Evaluating the Unilateral Price and Variety Effects of Horizontal Mergers

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Introduction

Industrial organization and marketing researchers have known for some time that firms who sell differentiated products compete not only in prices but in variety as well. For example, more than thirty years ago it was argued that ready-to-eat-cereal manufacturers regularly used new product introductions as tools to keep potential competitors at bay (Schmalensee 1978). More recently, researchers have demonstrated that variety decisions (e.g. line length) can be used as competitive weapons and thus should be set in conjunction with profit maximizing prices (Draganska & Jain 2005; Draganska, Mazzeo, & Sime 2009). Furthermore, numerous studies have shown that consumer welfare can be positively or negatively affected by manufacturer and retailer decisions regarding product variety (e.g. Pofahl & Richards 2009; Kim 2004; Hausman 1994). Despite these findings, empirical work in the area of horizontal merger analysis continues to focus primarily on the prediction of post merger price changes and subsequent consumer welfare effects. However, it is clear from the literature that firms who internalize competitive pressures through agglomeration are likely to affect consumer welfare through new price and variety decisions. Thus, empirical work that explores optimal pricing and variety choices within the context of horizontal mergers is in order.

The goal of our research is to gain a better understanding of simultaneous price and variety decisions within the context of a horizontal merger. We achieve this goal by simulating numerous hypothetical mergers between well-known soft drink companies who likely compete in prices and variety. Using data and methods described below, we estimate post-merger price and variety changes associated with each merger.

The remainder of the paper is organized as follows. In section two we briefly outline merger simulation research and show how our study contributes to the existing literature. Section three contains background information on the carbonated soft drink industry and why it is an appropriate category for consideration within our framework. Next we provide details of our modeling approach. In section five we describe our data and estimation techniques and present results and conclusions in section six.

Merger Simulation Research

In "Economic Analysis of Differentiated Products Mergers using Real World Data," Hausman and Leonard (1997) state:

Economic analyses of the competitive effects of mergers in differentiated product industries typically concentrate on the potential for so-called unilateral effects. Unilateral effects arise when the products of the merging parties place significant competitive restraints on each other prior to the merger. The merged company may then be able to raise prices post-merger, unilaterally, depending on the importance of the pre-merger competitive constraints the merging firms hand on each other.

An analysis of unilateral effects thus seeks to determine whether the removal of the competitive constraints the merging firms' products place on each other is likely to lead to higher prices after the merger.

The analysis of unilateral effects, i.e., post-merger price changes, is still the focus of merger simulation to this day. As defined by Hausman and Leonard in 2005, merger simulation is "The technique of using a model of consumer demand together with a model of competition to predict the price effects of a merger". From Hausman et al's seminal work in 1994 on the beer category, various extensions of the literature have been realized. Multiple differentiated product categories have been studied such as ready to eat cereal by Nevo(2000), spaghetti sauce by

Capps et al (2003), CSD's by Dubé (2005), and coffee by Villas-Boas (2007). Different demand specifications have been used such as the AIDS (Werden 1997), Rotterdam (Capps et al 2003), Mixed Logit (Villas Boas 2007), and Multiple Discreteness models (Dubé 2005). Furthermore, although most studies have assumed a coordinated channel structure some have introduced Manufacturer-Stackelberg (Villas Boas 2007) as a competition structure more consistent with retailers' behavior in the marketplace. One common theme among all these studies though is the goal of ascertaining post-merger price changes, the only unilateral effect taken into consideration.

Naturally, merger simulation has come to be recognized as a useful tool in the analysis of potential mergers between firms though not without its critics ("Whither Merger Simulation?", 2004). Around roughly the same time that merger simulation was being developed to analyze post-merger price changes, some in the antitrust community have argued that effects on non-price attributes should be important factors considered while analyzing these potential mergers (Averitt and Lande 1997,2007; Lande 2001; Guiltinan 2002). Consumer choice, which in some cases on focuses variety, is seen as one of those vital non-price attributes (Leary 2001; Guiltinan 2002). Only recently has the profession explicitly considered some other variable besides price changes in a merger simulation. Draganska et al (2009) considered product line length along with price as a factor following the influential work in 2005 in which Draganska and Jain show that differentiated consumer product firms should optimize price and line length for profit maximization. Draganska et al found that along with price increases, product line length in the ice cream category would decrease in order to reduce substitutability between the post-merger firm's products and hence eliminate cannibalization among its own products. However, their results are limited to only a subset (vanilla) of the highly differentiated ice cream category.

The Carbonated Soft Drink Industry

The carbonated soft drink (CSD) industry is an ideal candidate for the application of this study. Not only is this industry highly active in terms of consolidation (e.g. see Dube, 2005 for an overview of merger activity in this industry) but it also provides a good example of a category that competes in price and variety. To understand the importance of variety within this category one must consider the pricing structure that is typically observed. The standard practice of CSD manufacturers is to offer several lines of merchandise where individual products within each line are uniformly priced. For example, popular CSD lines include 2 liter bottles, 12 oz. cans in 12 packs, 12 oz. cans in 24 packs, and single 20 oz. bottles usually shelved at checkout refrigerators. Each manufacturer will offer numerous stock keeping units (SKUs) for each line but typically prices each SKU within a line the same. For example, a 2 liter bottle of Sprite is usually priced the same as a 2 liter bottle of Coke Classic. Given this uniformity of pricing within a line it makes sense that variety or line length decisions may play a more crucial competitive role that in categories with non-uniform pricing. Support for this idea can be found in Draganska and Jain (2005) who show that line extensions can be used in lieu of price changes as a competitive reaction to the price or line length changes of a rival firm. Thus, when considering horizontal mergers within the CSD industry price simulations alone may not be enough to understand the potentially anti-competitive effects that could occur as a result of the merger.

Methodology

To facilitate the notion of "variety," we conduct our analysis at the line-level. Well-known examples of food lines include products such as Yoplait Original – 6oz. yogurt, Pepsi 20oz. bottles, etc. Within each line there are numerous flavors or brands that are typically priced the same as all other products within the line. For example, PepsiCo typically prices a 20oz. bottle of Diet Pepsi the same as a 20oz. bottle of Regular Pepsi. Likewise, a 2-liter bottle of Sprite is usually priced the same as a 2-liter bottle of Coke Classic. While consumers choose between flavors and/or brands within each line, it seems reasonable to assume that firms choose how many options are available within each line and how the entire line will be priced (Draganska & Jain 2005).

In order to estimate demand, we use the Linear Approximate Almost Ideal Demand System (Deaton and Muelhbauer, 1980) whose use for merger simulation has ample precedent (Hausman, Leonard, and Zona, 1994; Werden, 1997; Capps, Church, and Love, 2003). The LA/AIDS model is of the form:

$$w_i = \alpha_i + \sum_{j=1}^{N} \gamma_{ij} \ln(p_j) + \beta_i \ln(X / P^*), \tag{1}$$

where w_i denote the expenditure share of brand *i*, where $w_i = (p_i q_i)/X$, p_i is the price of brand *i*, q_i the quantity of brand *i* demanded, X is total expenditure on the group of brands, and P^* is a price index defined as $\ln(P^*) = \alpha_0 + \sum_j \alpha_j \ln(p_j) + (0.5)\sum_j \sum_i \gamma_{ij} \ln(p_i)\ln(p_j)$. We impose adding up, homogeneity and symmetry where $\sum_{i=1}^{N} \alpha_i = 1, \sum_{i=1}^{N} \beta_i = 0,$ and $\sum_{i=1}^{N} \gamma_{ij} = 0;$ for homogeneity $\sum_{j=1}^{N} \gamma_{ij} = 0;$ and for symmetry $\gamma_{ij} = \gamma_{ji}$.

Following Draganska and Jain (2005), we include the line length parameter within the LA/AIDS equation as such

$$w_i = \alpha_i + \sum_{j=1}^{N} \gamma_{ij} \ln(p_j) + \beta_i \ln(X / P^*) + \theta_i l_i + \lambda_i l_i^2 \tag{2}$$

We impose adding up with these new parameters by making sure that not only do $\sum_{i=1}^{N}\alpha_i = 1,\ \sum_{i=1}^{N}\beta_i = 0,$ and $\sum_{i=1}^{N}\gamma_{ij} = 0,$ but that $\sum_{i=1}^{N}\theta_i = 0,\ \sum_{i=1}^{N}\lambda_i = 0$ as well.

For elasticities, Green and Alston(1990) provide the below equation to compute uncompensated own and cross-price elasticities

$$\varepsilon_{ij}^{AIDS} = -\delta_{ij} + \frac{\gamma_{ij} - \beta_i w_j}{w_i} \tag{3}$$

where δ_{ij} is the Kronecker delta equal to 1 when $i = j$ and 0 otherwise. Elasticities with respect to line length are calculated as follows:

$$\varepsilon_i^l = \left(\theta_i + 2\lambda_i l\right)\frac{l_i}{w_i} \tag{4}$$

The supply side is modeled under the assumption that the channel is 'coordinated', i.e. that manufacturers sell directly to end consumers. We recognize that this assumption is unrealistic given the reality of how consumer packaged goods are merchandised through retailers. However, this assumption is standard in the merger simulation literature and is used as a 'benchmark' starting point in our analysis. Future versions of this study will include more realistic channel structures where wholesale and retail decisions will be considered in a two-stage game theoretic framework

The first step is to recover marginal costs. We'll say that M is the number of competing manufacturers, each producing a unique set $K_1, K_2, \ldots, K_M$ of brands. The profit function for the mth firm is:

$$\Pi^m = \sum_{k\in K}\left(p_k - c_k\right)q_k\left(p_1,\ldots,p_k,l_1,\ldots,l_k\right) - \lambda_{1k}l_k \tag{5}$$

where c_k is the marginal cost of producing manufacturer m's kth brand and λ_{1k} is the marginal cost of increasing the line length of manufacturer m's kth brand. Since we assume price competition, we obtain the following first order conditions rearranged in elasticity form:

$$\frac{\partial \Pi^m}{\partial p_k} = w_k + \left(\frac{p_k - c_k}{p_k} \right) \varepsilon_{kk} w_k + \sum_{l \in K_m} \left(\frac{p_l - c_l}{p_l} \right) \varepsilon_{lk} w_l = 0 \quad \forall k \in K_m \tag{6}$$

$$\frac{\partial \Pi^m}{\partial l_k} = \left(\frac{p_k - c_k}{p_k} \right) \eta_k w_k \left(\frac{X}{l_k} \right) - \lambda_{1k} = 0 \quad \forall k \in K_m \tag{7}$$

where X is again the total category expenditure. We then use estimated demand elasticities, mean prices and mean expenditure shares to solve the first order conditions for marginal costs.

To simulate a merger between manufacturers m and n we let $K_m \cup K_n = K_{mn}$ and the profit equation for the merged manufacturers is

$$\Pi^{m+n} = \sum_{k \in K_{mn}} (p_k - c_k) q_k (p_1, \ldots, p_k, l_1, \ldots, l_k) - \lambda_{1k} l_k \tag{8}$$

and the corresponding first order conditions are:

$$\frac{\partial \Pi^{m+n}}{\partial p_k} = w_k + \left(\frac{p_k - c_k}{p_k} \right) \varepsilon_{kk} w_k + \sum_{j \in K_{mn}} \left(\frac{p_j - c_j}{p_j} \right) \varepsilon_{jk} w_j = 0 \quad \forall k \in K_{mn} \tag{9}$$

$$\frac{\partial \Pi^m + n}{\partial l_k} = \left(\frac{p_k - c_k}{p_k} \right) \eta_k w_k \left(\frac{X}{l_k} \right) - \lambda_{1k} = 0 \quad \forall k \in K_{mn} \tag{10}$$

We then assume that marginal costs, elasticities, and expenditure shares remain fixed at pre-merger levels and solve the post-merger first-order conditions for post-merger prices and line lengths.

In order to find standard errors for percentage price change and line length, we implement a straightforward bootstrap procedure. First, since we have 463 observations in our data set, we sample with replacement 463 observations from the original data set. Second, we compute percentage price change and line length using the procedure described above. Finally, we repeat these first two steps 1000 times and calculate standard deviations for our parameters from the 1000 observations for each respective result. We follow Capps et al (2003) in choosing 1000 bootstraps.

Data and Estimation

The data consists of IRI chain level scanner data from two markets, Phoenix and Houston, made up of price and volume observations reported in ounces and line length, i.e., number of items within a product line for a given company. For example, the Coke 12-pack line would included such products as Coke Classic, Diet Coke, Coke Zero, etc. Chains included are Fiesta Mart, HEB, Kroger, and Randall's in Houston and Albertson's, Bashas, Fry's, and Safeway in Phoenix. The data is in 4 week intervals ranging from September of 2002 to July of 2007. Pofahl (2007) notes that this low frequency data could allow more accuracy in determining consumers' responsiveness to permanent price changes in the form of demand elasticities. In order to facilitate our study of line length, we have aggregated to the line level where lines are defined by the manufacturer and size of the packaging. We focus our attention on Coca-Cola, Pepsi, and Cadbury-Schweppes carbonated soft drinks at the 12-pack and 2 liter sizes. These combinations of manufacturers and sizes make up 63% of the CSD market in Houston and Phoenix.

Estimation of our demand model was done using Seemingly Unrelated Regression (SUR). As is standard in the literature one equation was dropped from the model and the remaining N-1 equations were jointly estimated. Parameters from the dropped equation were recovered using the theoretical restrictions discussed in the model section above.

Table 1. Summary Statistics for Six CSD Lines

	Quantity (oz.)	Price/ounce	Line Length	Rev. Share
Cocacola 12p	44789157.8	0.021	21.84	0.23
	(29460085)	(0.003)	(4.18)	
Pepsico 12p	20590355.25	0.020	18.93	0.15
	(22265032)	(0.003)	(1.98)	
CadbSchwp 12p	20572198.12	0.022	18.57	0.10
	(17564026)	(0.004)	(4.54)	
Cocacola 2 liter	15502984.41	0.016	17.52	0.08
	(9700298)	(0.002)	(2.16)	
Pepsico 2 liter	8420080.372	0.016	18.11	0.07
	(9692245)	(0.002)	(2.36)	
CadbSchwp 2 liter	7076774.107	0.017	16.77	0.04
	(5358450)	(0.002)	(1.99)	

Note: Standard Errors are in parentheses

Results

We use Seemingly Unrelated Regression(SUR) to estimate the model in R with the package systemfit. We dropped the last equation to avoid singularity and to allow us the ability to impose the restrictions. We tested for homogeneity and symmetry. The Wald tests rejected both assumptions, but we did impose them in order to conform to theory. Most of the γ_{ij} estimates are significant with a few exceptions. Of the most interest are the line length parameters. Due to the quadratic nature of the line length parameters, we would expect to see θ_i's as positive and the λ_i's as negative, but this, for the most part, is not the case. For the 12-packs (lines 1-3), it is the exact opposite. For the 2-liters (lines 4-6), the line length parameters conform to our expectations, but none of them are significant. This is an inconvenient result which will have to be addressed in future research.

Table 2. LA/AIDS Parameter Estimates

Par	Est	T-val	p-val	Par	Est	T-val	p-val
a1	1.229	10.88	0	g35	0.07	9.88	0
g11	-0.512	-20.47	0	g36	0.004	0.26	0.795
g12	0.183	9.7	0	th3	-0.004	-1.66	0.096
g13	0.033	2.12	0.034	lm3	0	2.8	0.005
g14	0.117	8.82	0	b3	0.037	8.89	0
g15	0.063	7.45	0	a4	0.459	4.51	0
g16	0.116	7.66	0	g41	0.117	8.82	0
th1	-0.005	-0.94	0.347	g42	0.004	0.28	0.779
lm1	0	1.13	0.257	g43	0.068	5.88	0
b1	-0.038	-6.94	0	g44	-0.257	-15.48	0
a2	0.903	4.09	0	g45	0.031	4.25	0
g21	0.183	9.7	0	g46	0.038	2.81	0.005
g22	-0.325	-13.37	0	th4	0.003	0.3	0.764
g23	0.181	11.66	0	lm4	0	-0.08	0.937
g24	0.004	0.28	0.779	b4	-0.024	-7.53	0
g25	-0.004	-0.57	0.57	a5	-0.085	-1.77	0.078
g26	-0.039	-2.5	0.012	g51	0.063	7.45	0
th2	-0.114	-5.49	0	g52	-0.004	-0.57	0.57
lm2	0.003	5.57	0	g53	0.07	9.88	0
b2	0.017	3.25	0.001	g54	0.031	4.25	0
a3	-0.441	-5.57	0	g55	-0.121	-16.88	0
g31	0.033	2.12	0.034	g56	-0.037	-4.43	0
g32	0.033	11.66	0	th5	0.003	0.74	0.463
g33	-0.355	-18.43	0	lm5	0	-0.28	0.779
g34	0.068	5.88	0	b5	0.003	1.7	0.09

Looking on the elasticities below, we can see that each product line is quite elastic and that most cross-price elasticities are positive as we would expect. Although some cross-price elasticities are negative, most of them are close to zero and probably not statistically different than zero.

The line length elasticities of demand are for the most part close to zero or less than one indicating inelasticity except for the Cadbury 2 liter elasticity. This is due to the fact that the Cadbury 2 liter equation was dropped in the estimation so that we could impose our constraints. When we estimated the unconstrained LA/AIDS this elasticity fell in line with the others. As we will see in the results, this elasticity could be the cause of some wild estimates that we find for the Cadbury 2 liter. This issue is one of the limitations of this paper and should be resolved in future research.

Marginal product costs are in line as they are all less than the prices reported above. Marginal costs of line length appear very low, but keep in mind that this is the cost of increasing line length per ounce of product produced. Pepsi 12-packs appear to be well positioned with the lowest marginal cost of adding an additional line.

Table 3. Uncompensated Own- and Cross-price Elasticities

Elasticity		Coke 12p	Pepsi 12p	Cadb 12p	Coke 2l	Pepsi 2l	Cadb 2l
Coke	12p	-2.17	0.45	0.09	0.29	0.15	0.28
Pepsi	12p	1.03	-2.92	1.05	0.01	-0.03	-0.23
Cadb	12p	0.09	0.94	-2.93	0.34	0.36	0.01
Coke	2lt	1.08	0.07	0.61	-3.16	0.27	0.33
Pepsi	2lt	1.16	-0.1	1.31	0.57	-3.3	-0.72
Cadb	2lt	2.26	-0.78	0.06	0.74	-0.74	-2.6

Table 4. Line Length Elasticities

Elasticity	Coke 12p	Pepsi 12p	Cadb 12p	Coke 2l	Pepsi 2l	Cadb 2l
Line Length	0.07	0.01	0.33	0.31	0.59	2.12

Table 5. Marginal Cost Estimates

	Coke 12p	Pepsi 12p	Cadb 12p	Coke 2lt	Pepsi 2lt	Cadb 2lt
Product	0.01	0.0135	0.0144	0.0084	0.0114	0.0103
Line Length	0.0007	0.00004	0.0011	0.001	0.0005	0.0025

We simulate three mergers: Coke-Pepsi, Coke-Cadbury Schweppes, and Cadbury Schweppes-Pepsi. Table 6 shows the results of our Coke-Pepsi merger. As expected from a merger of two companies of their respective sizes and market power, the price increases are substantial and statistically significant in all cases. The simulation also tells us that the merged Coke-Pepsi firm should increase line lengths substantially (average line length calculated from the data is in parentheses). All of these effects are statistically significant as well.

Table 6. Coke/Pepsi Merger Simulation Results

Line	Price Change (%)	SE	Line Length	SE
Coke 12p	59.97	8.91	29.15(21.8)	1.03
Pepsi 12p	70.8	11.19	34.22(18.9)	2.23
Coke 2lt	28.79	9.69	21.61(17.5)	1.36
Pepsi 2lt	106.22	20.21	40.66(18.1)	3.8

The Coke-Cadbury merger is somewhat more problematic. As expected, we see price increases in 3 of 4 product lines in the merged firm (although the price changes for two of three of these products are statistically insignificant), but the fourth line, Cadbury Schweppes 2-liters, has some curious outcomes. First, the price change is highly negative and would induce a negative price for that product; something that clearly does not makes sense. Second, the line length outcome suggests a huge increase in line length even though price has decreased below zero according to the price change. The other three line lengths do indicate increases and are statistically significant.

Table 7. Coke/Cadbury Merger Simulation Results

Line	Price Change (%)	SE	Line Length	SE
Coke 12p	78.24	45.57	30.40(21.8)	1.69
Cadbury 12p	32.46	8.44	27.25(18.6)	1.86
Coke 2lt	122.76	101.41	27.61(17.5)	2.35
Cadbury 2lt	-320.83	416.8	55.05(16.8)	7.67

The Cadbury-Pepsi gives us clearer results than the Coke-Cadbury Schweppes merger, but not as clear cut as the Coke-Pepsi merger. All price changes are statistically significant and three out of fourth lines would increase price after the merger. The odd man out is again the Cadbury 2-liter who would decrease price at a more reasonable level than in the Coke-Cadbury Merger. For the first time in any of the three mergers, one of the line lengths is not statistically significant (Cadbury 2-liter). The other three lines would again increase length and these changes are statistically significant.

Table 8. Cadbury/Pepsi Merger Simulation Results

Line	Price Change (%)	SE	Line Length	SE
Cadbury 12p	55.96	14.79	31.28(18.6)	2.01
Pepsi 12p	41.65	13.45	29.77(18.9)	1.83
Cadbury 2lt	-32.84	7.49	3.89(16.8)	4.12
Pepsi 2lt	39.48	16.78	30.50(18.1)	2.62

Conclusions

As we expected, for the most part we saw substantial price increases for product lines after the merger took place due to increased market power, but unexpectedly, in every case except one the merged entity increased line length. Our findings could in part be explained by Schmalensee's (1978) research in the ready-to-eat cereal market in which he found that the industry used brand (line) proliferation as a deterrence to entry. Cotterill (1999) noted that cereal manufacturer's preferred to compete with private labels by increased market segmentation because this denied private labels sufficient distribution volume necessary to remain in business. Also in 1999, Representative Gejdenson and Senator Schumer echoed Cotterill's findings when they stated, "The four dominant cereal companies have successfully kept less expensive generic brands from attaining significant market share by "differentiating" the market (introducing new varieties)". Using market power to create barriers to entry may provide some explanation for our line length results, but these results are in direct contrast to prior findings in the literature such as Dranganska et al (2009) who found that line length should decrease in mergers of horizontally differentiated consumer product companies.

There remain stark limitations to this research. First, although useful, the LA/AIDS model is generally considered an inferior model to estimate demand as compared with, for example, a mixed logit model. Introducing the mixed logit or some more modern demand estimation procedure would be a substantial improvement of our study. Second, our assumption of Channel

Coordination is patently unrealistic. Retailers do mark up the wholesale price so that they can make a profit and therefore, Manufacturer Stackelberg competition would be a more realistic version of supply side interaction. This follows Peters (2006) observation from his study of airline mergers that merger simulations are more accurate tools if more flexible models of firm conduct are incorporated. Flexibility is definitely not a characteristic of Channel Coordination. Third, even though our findings indicate large product line length increases, retailers ultimately decide which producers will obtain the shelf space in their stores. Although a producer may introduce 10 new products to a retailer, that retailer could only choose to give up the shelf space for a few of those products. This is an increasingly realistic scenario with the success of private label products in retails stores. Incorporating a model for the allocation of retail shelf space would greatly enhance the inherent realism and applicability of these merger simulations. In a related matter, Inderst and Shaffer(2007), in their study of retail mergers, found that suppliers, anticipating further concentration in the retail industry, will produce less differentiated products reducing product variety. High retail concentration, absent any future mergers, is already a concern in some parts of the world and may therefore have an effect on variety in some locations.

Clearly, any future research should attempt to resolve the discrepancy between our findings and Draganska et al(2009) by introducing more flexible demand specifications, Manufacturer Stackelberg competition, and a model of shelf space allocation within retail stores. These along with other improvements would provide a more realistic simulation and would give us a better idea of whether variety increases or decreases in mergers of differentiated consumer product firms.

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