario 0).

To better understand this result, we elaborate on the changes in the market when both retailers select a CC. We find that optimal retail prices increase by 5% in R1 and 1% in R2. Wholesale prices rise (by 2.8%, on average) because manufacturers are Stackelberg leaders and endogenize the retailers' price reaction functions.[4] To illustrate this intuition, we isolated the impact of price coordination (i.e., category-level retail pricing) by simulating a partial equilibrium where wholesale prices are unchanged from Scenario 0 and retail prices are optimized to maximize category profits. As expected, in this partial equilibrium, price coordination across all UPCs in the category would benefit both retailers. Specifically, compared with Scenario 0, the gains for R1 would amount to $3,000 per week and for R2 would amount to $1,000 per week.

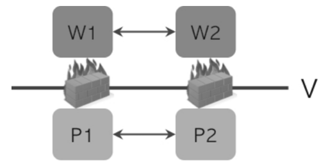
[3] See Villas-Boas (2007, 2009) and Bonnet and Dubois (2010) for similar policy simulation procedures.

[4] In other words, when both retailers use a CC, W1 and W2 endogenize P1's and P2's price reaction functions.

The finding that category price coordination can produce lower retailer profits contradicts the claim made by Basuroy et al. (2001) that category price coordination strictly increases retailer profits in a channel model based on linear demand. The (mixed) logit demand model is ubiquitous in empirical research, but the analytical channels literature in marketing (see, e.g., McGuire and Staelin 1983; Coughlan and Wernerfelt 1989; Lal 1990; Basuroy et al. 2001; Wang et al. 2003; Desai et al. 2004, 2007; Subramanian et al. 2010; Kurtuluş and Toktay 2011) generally employs linear demand for tractability.[5] An implication of our research is that prior insights on category price coordination do not generalize to a setting with logit demand.[6] Consistent with this result, Lee and Staelin (1997) used a general demand function to show that under some conditions, retailers may be better off avoiding price coordination. They introduced the concept of vertical strategic interaction, i.e., the best margin response to a change in the margins of another channel member. The authors called for empirical research to determine whether the types of interactions explored in their theoretical research exist in the real world. Our findings suggest that, in Lee and Staelin's terminology, the market environment exhibits vertical strategic complementarity as manufacturers' best response to retailers' margin increase is to also increase their own margins. In fact, this complementarity is a plausible explanation for why retailers in our data set engage in product-level pricing rather than coordinated pricing (see §4.2), and it provides and additional argument for why some retailers still forgo CC arrangements (see §1).

5.2.2. Scenario 2: Horizontal Information Firewalls Deactivated. Figure 3 shows vertical information firewall V within a CC's organization when the same manufacturer is the CC for both retailers. As before, the teams that set wholesale prices to retailers R1 and R2 (i.e., W1 and W2, respectively) coordinate. Now, however, the teams that recommend retail prices to R1 and R2 (i.e., P1 and P2, respectively) can also coordinate because the horizontal information firewall has been deactivated. The presence of a vertical information firewall still implies that the CC's wholesale price teams (i.e., W1 and W2) cannot coordinate with the retail price recommendation teams (i.e., P1 and P2). Retailers provide information on all manufacturer wholesale prices to the CC's retail price recommendation teams.

Figure 3 Pricing Teams in a CC's Organization When Vertical Information Firewalls Are Activated But Horizontal Information Firewalls Are Deactivated



Note. A vertical information firewall V blocks the vertical flow of information between the wholesale and retail price teams.

When horizontal information firewalls are deactivated and retailers use the same CC, the latter can recommend prices to maximize profits across both retailers, or

$$\{p^*_{jrt}\colon r \in \{1,2\}, j \in S_r\} = \arg\max \sum_{r=1}^{2} \sum_{j\in S_r} [p_{jrt} - w_{jrt}] D_{jrt}(p).$$

It is noteworthy that profits across both retailers decrease further by \$6,000 compared with those in Scenario 1 (i.e., a loss of \$24,000 when compared with Scenario 0). At first glance this result may seem surprising because it implies that when a CC eliminates retail competition by deactivating the horizontal information firewall, retailer performance deteriorates. In essence, the intuition for this result is the same as for Scenario 1. Coordinating retail prices across chains is an extension of coordination within a category; i.e., the products sold in R1 and R2 are priced jointly for overall profitability with the help of a CC. To further explore this finding, we set wholesale prices to Scenario 0 levels and derive the partial equilibrium retail prices that maximize category profits across retailers. In this setting we indeed find that price coordination across all UPCs sold in both chains would benefit retailers if wholesale prices are not changed. The estimated combined gains average \$5,000 per week compared with Scenario 0. We discuss the welfare implications of Scenarios 1 and 2 in detail in §5.4.

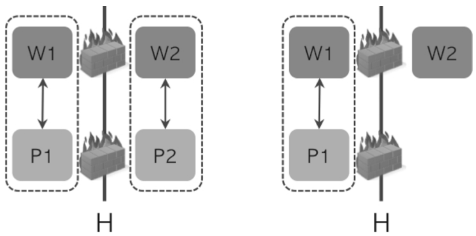
5.3. Vertical Information Firewalls Deactivated

5.3.1. Scenario 3: Horizontal Information Firewalls Activated. Figure 4 illustrates the positioning of a horizontal firewall within a CC's organization when she works with both retailers (left panel) or only retailer R1 (right panel). In the left panel, the CC again has four pricing teams. Without vertical information firewalls, however, the CC and retailer form an alliance that optimizes a joint objective function.

[5] Optimal retail and wholesale prices are a function of higher-order derivatives that are not present under a linear demand system assumption.

[6] In addition to this empirical evidence, we derived profits and optimal wholesale and retail prices for a simple analytical model with logit demand. We find that demand parameters exist for which category price coordination produces lower retail profits compared with UPC-level pricing. Details are available from the authors on request.

Figure 4 Pricing Teams in a CC's Organization When Vertical Information Firewalls Are Deactivated But Horizontal Information Firewalls Are Activated



Notes. The graph illustrates the positioning of information firewalls when a firm is the CC for both retailers (left panel) or only for retailer R1 (right panel). A horizontal information firewall H blocks the horizontal flow of information.

By integrating the wholesale and retail price teams assigned to a specific retail account, the CC *breaks* the firm. Specifically, in a scenario in which vertical information firewalls have been deactivated, the horizontal information firewall extends to the wholesale price teams, as illustrated in Figure 4. In the right panel, the CC has three pricing teams. The teams that determine wholesale and retail prices for retailer R1 (i.e., W1 and P1) communicate and coordinate prices for the CC's products. A large literature in marketing and economics has studied coordination in vertical channels (see, e.g., Spengler 1950, Jeuland and Shugan 1983, McGuire and Staelin 1983, Coughlan 1985, Moorthy 1987, Coughlan and Wernerfelt 1989, Lal 1990, Rao and Srinivasan 1995, Desai and Srinivasan 1996, Villas-Boas 1998). As summarized in Desai et al. (2004, p. 7), "An important insight from this literature is that a manufacturer can solve the price coordination…problem by choosing a two-part contract in which the wholesale price is set at the manufacturer's marginal cost." Consistent with this insight, when vertical firewalls are deactivated, a CC sets wholesale prices to marginal cost when recommending optimal prices to the retailer. In the panel on the left, the CC has formed an alliance with both retailers. In each alliance, wholesale and retail prices are coordinated. However, when the horizontal information firewall is activated, the break in the firm ensures the two alliances cannot coordinate.

In this scenario manufacturers not engaged as a CC set wholesale prices for product line profit maximization across stores as Stackelberg leaders, as in all previous scenarios. A retailer can maximize category profits by setting retail prices recommended by the CC as

$$\{p^*_{jrt}\colon j \in S_r\} = \arg\max \Bigg\{ \sum_{j \in S_r^{CC}} [p_{jrt} - c^m_{jrt}] D_{jrt}(p) + \sum_{j \in S_r^{NCC}} [p_{jrt} - w_{jrt}] D_{jrt}(p) \Bigg\}.$$

As before, the retailer provides information on all manufacturer wholesale prices to the CC's retail price recommendation team. Note that for the CC's products (S_r^{CC}), wholesale price is replaced by marginal cost. For the non-CCs' products (S_r^{NCC}), wholesale prices are used. If the CC works only with retailer R1, she will set wholesale prices that maximize product line profits in R2 as $\{w^*_{jrt}\colon\ r = 2,\ j \in S^m_r\} = \arg\max \sum_{j \in S^m_r} [w_{jrt} - c^m_{jrt}] D_{jrt}(p(w))$. If neither retailer selects a CC, UPC-level profit maximization is used, as before.

The scarcity of research on CC arrangements and their lack of transparency imply that profit-sharing arrangements and negotiations between the retailer and CC are not well understood. Therefore, we focus on the effects of these arrangements on the CC–retailer alliance as a whole. Table 8 shows the change in combined profits for the CC–retailer alliance when different combinations of manufacturers are used to support retail pricing decisions. If retailers are able to negotiate an appropriate part of the increased profit pie, our empirical results indicate that retailers may be better off choosing the largest manufacturer as a CC. Specifically, we find that when both retailers engage in a CC arrangement with the leading manufacturer (M1), alliance profits are larger than any other payoff reported in Table 8. Even though the current state of the literature on CCs provides insufficient guidance to determine which CC the retailer *should* choose, we know from surveys that retailers generally capture most of the monetary benefits from the CC arrangement (e.g., Gooner et al. 2011) and that the leading manufacturer is often selected as CC in practice (see Kurtuluş and Toktay 2011). Our results are consistent with the observation that retailers tacitly enter into CC arrangements that can leave them significantly better off.

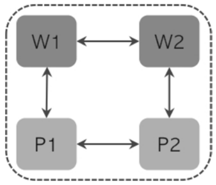
5.3.2. Scenario 4: Horizontal Information Firewalls Deactivated Figure 5 illustrates the level of coordination that can be achieved when both retailers use the same CC and all information firewalls are deactivated. In this setting the CC can suggest

Table 8 Difference in Profits Compared with Scenario 0 When Vertical Information Firewalls Are Deactivated But Horizontal Information Firewalls Are Activated

	CC for chain R2							
CC for chain R1	None		M1		M2		M3	
None	0	0	−5	**32**	−3	12	−1	2
M1	**103**	−2	**88**	**20**	**97**	7	**102**	−1
M2	35	−2	27	**29**	31	9	34	−1
M3	−9	−1	−14	**34**	−12	12	−10	1

Note. Numbers in bold represent the largest increase in profits ($000) for the CC alliance with R1 (first number) or R2 (second number).

Figure 5 Pricing Teams in a CC's Organization When Both Vertical and Horizontal Information Firewalls Are Deactivated



retail prices to maximize alliance profits across both retailers, or

$$\{p^*_{jrt} : r \in \{1, 2\}, j \in S_r\} = \arg\max\left\{\sum_{r=1}^{2}\sum_{j\in S_r^{CC}} [p_{jrt} - c^m_{jrt}]\, D_{jrt}(p) + \sum_{r=1}^{2}\sum_{j\in S_r^{NCC}} [p_{jrt} - w_{jrt}] D_{jrt}(p)\right\}.$$

When both retailers choose M1 as the CC, we find that alliance profits increase by an additional \$3,000 compared with Scenario 3 and by \$111,000 compared with Scenario 0. In contrast to Scenario 2, we find that profits increase when retail competition is eliminated following deactivation of the horizontal information firewall. The main difference between these two results is that, without any information firewalls, the CC does not change wholesale prices when retail prices are coordinated across retailers. Because retail prices for the CC's goods are lowered in Scenarios 3 and 4, non-CCs cannot increase their wholesale prices without losing additional sales. We discuss the welfare implications of the four scenarios in detail in the next section.

5.4. Welfare Implications

We summarize the welfare effects of CC arrangements with and without vertical and horizontal information firewalls in Tables 9 and 10, respectively. Table 9 shows results for Scenarios 1 and 2 when both retailers select a CC. Because vertical information firewalls are activated, the CC acts as an independent consultant who recommends retail prices to maximize category profits. We find that both retailers, all three manufacturers, and consumers would be worse off in Scenario 1 compared with the status quo (Scenario 0, where there is no CC). We discussed the intuition for the effects on retail profits in §5.2.1. Average retail prices rise as a result of category price coordination and higher wholesale prices, which, in turn, reduce consumer welfare and the share of the inside option by 15% (i.e., category shrinkage). The negative impact of category price coordination on manufacturer performance is consistent with previous research (e.g., Basuroy et al. 2001). Although CM purports to produce a win-win-win outcome for manufacturers, retailers, and consumers, our findings suggest a lose-lose-lose outcome may be more likely when both vertical and horizontal information firewalls are activated.

Scenario 2 in Table 9 shows the effects of deactivating horizontal information firewalls and retail competition. As discussed in §5.2.1, eliminating retail competition not only harms consumers but, paradoxically, reduces retailer and manufacturer performance.

Next, we turn our attention to scenarios in which vertical information firewalls have been deactivated. Scenario 3 in Table 10 shows that consumer welfare is substantially enhanced (\$22,000) when both retailers use M1 as a CC and horizontal information firewalls are activated. The increase in consumer welfare can be attributed to the lower prices

Table 9 Weekly Welfare and Profit Implications Compared with Scenario 0 (in \$000) When Both Retailers Use a CC and Vertical Information Firewalls Are Activated

Scenario	Consumer welfare	R1 profit	R2 profit	M1 profit	M2 profit	M3 profit	Social welfare
Scenario 1	−7	−17	−1	−26	−9	−1	−60
Scenario 2	−13	−24[a]		−37	−12	−2	−87
Scenario 2 − Scenario 1	−6	−6		−11	−3	−1	−27

[a]Profit numbers (\$000) for R1 and R2 combined.

Table 10 Weekly Welfare and Profit Implications Compared with Scenario 0 (in \$000) When Both Retailers Use M1 as a CC and Vertical Information Firewalls Are Deactivated

Scenario	Consumer welfare	R1 + M1 profit	R2 + M1 profit	M2 profit	M3 profit	Social welfare
Scenario 3	22	88[a]	20[a]	−29	−4	97
Scenario 4	15	111[a]		−34	−5	88
Scenario 4 − Scenario 3	−7	3[a]		−5	−1	−9

[a]Profit numbers (\$000) for the CC retailer alliance.

retailers charge for the CC's products. Even though both CC–retailer alliances achieve higher profits, manufacturers not selected as a CC face a profit decline of \$33,000 (\$29,000 + \$4,000). In this scenario the increase in social welfare is substantial, suggesting that CC arrangements without vertical information firewalls may be socially desirable even though non-CCs may be worse off. Scenario 4 in Table 10 shows welfare effects when all information firewalls are deactivated. Although the CC–retailer alliance achieves even higher profit levels in this scenario, consumer welfare is reduced, and the non-CCs are worse off compared with Scenario 3. These results demonstrate the importance of structuring CC arrangements to maintain price competition across retailers when both use the same CC.

As mentioned in §1, retailers expect CC arrangements to increase the size of the category pie. In contrast to Scenario 1, we find that when M1 is the CC in both chains, the share of the inside option can increase by as much as 75.8%; i.e., CC arrangements can drive category growth (Wang et al. 2003, Gooner et al. 2011). In the presence of a CC, the non-CCs still face pricing inefficiencies in the channel, forcing them to lower wholesale prices. Moreover, when retail prices are set to maximize category profits, prices charged to consumers for the non-CCs' products should increase compared with those in Scenario 0 (Basuroy et al. 2001). Two opposing forces drive retail prices for the CC's products: vertical price coordination drives retail prices down, whereas category pricing drives them up. Our results demonstrate that manufacturers not selected as a CC indeed reduce wholesale prices slightly (i.e., 0.5%, on average). As expected, in equilibrium, M2's and M3's retail prices increase by 4% across chains. As a result, non-CC market shares decrease between 15% and 30%. In contrast, retail prices for the CC's products are reduced substantially: −22.95% in R1 and −27.29% in R2. Consequently, M1's overall market share increases by 120.7% in R1 and 165.5% in R2 (Wang et al. 2003). It is important to note that these policy simulations evaluate the *potential* benefits of CC arrangements that eliminate channel inefficiencies and/or remove retail competition.[7]

In sum, we demonstrate that when vertical information firewalls are activated, CC arrangements are socially inefficient. All agents are strictly worse off, especially when horizontal firewalls are deactivated (i.e., Scenario 2). In contrast, when vertical information firewalls are deactivated, CC arrangements can increase alliance profits and boost both consumer and social welfare substantially (i.e., Scenario 3). However, horizontal information firewalls are needed to safeguard these benefits (i.e., Scenario 4). We discuss the implications of our findings for retailers, manufacturers, consumers, policy makers, and researchers in the next section.

6. Conclusions

Our study is, to the best of our knowledge, the first to quantify the costs and benefits of CC arrangements for retailers, manufacturers, and consumers. We also determine how (de)activation of vertical and horizontal information firewalls influence these outcomes. Below we discuss the implications of our results for market participants and public policy.

6.1. Implications for Retailers

It has been argued that retailers lack both the resources and the capabilities to effectively implement CM in all product categories. We show that CC arrangements can provide retailers with the benefits of coordinated category pricing when unable to implement it profitably themselves—but only when vertical information firewalls are deactivated. When all FTC-recommended information firewalls are activated, retailers face a reduction in profitability from coordinated category pricing, even when outsourced to a CC.

Even with the increase in CC collaborations, many retailers remain concerned about opportunistic behavior (Morgan et al. 2007). Manufacturers that serve as CCs walk a fine line between optimizing the retailer's performance and optimizing their own. Retailers could use models such as ours to detect undesirable CC behavior. However, monitoring a CC's recommendations may increase retailer costs and diminish gains. Our estimates of the monetary benefits from CC arrangements can be viewed as an upper bound on the warranted level of retailer investment to implement and monitor a CC's recommendations.

Retailers are concerned about legal action and militant behavior by non-CCs whose performance declines when a CC arrangement is in place. We find

[7] To determine the stability of our results for Scenario 3, we reestimated policy simulations for a price coefficient of −0.664 and −1.08 (i.e., plus or minus a standard error of the estimated parameter of −0.872 reported in Table 4). We find that the consumer welfare benefits of deactivating vertical information firewalls are very similar for the different parameter values. For the mean price coefficient (−0.872), the estimated benefits are \$22,000 per week (see Table 10). When demand is less sensitive to price changes (i.e., a price parameter of −0.664), the potential benefits are higher (\$27,000), and they are lower (\$19,000) when demand is more sensitive to price (i.e., a price coefficient of −1.08). These differences can be explained by the higher (lower) markups manufacturers and retailers achieve when price sensitivity is lower (higher). We find that the CC–retailer alliance can achieve profit gains of \$360,000 if demand is less price sensitive (i.e., −0.664), but the benefits of deactivating vertical information firewalls are lower (\$5,000) when demand is more price sensitive (i.e., −1.08).

that when vertical information firewalls are deactivated, the increase in CC retailer alliance profits exceeds non-CCs' losses, suggesting an opportunity to develop profit-sharing arrangements that can benefit all industry participants (see Subramanian et al. 2010 for a related argument). In practice, there is little evidence of opportunistic CC behavior and complaints by non-CCs, suggesting that this could be a plausible outcome (Gooner et al. 2011).

Finally, retailers should consider long-term implications when weighing the pros and cons of CC arrangements. Managing a category requires comprehensive insight into consumer preferences and purchasing patterns. By outsourcing CM components to suppliers, retailers not only risk losing touch with consumers, which may be hard to regain (Kurtuluş and Toktay 2004), but also risk losing power in the channel. The long-term implications of CC arrangements for retailers warrant further study.

6.2. Implications for Manufacturers

How much should manufacturers invest to develop CC capabilities? We quantified the size of the total profit pie the retailer and CC share when the latter supports the retailer's pricing decisions. Even though a manufacturer may not share greatly in the spoils when the retailer has significant channel power (Gooner et al. 2011), we show that the profit implications of missing out on the CC job can be substantial, regardless of the information firewall configuration implemented by the CC. However, manufacturers covet the role of CC not only to avoid potential profit losses but also to gain influence on retailer decision making (Kurtuluş and Toktay 2011). In fact, companies such as Total Floral envision vendor-managed stores in which manufacturers manage product mix, pricing, ad profiles, and even in-store labor (*Progressive Grocer* 2007). More research is needed to establish which manufacturer investments in CC capabilities are most beneficial for retailers, manufacturers, and consumers.

6.3. Implications for Consumers

We show that consumer welfare and category consumption will decrease when a CC activates all FTC-recommended information firewalls. Deactivating vertical information firewalls can, however, result in sizable benefits for consumers, even when the CC enables retail collusion by deactivating horizontal information firewalls. In other words, whereas retail collusion can be detrimental to consumers, the benefits of removing channel inefficiencies are stronger. The importance of establishing horizontal information firewalls depends on, among other things, the extent of retail competition in a particular market. Without explicit restrictions on horizontal information flows, consumer welfare could be harmed substantially in highly competitive markets.

6.4. Implications for Public Policy

The most important implications of our research are for public policy. While Desrochers et al. (2003) speculated that CC arrangements can limit smaller suppliers' ability to compete, lead to higher prices, and reduce consumer welfare, our study is the first, to our knowledge, to empirically investigate the impact of a CC for market participants. Although CC arrangements can hurt competitors' performance, in practice, manufacturers compete for the job. Moreover, it is not clear whether the impact of a CC's actions on other manufacturers should be considered anticompetitive, particularly since consumers can benefit from CC arrangements. Despite retailers' and policy makers' concerns about CC opportunism, we show that the social welfare benefits of CC arrangements can be substantial. In fact, when vertical information firewalls are deactivated and horizontal information firewalls are activated, total firm welfare increases. As mentioned above, this offers an opportunity to improve performance for all parties.

Some CCs claim to stringently implement the FTC-recommended information firewalls; however, our findings demonstrate that when both vertical and horizontal information firewalls are activated, CC arrangements are socially inefficient. Furthermore, we suggest that the reluctance of some retailers to outsource category pricing may stem from the CC's inability to create value for retailers, manufacturers, or consumers when vertical information firewalls are activated. Although we find that horizontal information firewalls should be activated in CC arrangements, we suggest that maintaining vertical information firewalls is not in the consumers' best interest. We demonstrate that policy makers could use our empirical approach to assess the impact of alternative information firewall regulations for CC arrangements.

6.5. Implications for Researchers

Our research also provides new insights into the value of category price coordination. Specifically, we suggest that findings from prior analytical studies on product line and category pricing are sensitive to the choice of demand function (i.e., linear or logit demand), which could potentially lead to very different policy recommendations. Moreover, our results may also have interesting implications for research on horizontal downstream mergers in industrial organization. In particular, the findings for Scenario 2, in which prices are set to eliminate retail competition, suggest a setting where downstream mergers may be unprofitable.

6.6. Limitations and Suggestions for Future Research

To date, researchers have not had access to detailed archival data on CC arrangements because of antitrust concerns. The lack of data, scarcity of research, and limited transparency of CC arrangements imply that profit sharing by and negotiations between the retailer and CC are not well understood. It is therefore not possible to empirically determine how manufacturers and retailers will share the gains from a CC arrangement, nor is it possible to determine how manufacturers will compete for the CC position. In theory, the possibilities are broad and depend on the relative bargaining power of the retailer and manufacturer (Wang et al. 2003). We believe more analytical research is needed to determine how CC arrangements *should* be structured to achieve the benefits illustrated in our paper.

Although we focus on category pricing, a CC may also be asked to support assortment decisions (Kurtuluş and Toktay 2011), which could have important legal implications. For example, the FTC (2001) has expressed concerns that CC arrangements may result in strategic exclusion of rival products. [8] Furthermore, Kurtuluş and Toktay (2011) suggested that CCs may push for increased assortment diversity to limit competition. However, retailers may benefit from lower levels of differentiation because it increases manufacturer competition and drives down wholesale prices. Additional empirical research on CC participation in various aspects of retailer decision making—such as category planning and shelf-space allocation, for example—can produce important insights for both managers and policy makers Subramanian et al. (2010).

We estimate optimal wholesale and retail prices at the weekly level but cannot account for the dynamic effects of promotions. Although this model limitation does not bias our cost estimates, as mentioned in §4, future research should investigate the benefits of using a CC to support dynamic retail pricing. Furthermore, our results are derived for one geographic market and category. To enhance the generalizability of the reported findings, future research should seek to establish boundary conditions by deriving a broad set of comparative statics from an analytical model. Although perhaps less general, our policy simulations do offer comparative statics in an important parameter region—those estimated from the data. We believe our research approach and effect size estimates are complimentary to existing analytical work that provides directional effects on category captaincy.

Our empirical research established both the potential detrimental and beneficial effects of CC arrangements and evaluated the influence of vertical and horizontal information firewalls. We hope our findings encourage additional research on category captaincy and bring us one step closer to a better understanding of this fascinating business practice.

[8] See, e.g., *Conwood Co. v. United States Tobacco Co.*, 290 F.3d 768 (6th Cir. 2002) or *R.J. Reynolds Tobacco Co. v. Philip Morris Incorporated*, 199 F.Supp.2d 362 (2002).

References

Basuroy S, Mantrala MK, Walters RG (2001) The impact of category management on retailer prices and performance: Theory and evidence. *J. Marketing* 65(4):16–32.

Berry S, Levinsohn J, Pakes A (1995) Automobile prices in market equilibrium. *Econometrica* 63(4):841–890.

Besanko D, Dubé J-P, Gupta S (2005) Own-brand and cross-brand retail pass-through. *Marketing Sci.* 24(1):123–137.

Blattberg RC, Fox EJ (1995) *Category Management: A Series of Implementation Guides* (Food Marketing Institute, Washington, DC).

Bonnet C, Dubois P (2010) Inference on vertical contracts between manufacturers and retailers allowing for nonlinear pricing and resale price maintenance. *RAND J. Econom.* 41(1):139–164.

Bronnenberg BJ, Kruger MW, Mela CF (2008) The IRI marketing data set. *Marketing Sci.* 27(4):745–748.

Chintagunta PK (2002) Investigating category pricing behavior at a retail chain. *J. Marketing Res.* 39(2):141–154.

Chintagunta PK, Nair HS (2011) Discrete-choice models of consumer demand in marketing. *Marketing Sci.* 30(6):977–996.

Chintagunta PK, Dubé J-P, Singh V (2003) Balancing profitability and customer welfare in a supermarket chain. *Quant. Marketing Econom.* 1(1):111–147.

Choi SC (1991) Price competition in a channel structure with a common retailer. *Marketing Sci.* 10(4):271–296.

Corstjens J, Corstjens M (1995) *Store Wars: The Worldwide Battle for Mindspace and Shelfspace* (John Wiley & Sons, Chichester, UK).

Coughlan AT (1985) Competition and cooperation in marketing channel choice: Theory and application. *Marketing Sci.* 4(2): 110–129.

Coughlan AT, Wernerfelt B (1989) On credible delegation by oligopolists: A discussion of distribution channel management. *Management Sci.* 35(2):226–239.

Desai PS, Srinivasan K (1996) Aggregate versus product-specific pricing: Implications for franchise and traditional channels. *J. Retailing* 72(4):357–382.

Desai PS, Koenigsberg O, Purohit D (2004) Strategic decentralization and channel coordination. *Quant. Marketing Econom.* 2(1): 5–22.

Desai PS, Koenigsberg O, Purohit D (2007) The role of production lead time and demand uncertainty in marketing durable goods. *Management Sci.* 53(1):150–158.

Desrochers DM, Gundlach GT, Foer AA (2003) Analysis of antitrust challenges to category captain arrangements. *J. Public Policy Marketing* 22(2):201–215.

Dewsnap B, Hart C (2004) Category management: A new approach for fashion marketing? *Eur. J. Marketing* 38(7):809–834.

Dubé J-P (2004) Multiple discreteness and product differentiation: Demand for carbonated soft drinks. *Marketing Sci.* 23(1):66–81.

Dubé J-P (2005) Product differentiation and mergers in the carbonated soft drink industry. *J. Econom. Management Strategy* 14(4): 879–904.

Dussart C (1998) Category management: Strengths, limits and developments. *Eur. Management J.* 16(1):50–62.

FTC (Federal Trade Commission) (2001) Report on the Federal Trade Commission workshop on slotting allowances and other marketing practices in the grocery industry. Report, Federal Trade Commission, Washington, DC. http://www.ftc.gov/os/2001/02/slottingallowancesreportfinal.pdf.

Gooner RA, Morgan NA, Perreault WD Jr (2011) Is retail category management worth the effort (and does a category captain help or hinder)? *J. Marketing* 75(5):18–33.

Hendel I, Nevo A (2006) Measuring the implications of sales and consumer inventory behavior. *Econometrica* 74(6):1637–1673.

Herderschee-Hunter G (2003) Antitrust and category captains: Roundtable discussion. Report, American Antitrust Institute, Washington, DC. http://antitrustinstitute.org/archives/files/270.pdf.

Hofstetter J (2006) Assessing the contribution of ECR. *ECR J.* 6(1):20–29.

Jeuland AP, Shugan SM (1983) Managing channel profits. *Marketing Sci.* 2(3):239–272.

Kadiyali V, Chintagunta P, Vilcassim N (2000) Manufacturer-retailer channel interactions and implications for channel power: An empirical investigation of pricing in a local market. *Marketing Sci.* 19(2):127–148.

Kurtuluş M, Toktay B (2004) Category captainship: Who wins, who loses? *ECR J.* 4(2):26–33.

Kurtuluş M, Toktay LB (2011) Category captainship vs. retailer category management under limited retail shelf space. *Production Oper. Management* 20(1):47–56.

Lal R (1990) Improving channel coordination through franchising. *Marketing Sci.* 9(4):299–318.

Lee E, Staelin R (1997) Vertical strategic interaction: Implications for channel pricing strategy. *Marketing Sci.* 16(3):185–207.

Lindblom A, Olkkonen R (2008) An analysis of suppliers' roles in category management collaboration. *J. Retailing Consumer Services* 15(1):1–8.

McGuire TW, Staelin R (1983) An industry equilibrium analysis of downstream vertical integration. *Marketing Sci.* 2(2):161–191.

Meza S, Sudhir K (2006) Pass-through timing. *Quant. Marketing Econom.* 4(4):351–382.

Moorthy KS (1987) Managing channel profits: Comment. *Marketing Sci.* 6(4):375–379.

Morgan NA, Kaleka A, Gooner RA (2007) Focal supplier opportunism in supermarket retailer category management. *J Oper. Management* 25(2):512–527.

Nevo A (2000) Mergers with differentiated products: The case of the ready-to-eat cereal industry. *RAND J. Econom.* 31(3):395–421.

Nevo A (2001) Measuring market power in the ready-to-eat cereal industry. *Econometrica* 69(2):307–342.

Nijs V, Misra K, Anderson ET, Hansen K, Krishnamurthi L (2010) Channel pass-through of trade promotions. *Marketing Sci.* 29(2):250–267.

Peltzman S (2000) Prices rise faster than they fall. *J. Political Econom.* 108(3):466–502.

Progressive Grocer (2007) Category captains 2007: Armed and ready. (November 15) 24–114.

Progressive Grocer (2008) Category captains 2008: Marching orders. (November) 40–86.

Rao RC, Srinivasan S (1995) Why are royalty rates higher in service-type franchises? *J. Econom. Management Strategy* 4(1):7–31.

Raskin A (2003) Who's minding the store? *Business 2.0* (February 1) http://money.cnn.com/magazines/business2/business2_archive/2003/02/01/335956/.

Rivers D, Vuong Q (2002) Model selection tests for nonlinear dynamic models. *Econometrics J.* 5(1):1–39.

Small KA, Rosen HS (1981) Applied welfare economics with discrete choice models. *Econometrica* 49(1):105–130.

Spengler JJ (1950) Vertical integration and antitrust policy. *J. Political Econom.* 58(4):347–352.

Srinivasan S, Pauwels K, Nijs VR (2008) Demand-based pricing versus past-price dependence: A cost-benefit analysis. *J. Marketing* 72(1):15–27.

Subramanian U, Raju JS, Dhar SK, Wang Y (2010) The competitive consequences of using a category captain. *Management Sci.* 56(10):1739–1765.

Sudhir K (2001) Structural analysis of manufacturer pricing in the presence of a strategic retailer. *Marketing Sci.* 20(3):244–264.

Thomadsen R (2007) Product positioning and competition: The role of location in the fast food industry. *Marketing Sci.* 26(6):792–804.

Villas-Boas JM (1998) Product line design for a distribution channel. *Marketing Sci.* 17(2):156–169.

Villas-Boas SB (2007) Vertical relationships between manufacturers and retailers: Inference with limited data. *Rev. Econom. Studies* 74(2):625–652.

Villas-Boas SB (2009) An empirical investigation of the welfare effects of banning wholesale price discrimination. *RAND J. Econom.* 40(1):20–46.

Wang Y, Raju JS, Dhar SK (2003) The choice and consequences of using a category captain for category management. Working paper, Wharton School, University of Pennsylvania, Philadelphia.

Webster FE Jr (1992) The changing role of marketing in the corporation. *J. Marketing* 56(4):1–17.

Zbaracki MJ, Ritson M, Levy D, Dutta S, Bergen M (2004) Managerial and customer costs of price adjustment: Direct evidence from industrial markets. *Rev. Econom. Statist.* 86(2):514–533.