Essays on vertical integration, vertical contracts, and competitive effects

by

Millagaha Gedara Nuwan Indika

B.A., University of Colombo, 2009
M.A., University of Colombo, 2012
M.A., Western Illinois University, 2013

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Economics
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Abstract

This dissertation consists of two essays on vertical integrations that occurred in the U.S. Carbonated Soft Drink (CSD) industry, i.e., PepsiCo and Coca-Cola acquired their biggest bottlers. In 2010, the Federal Trade Commission (FTC) raised concern that Coca-Cola and PepsiCo's acquisition of bottlers may have anticompetitive effects in the CSD industry. This dissertation analyses the recent structural changes in the CSD industry to investigate competition by modeling the vertical structure of the upstream (e.g., manufacturers) and downstream (e.g., bottlers) level.

The first essay empirically investigates how vertical integration impacts prices in the presence of common agency: a downstream firm may also produce and distribute an upstream rival's products. We use the structural econometric models of demand and supply to analyze the recent structural changes in the CSD industry. Our results suggest that for products with eliminated double margins (Coca-Cola and PepsiCo), decreased prices. However, with regards to rival products (Dr Pepper Snapple Group), prices decreased for 12 oz 6 packs, and prices increased for 20 oz bottles. Specifically, the results show that vertical integration resulted in not only an anticompetitive effect but also a procompetitive effect. These mixed findings are consistent with the theoretical concern of pricing behavior in the presence of common agency and suggest caution when evaluating vertical integration in the CSD industry.

The second essay analyzes the nature of competition by modeling the vertical contracts (linear and non-linear) between manufacturers and bottlers before and after the vertical integration. Our empirical findings suggest that during the respective pre-integration periods, Coca-Cola and PepsiCo each use nonlinear pricing contracts to supply their intermediate soft drink products to bottlers, with imposing retail price maintenance (RPM) under zero bottler margins. RPM is the practice whereby manufacturers make a contract with bottlers, that the bottlers will sell the manufacturer's product at certain prices. However, the post-integration period, upstream manufacturers that directly own downstream bottlers eliminated the double marginalization, whereas all other upstream manufacturers in the market actively compete in wholesale prices with rival manufacturers, leaving zero markups to their corresponding bottlers. Finally, we do not find evidence that manufacturers use different pricing contracts with bottlers for different product sizes (12 oz 6 pack and 20 oz bottles) during the pre-integration and post-integration periods.

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Major Professor
Philip G. Gayle

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Dedication

To my loving wife, Madushika Nadeeshani, for her endless love and support.

To my late loving, beautiful little daughter, Anne Vihara, who made me stronger.

Chapter 1 Does vertical integration in the U.S. Carbonated Soft Drink industry lead to anticompetitive effects?

1.1 Introduction

Over the last two decades, vertical integration has been an important subject of theoretical research in economics. Economic theory suggests that vertical mergers can produce procompetitive and anticompetitive effects in a market (Salinger 1988, Ordover et al.1990, Riodern 1998, Choi and Yi 2000, Chen 2001, Lafontaine and Slade 2007). More specifically, vertical integration can eliminate double marginalization and improve efficiency. Thus, the procompetitive effect of vertical integration results in a lower price and higher sales of the final product. In contrast, vertical integration can also lead to a higher price of the final product, an anticompetitive effect. Considering a theoretical market model in common agency with two products, Salinger (1991) shows that the effect of eliminating double marginalization for one product can lead to downstream prices: (i) for both products to fall; (ii) for both products to rise; or (iii) the price of the integrated product to fall, and the price of the unintegrated product to rise. In this case, a common agency refers to a downstream distributor/retailer carrying the product of different upstream firms. In other words, upstream firms sell products to final consumers through the same distributor/retailer.

A common agency is a unique feature of the U.S. Carbonated Soft Drink (CSD) industry. In the CSD industry, a bottler is typically considered a common agency that bottles and produces the products of both Coca-Cola/PepsiCo and Dr Pepper Snapple Group (DPSG). In other words, most Coca-Cola and PepsiCo franchise bottlers distribute allied brands of DPSG. Due to integration with major bottlers in 2010, Coca-Cola and PepsiCo changed its strategy and structure of the U.S. CSD industry. Coca-Cola and PepsiCo have facilitated much of the bottler consolidation in this industry as they vertically integrated with bottlers. However, double marginalization is not eliminated for DPSG products that are bottled by vertically integrated PepsiCo or Coca-Cola bottlers. As such, the distribution system of the industry is becoming increasingly imbalanced, and it allows the Coca-Cola and PepsiCo greater power to control that system. For example, DPSG products may not be promoted by Coca-Cola/PepsiCo's bottler and ultimately excluded from the bottling operation. Thus, there is a potential trade-off between gains of efficiency for Coca-Cola/PepsiCo products and possible foreclosure of DPSG products in bottling.

In 2010, the Federal Trade Commission (FTC) was concerned that Coca-Cola's and PepsiCo's acquisitions of bottlers may have an anticompetitive effect in the CSD industry. This study analyses the recent structural changes in the CSD industry to investigate competition by modeling the vertical structure of the upstream (e.g., the Coca-Cola and PepsiCo) and downstream (e.g., bottlers) level. Specifically, we model the firms' behavior in the CSD industry by using a structural econometric model to determine how vertical integration impacts DPSG's prices in the presence of common agency. To best of our knowledge, this is the first study that models the vertical structure in the presence of common agency while considering vertical integration between the manufacturer and bottler in the U.S. CSD industry.

We use monthly retail scanner data on the U.S. CSD industry between 2008 and 2012 from the IRI Marketing Data Set (Bronnenberg et al., 2008). We first estimate consumer demand by using a random coefficient discrete choice model and use those estimates to compute price-cost margins for the upstream manufacturer and the downstream bottler (as in Villas-Boss, 2007, and Bonnet and Dubosis, 2010). Following the spirit of work by Villas-Boas (2007), we estimate the price-cost margin without observing data on wholesale prices. Moreover, we assume that the upstream manufacturers compete with each other in a Nash-Bertrand fashion in wholesale prices, and the bottlers use wholesale prices to compete with each other in a Nash-Bertrand fashion in retail prices. The bottlers set retail prices in our model. In other words, we assume that retailers are passive. That is, rather than engage in strategic price-setting behavior to maximize retail profits; we assume retailers are passive and set retail prices just high enough to cover their input costs and per-unit prices paid to bottlers. Based on estimated margins from manufacturers and bottlers, we recover the marginal cost by subtracting margins from retail prices. Finally, we perform counterfactual simulations to find the Nash equilibrium prices in the situation of vertical dis-integration between manufacturer and bottler. In other words, how would equilibrium product prices change if a given upstream manufacturer did not own a downstream bottler? Also, we assume no-cost efficiency gain results from vertical integration. Finally, our goal is to compare the simulated equilibrium price with actual equilibrium price to assess the price effect due to vertical integration.

The results of demand estimates suggest that a consumer's demand for CSD is significantly influenced by both price and non-price characteristics, such as calories, carbohydrates, sodium, sugar, and caffeine content. The standard deviations of the random coefficient logit model find that consumer's responses to change in calories and sodium are heterogeneous. Our counterfactual experiment suggests that for products with eliminated double margins (Coca-Cola and PepsiCo), vertical integration decreases prices. However, with regards to the rival's products (DPSG), prices decrease for a 12 oz 6 pack, whereas prices increase for 20 oz bottles. Specifically, the results show that the vertical integration of PepsiCo and Coca-Cola with their major bottlers results in not only an anticompetitive effect but also a procompetitive effect. The results of the procompetitive effect do not support the FTC's opposition to the vertical integration between PepsiCo and Coca-Cola with bottlers.

The remainder of the paper is organized as follows: Section 1.2 reviews the literature and conceptual discussion of the impact of vertical integration on prices in the presence of common agency; Section 1.3 describes the CSD market structure and provides a description of the data; Section 1.4 outlines the structural econometric model of CSD demand and supply, including the estimation procedure; Results are discussed in Section 1.5. Lastly, Section 1.6 offers concluding remarks.

1.2 Literature Review

There are limited formal empirical analyses of the competitive effects of vertical integration in the presence of common agency. In a recent paper, Luco and Marshall (2017) analyze the PepsiCo and Coca-Cola vertical integration with bottlers by using weekly scanner data. They mainly consider three product sizes: 20 oz bottles, 67.6 oz bottles, and 144 oz boxes of cans. The results show that vertical integration decreased prices for both PepsiCo and Coca-Cola products and increased prices for DPSG products. Further, they suggest that vertical integration may have hurt consumers.

In contrast, Adachi (2017a) finds that PepsiCo's vertical integration with bottlers is procompetitive in the U.S. CSD industry. The study uses monthly scanner data and focuses on 12 oz products to analyze the competitive effects of vertical integration. The study identifies that the fall in prices is stronger in markets with Coca-Cola common agency than in markets with PepsiCo common agency. Similarly, price reductions on DPSG products are weaker in the markets with PepsiCo common agency than in the markets with Coca-Cola common agency and show the effects of the vertical integration would differ across the mode of common agency.

Adachi (2017b) investigates the effect of the vertical integration of Coca-Cola and its bottler. The paper finds that Coca-Cola's vertical integration leads to an anticompetitive effect in the CSD industry. However, the study argues that Coca-Cola's vertical integration may have caused transactional conflicts with their major bottler, and those conflicts passed through to its final prices. The study uses both retail scanner data and stock market data to confirm the findings. The study further shows that Coca-Cola's acquisition of its biggest bottler is an unsuccessful integration.

In summary, these empirical works present mixed findings of the effects of vertical integration in the presence of common agency in the U.S. CSD industry. Moreover, these studies analyze the competitive effect by using a reduced form approach and elaborate different nature of outcomes of vertical integrations in the CSD industry. However, these studies do not consider the structure of vertical relationships between manufacturers and bottlers and their pricing behavior. Thus, we intend to analyze the vertical integrations on prices in the presence of common agency by using a structural econometric model.

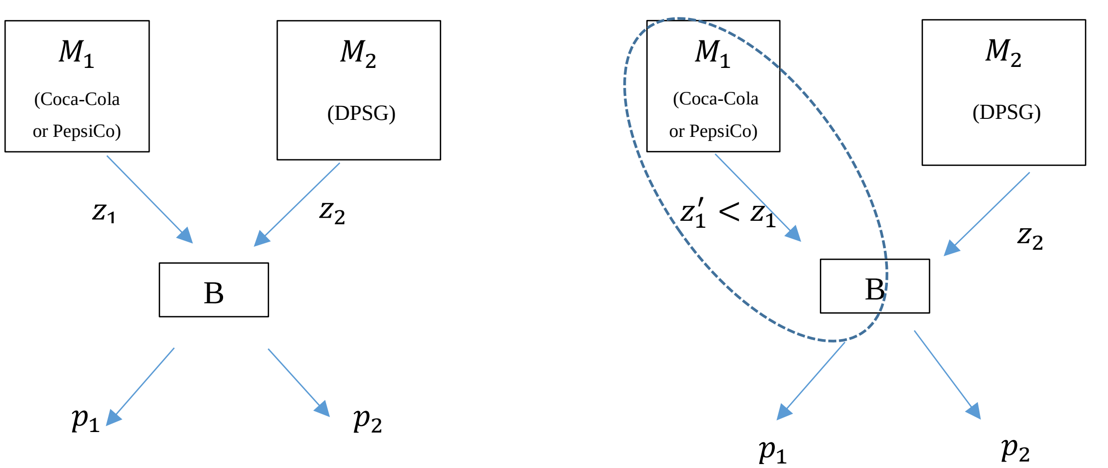
The empirical industrial organization literature presents mixed findings as to whether the anti- or pro-competitive effects of vertical integration dominate in any particular case. Chipty (2001) focuses on the cable television industry and analyzes the effects of vertical integration between programming and distribution. The results suggest that the foreclosure effect dominating in the U.S. pay television industry implies that some program services cannot get access to the vertically integrated distribution networks. However, the study shows that vertical integration benefits the consumer because of the associated efficiency gains. Hastings and Gilbert (2005) find evidence of a foreclosure effect by using the wholesale gasoline industries and the relationship between West Coast gasoline refining and retailing markets. They find that vertical integration leads to an increase in both wholesale prices and rivals' costs. Hortacsu and Syverson (2007) syrup on the U.S. cement industry and show that vertically-integrated cement and ready-mixed concrete plants lead to lower prices. The evidence suggests that efficiency gains are dominating potential foreclosure effects.

Furthermore, there are some empirical analyses of vertical relationships between upstream and downstream levels that focus on different industries; [the EU CSD industry, Bonnet and Réquillart (2012); the yogurt industry, Villas-Boas (2007); the coffee industry, Bonnet et.al. (2013); the bottled water industry, Bonnet, and Dubois (2010); the U.S. beer industry; Aschenfelter et al. (2015); the U.S. video rental industry; Mortimer (2008); the U.S. healthcare industry; Gowrisankan et al. (2015), Ho and Lee (2017)]. We contribute to the literature on the effect of vertical integration on prices by modeling the vertical structure between the upstream and downstream levels in the U.S. CSD industry.

1.2.1 Common Agency and Vertical Integration

In this section, we briefly explain Salinger's (1991) theoretical model of common agency in a vertical structure context to understand how a vertical integration causes possible different effects on final product prices. The vertical integration of Coca-Cola and PepsiCo with some of their largest franchised bottlers will eliminate the double marginalization of the brands of Coca-Cola and PepsiCo, but it does not eliminate it for the brands owned by DPSG. In other words, DPSG remains independent of selling inputs to the bottlers that are owned by Coca-Cola and PepsiCo. The elimination of double marginalization in Coca-Cola and PepsiCo products but not allied products of DPSG generates the pricing strategies of common agency bottlers.

Figure 1.1: Illustrates the Market Structure.



(i) Framework before Vertical Integration

(ii) Framework after Vertical Integration

Following Salinger (1991), there are two upstream syrup manufacturers (M_1 and M_2: Coca-Cola or PepsiCo and DPSG) selling differentiated inputs, to the monopolist downstream bottler (B). The downstream bottler is the sole seller of the two particular products (Coca-Cola /PepsiCo and DPSG). The monopolist bottler has an exclusive contract to handle products from the two distinct upstream manufacturers. M_1 sells an input to B at a price denoted by z_1, and B produces and sells canned and bottled carbonated beverages to consumers at prices contained in price vector p_1. Similarly, B purchases input from M_2 (DPSG) at price z_2, and then sells products at a price p_2. Thus, the downstream bottler transforms the inputs into final products and sells substitute products from two distinct manufacturers. Also, with B integrated with M_1, z_1' represents the input price of product 1 after the integration. Figure 1.1 shows the market structure before and after vertical integration.

In this setting and the given demand for the two goods: $Q_i = q_i(p_1, p_2)$, $i = 1,2$, and the profit function of downstream bottler: $\Pi_i = \sum_{i=1}^{2}(p_i - z_i)q_i(p_1, p_2)$, we can write the first-order conditions for profit maximization equilibrium prices, p_1 and p_2, as follows:

$$\frac{\partial \Pi}{\partial p_1} = q_1 + (p_1 - z_1)\,\frac{\partial q_1}{\partial p_1} + (p_2 - z_2)\,\frac{\partial q_2}{\partial p_2} = 0 \tag{1.1}$$

$$\frac{\partial \Pi}{\partial p_2} = q_2 + (p_1 - z_1)\,\frac{\partial q_1}{\partial p_2} + (p_2 - z_2)\,\frac{\partial q_2}{\partial p_2} = 0 \tag{1.2}$$

The vertical integration of upstream manufacturer M_1 and the monopolist bottler will cause an input cost for production of Coca-Cola/PepsiCo to decrease ($z_1' < z_1$) and leaves z_2 at its original values for DPSG products. Thus, we can evaluate the final equilibrium prices due to a change in input prices to identify the pricing strategies of bottler as follow:

$$\frac{\partial \Pi^{VI}}{\partial p_1} = q_1 + (p_1 - z_1')\,\frac{\partial q_1}{\partial p_1} + (p_2 - z_2)\,\frac{\partial q_2}{\partial p_2} = 0 \tag{1.3}$$

$$\frac{\partial \Pi^{VI}}{\partial p_2} = q_2 + (p_1 - z_1')\frac{\partial q_1}{\partial p_2} + (p_2 - z_2)\frac{\partial q_2}{\partial p_2} = 0 \quad (1.4)$$

The decreased input cost to the bottler for the integrated products (Coca-Cola and PepsiCo) causes an increase in the markup ($p_1 - z_1'$) for those products and affects profit maximization of the unintegrated product (DPSG). The increased markup ($p_1 - z_1$ versus the $p_1 - z_1'$) for integrated products will create an incentive to the bottler to increase demand for the integrated products and raises the price of the unintegrated products. However, if the increase in markup is small and the effects of the diversion of demand are small, then it decreases the prices of both products. If the markup is large, but the diversion effect is small, then decrease the price of the integrated product and increase the price of other product. However, if the diversion effect is large relative to the markup, then the price of both products will increase. The diversion effect depends on the demand for substitutes, $\frac{\partial q_i}{\partial p_j}, i = 1,2\ j = 2,1$ (i.e., the greater $\frac{\partial q_1}{\partial p_2}$, the greater the diversion effect, where q_1 is the sales of the integrated products, and p_2 is the price of the unintegrated product). Thus, the reduction in z_1 (to z_1') on prices depends on the own and cross-price elasticity of demand and the level of the markup of integrated products compared to the markup pre-integration. In summary, considering a theoretical market model with two products, Salinger (1991) shows that the effect of eliminating double marginalization for one product can lead to downstream prices: (i) for both products to fall; (ii) for both products to rise; or (iii) the price of the integrated product to fall, and the price of the unintegrated product to rise.

1.3 Background and Data

1.3.1 Industry Background

In this section, we explain the structure and the most recent vertical transactions of the U.S. CSD industry. The CSD industry is characterized by some different actors: syrup producers, bottlers, and the retail level. Combinations of these actors are used to make products available to the consumers. Syrup producers are characterized by the upstream manufacturer (e.g., Coca-Cola) and sell syrup to downstream bottlers. Bottlers added carbonated water, sweeteners, and other ingredients, and then package the drinks into bottles or cans. Moreover, bottlers distribute canned and bottled soft drink products to the retail trade in their exclusive territories. Retailers such as grocery stores and supermarkets, then make carbonated beverages available to consumers.

Over the past three decades, the CSD industry has changed dramatically. The featured products, package introductions, and non-price promotions have become more complex and volatile. Building brand loyalty and minimizing transportation cost are the most important aspects of the CSD industry. Thus, manufacturers have relied heavily on bottlers concerning new products and packages, promotions, and marketing innovations. Also, PepsiCo and Coca-Cola bottlers adopted the production of allied brands like Dr Pepper and 7-UP to their bottling systems in the 1980s.

Moreover, the introduction of nonreturnable containers, advances in transportation, and technological innovation led to improving the minimum efficient scale in bottling operations which leads to bottling operations that exploit "economies of scope" in production (Muris et al., 1992). Thus, independent bottlers combined and created large multi-franchise operations (MFO) to accommodate increases in minimum efficient scale. However, the formation of MFO scattered and slowed in responding to the new CSD environment. Table 1 presents changes in the number of bottling operations and the average production of CSD bottling plants. It shows that the number of bottlers decreased as other bottlers and their franchisors acquired franchised bottlers.

Table 1.1: Number and Average Production of U.S. CSD Bottling Plants

Year	Number of Plants	Total Cases	Aver. Cases Per Plant
1970	3054	2,971,000,000	972,823
1980	1859	4,930,000,000	2,651,963
1990	807	7,780,000,000	9,640,644
1998	498	9,880,000,000	19,839,357

Source: Saltzman, Levy, and Hilke, (1999)

“In essence, Coca-Cola and Pepsi-Cola needed to change their distribution systems in order to implement effectively, the strategies that were stimulated by the new environment because the relative transaction costs of the independent bottling systems in the environment were too high” (Muris et al., 1992, 256). Furthermore, to implement new products and packaging using independent bottlers is expensive. “The success of product introductions hinges, first, on the ability of the manufacturer to convince retailers to take on the product and market it effectively and, ultimately, on consumer acceptance. Syrup manufacturers face an additional hurdle in introducing a new product or package – they must convince their independent bottlers to handle the item" (Muris et al., 1992, 272).

In the 1990s, Coca-Cola and PepsiCo continued buying many independent bottlers and combining their territories, allow them to control new products and process innovations. On the other hand, they are operating larger bottlers, more manageable, and economic scale. Table 1.2 shows the trend in the number of bottling plants consolidate by Coca-Cola and PepsiCo in the 80s and 90s.

Table 1.2: Number of Coca-Cola and PepsiCo Bottlers

Year	Coca-Cola Bottlers	PepsiCo Bottlers
1983	319	256
1987	192	180
1998	94	119

Source: Saltzman, Levy, and Hilke (1999)

In 2009 and 2010, two major vertical integrations took place in the CSD industry: (1) PepsiCo integrated with Pepsi Bottling Group Inc (PBG) and PepsiAmericas (PAS) in August of 2009, and (2) Coca-Cola integrated with Coca-Cola Enterprises Inc (CCE) in February of 2010. Vertical integration refers to the situation in which an upstream manufacturer (e.g., Coca-Cola or PepsiCo) directly owns a downstream bottler. DPSG has used its bottlers to distribute their products in some areas but mostly rely on the Coca-Cola and PepsiCo bottling systems in most areas in the U.S. More specifically, most Coca-Cola and PepsiCo franchise bottlers distribute allied brands of DPSG.

Before the vertical integration, PBG bottled and distributed 40%, and PAS bottled and distributed 43% of PepsiCo products. Further, 20% of DPSG products were bottled, canned, and distributed by PBG and PAS. As well as, CCE bottled and canned about 75% and 14 % of Coca-Cola and DPSG products in 2009, respectively. DPSG is the third-largest CSD producer in the industry.

PepsiCo's CEO, Indra Nooyi explained the impetus for the merger that "the fully integrated beverage business will enable us to bring innovative products and packages to market faster, streamline our manufacturing and distribution systems and react more quickly to changes in the marketplace, much like we do with our food business. " Also, Coca-Cola's CEO, Muhtar Kent noted the benefit of the acquisition that “fundamental industry forces have altered the consumer, customer and competitive landscape," he said. "Our franchise system cannot remain static. We have to create the next generation of high-return opportunities.”

In 2010, the Federal Trade Commission (FTC) raised concern that Coca-Cola and PepsiCo's acquisition of bottlers may have anticompetitive effects in the CSD industry. The FTC expressed the view that Coca-Cola and PepsiCo will have access to DPSG's commercially sensitive marketing plans through the downstream bottlers, and it would make DPSG a less effective competitor in the CSD industry. In other words, Coca-Cola and PepsiCo could use sensitive information in ways that weaken competition such as, not promote DPSG brands or ultimately excluded DPSG brands from the bottling operation. However, the FTC approved the acquisitions of PepsiCo and Coca-Cola under the condition of set up the "firewall” to protect the marketing information of DPSG. Under this “firewall” Coca-Cola and PepsiCo could only participate bottling process and cannot access confidential information of DPSG. Thus, PepsiCo and Coca-Cola completed the acquisition process in February 2010 and October 2010 respectively. This merger agreements lead to grant Coca-Cola and PepsiCo exclusive license to sell and distribute DPSG products in CCE, PBG and PAS exclusive territories. Finally, Coca-Cola renamed the sales and operational elements of CCE to Coca-*Cola Refreshments* (CCR) and PepsiCo establishing a wholly-owned PepsiCo bottler (PBG, PAS), the Pepsi Beverages Company (PBC).

1.3.2 Data

The data for this study is constructed from the IRI retail Dataset. The data provide product sales information for a large number of stores and cover a wide range of geographic areas across the U.S. A broad array of markets is necessary to explore manufacturer, retailer, and consumer behavior across regions. The market in this study is defined as a combination of geographical area (county) and a period (month and year). The county is chosen as the geographical area.

IRI provided weekly retail data for the 50 IRI geographic markets by Universal Product Codes (UPC). These 50 geographic markets can be differentiated from the store location. Unlikely other research, we use IRI store location (zip code) files to identify in which counties stores locate within the U.S. Thus, we explore 5372 unique stores throughout 685 counties in the US. We use retail store data on CSDs in 685 counties across the U.S., for the period 2008-2012.

We consider the three biggest syrup producers: Coca-Cola, PepsiCo, and DPSG. We choose all possible carbonated beverage brands based on these syrup producers and availability in the IRI retail Dataset. We aggregate weakly data up to monthly unit sales and revenue. The average retail prices are computed, dividing monthly sales revenue by monthly unit sales. The market size is calculated by multiplying a county's population by its per capita per month consumption of soft drinks. We define a product as a unique combination of brand, packages, sizes, and retailers (stores). Different package sizes of a brand at a store are treated as distinct products within a market (e.g., 12 oz of 6 pack of cans diet coke is a different product than 20 oz of bottle diet coke at a store).

About 61 percent of the CSD sales represent 12 oz, 20 oz, and 67.5 oz bottles and cans. To reduce the computational burden of the econometric estimation, we mainly focus on 12 oz 6 packs and 20 oz bottles for this analysis. Table 1.3 presents summary statistics on the retail prices of the selected top brands in each manufacturer. The summary statistics of all brands that are included in the analysis are given in the appendix. Table 1.3 shows that the 12 oz 6 pack and 20 oz bottle products have similar average prices per oz between brands but slightly different prices per oz between product sizes. The average price per oz of the 20 oz bottles is double the average price per oz of the 12 oz 6 pack. Moreover, the results indicate that carbonated beverages are a differentiated food category.

Table 1.3: Summary Statistics: Retail Prices ($ per oz)

	N	Mean Price ($ per oz)	S.D.	Max	Min
		12 oz 6 pack			
Retail Price	151,366	0.0454	0.0097	0.2043	0.0001
Coca-Cola					
Tab	16,641	0.0487	0.0072	0.1128	0.0098
Diet Coke	11,720	0.0405	0.0115	0.1668	0.0124
Coke Zero	2,165	0.0398	0.0162	0.1558	0.0173
PepsiCo					
Diet Mountain Dew	3,430	0.0393	0.0086	0.1167	0.0122
Diet Pepsi	7,135	0.0411	0.0078	0.1100	0.0122
Caffeine Free Diet Pepsi	1,520	0.0435	0.0079	0.0972	0.0137
DPSG					
Ibc	65,128	0.0474	0.0073	0.2043	0.0164
Canada Dry	14,398	0.0439	0.0111	0.1311	0.0001
Canfield	12,133	0.0457	0.0114	0.1651	0.0124
		20 oz bottles			
Retail Price	813,588	0.0755	0.0099	0.0075	0.2801
Coca-Cola					
Caffeine Free Diet Coke	113,503	0.0766	0.0072	0.1126	0.0117
Coke Zero	111,316	0.0766	0.0074	0.1315	0.0124
Diet Black Cherry Vanilla Coke	44,083	0.0766	0.0079	0.1212	0.0104
PepsiCo					
Caffeine Free Diet Pepsi	111,932	0.0759	0.0075	0.1097	0.0079
Diet Mountain Dew	91,583	0.0758	0.0077	0.1149	0.0139
Diet Mountain Dew Caffeine Free	26,353	0.0760	0.0075	0.1097	0.0106
DPSG					
A & W	88,893	0.0760	0.0080	0.1496	0.0090
Caffeine Free Diet Dr Pepper	61,626	0.0712	0.0137	0.1573	0.0164
Caffeine Free Diet Sun Drop	46,815	0.0711	0.0142	0.2338	0.0113

1.3.2.1 Product Characteristics Data

Lopez and Fantuzzi (2012) suggest that brand characteristics such that sugar, sodium, and caffeine content can affect consumer choices. The information on brand characteristics is collected by examining the labels on each CSD brand. We obtained this information from manufacturer websites and grocery stores. Table 1.4 indicates descriptive statistics and correlation among the non-price characteristics across the bands.

Table 1.4: Average and Correlation of the Non-Price Characteristics

Variable	Mean	S.D	Min	Max	Correlation			
					Sodium	Sugars	Caffeine	Calories
12 oz 6 pack								
Sodium(mg)	46.42	24.28	0	105	1			
Sugars(g)	20.94	21.33	0	50	0.77	1		
Caffeine(mg)	7.07	16.12	0	68.4	-0.11	-0.43	1	
Calories	91.31	82.31	0	190	0.81	0.99	-0.49	1
20 oz bottles								
Sodium(mg)	77.45	21.55	0	210	1			
Sugars(g)	4.78	17.95	0	75	0.66	1		
Caffeine(mg)	41.28	35.69	0	114	-0.20	-0.28	1	
Calories	26.20	69.87	0	290	0.77	0.94	-0.39	1

N=151,366 and 813,588 for 12 oz 6 pack and 20 oz bottles respectively.

Table 1.4 shows that 12 oz 6 pack products on average have a higher content of sugar and calories, whereas 20 oz bottles have a higher content of sodium and caffeine. The average content of sugars in 12 oz 6 pack products is generally about five times larger than the average content of sugars in 20 oz bottles. There is a higher correlation between calories and sugars. Moreover, sodium highly correlates with sugars, and caffeine has a negative correlation with sugar and sodium within size.

Carbonated Soft Drinks introduced different sizes, shapes, and packages over the last four decades. Research on exploring the taste among different packages reveals there is subtle variation in taste drinking among aluminum cans, plastic, and glass bottles[1]. Thus, we include a zero-one dummy variable that takes the value one for cans and zero for bottles (both plastic and glass) in the model to explore the package type that makes different to taste[2].

[1] http://www.coca-cola.co.uk/stories/bottle-vs-can-how-do-you-prefer-your-coca-cola

[2] Notice that there is no package type for 20 oz bottles because 98% of those products contain as plastic bottles in the sample.

We also use the Public Use Microdata Sample (PUMS) data (2008 through 2012) to identify the county-level demographic characteristics. An individual's demographics are presumably relevant to his or her demand for CSDs. These features of the data are conducive to studying the competitive effects of recent vertical integrations in the U.S. CSD industry. We randomly draw 200 individuals from each county (for each year) under the normal distribution. Thus, the sample includes 200×18500 (for 12 oz 6 pack) and 200×23674 (for 20 oz bottles) consumer observations. The individual's income is considered to allow heterogeneous responses to price and other non-price characteristics. To identify the total population for each county, we use census data. Interactions of price and non-price characteristics with consumer characteristics (e.g., income) are considered in the model.

To identify the bottlers, we assume that carbonated beverages are delivered to each store from the nearest distribution center, which connects to the bottler. In other words, distribution centers are used to identify the bottlers because distribution centers are connected to the bottlers. Thus, we calculated the driving distance between each retail store and the closest distribution centers for each of the three syrup producers. DPSG products are bottled and distributed by either Coca-Cola, PepsiCo, or DPSG bottler. Thus, for DPSG products, we choose the nearest distributor among the distribution centers of Coca-Cola, PepsiCo, and DPSG. On the other hand, for Coca-Cola/PepsiCo products, we identify the closest distributor among the distribution centers of Coca-Cola/PepsiCo. We use a database called ReferenceUSA to collect the location addresses for distribution centers.

Table 1.5 presents information about the distribution of bottlers throughout the sample period. It shows about 98% of counties that PepsiCo products are distributed by vertically integrated PepsiCo bottler (PBG and PAS). Also, 64% of counties that Coca-Cola products are distributed by vertically integrated Coca-Cola bottler (CCE). In the case of DPSG, about 90% of counties that DPSG product is bottled and distributed by PepsiCo and Coca-Cola bottlers, whereas 10% of DPSG products are bottled and distributed by DPSG bottler.

Table 1.5: Products Distribution of Bottlers

Bottler’s	2008	2009	2011	2012
Coca-Cola				
Coca-Cola Enterprise (CCE)	62.69	61.67	-	-
Coca-Cola Refreshments (CCR)	-	-	64.8	64.21
Other Coca-Cola Bottlers	37.31	38.33	35.21	35.79
PepsiCo				
Pepsi Bottling Group (PBG)	82.19	81.59	-	-
PepsiAmericas (PAS)	15.22	15.55	-	-
Pepsi Bottling Company (PBC)	-	-	96.07	98.07
Other PepsiCo Bottlers	17.8	18.4	3.93	1.93
Dr Pepper distributed by				
Coca-Cola Enterprise(CCE)	31.98	31.65	-	-
Coca-Cola Refreshments (CCR)	-	-	31.62	31.23
Other Coca-Cola Bottlers	23.21	22.19	23.32	23.73
Pepsi Bottling Group (PBG)	28	28.91	-	-
PepsiAmericas(PAS)	5.87	5.98	-	-
Pepsi Bottling Company (PBC)	-	-	33.04	32.86
Other PepsiCo Bottlers	2.54	2.33	2.21	1.88
Dr Pepper Snapple	8.4	8.93	9.79	10.31
Number of Counties	359	385	369	388

Note: The year 2010 is excluded because PepsiCo and Coca-Cola vertical integration took place in the year 2010.

1.4 The Econometric Model

1.4.1 Demand Side

This section is based on the demand and supply model. On the demand side, we use the random coefficients logit model. A random coefficient logit model captures unobserved individuals’ heterogeneity and controls the other exogenous factors that can impact an individual's brand choice. On the supply side, we consider a sequential price-setting game between manufacturers and bottlers in which manufactures first set per-unit wholesale prices to be paid by bottlers, and conditional on these wholesale prices bottlers set per-unit prices to charge retailers.

We assume Nash-Bertrand competition among both manufacturer and bottlers. We further consider the supply model under the assumption of passive retailers.

We use m to denote market and $j = 1, \dots, J$ to denote products. In a given beverage market consumer i has $J + 1$ alternative options, i.e., either consumer can choose among $j = 1, \dots, J$ products or the consumer can choose outside option $j = 0$. The indirect utility V_{ijm} of consumer i from purchasing a CSD product j in market m is given by,:

$$V_{ijm} = d_j + d_m + x_{ijm}\beta_i - \alpha_i p_i + \xi_{jm} + \varepsilon_{ijm} \tag{1.5}$$

where d_j represents the product (brand-store) fixed effects capturing time-invariant product characteristics; d_m is the market (county-year-month) fixed effects that capture the unobserved determinants of demand; and x_{ijm} is a $k \times 1$ vector of observed non-price product characteristics. In this study, we include the amount of sodium, sugar, caffeine, calories and a zero-one indicator variable that takes the value one for cans and zero for bottles (plastic and glass); p_i is the unit price per oz of CSD product j in market m; ξ_{jm} capture unobserved product characteristics; these are observed by consumers and firms but unobserved by the researcher; ε_{ijm} represents the individual-specific random component of utility that captures deviation of the individual's preference from the mean utility.

The random coefficients β_i represent a vector of consumer-specific marginal utilities associated with the different non-price product characteristics in x_{ijm}, and α_i the consumer-specific marginal utility of price. The coefficients of β_i and α_i are vary across consumers; this variation can be explained by m -dimensional column vector of demographic variables (D) and k -dimensional column vector that captures unobserved consumer characteristics (v_i). Formally, this can be modeled as:

$$\begin{pmatrix} \alpha_i \\ \beta_i \end{pmatrix} = \begin{pmatrix} \alpha \\ \beta \end{pmatrix} + \Gamma D_i + \delta v_i \tag{1.6}$$

Γ is a $k \times m$ matrix of coefficients that measure how taste characteristics vary with demographic characteristics, and δ is a $k \times k$ diagonal matrix that captures the unobservable heterogeneity due to random shocks v_i. We consider income is a demographic variable and included as a deviation from their respective means. The mean of the demographic variable in D_i is zero. Also, it is assumed that $v_i \sim N(O, I)$. Thus, the indirect utility function (1.5) can be broken down into three parts:

$$V_{ijm} = \delta_{jm} + \mu_{ijm} + \varepsilon_{ijm} \tag{1.7}$$

Let, δ_{jm} represents the mean utility level of each of the j products and can be written as:

$$\delta_{jm} = d_j + d_m + x_{jm}\beta_i - \alpha_i p_i + \xi_{jm} \tag{1.8}$$

We consider outside good option as a no-purchase option, indexed by $j = 0$; $(V_{i0m} = \varepsilon_{i0m})$. Let $\theta = (\Gamma, \delta)$ be a vector of a non-linear parameter. Further, let

$$\mu_{ijm}\left(x_{jm}, p_{jm}, v_i, D_i; \theta\right) = [-p_{jm}, x_{jm}](\Gamma D_i + \delta v_i) \tag{1.9}$$

This equation denotes consumer-specific deviations from the mean utility given by the interaction between consumer and product characteristics. Therefore, equation (1.9) implies the mean utility (δ_{jm}) and a consumer-specific mean-zero deviation from the utility $(\mu_{ijm} + \varepsilon_{ijm})$. Further, ε_{ijm} represented the idiosyncratic tastes and assumed to be i.i.d. type I extreme value distribution. Thus, the predicted market share of product j is given by:

$$s_{jm} = \int \frac{exp^{(\delta_{jm} + \mu_{ijm})}}{1 + \sum_{l=1}^{J} exp^{(\delta_{lm} + \mu_{ilm})}} d\hat{F}(D) dF(v) \tag{1.10}$$

where $\hat{F}(D)$ is the empirical distribution from the demographic data, and $F(v)$ is the multivariate standard distribution. As in Nevo (2000), there is no closed-form solution for the equation in (1.10), and thus it must be approximated numerically using random draws from $\hat{F}(D)$ and $F(v)$.

The measure M of the market size is assumed to be the per capita consumption per month of all CSDs multiplied by the population of the county. Thus, the observed market share of product j is given by $S_j = \frac{q_j}{M}$, where q_j are the units sold.

1.4.2 Supply Side

On the supply model, we assume a syrup producer (upstream manufacturer) set their per unit wholesale prices (p^w) first, in a Nash-Bertrand manufacturer level, and then downstream bottlers follow, setting per-unit prices (p) for these products in a Nash-Bertrand fashion. We further assume that retailers are passive, and bottlers have sole market power in the marketing channel and thus set per-unit prices. We first define bottlers' profit-maximizing behavior in setting per unit prices that consumer pay, and then define manufacturer behavior in setting wholesale prices.

Let $b = 1 \dots B$ bottlers that compete in the downstream market. Bottler b profit function is given by:

$$\pi_b = \sum_{j \epsilon s_m^b} (p_{jm} - p_{jm}^w - c_{jm}^b) \times q_{jm} \tag{1.11}$$

where s_m^b is a subset of the $j = 1, \dots, J$ CSD products that are offered for sale by bottler b to the consumer in market m; p_{jm} is the per-unit price of product j; c_{jm}^b is the bottler's marginal cost of product j; q_{jm} denotes a quantity of product j sold in market m and $q_{jm} = M_m \times s_{jm}(p)$. Therefore, each bottler solves the following profit maximization problem.

$$\max_{p_{jm} \forall j \in s_m^b} \left[\sum_{j \epsilon s_m^b} (p_{jm} - p_{jm}^w - c_{jm}^b) \times M_m \times s_{jm}(p) \right] \tag{1.12}$$

Following expressions in Nevo (2000) and Villas-Boas (2007), the set of J first-order conditions generated from equation (1.11) can be solved for the price-cost margin for all products and expressed as the following vector notation:

$$p - p^w - c^b = -[T_b * \Delta_b]^{-1} s(p) \tag{1.13}$$

where p, p^w, c^b, and $s(p)$ are $J \times 1$ vector of final prices, wholesale prices, bottler's marginal costs, and product share respectively. T_b is a $J \times J$ matrix that has the general element of zero and ones based on the bottler's ownership structure of the J products.; Matrix Δ_b is a $J \times J$ matrix that contains first-order partial derivatives of predicted product share with respect to final prices, i.e

$$\Delta_b = \begin{bmatrix} \frac{\partial s_1}{\partial p_1} & \cdots & \frac{\partial s_J}{\partial p_1} \\ \vdots & \ddots & \vdots \\ \frac{\partial s_1}{\partial p_J} & \cdots & \frac{\partial s_J}{\partial p_J} \end{bmatrix}$$

where $T_b * \Delta_b$ represents the element-by-element multiplication of the two matrices.

Now we turn to the problem of upstream syrup manufacturers. Each syrup manufacturers maximize profit by choosing the wholesale price (p^w), knowing that bottlers behave under equation (1.13). Let s_m^f be a subset of the J products that syrup manufacturer f sells to bottler in market m. Also, let syrup manufacturers' marginal cost be given by c_{jm}^w. Syrup manufacturer f solves the following profit maximization problem:

$$\max_{p_{jm}^w \forall j \in s_m^f} \left[\sum_{j \epsilon s_m^f} (p_{jm}^w - c_{jm}^f) \times M_m \times s_{jm}(p(p^w)) \right] \tag{1.14}$$

The first-order conditions from the syrup manufacturers' generated a pure strategy Bertrand Nash equilibrium in wholesale prices and using matrix notation implies the following markup equation:

$$p^w - c^w = -\left[T_f * \Delta_f\right]^{-1} s(p) \tag{1.15}$$

where p^w and c^w are a $J \times 1$ vector of wholesale prices and syrup manufacturers marginal cost respectively; T_f is a $J \times J$ matrix of zeros and ones that capture the J products ownership structure of across syrup manufacturers. Let Δ_p be a $J \times J$ matrix of final prices with respect to wholesale prices, i.e.,

$$\Delta_p = \begin{bmatrix} \frac{\partial p_1}{\partial p_1^w} & \cdots & \frac{\partial p_J}{\partial p_1^w} \\ \vdots & \ddots & \vdots \\ \frac{\partial p_1}{\partial p_J^w} & \cdots & \frac{\partial p_J}{\partial p_J^w} \end{bmatrix}$$

Thus, $\Delta_f = \Delta_p' \Delta_b$, which captures the response of all predicted product share with respect to marginal changes in wholesale prices (Villas-Boas,2007).

Finally, we sum equation (1.13) and (1.15) to derive an expression for the overall price-cost margin for CSD products, yields:

$$p - c^f - c^b = -[T_b * \Delta_b]^{-1} s(p) - [T_f * \Delta_f]^{-1} s(p) \tag{1.16}$$

Note that we recover overall price-cost margin in equation (1.16) without information regarding wholesale prices, implies that the researcher does not need to know p^w. On the other hand, data on wholesale prices in CSD industries are difficult to obtain.

1.4.3 Counterfactual simulation of vertical dis-integration Nash equilibrium

We use equation (1.16) to perform a counterfactual situation that how equilibrium prices affected if bottler is not integrated with an upstream syrup manufacturer. The primary purpose of the simulations is to measure market effects relative to a situation where vertical integration eliminates double marginalization of CSD products.

Based on equation (1.16), we recover the sum of bottlers and syrup manufacturers' marginal costs as follows:

$$\hat{c}_T = (c^f + c^b) = p - \left[- \underbrace{[T_b * \Delta_b]^{-1} s(p)}_{m_d} - \underbrace{[T_f * \Delta_f]^{-1} s(p)}_{m_u} \right] \tag{1.17}$$

where $\hat{c}_T$ is $J \times 1$ vector of aggregate marginal cost for supplying each product; p is actual prices from the data; m_d and m_u are downstream and upstream markup, respectively. Assuming that bottlers follow in a Nash-Bertrand pricing game and using recovered $\hat{c}_T$, we simulate a new equilibrium price vector p^* as follow:

$$p^* = \hat{c}_T - \left[T_b^{dis-integration} * \Delta_b\right]^{-1} s(p^*) - \left[T_f * \Delta_f\right]^{-1} s(p^*) \tag{1.18}$$

where $T_b^{dis-integration}$ is a $J \times J$ matrix of zeros and ones that capture the J products ownership structure of across bottlers under the vertical dis-integration situation.

1.4.4 Estimation

In the demand estimation, our goal is to derive the coefficient of estimates that produce product market share close to observed market share across all consumers. Following the literature on discrete choice models of demand, we assume that unobserved product characteristics, ξ_{jm} are uncorrelated with changes in the observed non-price product characteristics, x_{jm}. Thus, we included brand dummy variables in the mean utility function to captures unobserved product characteristics (ξ_{jm}) and the factors that do not vary by market (x_{jm}) . Following, Nevo (2000), we estimate the demand parameter using the Generalized Method of Movements (GMM). Interacting the instruments with ξ_{jm} in the demand model, we construct moment and formulate the GMM optimization problem as follow;

$$\min_{\alpha,\beta,\theta} \xi' Z \phi^{-1} Z' \xi \tag{1.19}$$

where Z is the matrix of instruments that are orthogonal to the error term; ϕ^{-1} is the standard weighting matrix, and θ represents the non-linear parameters of Γ and δ. ξ is the function of parameters, where $\delta_{jm} - \left(d_j + x_{jm}\beta_i - \alpha_i p_i\right)$. Notice that δ_{jm} is unknown in equation (1.19), and its value implicitly depends on parameter vector θ. Following the literature Berry, et al.,(1995) and Nevo (2000), δ_{jm} can be obtained numerically by solving:

$$S_{jm} = s_{jm}\left(\delta_{jm}, \theta\right) \tag{1.20}$$

This implies the form of equating observed share to the estimated product share[3] from the mean utility across all consumers. By guessing the initial values for θ, and using the numerical algorithm, we can solve for the values of δ_{jm} that satisfy equation (1.20). With the values of δ_{jm}, we can formulate and minimize the optimization problem of equation (1.19) to recover estimates of α. We then apply minimum distance estimator to recover β by using estimated brand fixed effects as proposed by Nevo (2000).

Using estimated brand fixed effects under the GMM procedure, we apply the GLS regression to estimate the coefficient of β as follow (See Nevo,2000):

$$\hat{\beta} = (x'\psi^{-1}x)^{-1}x'\psi^{-1}\hat{d} \tag{1.21}$$

where $\hat{d}$ denotes the $J \times 1$ vector of brand coefficients estimated from the GMM procedure; ψ is the variance-covariance matrix of estimated brand dummy coefficients, and x is the $J \times K$ matrix of non-price characteristics that are invariant across the market.

1.4.5 Instruments:

Price is potentially endogenous because prices will depend on the observed and unobserved product and consumer characteristics. As such, the estimated coefficient on the price will be inconsistent. Thus, we need to find an appropriate instrument for the price when estimating demand. Other than syrup, the main components of bottler's costs include high fructose corn syrup (HFCS), packaging (e.g., aluminum for a can), electricity prices, and transportation. The prices of this input-cost are valid instruments for the CSD price in-demand model because price decision is exogenous to the cost side variables. In other words, this input-cost is uncorrelated to CSD demand

[3] The predicted market share given in equation (1.10) can be approximated by:

$$s_{jm} = \frac{1}{ns}\sum_{i=1}^{ns}\frac{exp^{\delta_{jm}+[-p_{jm},x_{jm}](\Gamma D_i+\delta v_i)}}{1+\sum_{l=1}^{J} exp^{\delta_{lm}+[-p_{lm},x_{lm}](\Gamma D_i+\delta v_i)}}$$

where ns represents random draws of individuals (=200) from the distribution of v and D.

shocks but correlated with the CSD price through the production cost of CSD. One set of instruments we use for the CSD price is the interaction between brand dummy variables and input-cost prices, as in Villas-Boas (2007). The included input-cost prices are: monthly wholesale prices for both HFCS55 and HFCS42 (USDA Sugar and Sweeteners Yearbook) for Coca-Cola/PepsiCo and DPSG products respectively and monthly average electricity prices (cents/KWh) on industrial sectors for each state (US Department of Energy, Energy Information Administration). The distribution of CSD products is another main component of the bottler's costs. Thus, we consider driving distance from the closer distributer to the designated retailer as a proxy for transportation costs. In the last set of instrumental variables, we consider the characteristics of competing products (the so-called "BLP instruments") suggested by Berry et al. (1995). These characteristics are appropriate instruments because they are excluded from the indirect utility function and correlated with prices via the markups. Thus, we consider marketing information in the scanner data correspond to the ordinal variables of feature, display, and promotion as characteristics of competing products. We use these variables to compute the BLP instruments as a deviation from the average of other competing products.

1.4.6 Supply Estimation

After having estimated the demand model, and following equation (1.13), (1.15) and (1.16), we estimate the equation (1.17) to recover the sum of bottler and syrup manufacturer marginal cost. Finally, we simulate a new equilibrium price vector p^* in equation (1.18) to perform a counterfactual situation.

1.5 Results

1.5.1 Demand

Table 1.6 shows the results of the estimates of the standard logit model and the random coefficient logit model for 12 oz 6 pack and 20 oz bottles. Estimates of the standard logit model are based on OLS and 2SLS methods. The estimates show that there is a significant difference in the OLS price coefficient estimate compared to the 2SLS price coefficient estimates, implying that the price coefficient is biased if instruments are not used for the price. The Wu-Hausman test is statistically significant at 1% level, suggesting that the price is exogenous. However, our discussion mainly focuses on the random coefficient logit model, because the standard logit model does not take to the account of heterogeneity in consumer taste. The parameters estimate of the mean utility for the random coefficient model are presented in columns 3,4, 5, and 8.9,10 in Table 1.6 for 12 oz 6 pack and 20 oz bottles, respectively. The parameters estimate of the price and non-price characteristics are associated with consumer heterogeneity.

1.5.1.1 Demand Estimation Results of 12 oz 6 pack

In Table 1.6, on average, the coefficient of the price is statistically significant at 1% level of significance, and the negative impact on utility implies that individuals have a strong negative valuation on price. The estimated coefficient of the "package type" dummy variable is negative, suggesting that, on average, individuals get lower utility consuming soda from can vs. bottle. Research on exploring the reasons[4] for packaging and difference of the taste emphasizes that more than 60% of people like bottles (plastic or glass) than cans. Reasons for this preference are (i) easier to pour from, (ii) able to pop the lid back on in between sips (iii) feel tastes better, and carry easily in a bag. Thus, our results seem to be more consistent with consumer prefer bottle vs. can. As shown in the results of 12 oz 6 packs, the consumer has, on average, a significant and negative valuation of sodium, caffeine and calorie content. Concerning nutrition standpoint, the sugar content is positively related to the average consumers' utility over health concerns. It may reflect the evidence to the link between the carbonated beverage and chronic diseases. The estimated mean parameters for Coca-Cola and PepsiCo company implies that consumers have a higher intrinsic valuation of Coca-Cola and PepsiCo products relative to DPSG products.

The fourth column displays the taste variation parameters for product characteristics, which are unobserved to the researcher. The standard deviations of the calorie and sodium coefficient are significant, suggesting that consumers' are heterogeneous concerning their taste for calorie and sodium. The fifth column measures how characteristics of taste vary with income. The interaction variable of calorie with income is statistically significant at 1% level, implying that consumers with higher income are smaller disutility on calories.

[4] http://www.coca-cola.co.uk/stories/bottle-vs-can-how-do-you-prefer-your-coca-cola

1.5.1.2 Demand Estimation Results of 20 oz bottles

In Table 1.6, the price coefficient is negative and statistically significant at the 1% significance level, suggest that, on average, consumers are less likely to consume 20 oz bottles, the higher its price, ceteris paribus. Similar to the results of the 12 oz 6 pack, the consumers have a negative valuation of caffeine and calorie content. In contrast, the results show that consumers have, on average, a negative valuation of sugar and a positive valuation of sodium content. From a nutrition standpoint, the positive coefficient for sodium may reflect a preference for flavor over nutrition concerns. This positive consumer valuation is given the link between the carbonated beverage and blood pressure. As shown by the descriptive statistics, the average content of sodium in 20 oz bottles is two times larger than the average content of sodium in 12 oz 6 pack products. Finally, the results of the fixed effects of CSD company imply that, relative to DPSG products, consumers have a higher intrinsic value of PepsiCo and Coca-Cola products.

1.5.2 Demand Elasticities

Using the structural demand estimates, we compute the own and cross-price elasticity for each manufacturer during pre and post vertical integration periods of Coca-Cola and PepsiCo. Overall, the own-price elasticity estimates do not highly variate across manufacturers. Moreover, Table 1.7 shows that the estimated own-price elasticities for each manufacturer in the pre-integration period are similar to the post-integration period of both Coca-Cola and PepsiCo. As compared to the 12 oz 6 pack products, Table 1.7 shows that manufacturers selling 20 oz bottles are less price-sensitive in the pre-integration and post-integration period. The own-price elasticity for upstream manufacturers (Coca-Cola, PepsiCo, and DPSG) selling 12 oz 6 pack, range between -4.7 to -5.1. In Table 1.7, for example, the mean own price elasticity for products of 12 oz 6 pack sold by Coca-Cola is -4.76, implying on average that increasing the price of the Coca-Cola brand by 1% leads to decreases the consumer demand for these products by 4.76%. The magnitude of these estimated own-price elasticities is similar to other studies in the CSD market used by scanner data. Dube (2005) reported own price elasticities ranging from -3 to -6 in the Denver area, while Dhar et al. (2005) estimated own-price elasticities between -2.7 to -4.4. Chan (2006) reported own price elasticities ranging from -5 to -11 at a household level in CSD. For the CSD in the EU market, Bonnet and Requillart (2012) found elasticities ranging from -2 to -4.

We also report the average of the cross-price elasticity of all products across the manufacturer between 12 oz 6 pack and 20 oz bottles in Table 1.7. All the estimated cross-price elasticities are positive as expected, implying that CSD products are substitutes. There is a variation in mean cross-price elasticity across manufacturers in 12 oz 6 pack. Manufacturers experience lower cross-price elasticity in the post-integration period compared to the pre-integration period of Coca-Cola, PepsiCo, and DPSG for products of 20 oz bottles. In Table 1.7, for example, the average cross-price elasticity between Coca-Cola and DPSG in the pre-integration of Coca-Cola implies that if the price of Coca-Cola products increases by 1%, then the quantity demand for DPSG products increases by 0.0021%.

It is interesting to note that the cross-price elasticities are quite small when compared to the own price elasticities. This implies that consumers are highly sensitive to CSD prices for their chosen brands and will substitute to the outside good compares to another brand of CSD. The cross-price elasticity for the Coca-Cola products relatively higher compared with other manufacturer's products in both pre-integration and post-integration periods implies that consumers consider Coca-Cola's products as closer substitutes to other manufacturer's products.

1.5.3 Computed Markup and Recovered Marginal Cost Estimates

Using random coefficient demand estimates, we computed the upstream and downstream price-cost markups for the supply model (See equation 1.13 and 1.15) and recovered the total marginal cost by subtracting the estimated total margins from retail prices (See equation 1.16). Summary statistics on total price-cost markup and recovered marginal costs by the common agency for the pre-integrated and post-integrated period are reported in Table 1.8 and Table 1.9 regarding 12 oz 6 pack and 20 oz bottles. The Lerner Index indicates the ratio of markup to price.

Table 1.8 shows that on average total price-cost margins are significantly greater for CSD products that bottled by the common agency in the pre-integrated period than the post-integrated period for both sizes. For example, 12 oz 6 pack, upstream PepsiCo, and DPSG products that bottled by an unintegrated common agency account for 46% and 47% mean total margins as a percent of the price, respectively. It is noted that average total margins are not significantly different across the unintegrated common agencies that bottled and distributed upstream products (Coca-Cola/PepsiCo and DPSG).

In Table 1.9, as expected for both sizes, on average, Coca-Cola and PepsiCo products bottled and distribute with twice lower total margin as a percent of price by vertically integrated bottlers compared to total margins of upstream rival's products (DPSG). For example, the average total margins of Coca-Cola and PepsiCo products bottled by vertically integrated Coca-Cola and PepsiCo bottlers are 28% and 29%, respectively, for 20 oz bottles. Also, the estimated mean total margins are not significantly different for DPSG products that bottled and distributed by integrated bottlers during the post-integrated period.

However, mean total marginal costs do not significantly differ across common agencies during the pre-integrated and the post-integrated period. Therefore, the decrease in mean total margins of integrated products over the post-integrated period is less likely due to the cost factor.

Table 1.6: Demand Estimation Results of 12 oz 6 pack and 20 oz bottles

	12 oz 6 pack					20 oz bottles				
	Standard Logit Model		Random coefficient logit model			Standard Logit Model		Random coefficient logit model		
	OLS (Means)	2SLS (Means)	RCM (Means)	Standard Deviations	Interactions with Income	OLS (Means)	2SLS (Means)	RCM (Means)	Standard Deviations	Interactions with Income
Variable	α, β	α, β	α, β	Γ	δ	α, β	α, β	α, β	Γ	δ
Price	-3.4489***	-6.8953***	-109.3401***	-0.4261		-0.3170***	-39.8314***	-46.1316***	-3.887	
	(0.1684)	(1.4300)	(3.8226)	(5.5130)		(0.0279)	(0.9621)	(1.8740)	(8.9303)	
Package Type	-0.2815***	-0.3020***	-1.9431***			-	-	-	-	
	(0.0127)	(0.0145)	(0.0679)							
_Cons	0.0061 [a]	0.0028 [a]	0.2711*** [a]	-0.0486	-0.0328	-0.3281*	-0.3146	-4.2404***	0.2577	-0.4546
	(0.0001)	(0.1068)	(0.0197)	(0.2443)	(0.2928)	(0.1923)	(0.3578)	(0.1560)	(1.6346)	(1.5910)
Sodium	0.00009[a]	0.0002 [a]	-0.0711*** [a]	-5.8113***	0.0035	0.00003*[a]	0.0002***[a]	0.0072***[a]	0.1448	-0.2456
	(0.0001)	(0.0001)	(0.0005)	(0.3907)	(0.3021)	(0.0000)	(0.0001)	(0.0007)	(1.5879)	(2.1360)
Calories	-0.0015*** [a]	-0.0017*** [a]	-0.0107*** [a]	-3.7602*	3.7535***	0.00003***[a]	0.0006*[a]	-0.0052*[a]	8.3896	0.7108
	(0.0002)	(0.0002)	(0.0007)	(2.1119)	(1.7988)	(0.0000)	0.0000	(0.0027)	(5.5446)	(96.695)
Sugar	0.0008 [a]	0.0013* [a]	0.0121*** [a]			-0.0001*** [a]	-0.0026***[a]	-0.0082***[a]		
	(0.0007)	(0.0007)	(0.0022)			0.0000	(0.0001)	(0.0001)		
Caffeine	0.0005** [a]	0.0006*** [a]	-0.0132*** [a]			-0.000017*[a]	-0.000027a	-0.0005*[a]		
	(0.0001)	(0.0001)	(0.0005)			(0.0000)	(0.0000)	(0.0003)		
Coke	0.0098 [a]	0.0009 [a]	0.8232*** [a]			0.0047***[a]	0.06544***[a]	-0.0413***[a]		
	(0.0072)	(0.0085)	(0.0211)			(0.0010)	(0.0032)	(0.0176)		
Pepsi	0.0583*** [a]	0.0543*** [a]	0.8644*** [a]			0.0033***[a]	0.05454***[a]	0.1638***[a]		
	(0.0085)	(0.0087)	(0.0229)			(0.0011)	(0.0030)	(0.0295)		
GMM Objective			0.0218					0.0002		
N	151366	151366	151366			813588	813588	813588		
Fixed effects										
Month	Yes	Yes	Yes			Yes	Yes	Yes		
Year	Yes	Yes	Yes			Yes	Yes	Yes		
County	Yes	Yes	Yes			Yes	Yes	Yes		
Brand	Yes	Yes	Yes			Yes	Yes	Yes		
Store	Yes	Yes	Yes			Yes	Yes	Yes		
Wu -Hausman		8.17878***					5871.63***			

Standard errors in parentheses, ***, **,* are indicate statistical significance at 1%, 5% and 10% respectively, [a] Estimates from a Minimum Distance Procedure, see Nevo (2000).

Table 1.7: Manufacturer's mean own and cross-price elasticity for all products of 12 oz 6 pack and 20 oz bottles

	12 oz 6 pack			20 oz bottles		
Coca-Cola Pre-integration	Coca-Cola	PepsiCo	Dr Pepper Snapple Group	Coca-Cola	PepsiCo	Dr Pepper Snapple Group
Coca-Cola	-4.763	-	-	-3.3117	-	-
PepsiCo	0.0035	-4.7017	-	0.0022	-3.2847	-
Dr Pepper Snapple Group	0.0164	0.0054	-4.8182	0.0021	0.0022	-3.1601
Coca-Cola Post-integration	Coca-Cola	PepsiCo	Dr Pepper Snapple Group	Coca-Cola	PepsiCo	Dr Pepper Snapple Group
Coca-Cola	-5.1228	-	-	-3.36259	-	-
PepsiCo	0.0038	-5.0325	-	0.0016	-3.5732	-
Dr Pepper Snapple Group	0.0135	0.0055	-5.1911	0.0015	0.0016	-3.4491
PepsiCo Pre-integration	Coca-Cola	PepsiCo	Dr Pepper Snapple Group	Coca-Cola	PepsiCo	Dr Pepper Snapple Group
Coca-Cola	-4.7013	-	-	-3.2609	-	-
PepsiCo	0.0034	-4.6797	-	0.0024	-3.2496	-
Dr Pepper Snapple Group	0.0163	0.0055	-4.7516	0.0023	0.0023	-3.1154
PepsiCo Post-integration	Coca-Cola	PepsiCo	Dr Pepper Snapple Group	Coca-Cola	PepsiCo	Dr Pepper Snapple Group
Coca-Cola	-5.0921	-	-	-3.5873	-	-
PepsiCo	0.0038	-5.0188	-	0.00168	-3.5313	-
Dr Pepper Snapple Group	0.0143	0.0053	-5.1506	0.00161	0.00163	-3.4137

Table 1.8: Price-cost markup and recovered cost by the common agency for the pre-integrated period of 12 oz 6 pack and 20 oz bottles

Upstream (Syrup Manufacturer)	Downstream (Bottler)	12 oz of 6 pack			20 oz bottles		
		Total Margin (Upstream + Downstream)		Total Recovered Marginal Cost	Total Margin (Upstream + Downstream)		Total Recovered Marginal Cost
		Mean Levels ($ per oz)	Mean Percent of Price (Lerner Index) (%)	Mean Levels ($ per oz)	Mean Levels ($ per oz)	Mean Percent of Price (Lerner Index) (%)	Mean Levels ($ per oz)
Coca-Cola	Coca-Cola Enterprises (CCE)	0.0193***	46.89***	0.0246***	0.0452***	62.10***	0.0284***
		(0.000)	(0.31)	(0.000)	(0.000)	(0.02)	(0.000)
DPSG	Coca-Cola Enterprises (CCE)	0.0203***	48.17***	0.0242***	0.0456***	67.45***	0.0253***
		(0.000)	(0.19)	(0.000)	(0.000)	(0.12)	(0.000)
Coca-Cola	*Other Coca-Cola*	0.0193***	46.92***	0.0245***	0.0454***	62.50***	0.0281***
		(0.000)	(0.20)	(0.000)	(0.000)	(0.03)	(0.000)
DPSG	*Other Coca-Cola*	0.0208***	49.70***	0.0232***	0.0472***	70.73***	0.0226***
		(0.000)	(0.42)	(0.000)	(0.000)	(0.17)	(0.000)
PepsiCo	Pepsi Bottling Group	0.0192***	46.41***	0.0241***	0.0452***	63.42***	0.0269***
		(0.000)	(0.26)	(0.000)	(0.000)	(0.03)	(0.000)
DPSG	Pepsi Bottling Group	0.0202***	47.93***	0.0238***	0.0458***	69.68***	0.0230***
		(0.000)	(0.20)	(0.000)	(0.000)	(0.14)	(0.000)
PepsiCo	PepsiAmericas	0.0196***	47.80***	0.0235***	0.0457***	64.06***	0.0265***
		(0.000)	(0.37)	(0.000)	(0.000)	(0.07)	(0.000)
DPSG	PepsiAmericas	0.0211***	50.00***	0.0229***	0.0466***	67.94***	0.0237***
		(0.000)	(0.48)	(0.000)	(0.000)	(0.23)	(0.000)
PepsiCo	*Other PepsiCo*	0.0223***	62.15***	0.0162***	0.0449***	63.40***	0.0269***
		(0.000)	(1.93)	(0.000)	(0.000)	(0.16)	(0.000)
DPSG	*Other PepsiCo*	0.0236***	56.90***	0.0202***	0.0455***	67.11***	0.0236***
		(0.000)	(2.48)	(0.000)	(0.000)	(0.33)	(0.000)

Standard errors in parentheses, and * p<0.1, ** p<0.05, *** p<0.01

Table 1.9: Price-cost markup and recovered cost by the common agency for the post-integrated period of 12 oz 6 pack and 20 oz bottles

Upstream (Syrup Manufacturer)	Downstream (Bottler)	12 oz of 6 pack: Total Margin Upstream + Downstream): Mean Levels ($ per oz)	12 oz of 6 pack: Total Margin Upstream + Downstream): Mean Percent of Price (Lerner Index) (%)	12 oz of 6 pack: Total Recovered Marginal Cost: Mean Levels ($ per oz)	20 oz bottles: Total Margin Upstream + Downstream): Mean Levels ($ per oz)	20 oz bottles: Total Margin Upstream + Downstream): Mean Percent of Price (Lerner Index) (%)	20 oz bottles: Total Recovered Marginal Cost: Mean Levels ($ per oz)
Coca-Cola	Coca-Cola Refreshments	0.0097***	21.67***	0.0373***	0.0226***	28.67***	0.0581***
		(0.000)	(0.07)	(0.000)	(0.000)	(0.01)	(0.000)
DPSG	Coca-Cola Refreshments	0.0199***	43.88***	0.0274***	0.0459***	63.88***	0.0315***
		(0.000)	(0.18)	(0.000)	(0.000)	(0.25)	(0.000)
Coca-Cola	*Other Coca-Cola*	0.0191***	42.45***	0.0284***	0.0455***	56.67***	0.0353***
		(0.000)	(0.23)	(0.000)	(0.000)	(0.02)	(0.000)
DPSG	*Other Coca-Cola*	0.0230***	50.85***	0.0248***	0.0470***	63.72***	0.0301***
		(0.000)	(1.92)	(0.000)	(0.000)	(0.14)	(0.000)
PepsiCo	Pepsi Bottling Company (PBC)	0.0094***	21.67***	0.0366***	0.0226***	29.04***	0.0561***
		(0.000)	(0.12)	(0.000)	(0.000)	(0.01)	(0.000)
DPSG	Pepsi Bottling Company (PBC)	0.0210***	46.67***	0.0265***	0.0466***	64.37***	0.0292***
		(0.000)	(1.04)	(0.000)	(0.000)	(0.21)	(0.000)
PepsiCo	*Other PepsiCo*	0.0186***	41.34***	0.0286***	0.0449***	58.41***	0.0332***
		(0.000)	(0.90)	(0.000)	(0.000)	(0.16)	(0.000)
DPSG	*Other PepsiCo*	0.0323***	72.86***	0.0145***	0.0459***	61.38***	0.0301***
		(0.000)	(10.89)	(0.000)	(0.000)	(0.21)	(0.000)

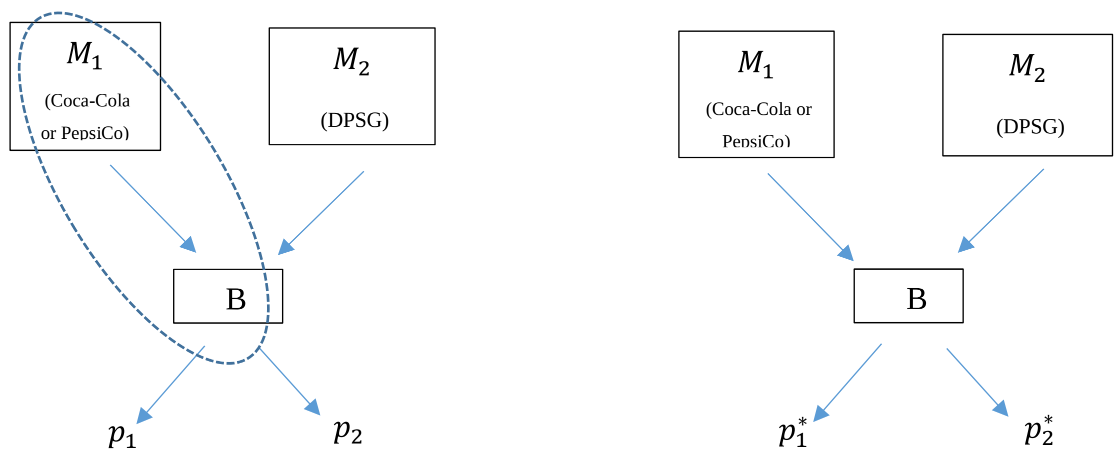
Standard errors in parentheses, and * p<0.1, ** p<0.05, *** p<0.01

1.5.4 Counterfactual simulations

This subsection is based on the results of counterfactual simulation in vertically integrated markets. We define the vertically integrated market as a downstream bottler which is owned by at least one of the upstream syrup manufacturer (Coca-Cola or PepsiCo). In other words, if there is no vertically integrated bottler available in the given market, then we do not consider that market as a vertically integrated market.

Figure 1.2 illustrates the graphical example of the market structure and vertical integration of the CSD industry. We design and implement counterfactual dis-integration experiments to assess the market impacts of vertical integration. For example, a typical counterfactual experiment we ask the question: How would equilibrium product prices change if a given upstream manufacturer did not own a downstream bottler?

Figure 1.2: The market structure of the CSD industry



(a) Vertical Integration

(b) Counterfactual Situation (Vertical dis-integration)

Figure 1.2a illustrates the actual situation in which the downstream bottler (B) is integrated with an upstream manufacturer M_1 (Coca-Cola /PepsiCo), while Figure 1.2b presents the counterfactual situation in which the bottler is not integrated with the upstream manufacturer M_1. We assess the effects of vertical integration by using equation (1.18) to predict how market equilibrium prices would change if markets that are actually like Figure 1.2a were to become like Figure 1.2b.

Table 1.10: Estimated means and changes in retail prices -common agency and vertically integrated bottler for 12 oz 6 pack and 20 oz bottles

	12 oz of 6 pack			20 oz bottles		
	Mean Predicted Counterfactual Dis-Integration Prices(p^a) ($ per oz)	Mean Actual Prices in Markets with Vertically Integrated Firms(p^b) ($ per oz)	Mean Percentage Price Changes $\left(\frac{p^a - p^b}{p^b}\right) * 100$	Mean Predicted Counterfactual Dis-Integration Prices(p^c) ($ per oz)	Mean Actual Prices in Markets with Vertically Integrated Firms(p^d) ($ per oz)	Mean Percentage Price Changes $\left(\frac{p^c - p^d}{p^d}\right) * 100$
PepsiCo integrated with the downstream bottler						
PepsiCo Products	0.05526***	0.04608***	21.14028***	0.10110***	0.07865***	28.90176***
	(0.000)	(0.000)	(0.110)	(0.000)	(0.000)	(0.011)
PepsiCo distributes DPSG Products	0.04746***	0.04734***	0 .25111***	0.07564***	0.07575***	-0.14718***
	(0.000)	(0.000)	(0.014)	(0.000)	(0.000)	(0.001)
Coca-Cola integrated with the downstream bottler						
Coca-Cola Products	0.05608***	0.04690***	20.63208***	0.10318***	0.08067***	28.09013***
	(0.000)	(0.000)	(0.060)	(0.000)	(0.000)	(0.008)
Coca-Cola distributes DPSG Products	0.04729***	0.04722***	0.16255***	0.07721***	0.07733***	-0.15830***
	(0.000)	(0.000)	(0.013)	(0.000)	(0.000)	(0.000)

Standard errors in parentheses, and * p<0.1, ** p<0.05, *** p<0.01

Table 1.10 represents the estimation results of the effects of Coca-Cola and PepsiCo vertical integration on retail prices for both sizes. For example, column I, column 2, and column 3 reports mean predicted counterfactual prices due to vertical dis-integration, mean actual prices in markets with vertically integrated firms, and mean changes in prices respectively for 12 oz 6 pack.

The counterfactual price changes are statically significant at the 1% level. The results reveal that for products with eliminated double margins (Coca-Cola and PepsiCo) the average retail price decreases for both sizes, which is in contrast with the effect of vertical integration on the prices of rival products (DPSG) that are bottled by vertically integrated bottlers. With regards to DPSG's products, price decreases for 12 oz 6 pack, whereas price increases for 20 oz bottles. Under the assumptions that we made for demand side (e.g., random coefficient model) and supply-side (e.g., estimating price-cost margins under the assumption that retailers are passive, and no-cost efficiency gains), the estimates suggest that vertical integration with bottlers results in procompetitive effects for 12 oz 6 pack and anticompetitive effects for 20 oz bottles. These results empirically support the Salinger's (1991) theoretical argument of vertical integration in a common agency which causes possible different effects on final product prices. Finally, the results reveal that the elimination of double marginalization for one set of products (Coca-Cola/PepsiCo) may or may not benefit consumers in the CSD industry.

1.6 Conclusion

Economic research on the CSD industry is limited to the analysis of demand, leaving questions about competition and consumer welfare. Using a structural model, we investigate the price effects of one of the biggest vertical integration in the U.S. CSD industry in the presence of common agency, where a downstream bottler may also distribute its upstream rival's products. Specifically, we model the upstream syrup manufacturer and downstream bottler's behavior in the CSD industry to determine how vertical integration impacts prices in the presence of common agency.

We use monthly retail scanner data on the U.S. CSD industry from 2008 through 2012 to evaluate the competitive effects. We apply the random coefficient discrete choice model to estimate the demand side. Flowing Villas-Boas (2007), we use demand estimates to compute price-cost margin for upstream manufacturers and downstream bottlers without observing data on wholesale prices. Moreover, we consider a sequential price-setting game between manufacturers and bottlers and further assume Nash-Bertrand competition among both manufacturers and bottlers. More specifically, we consider the linear pricing supply model and assume retailers are passive, such that retailers set prices at a level that is just high enough to cover their input costs and per-unit prices paid to bottlers. Using the counterfactual ownership structure of manufacturers and bottlers (vertical dis-integration), we simulate the Nash equilibrium prices. As a result, we compare the simulated equilibrium price with factual prices to access the price effect due to the vertical integration by assuming no-cost efficiency gains is resulting from the vertical integration.

The econometric results suggest that the vertical integration of PepsiCo and Coca-Cola with their major bottlers decreases the prices of DPSG for 12 oz 6 pack and increases the prices of DPSG products for 20 oz bottles. However, the vertical integration of the CSD industry caused price decreases for both Coca-Cola and PepsiCo products bottled by vertically integrated bottlers for both sizes. In other words, counterfactual simulations suggest that the vertical integration with bottler's results in procompetitive effects for 12 oz 6 pack and anticompetitive effects for 20 oz bottles. These mixed findings do not support the FTC's opposition to the vertical integration between PepsiCo and Coca-Cola with their major bottlers in 2010. However, the results are consistent with theoretical results in vertical integration with common agency pricing literature.

This study can be extended to evaluate various strategic models of vertical structure in the CSD industry. One extension of this paper is to consider models of the vertical relationship under the different supply scenarios with linear pricing. For example, assess the welfare effect of vertical integrated collusive upstream manufacturers or downstream bottlers. Moreover, another application of this paper can estimate the effect of vertical integration under the presence of non-linear pricing following the modeling procedure proposed by Rey and Vege (2004), and Bonnet and Dubois (2010).

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Chapter 2 The competitive effects of vertical contracts between manufacturers and bottlers: Evidence from the U.S. Carbonated Soft Drink Industry

2.1 Introduction

In 2010, two major vertical integrations took place in the Carbonated Soft Drink (CSD) industry: (1) In February, PepsiCo, the world's second-largest soft drink manufacturer, acquired two bottlers, Pepsi Bottling Group Inc (PBG) and PepsiAmericas Inc (PAS) ; and (2) In October, Coca-Cola, the world's largest soft drink manufacturer, acquired Coca-Cola Enterprises Inc (CCE). Before the acquisitions, PBG operated 40% of PepsiCo products, while PAS operated 43%. Furthermore, 20% of Dr Pepper Snapple Group's (DPSG) products, the third largest soft drink manufacturer in the US in 2009, were bottled, canned, and distributed by PBG and PAS. In 2009, CCE bottled and canned approximately 75% and 14% of Coca-Cola and DPSG products, respectively.

Vertical integration can eliminate the problem of double marginalization that often exists between two or more vertically related firms. The double marginalization problem emerges when two or more vertically related firms in the supply chain have market power, and each of these firms non-cooperatively chooses to charge a markup on the commodity they sell. In such cases, the markups are set at levels that may maximize each firms' profit, but not maximize the combined profit across the firms. Vertical integration can solve this problem of double marginalization because the vertically integrated firm is appropriately incentivized to coordinate the pricing of its upstream and downstream operations to maximize the overall profit of the firm. Subsequent to integration, Coca-Cola and PepsiCo distribute a subset of their products through their company-owned bottlers and their remaining products through independently owned bottlers. Note, however, that the double marginalization problem is not eliminated for Coca-Cola and PepsiCo products that are bottled by independently owned bottlers.

With these vertical integrations, bargaining power in the vertical structure and the strategic vertical contracts between independently owned bottlers and Coca-Cola and PepsiCo may change, which in turn may affect retail prices and consumer welfare in the CSD industry. This study analyzes the extent to which vertical contracts between independently owned bottlers and Coca-Cola, PepsiCo, and DPSG are affected by the vertical integrations that occurred in 2010. To the best of our knowledge, this is the first paper to analyze the impact of vertical integration on vertical contracts between manufacturers and bottlers in the U.S. CSD industry.

We begin by specifying a structural econometric demand and supply model that allows linear and nonlinear pricing contracts between manufacturers and bottlers before and after the two major vertical integrations that occurred in 2010. The econometric model is estimated using retail scanner data on the U.S. CSD industry between 2008 and 2012. In the spirit of work by Villas-Boas (2007), we estimate the price-cost margins of soft drink products without observing data on wholesale prices. In order to better focus on vertical relationships between manufacturers and bottlers, we make the simplifying assumption that retailers are passive, i.e., they do not engage in strategic price-setting simply set prices at a level that is just high enough to cover their input costs. However, bottlers do engage in strategically setting the prices charged to retailers, and through their prices, combined with the assumption that retailers are passive, indirectly influence the level of retail prices. As such, the supply-side of the structural econometric model assumes bottlers effectively determine retail prices. As in Villas-Boas (2007), and Bonnet and Dubois (2010), we first estimate consumer demand using a random coefficients discrete choice model. Following the empirical framework of Bonnet and Dubois (2010), we then use the demand estimates to compute the product level price-cost margins for the upstream manufacturers and downstream bottlers under linear and nonlinear pricing models. Finally, using statistical tests for non-nested model selection, we select the supply model that best approximates price-setting behavior in the U.S. CSD industry prior to vertical integration separate from the supply model that best approximates price-setting behavior subsequent to vertical integration.

The results of demand estimates suggest that consumer's demand for CSD is significantly influenced by both price and non-price characteristics such as calories, carbohydrates, sodium, sugar, and caffeine content. The standard deviations of the random coefficients logit model reveal that consumers' preferences are heterogeneous with respect to calories and sodium contents of CSD products.

Consisting with empirical findings in the European Union (EU) CSD industry [Bonnet and Réquillart (2012)] and also other industries [Bonnet and Dubois (2010); and Bonnet et.al. (2013)], our results suggest upstream manufacturers rely on more efficient non-linear pricing contracts in the form of two-part tariffs with RPM rather than inefficient linear pricing contracts.

More specifically, our findings suggest that each manufacturer during Coca-Cola and PepsiCo pre-integration periods charge bottlers non-linear prices (two-part tariff) with imposing RPM under zero bottler margins. However, the post-integration period, vertically integrated upstream manufactures with downstream bottlers, eliminated the double marginalization, whereas all other upstream manufactures in the market actively compete in wholesale prices with rival manufacturers, leaving zero markups to their corresponding bottlers. In other words, the strategic pricing contract of unintegrated manufacturers uses a two-part tariff with RPM in a manner that leaves zero markups to bottlers when PepsiCo and Coca-Cola acquired their biggest bottlers (CCE, PAS, and PBG) and eliminated the double marginalization. Finally, the supply-side analysis has not found evidence that manufacturers use different pricing contracts with bottlers for different product sizes (12 oz 6 pack and 20 oz bottles) during the pre-integration and post-integration periods.

The strategic behavior between manufacturers and retailers has been emphasized recently in the empirical industrial organization. Several recent papers examine strategic behavior in the vertical relationship between manufacturer and retailer using linear and nonlinear pricing models in different industries [the yogurt industry, Villas-Boas (2007); the coffee industry, Bonnet et al. (2013); the bottled water industry, Bonnet, and Dubois (2010)]. However, the competition analysis of vertical relationship focus in the U.S CSD industry is limited.

Bonnet and Réquillart (2012), analysis the impact on the EU CSD industry of a reform of the EU sugar policy using a structural model. They consider the vertical relationship as a manufacturer and retailer level and model the different supply models using linear as well as non-linear pricing models to identify the best model that represents the industry. Specifically, they consider how the change in the production cost of soft drinks that impact the manufacturer's and retailers' strategic behavior. They identify the best supply model where manufacturers and retailers use two-part tariff contracts with RPM. After finding the best supply model for vertical contracts, they simulate the impact of the sugar policy reform. Despite that, our study aims to investigate linear and nonlinear pricing behavior while considering the vertical integration between the manufacturer and bottler in the U.S. CSD industry.

There are few empirical analyses of vertical contracts that focus on a different industry. Villas-Boas (2007) analyzed the US yogurt industry by using different vertical and horizontal contracts between manufacturers and retailers. She considered contracts as (1) a simple linear pricing model, (2) a vertically integrated model, and (3) a variety of strategic contracts by considering collusion and nonlinear pricing concerning private label products. The results support the nonlinear pricing contracts between manufacturers and retailers in the U.S. yogurt industry. However, the paper does not consider the nonlinear pricing contracts with or without RPM.

Rey and Vergé (2010) theoretically model the nonlinear pricing contracts with and without RPM. They show that two-part tariff with RPM soften intra-brand competition and may result in manufacturers to collude on retail prices by imposing wholesale prices equal to the marginal cost of production. However, if manufacturers impose wholesale prices greater than the marginal cost of production, they show that a two-part tariff with RPM may result in bellow monopoly prices. Thus, a two-part tariff with RPM impact eliminating the intra-brand competition whereas common agency eliminates the inter-band competition.

Bonnet and Dubois (2010) empirically analysis the theoretical model of nonlinear pricing contracts that develop by Rey and Vergé (2010). Bonnet and Dubois (2010) test the nonlinear pricing contracts with or without RPM between manufacturers and retailers in the French bottled water market during the 1998-2000 periods. They also examine the other contracts allowing retailers and manufacturers can use linear pricing and nonlinear pricing with or without collusion upstream and downstream. They identify that a two-part tariff with RPM is the best vertical contract in French water bottled market. They also identify that the retail price will drop by 7% under the two-part tariff if the two-part tariff with RPM is restricted.

Bonnet et al. (2013) investigate how upstream firm cost shock is passed to final consumer prices on the coffee market in Germany using linear and nonlinear pricing with or without RPM. They identify the cost pass-through is larger when firms use a two-part tariff with RPM compared to linear pricing. The results further suggest that not only demand elasticities but vertical contracts also can explain the different effects on cost pass-through.

Moreover, there are some other empirical analyses of vertical structure that focus on different industries:[the U.S. beer industry; Aschenfelter et al. (2015), the U.S. video rental industry; Mortimer (2008), the U.S. healthcare industry; Gowrisankan et al. (2015), Ho and Lee (2017)]. Given recent changes in the CSD industry, our study aims to be an initiate to investigate more complex pricing behavior of upstream and downstream level in the CSD industry that observed in other industries. Thus, the study contributes to the literature by modeling the linear and nonlinear pricing contracts in the presence of vertical integration in the U.S. CSD industry.

The remainder of the paper is organized as follows: Section 2.2 describes the CSD market structure and provides a description of the data; Section 2.3 outlines the structural econometric model of CSD demand and supply, including estimation procedure; Results are discussed in Section 2.4. Lastly, in Section 2.5 offers concluding remarks.

2.2 Background and Data

2.2.1 Industry Background

In this section, we explain the structure and the most recent vertical transactions of the U.S. CSD industry. The CSD industry is characterized by the number of different actors: syrup producers, bottlers, and the retail level. The combinations of these actors are used to make products available to consumers. Syrup producers are characterized by the upstream manufacturer (e.g., Coca-Cola) and selling syrup to downstream bottlers. Bottlers added carbonated water, sweeteners, and other ingredients, and then packaged the drinks into bottles or cans. Moreover, bottlers distribute canned and bottled soft drink products to the retail trade in their exclusive territories. Retailers such as grocery stores and supermarkets, which make carbonated beverages available to consumers.

Over the past three decades, the CSD industry has changed dramatically. The featuring products, package introductions, and non-price promotions become more complex and volatile. Building brand loyalty and transportation cost are the most important aspect of the CSD industry. Thus, manufacturers rely heavily on bottlers regarding new products and packages, promotions, and marketing innovations. Also, PepsiCo and Coca-Cola bottlers adopt the production of allied brands like Dr.Pepper and 7-UP to their bottling system in the 1980s.

Moreover, the introduction of nonreturnable containers, advance in transportation, and the innovation of technology lead to improving the minimum efficient scale in bottling operations, which leads to bottling operations to exploit "economies of scope" in production (Muris et al., 1992). Thus, independent bottlers combine and create large multi-franchise operations (MFO) to accommodate increases in minimum efficient scale. However, the formation of MFO scattered and slowed in responding to the new CSD environment. Table 2.1 presents changes in the number of bottling operations and the average scale of CSD bottling plants. It shows that the number of bottlers decreased, as other bottlers and their franchisors acquired franchised bottlers.

Table 2.1: Number and Average Production of U.S. CSD Bottling Plants

Year	Number of Plants	Total Cases	Aver. Cases Per Plant
1970	3054	2,971,000,000	972,823
1980	1859	4,930,000,000	2,651,963
1990	807	7,780,000,000	9,640,644
1998	498	9,880,000,000	19,839,357

Source: Saltzman, Levy, and Hilke (1999)

"In essence, Coca-Cola and Pepsi-Cola needed to change their distribution systems in order to implement effectively, the strategies that were stimulated by the new environment because the relative transaction costs of the independent bottling systems in the environment were too high" (Muris et al., 1992, 256). Furthermore, to implement new products and packaging by using independent bottlers are expensive. "The success of product introductions hinges, first, on the ability of the manufacturer to convince retailers to take on the product and market it effectively and, ultimately, on consumer acceptance. Syrup manufacturers face an additional hurdle in introducing a new product or package – they must convince their independent bottlers to handle the item" (Muris et al., 1992, 272).

In the 1990s, Coca-Cola and PepsiCo buying many independent bottlers and combining their territories, allow them to control new products and process innovations. As well as, they are operating larger bottlers, which are more manageable and economic scale. Table 2.2 shows the trend in the number of bottling plants consolidate by Coca-Cola and PepsiCo in the 80s and 90s.

Table 2.2: Number of Coca-Cola and PepsiCo Bottlers

Year	Coca-Cola Bottlers	PepsiCo Bottlers
1983	319	256
1987	192	180
1998	94	119

Source: Saltzman, Levy, and Hilke (1999)

DPSG is the third-largest CSD producer in the industry. DPSG has used its bottlers to distribute their products in some areas but mostly rely on Coca-Cola and PepsiCo bottling system in most areas in the U.S. More specifically, most Coca-Cola and PepsiCo franchise bottlers distribute allied brands of DPSG.

PepsiCo and Coca-Cola's acquisition of their biggest bottlers in 2010 was the biggest vertical integration in the CSD industry. PepsiCo's CEO, Indra Nooyi explained the impetus for the merger that "the fully integrated beverage business will enable us to bring innovative products and packages to market faster, streamline our manufacturing and distribution systems and react more quickly to changes in the marketplace, much like we do with our food business. " Also, Coca-Cola's CEO, Muhtar Kent noted the benefit of the acquisition that "fundamental industry forces have altered the consumer, customer and competitive landscape," he said. "Our franchise system cannot remain static. We have to create the next generation of high-return opportunities."

In 2010, the Federal Trade Commission (FTC) raised concern that Coca-Cola and PepsiCo's acquisition of bottlers may have anti-competitive effects in the CSD industry. The FTC expressed the view that Coca-Cola and PepsiCo will have access to DPSG's commercially sensitive marketing plans through the downstream bottlers, and it would make DPSG a less effective competitor in the CSD industry. In other words, Coca-Cola and PepsiCo could use sensitive information in ways that weaken competition such as, not promote DPSG brands or ultimately excluded DPSG brands from the bottling operation. However, the FTC approved the acquisitions of PepsiCo and Coca-Cola under the condition of set up the "firewall" to protect the marketing information of DPSG. Under this "firewall" Coca-Cola and PepsiCo could only participate bottling process and cannot access confidential information of DPSG. Thus, PepsiCo and Coca-Cola completed the acquisition process in February 2010 and October 2010 respectively. This merger agreements lead to grant Coca-Cola and PepsiCo exclusive license to sell and distribute DPSG products in CCE, PBG, and PAS exclusive territories. Finally, Coca-Cola renamed the sales and operational elements of CCE to Coca-Cola Refreshments (CCR), and PepsiCo is establishing wholly-owned PepsiCo bottlers (PBG, PAS), Pepsi Beverages Company (PBC).

2.2.2 Data

The data for this study is constructed from IRI retail Dataset. The data provide product sales information for a large number of stores and covers a wide range of geographic areas across the U.S. A broad array of markets is necessary to explore the manufacturer, bottler, and consumer behavior across regions. The market in this study defined as a combination of geographical area (county) and a period (month × year). The county is chosen as the geographical area.

IRI provided weekly retail data for the 50 IRI geographic markets by Universal Product Codes (UPC). These 50 geographic markets can be differentiated from the store location. Unlikely other research, we use IRI store location (zip code) files to identify stores which locate in counties in the U.S. Thus, we explore 5372 unique stores throughout 685 counties in the U.S. We use retail store data on CSDs in 685 counties across the U.S., for the period 2008-2012.

We consider the three biggest syrup producers: Coca-Cola, PepsiCo, and DPSG. We choose all possible carbonated beverage brands based on these syrup producers and availability in the IRI retail Dataset. We aggregate weakly data up to monthly unit sales and revenue. The average retail prices are computed, dividing monthly sales revenue by monthly unit sales. The market size), by multiplying each of the county population by per capita per month consumption of soft drinks. We define a product as a unique combination of brand, packages, sizes, and retailers (stores). Different package sizes of a brand at a store are treated as distinct products within a market (e.g., 12 oz of 6pack cans diet coke is a different product than 20 oz of bottle diet coke at a store).

About 61 percent of the CSD sales represent 12 oz, 20 oz, and 67.5 oz. To reduce the computational burden of the econometric estimation, we mainly focus on 12 oz 6 pack and 20 oz product sizes for this analysis. Table 2.3 represents summary statistics on the retail prices of the selected top brands in each manufacturer. The summary statistics of all brands that are included in the analysis are given in the appendix. Table 2.3 shows that the 12 oz 6 pack and 20 oz products on similar average prices per oz between brands but slightly different prices per oz within sizes. The average price per oz of the 20 oz bottles is twice larger than the average price per oz of the 12 oz 6 pack. Moreover, the results evident that carbonated beverages are a differentiated food category.

Table 2.3: Summary statistics: Retail prices ($ per oz)

	N	Mean Price ($ per oz)	S.D.	Max	Min
		12 oz 6 pack			
Retail Price	151,366	0.0454	0.0097	0.2043	0.0001
Coca-Cola					
Tab	16,641	0.0487	0.0072	0.1128	0.0098
Diet Coke	11,720	0.0405	0.0115	0.1668	0.0124
Coke Zero	2,165	0.0398	0.0162	0.1558	0.0173
PepsiCo					
Diet Mountain Dew	3,430	0.0393	0.0086	0.1167	0.0122
Diet Pepsi	7,135	0.0411	0.0078	0.1100	0.0122
Caffeine Free Diet Pepsi	1,520	0.0435	0.0079	0.0972	0.0137
DPSG					
Ibc	65,128	0.0474	0.0073	0.2043	0.0164
Canada Dry	14,398	0.0439	0.0111	0.1311	0.0001
Canfield	12,133	0.0457	0.0114	0.1651	0.0124
		20 oz bottles			
Retail Price	813,588	0.0755	0.0099	0.0075	0.2801
Coca-Cola					
Caffeine Free Diet Coke	113,503	0.0766	0.0072	0.1126	0.0117
Coke Zero	111,316	0.0766	0.0074	0.1315	0.0124
Diet Black Cherry Vanilla Coke	44,083	0.0766	0.0079	0.1212	0.0104
PepsiCo					
Caffeine Free Diet Pepsi	111,932	0.0759	0.0075	0.1097	0.0079
Diet Mountain Dew	91,583	0.0758	0.0077	0.1149	0.0139
Diet Mountain Dew Caffeine Free	26,353	0.0760	0.0075	0.1097	0.0106
DPSG					
A & W	88,893	0.0760	0.0080	0.1496	0.0090
Caffeine Free Diet Dr Pepper	61,626	0.0712	0.0137	0.1573	0.0164
Caffeine Free Diet Sun Drop	46,815	0.0711	0.0142	0.2338	0.0113

2.2.2.1 Product Characteristics Data

Lopez and Fantuzzi (2012) show that brand characteristics such that sugar, sodium, and caffeine content can affect consumer choices. The information on brand characteristics is collected by examining the labels on each CSD brand. We collected this information from manufacturer websites and grocery stores. Table 2.4 indicates descriptive statistics and correlation among the non-price characteristics across the bands.

Table 2.4: Average and Correlation of the non-price characteristics

Variable	Mean	S.D	Min	Max	Correlation			
					Sodium	Sugars	Caffeine	Calories
12 oz 6 pack								
Sodium(mg)	46.42	24.28	0	105	1			
Sugars(g)	20.94	21.33	0	50	0.77	1		
Caffeine(mg)	7.07	16.12	0	68.4	-0.11	-0.43	1	
Calories	91.31	82.31	0	190	0.81	0.99	-0.49	1
20 oz bottles								
Sodium(mg)	77.45	21.55	0	210	1			
Sugars(g)	4.78	17.95	0	75	0.66	1		
Caffeine(mg)	41.28	35.69	0	114	-0.20	-0.28	1	
Calories	26.20	69.87	0	290	0.77	0.94	-0.39	1

N=151,366 and 813,588 for 12 oz 6 pack and 20 oz bottles respectively.

Table 2.4 shows that 12 oz 6 pack products on average have a higher content of sugar and calories, whereas 20 oz bottles have a higher content of sodium and caffeine. The average content of sugars in 12 oz 6 pack products is generally about five times larger than the average content of sugars in 20 oz bottles. There is a higher correlation between calories and sugars. Moreover, sodium highly correlates with sugars, and caffeine has a negative correlation with sugar and sodium within size.

Carbonated Soft Drinks introduced different sizes, shapes, and packages over the last four decades. Research on exploring the taste among different packages reveals there is subtle variation in taste drinking among aluminum cans, plastic, and glass bottles[5]. Thus, we include a zero-one dummy variable that takes the value one for cans and zero for bottles (both plastic and glass) in the model to explore the package type that makes different to taste[6].

We also use the Public Use Microdata Sample (PUMS) data (2008 through 2012) to identify the county-level demographic characteristics. An individual's demographics are presumably relevant to his or her demand for CSDs. These features of the data are conducive to studying the competitive effects of recent vertical integrations in the U.S. CSD industry. We

[5] http://www.coca-cola.co.uk/stories/bottle-vs-can-how-do-you-prefer-your-coca-cola

[6] Notice that there is no package type for 20 oz bottles because 98% of those products contain as plastic bottles in the sample.

randomly draw 200 individuals from each county (for each year) under the normal distribution. Thus, the sample includes 200×18500 (for 12 oz 6 pack) and 200×23674 (for 20 oz bottles) consumer observations. The individual's income is considered to allow heterogynous responses to price and other non-price characteristics. To identify the total population for each county, we use census data. Interactions of price and non-price characteristics with consumer characteristics (e.g., income) are also considered in the model.

To identify the bottlers, we assume that carbonated beverages are delivered to each store from the nearest distribution center, which connects to the bottler. In other words, distribution centers are used to identify the bottlers because distribution centers are connected to the bottlers. Thus, we calculated the driving distance between each retail store and the closest distribution centers for each of the three syrup manufacturers. DPSG products are bottled and distributed by either Coca-Cola, PepsiCo, or DPSG bottler. Thus, for DPSG products, we choose the nearest distributor among the distribution centers of Coca-Cola, PepsiCo, and DPSG. On the other hand, for Coca-Cola/PepsiCo products, we identify the closest distributor among the distribution centers of Coca-Cola/PepsiCo. We use a database called ReferenceUSA to collect the location addresses for distribution centers.

Table 2.5 presents information about the distribution of bottlers throughout the sample period. It shows about 98% of counties that PepsiCo products are distributed by vertically integrated PepsiCo bottler (PBC). Also, 64% of counties that Coca-Cola products are distributed by vertically integrated Coca-Cola bottler (CCR). In the case of DPSG, about 90% of counties those DPSG products are bottled and distributed by PepsiCo and Coca-Cola bottlers, whereas 10% of DPSG products are bottled and distributed by DPSG bottler.

Table 2.5: Products Distribution of Bottlers

Bottler's	2008	2009	2011	2012
Coca-Cola				
Coca-Cola Enterprise (CCE)	62.69	61.67	-	-
Coca-Cola Refreshments (CCR)	-	-	64.8	64.21
Other Coca-Cola Bottlers	37.31	38.33	35.21	35.79
PepsiCo				
Pepsi Bottling Group (PBG)	82.19	81.59	-	-
PepsiAmericas(PAS)	15.22	15.55	-	-
Pepsi Bottling Company (PBC)	-	-	96.07	98.07
Other PepsiCo Bottlers	17.8	18.4	3.93	1.93
Dr Pepper distributed by				
Coca-Cola Enterprise(CCE)	31.98	31.65	-	-
Coca-Cola Refreshments (CCR)	-	-	31.62	31.23
Other Coca-Cola Bottlers	23.21	22.19	23.32	23.73
Pepsi Bottling Group (PBG)	28	28.91	-	-
PepsiAmericas(PAS)	5.87	5.98	-	-
Pepsi Bottling Company (PBC)	-	-	33.04	32.86
Other PepsiCo Bottlers	2.54	2.33	2.21	1.88
Dr Pepper Snapple	8.4	8.93	9.79	10.31
Number of Counties	359	385	369	388

Note: The year 2010 is excluded because PepsiCo and Coca-Cola vertical merger took place in the year 2010.

2.3 The Econometric Model

2.3.1 Demand Side

This section is based on the demand-side of the model. On the demand side, we use the random coefficients logit model. A random coefficient logit model captures unobserved individuals heterogeneity and controls the other exogenous factors that can impact an individual's brand choice.

We use m to denote market and $j = 1, \ldots, J$ to denote products. In a given beverage market consumer i has $J + 1$ alternative options, i.e., either consumer can choose among $j = 1, \ldots, J$ products or consumers can choose outside option $j = 0$, such that substitutes for CSD. The indirect utility V_{ijm} of consumer i from purchasing a CSD product j in the market, m is given by:

$$V_{ijm} = d_j + d_m + x_{ijm}\beta_i - \alpha_i p_i + \xi_{jm} + \varepsilon_{ijm} \quad (2.1)$$

where d_j represents the product (brand-store) fixed effects capturing time-invariant product characteristics; d_m is the market (county-year-month) fixed effects that capture the unobserved determinants of demand; x_{ijm} is a $k \times 1$ vector of observed non-price product characteristics; In this study, we include the amount of sodium, sugar, caffeine, calories and a zero-one indicator variable that takes the value one for cans and zero for bottles (plastic and glass); p_i is the unit price per oz of CSD product j in market m; ξ_{jm} capture unobserved product characteristics; these are observed by consumers and firms but unobserved by the researcher; ε_{ijm} represents the individual-specific random component of utility that captures deviation of the individual's preference from the mean utility.

The random coefficients β_i represent a vector of consumer-specific marginal utilities associated with the different non-price product characteristics in x_{ijm} and α_i the consumer-specific marginal utility of price. The coefficients of β_i and α_i are very across consumers; this variation can be explained by m -dimensional column vector of demographic variables (D) and k -dimensional column vector that captures unobserved consumer characteristics (v_i). Formally, this can be modeled as:

$$\binom{\alpha_i}{\beta_i} = \binom{\alpha}{\beta} + \Gamma D_i + \delta v_i \quad (2.2)$$

Γ is a $k \times m$ matrix of coefficients that measure how taste characteristics vary with demographic characteristics, and δ is a $k \times k$ diagonal matrix that captures the unobservable heterogeneity due to random shocks v_i. We consider income is a demographic variable and included as a deviation from their respective means. The mean of the demographic variable in D_i is zero. Also, it is assumed that $v_i \sim N(O, I)$. Thus, the indirect utility function (2.1) can be broken down into three parts:

$$V_{ijm} = \delta_{jm} + \mu_{ijm} + \varepsilon_{ijm} \quad (2.3)$$

Let, δ_{jm} represents the mean utility level of each of the j products and can be written as:

$$\delta_{jm} = d_j + d_m + x_{jm}\beta_i - \alpha_i p_i + \xi_{jm} \tag{2.4}$$

We consider outside good option as the no-purchase option, indexed by $j = 0$; ($V_{i0m} = \varepsilon_{i0m}$). Let $\theta = (\Gamma, \delta)$ be a vector of the nonlinear parameter. Further, let

$$\mu_{ijm}\left(x_{jm}, p_{jm}, v_i, D_i; \theta\right) = [-p_{jm}, x_{jm}](\Gamma D_i + \delta v_i) \tag{2.5}$$

This equation denotes consumer-specific deviations from the mean utility given by the interaction between consumer and product characteristics. Therefore, equation (2.3) implies the mean utility (δ_{jm}) and a consumer-specific mean-zero deviation from the utility ($\mu_{ijm} + \varepsilon_{ijm}$). Further, ε_{ijm} represents the idiosyncratic tastes and assumed to be i.i.d. type I extreme value distribution. Thus, the predicted market share of product j is given by:

$$s_{jm} = \int \frac{exp^{(\delta_{jm}+\mu_{ijm})}}{1 + \sum_{l=1}^{J} exp^{(\delta_{lm}+\mu_{ilm})}} d\hat{F}(D) dF(v) \tag{2.6}$$

where $\hat{F}(D)$ is the empirical distribution from the demographic data, and $F(v)$ is the multivariate standard distribution. As in Nevo (2000), there is no closed-form solution for the equation in (2.6), and thus it must be approximated numerically using random draws from $\hat{F}(D)$ and $F(v)$.

The measure M of the market size is assumed to be the per capita consumption per month of all CSDs multiplied by the population of the county. Thus, the observed market share of product j is given by $S_j = \frac{q_j}{M}$, where q_j are the units sold.

2.3.2 Supply Side

In this section, we focus on different supply models based on linear and nonlinear vertical price-setting between syrup manufacturer (upstream) and bottlers (downstream) in the CSD industry.

2.3.2.1 Linear pricing

Model A: *Double Marginalization*

On the supply side, we assume an upstream manufacturer set their per unit wholesale prices (p^w) first, in a Nash-Bertrand manufacturer level, and then downstream bottlers follow, setting per-unit prices (p) for these products in a Nash-Bertrand fashion. We further assume that retailers are passive, and bottlers have sole market power in the marketing channel and thus set per-unit prices. Also, we assume no-cost efficiency gain is resulting from the vertical integration. We first define bottlers' profit-maximizing behavior in setting per unit prices that consumer pay, and then define manufacturer behavior in setting wholesale prices.

Let $b = 1 \dots B$ bottlers that compete in the downstream market. Bottler b profit function is given by:

$$\pi_b = \sum_{j \epsilon s_m^b} (p_{jm} - p_{jm}^w - c_{jm}^b) \times q_{jm} \tag{2.7}$$

where s_m^b is a subset of the $j = 1, \dots, J$ CSD products that are offered for sale by bottler b to the consumer in market m; p_{jm} is the per-unit price of product j; c_{jm}^b is the bottler's marginal cost of product j; q_{jm} denotes a quantity of product j sold in market m and $q_{jm} = M_m \times s_{jm}(p)$. Therefore, each bottler solves the following profit maximization problem.

$$\max_{p_{jm} \forall j \in s_m^b} \left[\sum_{j \epsilon s_m^b} (p_{jm} - p_{jm}^w - c_{jm}^b) \times M_m \times s_{jm}(p) \right] \tag{2.8}$$

Following expressions in Nevo (2000) and Villas-Boas (2007), the set of J first-order conditions generated from equation (2.8) can be solved for the price-cost margin for all products and expressed as the following vector notation:

$$\gamma \equiv p - p^w - c^b = -[T_b * \Delta_b]^{-1} s(p) \tag{2.9}$$

where p, p^w, c^b, and $s(p)$ are $J \times 1$ vector of final prices, wholesale prices, bottler's marginal costs, and product share, respectively. T_b is a $J \times J$ matrix that has a general element of zero and ones based on the bottler's ownership structure of the J products; Matrix Δ_b is a $J \times J$ matrix that contains first-order partial derivatives of predicted product share with respect to final prices, i.e

$$\Delta_b = \begin{bmatrix} \frac{\partial s_1}{\partial p_1} & \cdots & \frac{\partial s_J}{\partial p_1} \\ \vdots & \ddots & \vdots \\ \frac{\partial s_1}{\partial p_J} & \cdots & \frac{\partial s_J}{\partial p_J} \end{bmatrix}$$

where $T_b * \Delta_b$ represents the element-by-element multiplication of the two matrices.

Now we turn to the problem of upstream syrup manufacturers. Each syrup manufacturers maximize profit by choosing the wholesale price (p^w), knowing that bottlers behave under equation (2.9). Let s_m^f be a subset of the J products that syrup manufacturer f sells to bottler in market m. Also, let syrup manufacturers' marginal cost be given by c_{jm}^f. Syrup manufacturer f solves the following profit maximization problem:

$$\max_{p_{jm}^w \forall j \in s_m^f} \left[\sum_{j \epsilon s_m^f} (p_{jm}^w - c_{jm}^f) \times M_m \times s_{jm}(p(p^w)) \right] \tag{2.10}$$

The first-order conditions from the syrup manufacturers' generated a pure strategy Bertrand Nash equilibrium in wholesale prices and using matrix notation implies the following markup equation:

$$\Gamma \equiv p^w - c^w = -\left[T_f * \Delta_f\right]^{-1} s(p) \tag{2.11}$$

where p^w and c^w are a $J \times 1$ vector of wholesale prices and syrup manufacturers marginal cost respectively; T_f is a $J \times J$ matrix of zeros and ones that capture the J product ownership structure across syrup manufacturers. Let Δ_p be a $J \times J$ matrix of final prices with respect to wholesale prices, i.e.,

$$\Delta_p = \begin{bmatrix} \frac{\partial p_1}{\partial p_1^w} & \cdots & \frac{\partial p_J}{\partial p_1^w} \\ \vdots & \ddots & \vdots \\ \frac{\partial p_1}{\partial p_J^w} & \cdots & \frac{\partial p_J}{\partial p_J^w} \end{bmatrix}$$

Thus, $\Delta_f = \Delta_p' \Delta_b$, which captures the response of all predicted product share with respect to marginal changes in wholesale prices (Villas-Boas,2007).

Finally, we sum equation (2.9) and (2.11) to derive an expression corresponding to the markup of double-marginalization resulting from the linear pricing model for CSD products, yields:

$$p - c^f - c^b = -[T_b * \Delta_b]^{-1} s(p) - [T_f * \Delta_f]^{-1} s(p) \quad (2.12)$$

Note that we recover overall price-cost margin in equation (2.12) without information regarding wholesale prices, implies that the researcher does not need to know p^w. On the other hand, data on wholesale prices in CSD industries are difficult to obtain.

2.3.2.2 Non-Linear Contracts

We consider now that upstream syrup manufacturer charges downstream bottler nonlinear prices in the form of two-part tariffs with or without RPM. In the empirical literature, two-part tariff supply contracts were recently considered into the analysis [Villas-Boas (2007); Bonnet and Dubois (2010)]. Under the two-part tariff, syrup manufacturers propose to take-it or leave-it contracts to bottlers with a franchise fee, as well as a per-unit wholesale syrup price. If offers have been accepted, the bottlers set consumer prices, and thus, contracts are satisfied. However, with retail price maintenance, the manufacturer can control the retail prices that bottler chargers to consumers. In other words, if syrup manufacturers have sufficient bargaining power with bottler, then the syrup manufacturer can impose retail price to consumers. Rey and Vergé (2004) show that the optimal strategy for manufacturers is to set retail prices instead of wholesale prices in their contracting relationship with retailers.

In the situation of two-part pricing strategy, the profit of bottler b is given by:

$$\pi_b = \sum_{j \epsilon s^b} (p_j - p_j^w - c_j^b) \times M \times s_j^b(p) - F_j^b \tag{2.13}$$

which implies that the bottler b pays the wholesale price p_j^w along with a franchise fee F_j^b for selling product j. Market subscript, m, is omitted to avoid the complication of the notation. On the other hand, a syrup manufacturer set their wholesale prices p_j^w and the franchise fees F_j^f in order to maximize profits equal to:

$$\pi_f = \sum_{j \epsilon s^f} (p_j^w - c_j^f) \times M \times s_j^f + F_j^f \tag{2.14}$$

s^f is a set of the j competing products sold by the manufacturer. Syrup manufacturer maximizes profit subject to the bottler's participation constraint for all $b = 1 \ldots B$: $\Pi^b \geq \overline{\Pi}^b$, where $\overline{\Pi}^b$ is bottlers exogenous outside option profit (i.e., lower bound of bottler profit). Syrup manufacturers can adjust the franchise fees such that participation constraint is binding, i.e. $\Pi^b = \overline{\Pi}^b$. By normalizing outside option as $\Pi^b = \overline{\Pi}^b = 0$ and substitute into the manufacturer's profit (14), we can obtain the following profit function:

$$\pi_f = \sum_{j \epsilon s^f} (p_j^w - c_j^f) \times M \times s_j^f + \sum_{j=1}^{J} (p_j - p_j^w - c_j^b) \times M \times s_j^f - \sum_{j \notin s^f} F_j^f \tag{2.15}$$

This expression shows that each syrup manufacturer fully internalizes the entire markup and maximizes profit by choosing wholesale prices, and retail price (in the case of RPM) for its products conditional on rivals' products. Note that the last term of the above expression $\sum_{j \notin s^f} F_j^f$ is constant and can be omitted from the manufacturer's profit function. Further, we can re-write the above profit function as:

$$\sum_{j\epsilon s^f}(p_j - c_j^b - c_j^f) \times M \times s_j^f + \sum_{j=1}^{J}(p_j - p_j^w - c_j^b) \times M \times s_j^f \tag{2.16}$$

Thus, the maximization of this objective function depends on manufacturers, whether they want to impose a two-part tariff with RPM or without RPM.

Model B: *Two-part tariff without RPM*

We now consider the situation of RPM that cannot be used by syrup manufacturers, but they can charge per unit wholesale prices and franchised fee to the bottlers. Thus, bottlers can choose retail prices, and the manufacturer can capture entire bottler surplus using franchised fee. Formally, manufacture f sets wholesale prices in the following maximization problem:

$$\max_{p_j^w \forall j \in s^f} \left\{ \sum_{j\epsilon s^f}(p_j - c_j^f - c_j^b) \times M \times s_j^f(p) + \sum_{j \notin s^f}\left(p_j - p_j^w - c_j^b\right) \times M \times s_j^f(p) \right\} \tag{2.17}$$

Then the first-order conditions are for all $j \in s^f$ yields:

$$\sum_{j\in s^f} \frac{\partial p_j}{\partial p_j^w} s_j(p) + \left(p_j - c_j^f - c_j^b\right) \sum_{j\in s^f} \frac{\partial s_j(P)}{\partial p_j} \frac{\partial p_j}{\partial p_j^w} + \sum_{j\notin s^f}\left(p_j - p_j^w - c_j^b\right)\left[\sum_{j\in s^f} \frac{\partial s_j(p)}{\partial p_j}\frac{\partial p_j}{\partial p_j^w}\right] = 0 \; \forall \in s^f \tag{2.18}$$

which gives total markup in matrix notation as:

$$\Gamma + \gamma \equiv -\left[I * (\Delta_p \times \Delta_b)\right]^{-1} \times \left[\Delta_p \times s(p) + \left((1 - I) * (\Delta_p \times \Delta_b)\right) \times (p - p^w - c^b)\right] \tag{2.19}$$

The above equation $*$ implies element-by-element multiplication, whereas $\times$ implies regular matrix multiplication. I is the $J \times J$ identity matrix. Using bottler markup derived from equation (2.9), we can estimate the above total markup.

Two-part Tariff with RPM

Since syrup manufacturers can capture bottler profits through the franchise fees and retail prices, the wholesale syrup prices have no direct effect on their profit.
The profit maximization problem in (2.16) can be written as:

$$\max_{p_j \forall j \in s^f} \left\{ \sum_{j \epsilon s^f} (p_j - c_j^f - c_j^b) \times M \times s_j^f(p) + \sum_{j \notin s^f} \left(p_j - p_j^w - c_j^b\right) \times M \times s_j^f(p) \right\} \quad (2.20)$$

Thus, we can write the first-order conditions for all $j \epsilon s^f$ yields:

$$s_j^f(p) + \sum_{j \in s^f} \left(p_j - c_j^f - c_j^b\right) \frac{\partial s_j^f(P)}{\partial p_j} + \sum_{j \notin s^f} \left(p_j - p_j^w - c_j^b\right) \frac{\partial s_j^f(P)}{\partial p_j} = 0 \; \forall \; j \in s^f \quad (2.21)$$

However, wholesale prices have a strategic influence on the manufacturer's profits (i.e., through their competitor's profit). Rey and Vergé (2004) show that multiple equilibria (a continuum) can be considered in this situation. Following Rey and Vergé (2004), we focus on two possible equilibria: (1) the case when the wholesale price is equal to the manufacturer's marginal cost of production ($p_j^w = c_j^f$) ; (2) the case when the bottler's price-cost margins are zero ($p_j - p_j^w - c_j^b = 0$).

Model C: *Two-part Tariff with RPM- wholesale price is equal to manufacturers marginal cost*

In this case, we assume that each manufacturer sets their wholesale prices equal to their marginal cost of production, $p_j^w = c_j^f$ and the first-order conditions can be expressed:

$$s_j^f(p) + \sum_{j=1 \ldots j} \left(p_j - c_j^f - c_j^b\right) \frac{\partial s_j^f(P)}{\partial p_j} = \; 0 \; \forall \; j = 1 \ldots J \quad (2.22)$$

which gives total markup (the sum of manufacturer and bottlers markup) in matrix notation from equation (2.22) as:

$$\Gamma + \gamma \equiv p - c^f - c^b = -[\Delta_b]^{-1} \times s(p) \tag{2.23}$$

The product ownership structure matrix in the above expression is $T_f = T_b = T_1$, where T_1 is a matrix of ones. The above total markup is equivalent to the scenario in which the industry vertically integrated and horizontally collusive.

Model D: *Two-part Tariff with RPM- Bottler markup equal to zero*

In this case, we assume that bottler markup is equal to zero, implying $p_j - p_j^w - c_j^b = 0$. The first-order condition in (2.21) reduces to:

$$s_j(p) + \sum_{j \in s^f} \left(p_j - c_j^f - c_j^b\right) \frac{\partial s_j^f(P)}{\partial p_j} = 0 \; \forall \, j \in s^f \tag{2.24}$$

Thus, the total markup can be represented using matrix notation as:

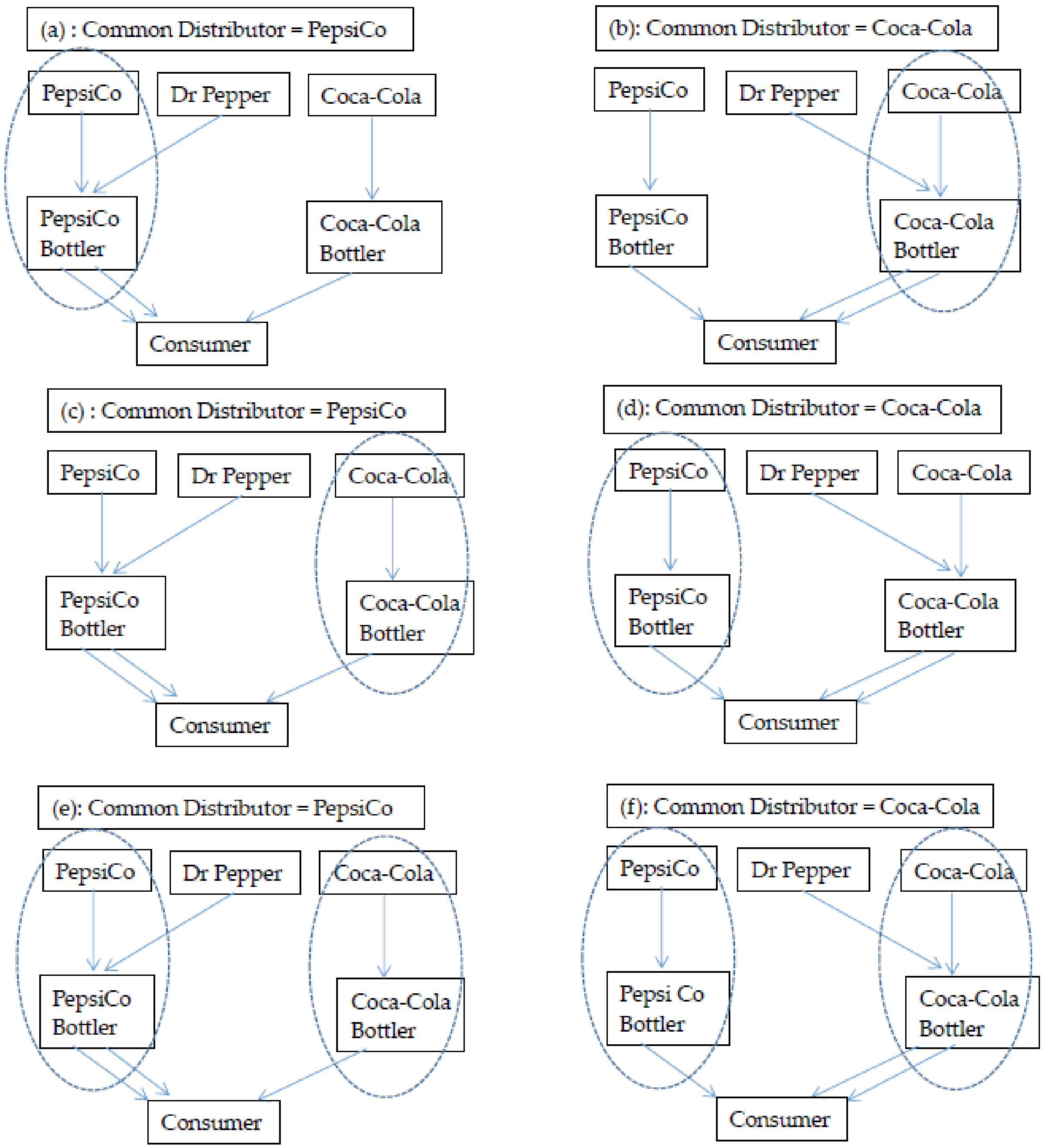
$$\Gamma + \gamma \equiv p - c^f - c^b = -\left[T_f * \Delta_b\right]^{-1} \times s(p) \tag{2.25}$$

The above total markup can be expressed in the situation in which syrup manufacturers actively compete in wholesale prices with rivals and leaving zero markups to bottlers.

2.3.2.3 After Vertical Integration

We now consider models involving pricing contracts after the vertical integration in the U.S. CSD industry. In this case, we consider the situation that the syrup manufacturers offer different pricing contracts to their corresponding bottlers. More specifically, vertically integrated upstream manufacturers and downstream bottlers eliminated the double marginalization, whereas all other upstream manufactures in the market offer different pricing contracts (linear or non-linear) to their corresponding bottlers. Figure 2.1 illustrates the graphical example of the market structures and vertical integration of the CSD industry. For example, Figure 2.1a shows the situation in which the downstream PepsiCo bottler is integrated with an upstream PepsiCo syrup manufacturer and eliminated the double marginalization, whereas DPSG and Coca-Cola syrup manufactures in the market did not own the downstream bottler but offer different pricing contracts to their corresponding bottlers. Similarly, we can observe there are some other possible market structures (i.e., b, c, d, e, and f) in the CSD industry.

Figure 2.1: Illustrates the Market Structures and Vertical Integration of the CSD industry



Model E: *Vertically integrated upstream syrup manufacturer and downstream bottler eliminated the double marginalization whereas all other unintegrated manufactures use TPT without RPM*

In this case, we consider that vertically integrated upstream and downstream firms eliminated the double marginalization in a manner that $p_j^w = c_j^f$. The markup of the vertically integrated structure is given by:

$$\Gamma + \gamma \equiv p - c^f - c^b = -[T_{VI} * \Delta_b]^{-1} s(p) \tag{2.26}$$

Effectively, the vertically integrated product ownership structure matrix denoted T_{VI}, treats products owned by integrated upstream and downstream firms. Other upstream unintegrated syrup manufacturers may offer a two-part tariff without RPM. In other words, all unintegrated bottlers choose independently retail prices charged to consumers. Thus, all other manufacturers' markups are determined by equation (2.19).

Model F: *Vertically integrated upstream manufacturer and downstream bottler eliminated the double marginalization whereas all other unintegrated manufactures use TPT with RPM-— wholesale prices set equal to manufactures marginal cost*

In this case, we consider that vertically integrated upstream and downstream firms eliminated the double marginalization. The markup for vertically integrated products is given by equation (2.26). We assume that other syrup manufacturers may offer TPT with RPM and set retail prices in a manner that $p_j^w = c_j^f$. In this case, all other manufacturers' markups are given by equation (2.23).

Model G: *Vertically integrated upstream manufacturer and downstream bottler eliminated the double marginalization whereas all other unintegrated manufactures use TPT with RPM—Bottler's markup equal to zero*

In this case, we consider that vertically integrated upstream and downstream firms eliminated the double marginalization. The markup for vertically integrated products is given by equation (2.26). We assume that other syrup manufacturers may offer TPT with RPM and set retail prices when $p_j^w \neq c_j^f$. In this case, all other manufacturers' markups are given by equation (2.25).

Model H: *Vertically integrated upstream manufacturer and downstream bottler eliminated the double marginalization, whereas all other unintegrated manufacturers use "sequential price-setting game" with bottlers.*

Finally, we consider that vertically integrated upstream and downstream firms eliminated the double marginalization. The markup for vertically integrated products is given by equation (2.26). For unintegrated products, we consider the sequential price-setting game between manufacturers and bottlers and further assume Nash-Bertrand competition among both manufacturers and bottlers. It corresponds to the markup of double-marginalization resulting from the linear pricing model. In this case, total markups are determined by equation (2.12).

2.3.3 Marginal Cost Specification

We can estimate the price-cost margins for each supply models according to their expressions obtained in the previous section. Let the different supply models be denoted by l, i.e $l = A, B, C, \ldots.., H$, for product j at time t under model l. The notation, Γ^l denote the vector of manufactures markups, and γ^l represents a vector of markups by bottlers in supply model l. Thus, total markups (syrup manufacturer plus bottler) generated by supply model l is:

$$\Gamma^l + \gamma^l = p - c^f - c^b \tag{2.27}$$

Based on equation (2.27), we recover the sum of bottlers and syrup manufacturers' marginal costs as follows:

$$\mathrm{p} - \Gamma^l(\hat{\lambda}_d) + \gamma^l(\hat{\lambda}_d) = c^f - c^b = \hat{c}_T \tag{2.28}$$

where markup terms, $\Gamma^l(\hat{\lambda}_d)$ and $\gamma^l(\hat{\lambda}_d)$ are a function of demand parameters, and $\hat{c}_T$ is $J \times 1$ vector of aggregate marginal cost for supplying each product: p is retail prices from the data. The left-hand side of the equation (2.28) is completely known, and the researcher does not need data on the marginal cost.

Assume now the following specification for the marginal cost function:

$$\mathrm{p} - \Gamma^l(\hat{\lambda}_d) + \gamma^l(\hat{\lambda}_d) = \exp(w_{jm}\psi + d_j + d_m + d^f + d^b + \varepsilon_{jm}) \tag{2.29}$$

where w_{jm} is a vector of variables that shift the marginal cost of product j at market m and ψ is the vector of parameters associated with w_{jm}: d_j represents the product (brand-store) fixed effects and d_m is the market (county-year-month) fixed effects that capture the unobserved determinants of demand. Moreover, d^f and d^b are manufacturer-specific and bottler-specific fixed effects. ε_{jm} is an unobservable random shock to the cost. Finally, we can estimate the equation (2.29) under each of the different supply models, $l = A, B, C, \ldots., H$. and use the non-nested statistical test developed by Vuong (1989) to identify which supply model(s) that explain the pricing behavior among syrup manufacturers and bottlers in the CSD industry during pre and post vertical integration, respectively.

2.3.3.1 Testing between alternative models

Based on equation (2.29), we estimate eight different supply models to identify the best model that explains the data in the CSD industry. Denoting l and l' are two different supply models obtain from estimates of the alternative supply models, $l = A, B, C, \ldots., H$. By using equation (2.29), we can obtain a likelihood ratio for comparing Model l and Model l' is given by:

$$LR = \sum_{n=1}^{N} (LL_n^l - LL_n^{l'}) \tag{2.30}$$

where N is the sample size: LL_n^l is the optimal value of the log-likelihood function[7] for Model l evaluated at observation n. Vuong (1989) shows that the likelihood ratio statistic in equation (2.30) can be normalized by its variance:

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[7] Assuming the error term of supply Model l follows a normal distribution, the log likelihood values for Model l can be denoted by:

$$LL_n^l = log\left[\varphi\left(\frac{\hat{c}_T - w_n\hat{\psi}}{\hat{\sigma}_l}\right)\right]$$

where $\hat{\sigma}_l$ is the computed standard deviation of the residuals from Model l: $\hat{\psi}$ is a vector of marginal cost parameters that estimates for Model l: $\varphi(.)$ is the standard normal distribution. Similarly, we estimate log likelihood values for alternative supply Model l'.

$$v^2 = \frac{1}{N}\sum_{n=1}^{N}\left(LL_n^l - LL_n^{l'}\right)^2 - \left[\frac{1}{N}\sum_{n=1}^{N}(LL_n^l - LL_n^{l'})\right]^2 \tag{2.31}$$

The resulting non-nested test statistic is:

$$Q = N^{-0.5}\frac{LR}{v} \tag{2.32}$$

Where Q is asymptotically distributed standard normal under the null hypothesis that the two models being compared by the test are asymptotically equivalent. For a one-tail test at a 5% significance level, $Q > 1.64$ implies the Model l' is statistically rejected in favor of Model l: and $Q < -1.64$ implies the Model l is statistically rejected in favor of Model l', while $-1.64 < Q < 1.64$ implies that it cannot statistically distinguish between the two models being compared.

2.3.4 Demand Estimation

In the demand estimation, our goal is to derive the coefficient of estimates that produce product market share close to observed market share across all consumers. Following the literature on discrete choice models of demand, we assume that unobserved product characteristics, ξ_{jm} are uncorrelated with changes in the observed non-price product characteristics, x_{jm}. Thus, we included brand dummy variables in the mean utility function to captures unobserved product characteristics (ξ_{jm}) and the factors that do not vary by market (x_{jm}). Following, Nevo (2000), we estimate the demand parameter using the Generalized Method of Movements (GMM).

Interacting the instruments with ξ_{jm} in the demand model, we construct moment and formulate the GMM optimization problem as follow;

$$\min_{\alpha,\beta,\theta} \xi' Z \phi^{-1} Z' \xi \tag{2.33}$$

where Z is the matrix of instruments that are orthogonal to the error term; ϕ^{-1} is the standard weighting matrix, and θ represents the nonlinear parameters of Γ and δ. ξ is the function of parameters, where $\delta_{jm} - \left(d_j + x_{jm}\beta_i - \alpha_i p_i\right)$. Notice that δ_{jm} is unknown in equation (2.34), and its value implicitly depends on parameter vector θ. Following the literature Berry et al., (1995) and Nevo (2000), δ_{jm} can be obtained numerically by solving:

$$S_{jm} = s_{jm}\left(\delta_{jm}, \theta\right) \tag{2.34}$$

This implies the form of equating observed share to the estimated product share[8] from the mean utility across all consumers. By guessing the initial values for θ, and using the numerical algorithm, we can solve for the values of δ_{jm} that satisfy equation (2.34). With the values of δ_{jm}, we can formulate and minimize the optimization problem of equation (2.33) to recover estimates of α. We then apply a minimum distance estimator to recover β by using estimated brand fixed effects as proposed by Nevo (2000).

Using estimated brand fixed effects under the GMM procedure; we apply the GLS regression to estimate the coefficient of β as follow (See Nevo, 2000):

$$\hat{\beta} = (x'\psi^{-1}x)^{-1}x'\psi^{-1}\hat{d} \tag{2.35}$$

where $\hat{d}$ denotes the $J \times 1$ vector of brand coefficients estimated from the GMM procedure; ψ is the variance-covariance matrix of estimated brand dummy coefficients, and x is the $J \times K$ matrix of non-price characteristics that are invariant across the market.

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[8] The predicted market share given in equation (2.10) can be approximated by:

$$s_{jm} = \frac{1}{ns}\sum_{i=1}^{ns} \frac{exp^{\delta_{jm}+[-p_{jm}, x_{jm}](\Gamma D_i + \delta v_i)}}{1 + \sum_{l=1}^{J} exp^{\delta_{lm}+[-p_{lm}, x_{lm}](\Gamma D_i + \delta v_i)}}$$

where ns represents random draws of individuals (=200) from the distribution of v and D.

2.3.5 Instruments

Price is potentially endogenous because prices will depend on the observed and unobserved product and consumer characteristics. As such, the estimated coefficient on the price will be inconsistent. Thus, we need to find an appropriate instrument for the price when estimating demand. Other than syrup, the main components of bottler's costs include high fructose corn syrup (HFCS), packaging (e.g., aluminum for a can), electricity prices, and transportation. The prices of this input-cost are valid instruments for the CSD price in-demand model because price decision is exogenous to the cost side variables. In other words, this input-cost is uncorrelated to CSD demand shocks but correlated with the CSD price through the production cost of CSD. One set of instruments we use for the CSD price is the interaction between brand dummy variables and input-cost prices, as in Villas-Boas (2007). The included input-cost prices are: monthly wholesale prices for both HFCS55 and HFCS42 (USDA Sugar and Sweeteners Yearbook) for Coca-Cola/PepsiCo and DPSG products respectively and monthly average electricity prices (cents/KWh) on industrial sectors for each state (US Department of Energy, Energy Information Administration). The distribution of CSD products is another main component of bottlers' costs. Thus, we consider driving distance from the closer distributer to the designated retailer as a proxy for transportation costs. In the last set of instrumental variables, we consider the characteristics of competing products (the so-called "BLP instruments") suggested by Berry et al. (1995). These characteristics are appropriate instruments because they are excluded from the indirect utility function and correlated with prices via the markups. Thus, we consider marketing information in the scanner data to correspond to the ordinal variables of feature, display, and promotion as characteristics of competing products. We use these variables to compute the BLP instruments as a deviation from the average of other competing products.

2.3.6 Supply Estimation

After having estimated the demand model, and the following equation (2.28), we estimate the marginal cost for different supply models. Then we follow the equation (2.29) and estimate the marginal cost function using the Ordinary Least Square (OLS) method. Thus, we estimate eight different supply equations correspond to their different markups.

2.4 Results

2.4.1 Demand

Table 2.6 shows the results of the estimates of the standard logit model and the random coefficient logit model for 12 oz 6 pack and 20 oz bottles. Estimates of the standard logit model are based on OLS and 2SLS methods. The estimates show that there is a significant difference in the OLS price coefficient estimate compared to the 2SLS price coefficient estimates, implying that the price coefficient is biased if instruments are not used for the price. The Wu-Hausman test is statistically significant at 1% level, suggesting that the price is exogenous. However, our discussion mainly focuses on the random coefficient logit model, because the standard logit model does not take to the account of heterogeneity in consumer taste. The parameters estimate of the mean utility for the random coefficient model are presented in columns 3,4, 5, and 8.9,10 in Table 2.6 for 12 oz 6 pack and 20 oz bottles respectively. The parameters estimate of the price and non-price characteristics are associated with consumer heterogeneity.

2.4.1.1 Demand Estimation Results of 12 oz 6 pack

In Table 2.6, on average, the coefficient of the price is statistically significant at 1% level of significance, and the negative impact on utility implies that individuals have a strong negative valuation on price. The estimated coefficient of the "package type" dummy variable is negative, suggesting that, on average individual get lower utility consuming soda from can vs. bottle. Research on exploring the reasons[9] for packaging and difference of the taste emphasizes that more than 60% of people like bottles (plastic or glass) than cans. Reasons for this preference are (i) easier to pour from, (ii) able to pop the lid back on in between sips (iii) feel tastes better, and carry easily in a bag. Thus, our results seem to be more consistent with consumer prefer bottle vs. can. As shown in the results of 12 oz 6 packs, the consumer has, on average, a significant and negative valuation of sodium, caffeine and calorie content. Concerning nutrition standpoint, the sugar content is positively related to the average consumers' utility over health concerns. It may reflect the evidence to the link between the carbonated beverage and chronic diseases. The estimated

[9] http://www.coca-cola.co.uk/stories/bottle-vs-can-how-do-you-prefer-your-coca-cola

mean parameters for Coca-Cola and PepsiCo company implies that consumers have a higher intrinsic valuation of Coca-Cola and PepsiCo products relative to DPSG products.

The fourth column displays the taste variation parameters for product characteristics, which are unobserved to the researcher. The standard deviations of the calorie and sodium coefficient are significant, suggesting that consumers' are heterogeneous concerning their taste for calorie and sodium. The fifth column measures how characteristics of taste vary with income. The interaction variable of calorie with income is statistically significant at 1% level, implying that consumers with higher income are smaller disutility on calories.

2.4.1.2 Demand Estimation Results of 20 oz bottles

In Table 2.6, the price coefficient is negative and statistically significant at the 1% significance level, suggest that, on average, consumers are less likely to consume 20 oz bottles, the higher its price, ceteris paribus. Similar to the results of the 12 oz 6 pack, the consumers have a negative valuation of caffeine and calorie content. In contrast, the results show that consumers have, on average, a negative valuation of sugar and a positive valuation of sodium content. From a nutrition standpoint, the positive coefficient for sodium may reflect a preference for flavor over nutrition concerns. This positive consumer valuation is given the link between the carbonated .beverage and blood pressure. As shown by the descriptive statistics, the average content of sodium in 20 oz bottles is two times larger than the average content of sodium in 12 oz 6 pack products. Finally, the results of the fixed effects of CSD company imply that, relative to DPSG products, consumers have a higher intrinsic value of PepsiCo and Coca-Cola products.

2.4.2 Demand Elasticities

Using the structural demand estimates, we compute the own and cross-price elasticity for each manufacturer during pre and post vertical integration periods of Coca-Cola and PepsiCo. Overall, the own-price elasticity estimates do not highly variate across manufacturers. Moreover, Table 2.7 shows that the estimated own-price elasticities for each manufacturer in the pre-integration period are similar to the post-integration period of both Coca-Cola and PepsiCo. As compared to the 12 oz 6 pack products, Table 2.7 shows that manufacturers selling 20 oz bottles are less price-sensitive in the pre-integration and post-integration period. The own-price elasticity for upstream manufacturers (Coca-Cola, PepsiCo, and DPSG) selling 12 oz 6 pack, range between -4.7 to -5.1. In Table 2.7, for example, the mean own price elasticity for products of 12 oz 6 pack sold by Coca-Cola is -4.76, implying on average that increasing the price of the Coca-Cola brand by 1% leads to decreases the consumer demand for these products by 4.76%. The magnitude of these estimated own-price elasticities is similar to other studies in the CSD market used by scanner data. Dube (2005) reported own price elasticities ranging from -3 to -6 in the Denver area, while Dhar et al. (2005) estimated own-price elasticities between -2.7 to -4.4. Chan (2006) reported own price elasticities ranging from -5 to -11 at a household level in CSD. For the CSD in the EU market, Bonnet and Requillart (2012) found elasticities ranging from -2 to -4.

We also report the average of the cross-price elasticity of all products across the manufacturer between 12 oz 6 pack and 20 oz bottles in Table 2.7. All the estimated cross-price elasticities are positive as expected, implying that CSD products are substitutes. There is a variation in mean cross-price elasticity across manufacturers in 12 oz 6 pack. Manufacturers experience lower cross-price elasticity in the post-integration period compared to the pre-integration period of both Coca-Cola, PepsiCo, and DPSG for products of 20 oz bottles. In Table 2.7, for example, the average cross-price elasticity between Coca-Cola and DPSG in the pre-integration of Coca-Cola implies that if the price of Coca-Cola products increases by 1%, then the quantity demand for DPSG products increases by 0.0021%.

It is interesting to note that the cross-price elasticities are quite small when compared to the own price elasticities. This implies that consumers are highly sensitive to CSD prices for their chosen brands and will substitute to the outside good compares to another brand of CSD. The cross-price elasticity for the Coca-Cola products relatively higher compared with other manufacturer's products in both pre-integration and post-integration periods implies that consumers consider Coca-Cola's products as closer substitutes to other manufacturer's products.

Table 2.6: Demand Estimation Results of 12 oz 6 pack and 20 oz bottles

	12 oz 6 pack					20 oz bottles				
	Standard Logit Model		Random coefficient logit model			Standard Logit Model		Random coefficient logit model		
	OLS (Means)	2SLS (Means)	RCM (Means)	Standard Deviations	Interactions with Income	OLS (Means)	2SLS (Means)	RCM (Means)	Standard Deviations	Interactions with Income
Variable	α, β	α, β	α, β	Γ	δ	α, β	α, β	α, β	Γ	δ
Price	-3.4489***	-6.8953***	-109.3401***	-0.4261		-0.3170***	-39.8314***	-46.1316***	-3.887	
	(0.1684)	(1.4300)	(3.8226)	(5.5130)		(0.0279)	(0.9621)	(1.8740)	(8.9303)	
Package Type	-0.2815***	-0.3020***	-1.9431***			-	-	-	-	
	(0.0127)	(0.0145)	(0.0679)							
_Cons	0.0061 [a]	0.0028 [a]	0.2711*** [a]	-0.0486	-0.0328	-0.3281*	-0.3146	-4.2404***	0.2577	-0.4546
	(0.0001)	(0.1068)	(0.0197)	(0.2443)	(0.2928)	(0.1923)	(0.3578)	(0.1560)	(1.6346)	(1.5910)
Sodium	0.00009[a]	0.0002 [a]	-0.0711*** [a]	-5.8113***	0.0035	0.00003*[a]	0.0002***[a]	0.0072***[a]	0.1448	-0.2456
	(0.0001)	(0.0001)	(0.0005)	(0.3907)	(0.3021)	(0.0000)	(0.0001)	(0.0007)	(1.5879)	(2.1360)
Calories	-0.0015*** [a]	-0.0017*** [a]	-0.0107*** [a]	-3.7602*	3.7535***	0.00003***[a]	0.0006*[a]	-0.0052*[a]	8.3896	0.7108
	(0.0002)	(0.0002)	(0.0007)	(2.1119)	(1.7988)	(0.0000)	0.0000	(0.0027)	(5.5446)	(96.695)
Sugar	0.0008 [a]	0.0013* [a]	0.0121*** [a]			-0.0001*** [a]	-0.0026***[a]	-0.0082***[a]		
	(0.0007)	(0.0007)	(0.0022)			0.0000	(0.0001)	(0.0001)		
Caffeine	0.0005** [a]	0.0006*** [a]	-0.0132*** [a]			-0.000017*[a]	-0.000027a	-0.0005*[a]		
	(0.0001)	(0.0001)	(0.0005)			(0.0000)	(0.0000)	(0.0003)		
Coke	0.0098 [a]	0.0009 [a]	0.8232*** [a]			0.0047***[a]	0.06544***[a]	-0.0413***[a]		
	(0.0072)	(0.0085)	(0.0211)			(0.0010)	(0.0032)	(0.0176)		
Pepsi	0.0583*** [a]	0.0543*** [a]	0.8644*** [a]			0.0033***[a]	0.05454***[a]	0.1638***[a]		
	(0.0085)	(0.0087)	(0.0229)			(0.0011)	(0.0030)	(0.0295)		
GMM Objective			0.0218					0.0002		
N	151366	151366	151366			813588	813588	813588		
Fixed effects										
Month	Yes	Yes	Yes			Yes	Yes	Yes		
Year	Yes	Yes	Yes			Yes	Yes	Yes		
County	Yes	Yes	Yes			Yes	Yes	Yes		
Brand	Yes	Yes	Yes			Yes	Yes	Yes		
Wu -Hausman		8.17878***					5871.63***			

Standard errors in parentheses, ***, **,* indicate statistical significance at 1%, 5%, and 10%, respectively, [a] Estimates from a Minimum Distance Procedure, see Nevo (2000).

Table 2.7: Manufacturer's mean own and cross-price elasticity for all products of 12 oz 6 pack and 20 oz bottles

	12 oz 6 pack			20 oz bottles		
Coca-Cola Pre-integration	Coca-Cola	PepsiCo	Dr Pepper Snapple Group	Coca-Cola	PepsiCo	Dr Pepper Snapple Group
Coca-Cola	-4.763	-	-	-3.3117	-	-
PepsiCo	0.0035	-4.7017	-	0.0022	-3.2847	-
Dr Pepper Snapple Group	0.0164	0.0054	-4.8182	0.0021	0.0022	-3.1601
Coca-Cola Post-integration	Coca-Cola	PepsiCo	Dr Pepper Snapple Group	Coca-Cola	PepsiCo	Dr Pepper Snapple Group
Coca-Cola	-5.1228	-	-	-3.36259	-	-
PepsiCo	0.0038	-5.0325	-	0.0016	-3.5732	-
Dr Pepper Snapple Group	0.0135	0.0055	-5.1911	0.0015	0.0016	-3.4491
PepsiCo Pre-integration	Coca-Cola	PepsiCo	Dr Pepper Snapple Group	Coca-Cola	PepsiCo	Dr Pepper Snapple Group
Coca-Cola	-4.7013	-	-	-3.2609	-	-
PepsiCo	0.0034	-4.6797	-	0.0024	-3.2496	-
Dr Pepper Snapple Group	0.0163	0.0055	-4.7516	0.0023	0.0023	-3.1154
PepsiCo Post-integration	Coca-Cola	PepsiCo	Dr Pepper Snapple Group	Coca-Cola	PepsiCo	Dr Pepper Snapple Group
Coca-Cola	-5.0921	-	-	-3.5873	-	-
PepsiCo	0.0038	-5.0188	-	0.00168	-3.5313	-
Dr Pepper Snapple Group	0.0143	0.0053	-5.1506	0.00161	0.00163	-3.4137

Table 2.8: Price-cost Margin and Recovered Marginal Cost ($ per oz)

	12 oz of 6 pack				20 oz bottles			
Models	Total Margin Mean Percent of Price (Lerner Index) (%)	Total Recovered Marginal Cost Mean Levels	Total Margin Mean Percent of Price (Lerner Index) (%)	Total Recovered Marginal Cost Mean Levels	Total Margin Mean Percent of Price (Lerner Index) (%)	Total Recovered Marginal Cost Mean Levels	Total Margin Mean Percent of Price (Lerner Index) (%)	Total Recovered Marginal Cost Mean Levels
	Coca-Cola Pre-Integration		PepsiCo Pre-Integration		Coca-Cola Pre-Integration		PepsiCo Pre-Integration	
A	46.5213***	0.0247***	47.1884***	0.0241***	60.8990***	0.0293***	63.8425***	0.0267***
	(0.198)	(0.000)	(0.132)	(0.000)	(0.024)	(0.000)	(0.024)	(0.000)
B	23.9294***	0.0341***	24.3145***	0.0335***	32.4138***	0.0494***	32.8464***	0.0485***
	(0.091)	(0.000)	(0.056)	(0.000)	(0.001)	(0.000)	(0.011)	(0.000)
C	24.7959***	0.0337***	25.2343***	0.0331***	32.5127***	0.0494***	32.9544***	0.0484***
	(0.097)	(0.000)	(0.067)	(0.000)	(0.001)	(0.000)	(0.011)	(0.000)
D	23.1596***	0.0345***	23.4159***	0.0339***	31.7567***	0.0499***	32.1283***	0.0490***
	(0.086)	(0.000)	(0.039)	(0.000)	(0.009)	(0.000)	(0.011)	(0.000)
	Coca-Cola Post-Integration		PepsiCo Post-Integration		Coca-Cola Post-integration		PepsiCo Post-Integration	
E	21.6374***	0.0377***	21.8597***	0.0374***	29.3903***	0.0564***	29.7881***	0.0555***
	(0.123)	(0.000)	(0.129)	(0.000)	(0.010)	(0.000)	(0.009)	(0.000)
F	21.9902***	0.0267***	22.2916***	0.0281***	29.4392***	0.0229***	29.8421***	0.0259***
	(0.125)	(0.000)	(0.132)	(0.000)	(0.010)	(0.000)	(0.009)	(0.000)
G	21.3442***	0.0270***	21.5635***	0.0284***	29.1258***	0.0231***	29.4753***	0.0262***
	(0.122)	(0.000)	(0.129)	(0.000)	(0.010)	(0.000)	(0.009)	(0.000)
H	38.7907***	0.0299***	40.1001***	0.0292***	41.8890***	0.0469***	44.2298***	0.0447***
	(0.357)	(0.000)	(0.330)	(0.000)	(0.040)	(0.000)	(0.034)	(0.000)

Standard errors in parentheses, and * p<0.1, ** p<0.05, *** p<0.01

2.4.3 Computed Markup and Recovered Marginal cost Estimates

Using random coefficient demand estimates, we computed the upstream and downstream price-cost markups for different supply models and recovered the total marginal cost by subtracting the estimated total margins from retail prices (See equation 2.28). Table 2.8 summarized the statistics on total price-cost markup and recovered total marginal costs for 12 oz 6 pack and 20 oz bottles during pre-integrated and post-integrated periods of Coca-Cola and PepsiCo. The Lerner Index indicates the ratio of markup to price. Table 2.8 shows that on average total price-cost margins and total marginal costs are greater for 20 oz bottles compared to 12 oz 6 pack products for all considered supply models during pre-integrated and post-integrated periods of Coca-Cola and PepsiCo. Overall, the average total price-cost margins and total marginal costs do not differ across pre-integration and post-integration of Coca-Cola and PepsiCo for both sizes.

As expected, on average computed total margin is largest correspond to the supply model of pure double-marginalization (Model A) in the pre-integration periods of Coca-Cola and PepsiCo for both sizes. For example, the average total margin retrieved from Model A during the Coca-Cola pre-integration period is 60% for products of 20 oz bottles. However, the average total margin recovered from the nonlinear pricing models is lower in the pre-integration period for both sizes.

The average computed total margin is largest for the supply model H in the post-integration period for both sizes. This is not surprising since Model H indicates that vertically integrated upstream and downstream firms eliminated the double marginalization whereas all other unintegrated upstream and downstream firms are using "sequential price-setting game" between manufacturers and bottlers. However, mean total margin from the remaining supply models (Model E, F, and H), which follow the integrated firms eliminated the double marginalization, whereas all other unintegrated firms use nonlinear pricing models are lower the post integrated period. Moreover, the average total margin retrieved from model G is the lowest in the post integrated period for both sizes of CSD products. Overall, the mean total margins that retrieved from the Model E, F, and G are lower during the post-integration period compared to supply models of pre-integration period for both sizes.

The mean total marginal costs recovered from these supply models do not significantly differ during the pre-integrated period and the post-integrated period. Therefore, the decrease in mean total margins of Coca-Cola and PepsiCo products over the post-integrated period is less likely due to cost factors.

2.4.4 Results from Statistical Model Selection

Table 2.9 presents the non-nested likelihood ratio test statistics (Q- the Vuong test from equation 2.32) for pairwise comparison of the alternative supply models during pre-integration and post-integration periods for both sizes of CSD products. In each column is the model being tested, and each raw is the alternative model being used to test. If the non-nested likelihood ratio test is greater than 1.64 implies that the alternative model is rejected and in favor of the supply model in the column. In other words, the column model is a better fit the data compared to the model in a row. If the test statistic value is negative and less than -1.64, then the alternative model in the row is performed well. However, if test statistics, $-1.64 < Q < 1.64$ implies that we cannot statistically distinguish between the model in the column compared to the model in the row.

From the Vuong test, the best approximate supply model during Coca-Cola and PepsiCo pre-integration periods for both sizes are Model D and outperforms all other models considered. Model D reveals that during the respective pre-integration periods, Coca-Cola and PepsiCo each use nonlinear wholesale pricing to supply their intermediate soft drink products to bottlers, with imposing retail price maintenance (RPM) under zero bottler margins

We now focus on the pairwise statistical comparison of supply models during Coca-Cola and PepsiCo post-integration periods for both sizes. The results reveal that the best approximates price-setting behavior during the post-integration period is Model G suggests that vertically integrated upstream manufacturers and downstream bottlers eliminated the double marginalization, whereas all other upstream manufacturers in the market offer two-part tariff pricing contracts with RPM to downstream bottlers in a manner that leaves zero markups to bottlers.

However, under the assumptions that we made for demand side (e.g., random coefficient logit model) and supply-side (e.g., estimating price-cost margins under the assumption that retailers are passive), the estimated supply models could affect the conclusions when accessing the competition in the presence of vertical integration in CSD industry.

According to supply models that we considered, the best approximate supply models (Model D pre-integration, but Model G post-integration) suggest the following. First, these results consistent with the idea in the CSD industry, which uses nonlinear pricing by manufacturers via two-part tariff contracts. Furthermore, upstream manufacturers invest heavily in their brands by launching massive advertising campaigns to promote brands with ownership of syrup formulations. Thus, it provides bargaining power to upstream manufacturers to use two-part tariff with RPM. Bonnet, and Vincent (2012), also find evidence of two-part tariff contracts with RPM in their analysis of the EU CSD industry. The evidence of nonlinear pricing contracts is also consistent with empirical findings in other industries [the coffee industry, Bonnet et al. (2013); the bottled water industry, Bonnet and Dubois (2010)]. Second, the supply-side analysis has not found any evidence that manufacturers use different pricing strategies with bottlers for different product sizes (12 oz 6 pack and 20 oz bottles) during the pre-integration and post-integration periods. In other words, regardless of different sizes, manufacturers use the same pricing contracts with their corresponding bottlers. Third, the results suggest that unintegrated upstream manufacturers rely on more sophisticated and efficient nonlinear pricing contracts with their corresponding bottlers rather than inefficient linear pricing contracts to compete with vertically integrated manufactures.

Table 2.9: Non-nested Likelihood Ratio Test Statistics for Pairwise Comparisons of Alternate Supply Models during the Pre and Post integration Period of Coca-Cola and PepsiCo

12 oz 6 pack					20 oz bottles				
Coca-Cola Pre-Integration Period	Model A	Model B	Model C	Model D	**Coca-Cola Pre-Integration Period**	Model A	Model B	Model C	Model D
Model A	NA				Model A	NA			
Model B	-63.88	NA			Model B	-162.12	NA		
Model C	-56.39	12.52	NA		Model C	-162.40	9.05	NA	
Model D	-70.47	-10.40	-16.28	NA	**Model D**	-162.10	-9.56	-15.35	NA
Coca-Cola Post-Integration Period	Model E	Model F	Model G	Model H	**Coca-Cola Post-Integration Period**	Model E	Model F	Model G	Model H
Model E	NA				Model E	NA			
Model F	7.02	NA			Model F	7.59	NA		
Model G	-6.97	-9.66	NA		**Model G**	-13.44	-14.07	NA	
Model H	57.01	53.79	65.47	NA	Model H	144.85	144.72	145.63	NA
PepsiCo Pre-Integration Period	Model A	Model B	Model C	Model D	**PepsiCo Pre-Integration Period**	Model A	Model B	Model C	Model D
Model A	NA				Model A	NA			
Model B	-58.14	NA			Model B	-141.40	NA		
Model C	-50.73	11.81	NA		Model C	-141.72	9.83	NA	
Model D	-65.24	-9.75	-15.32	NA	**Model D**	-142.00	-8.14	-14.80	NA
PepsiCo Post-Integration Period	Model E	Model F	Model G	Model H	**PepsiCo Post-Integration Period**	Model E	Model F	Model G	Model H
Model E	NA				Model E	NA			
Model F	8.26	NA			Model F	7.88	NA		
Model G	-8.02	-11.38	NA		**Model G**	-14.69	-14.88	NA	
Model H	40.04	38.76	41.52	NA	Model H	95.09	95.00	95.59	NA

2.5 Conclusion

In this paper, we consider the recent vertical integration that took place in the U.S. CSD industry (i.e., PepsiCo and Coca-Cola acquired their biggest bottlers in 2010) to assess the competition by modeling the vertical contracts between manufacturers and bottlers. Specifically, we analyze the linear and nonlinear vertical pricing contracts between upstream manufacturers and downstream bottlers before and after the vertical integration. We use these vertical contracting models to identify the best supply model in the CSD industry before and after the vertical integration.

Our findings suggest that each manufacturer during Coca-Cola and PepsiCo pre-integration periods charge bottlers nonlinear prices (two-part tariff) with imposing RPM under zero bottler margins. However, the post-integration period, upstream manufacturers that directly own downstream bottlers (CCE, PAS, and PBG), eliminated the double marginalization, whereas all other upstream manufacturers in the market actively compete in wholesale prices with rival manufacturers, leaving zero markups to their corresponding bottlers.

These findings suggest that unintegrated upstream manufacturers rely on efficient nonlinear pricing contracts with their corresponding bottlers rather than inefficient linear pricing contracts to compete with vertically integrated manufacturers. Furthermore, our results consistent with the idea that in the CSD industry, that brand names are strong and thus provide the bargaining power to upstream manufacturers to impose two-part tariff contracts with RPM. Moreover, these results are consistent with empirical findings in the EU CSD industry [Bonnet and Vincent (2012)] and also other industries [the coffee industry, Bonnet et.al. (2013); the bottled water industry, Bonnet and Dubois (2010)], that upstream manufacturers use nonlinear, instead of linear, wholesale price contracts in particular two-part tariff with RPM when selling their input to downstream firms. Finally, we do not find evidence that manufacturers use different pricing contracts with bottlers for different product sizes (12 oz 6 pack and 20 oz single bottles) during pre-integration and post-integration periods of Coca-Cola and PepsiCo.

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Appendix A

Table A:1: Summary statistics: Retail prices ($ per oz) for all brands of 12 oz 6 pack

	N	Mean	S.D.	Max	Min
Retail Price ($ per oz)	151,366	0.0455	0.0097	0.0001	0.2044
Coca-Cola					
TAB	16,641	0.0487	0.0072	0.1128	0.0099
DIET COKE	11,720	0.0406	0.0116	0.1668	0.0124
COKE ZERO	2,165	0.0399	0.0162	0.1559	0.0173
SPRITE ZERO	1,526	0.0463	0.0127	0.1282	0.0137
CAFFEINE FREE DIET COKE	441	0.0469	0.0119	0.1107	0.0182
DIET BARQS	248	0.0469	0.0259	0.1922	0.0137
DIET COKE WITH LIME	216	0.0432	0.0075	0.0690	0.0186
SEAGRAMS	44	0.0436	0.0127	0.0687	0.0142
DIET CHERRY COKE	37	0.0381	0.0049	0.0497	0.0267
DIET COKE WITH SPLENDA	32	0.0407	0.0092	0.0684	0.0158
VAULT ZERO	10	0.0379	0.0057	0.0483	0.0276
DIET MELLO YELLO	3	0.0400	0.0014	0.0414	0.0385
DIET SPRITE	2	0.0380	0.0147	0.0484	0.0275
NORTHERN NECK	2	0.0360	0.0079	0.0416	0.0304
PepsiCo					
DIET MOUNTAIN DEW	3,430	0.0394	0.0086	0.1168	0.0123
DIET PEPSI	7,135	0.0412	0.0078	0.1101	0.0123
CAFFEINE FREE DIET PEPSI	1,520	0.0436	0.0079	0.0973	0.0137
SIERRA MIST FREE	371	0.0424	0.0137	0.1089	0.0136
DIET SIERRA MIST	223	0.0441	0.0042	0.0531	0.0356
DIET WILD CHERRY PEPSI	197	0.0405	0.0100	0.0991	0.0139
PEPSI ONE	136	0.0425	0.0057	0.0552	0.0276
DIET PEPSI WITH LIME	31	0.0387	0.0113	0.0485	0.0167
MOUNTAIN DEW CAFFEINE FR	12	0.0405	0.0059	0.0483	0.0300
DIET PEPSI VANILLA	7	0.0273	0.0073	0.0377	0.0173
DPSG					
IBC	65,128	0.0474	0.0073	0.2044	0.0164
CANADA DRY	14,398	0.0439	0.0112	0.1312	0.0001
CANFIELD	12,133	0.0457	0.0115	0.1651	0.0125
A & W	7,258	0.0418	0.0096	0.1657	0.0006
DIET DR PEPPER	3,809	0.0426	0.0123	0.1297	0.0138
DIET RITE	1,072	0.0451	0.0150	0.1387	0.0137
DIET 7 UP	1,044	0.0503	0.0148	0.1452	0.0208
DIET SCHWEPPES	131	0.0425	0.0090	0.0765	0.0174
CRUSH	129	0.0407	0.0084	0.1079	0.0270
CAFFEINE FREE DIET DR PEPPER	52	0.0344	0.0116	0.0626	0.0174
DIET CHERRY 7 UP	29	0.0303	0.0090	0.0414	0.0156
DIET CHERRY VANILLA DR PEPPER	25	0.0256	0.0101	0.0405	0.0174
DIET VERNORS	8	0.0382	0.0067	0.0481	0.0276

Table A:2: Summary statistics: Retail prices ($ per oz) for all brands of 20 oz bottles

	N	Mean	S.D.	Max	Min
Retail Price ($ per oz)	813,588	0.0755	0.0099	0.0075	0.2801
Coca-Cola					
CAFFEINE FREE DIET COKE	113,503	0.0767	0.0072	0.1127	0.0117
COKE ZERO	111,316	0.0767	0.0075	0.1315	0.0125
DIET BLACK CHERRY VANILLA COK	44,083	0.0766	0.0080	0.1212	0.0104
DIET CHERRY COKE	37,190	0.0771	0.0080	0.1118	0.0163
DIET COKE	16,500	0.0776	0.0089	0.1097	0.0125
DIET COKE WITH LEMON	3,711	0.0813	0.0110	0.1222	0.0357
DIET COKE WITH LIME	1,001	0.0653	0.0129	0.0841	0.0242
DIET COKE WITH SPLENDA	126	0.0682	0.0047	0.0843	0.0554
DIET SPRITE	59	0.0716	0.0030	0.0758	0.0645
DIET VANILLA COKE	7	0.0665	0.0066	0.0693	0.0516
FRESCA	6	0.0751	0.0044	0.0832	0.0696
MR PIBB ZERO	4	0.0716	0.0051	0.0793	0.0688
SPRITE ZERO	4	0.0730	0.0025	0.0743	0.0693
VAULT ZERO	1	0.0794		0.0794	0.0794
PepsiCo					
CAFFEINE FREE DIET PEPSI	111,932	0.0760	0.0076	0.1097	0.0079
DIET MOUNTAIN DEW	91,583	0.0758	0.0078	0.1150	0.0140
DIET MOUNTAIN DEW CAFFEINE FR	26,353	0.0761	0.0076	0.1097	0.0106
DIET MOUNTAIN DEW CODE RED	26,158	0.0759	0.0090	0.1097	0.0081
DIET PEPSI	14,630	0.0730	0.0091	0.1097	0.0120
DIET PEPSI JAZZ	1,635	0.0675	0.0114	0.0896	0.0248
DIET PEPSI VANILLA	1,214	0.0659	0.0127	0.0896	0.0075
DIET PEPSI WITH LIME	375	0.0719	0.0077	0.0892	0.0494
DIET WILD CHERRY PEPSI	311	0.0687	0.0081	0.0809	0.0455
PEPSI ONE	183	0.0719	0.0057	0.0843	0.0495
SIERRA MIST FREE	96	0.0712	0.0054	0.0843	0.0595
DPSG					
A & W	88,893	0.0760	0.0080	0.1497	0.0091
CAFFEINE FREE DIET DR PEPPER	61,626	0.0712	0.0137	0.1574	0.0165
CAFFEINE FREE DIET SUN DROP	46,815	0.0712	0.0143	0.2338	0.0114
DIET 7 UP	8,813	0.0765	0.0362	0.2801	0.0169
DIET CHERRY VANILLA DR PEPPER	2,930	0.0688	0.0087	0.1565	0.0167
DIET DR PEPPER	2,204	0.0726	0.0104	0.0947	0.0262
DIET R C	115	0.0530	0.0090	0.0892	0.0490
DIET RITE	81	0.0768	0.0570	0.2796	0.0441
DIET SCHWEPPES	78	0.0653	0.0075	0.0751	0.0448
7 UP PLUS	49	0.0665	0.0055	0.0793	0.0536
DIET SQUIRT	2	0.0794	0.0001	0.0795	0.0794
DIET SUN DROP	1	0.0545		0.0545	0.0545