You save money when you buy in bulk: Does volume-based pricing cause people to buy more beer?

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Abstract:

This paper uses supermarket scanner data to estimate brand- and packaging-specific own- and cross-price elasticities for beer. We find that brand- and packaging-specific beer sales are highly price elastic. Cross-price elasticity estimates suggest that individuals are more likely to buy a higher-volume package of the same brand of beer than they are to switch brands. Policy simulations suggest that regulation of volume-based price discounts is potentially more effective than a tax increase at reducing beer consumption. Our results suggest that volume-based price discounting induces people to buy larger-volume packages of beer and may lead to an increased overall beer consumption.

Keywords: alcohol | price elasticity | brand substitution

Article:

1. INTRODUCTION

Alcohol consumption is the third leading cause of preventable death in the United States (Mokdad et al., 2004); in 2001, excessive alcohol consumption was responsible for an estimated 75 766 deaths (Midanik et al., 2004). Furthermore, alcohol abuse is associated with many behavioral and social problems, including domestic violence and homicide (USDHHS, 2000), traffic fatalities (USDHHS, 1994), and chronic health problems (USDHHS, 1994).

Despite these negative consequences, alcohol is widely marketed and promoted. For example, alcoholic beverage manufacturers spent more than $2 billion on advertising and promotion efforts in 1999 (FTC, 1999). Point-of-purchase promotions, in particular, are a popular and cost-effective method used by product manufacturers to reach consumers and increase sales. Point-of-purchase alcohol promotions can be found in nearly 90% of stores that sell alcohol (Terry-McElrath et al., 2003) and include price discounts, displays, and product placement, signage, in-store circulars, and other on-site merchandizing. A study by the Point of Purchase Association International, an industry trade group, claims that beer sales in supermarkets increased by between 2.9 and 17% in the presence of point-ofpurchase advertising (Beverage Industry Magazine, 2001).

In a recent study, Bray et al. (2007) found that large-volume packages of beer are more heavily promoted in grocery stores than are smaller-volume packages. Using supermarket scanner data, Bray et al. estimated the strength and direction of the association between product characteristics and promoted sales of beer in grocery stores. They found that large-volume units, such as 144- and 288-oz packages, were more likely to be promoted than smaller package sizes. Their results suggest that high levels of promoted sales for large-volume beer packages may result in increased beer consumption.

It is unclear, however, whether increased promotions of large-volume packages induce people to buy larger-volume packages of the same brand or to switch from one brand to another while keeping the volume purchased constant. In this paper, we use supermarket scanner data to estimate brand- and packaging-specific own- and cross-price elasticities for beer. Results suggest that the choice of beer brand and packaging are highly price elastic. Furthermore, cross-price elasticities suggest that individuals are more likely to buy a larger-volume package in response to a price discount than they are to buy a smaller-volume package or to switch brands.

2. DATA AND METHODS

2.1. Data

The primary data for this analysis are InfoScan Retail Tracking scanner data, licensed from Information Resources Incorporated (IRI) (2000). The scanner data are collected from supermarkets in 64 retail markets in the United States and reported for each calendar quarter from 1995–1999. Supermarkets are defined by IRI as large grocery stores having at least $2 million in annual sales, or about $5500 a day. Each retail market is a collection of counties centered on a metropolitan area, which combined captured approximately 72% of the US population on average from 1995 to 1999. Markets contain an average of 15 counties (range 1–78, median 9). The average market population is 3.1 million (range 367 000–18.7 million, median 2.5 million). We excluded three Pennsylvania markets (Harrisburg, Philadelphia, and Pittsburgh), because Pennsylvania prohibits the sale of alcoholic beer in grocery stores, so all beer sales reported in Pennsylvania markets were for nonalcoholic beer. We also excluded the Providence, Rhode Island, market, because all beer sales in that market were also for nonalcoholic beer. Although Rhode Island is not a beer control state, it is a strict licensure state, and grocery stores could not obtain licenses to sell alcoholic beer during the period covered by our data. As a result, the final analysis data include 60 markets.

The full scanner data originally purchased included the top 100 selling individual beer varieties (ranked by unit sales) in each market in 1999, which are identified by a unique item description. Each item description provides an individual beer variety's universal product code (UPC), abbreviated brand name (e.g. BDWSR for Budweiser), beer type (e.g. malt liquor, nonalcoholic, ale, lager), packaging (e.g. cans in a box), and unit size in ounces. In addition to the item description, for each beer variety in each market and quarter, the data also provide the proportion of total sales sold under a promotion, total unit and volume sales, and both the average promoted and nonpromoted unit prices.

For this analysis, we limited the data to those brands with data in each market and quarter for both promoted and nonpromoted sales of the three most prevalent unit sizes: 72-oz packages (6-packs), 144- oz packages (12-packs), and 288-oz packages (24-pack cases). We imposed this limitation for two reasons. First, a primary objective of the analysis is to estimate the within-brand substitution across packaging types. Thus, we limited the data to those brands for which we observed all three packaging types. Second, we want to identify elasticities of demand, not supply. To the extent that promotions are an independent decision by suppliers to reduce the price of beer, they represent an exogenous shift in the supply curve. Therefore, we used the variation between promoted and nonpromoted sales and price to identify the demand elasticities. If the timing or extent of promotions is influenced by demand considerations, as might be the case in an oligopolistic market, then our estimates may be biased. For example, retailers may discount beer prices during periods of exogenously high beer demand such as the Super Bowl in an attempt to induce increased purchases of other, high-profit margin goods such as snack food. In general the direction and extent of the resulting bias depends on the price elasticity of supply and the relative magnitude of the shifts in the supply and demand curves. For very highly elastic supply, as is likely the case in the short run in the beer industry, demand-induced promotions would cause us to over-estimate the demand elasticity.

In all, 25 unique brands (representing 33% of all sales) met the inclusion criteria. Of the data restriction we imposed, the only binding restriction on the brands of beer included in our analyses was that we observe sales for 6-, 12-, and 24-packs (all 3) in the same market and quarter. This restriction alone limited our data to the 25 brands included in our analyses.

Using the IRI data described above, we constructed a data set that contains two observations per brand, packaging type, market, and quarter. The first observation represents nonpromoted sales, and the second observation represents promoted sales. Each observation has the average real-unit price (weighted by unit sales) and total sales for each brand/packaging size/promotion combination that was present in each market and quarter from 1995–1999. The scanner data are aggregate sales data, and therefore we are unable to separate the effects of different types of promotions or the duration of promotions. For example, we cannot distinguish between a price reduction and an aisle display. What we can say is that, in a given market and quarter, 6-packs of Budweiser, for example, sold for an average of $3.00 when promoted and $4.00 when not promoted and that promoted sales accounted for 45% of total sales of Budweiser in the market quarter. Promoted sales would include all sales that occurred in the presence of any advertising or promotion, whether price related or not. The most prevalent brands are Budweiser (20%), Bud Light (18%), Coors Light (15%), and Miller Light (10%). Table I presents all brands in the analysis data and the frequency with which they occur.

3. EMPIRICAL MODEL

Table I. Beer brands included in analysis sample

Brand	Frequency	Percent
Budweiser	4242	20.1
Bud Light	3708	17.6
Coors Light	3150	14.9
Miller Light	2184	10.3
Miller Genuine Draft	1638	7.8
Natural Light	1374	6.5
Busch	996	4.7
Milwaukee's Best	966	4.6
Milwaukee's Best Light	552	2.6
Miller High Life	492	2.3
Coors	312	1.5
Miller Genuine Draft Light	222	1.1
Ice House	186	0.9
Michelob Light	198	0.9
Natural Ice	174	0.8
Molson Golden	150	0.7
Busch Light	78	0.4
Old Milwaukee	132	0.6
Old Style	114	0.5
Keystone Light	60	0.3
Budweiser Ice	48	0.2
Milwaukee's Best Ice	42	0.2
Molson Ice	42	0.2
Heineken	30	0.1
Molson Canadian	24	0.1
Total	21 114	99.9[a]

[a]Does not add to 100% because of rounding.

The empirical model used in this analysis is based on standard consumer demand theory (Deaton and Muellbauer, 1985) and on the theory of rational addiction (Becker and Murphy, 1988). Specifically, we estimated the following regression equation separately for each packaging type:

$$\ln(\text{SALES}_{ijpkt}) = \beta_0 + \beta_1 \ln(P72_{ipkt}) + \beta_2 \ln(P144_{ipkt}) + \beta_3 \ln(P288_{ipkt}) + \beta_4 \ln(\text{COMP}_{ijpkt}) + \beta_5 \ln(\text{OWNP}_{ijpkt-1}) + \beta_6 \ln(\text{OWNP}_{ijpkt+1}) + \beta_7 \ln(\text{INC}_{kt}) + \beta_8 X_{ijpkt} + \epsilon_{ijkt} \quad (1)$$

where SALESijpkt is the unit sales of brand i, package type j, and promotion status p in market k and quarter t.

The index i has 25 values representing the 25 brands in Table I; j has three possible values representing either 72-, 144-, or 288-oz packages; p has two possible values representing either promoted or nonpromoted observations; k has 60 possible values representing each of the 60 markets in the analysis data set; and t has 20 possible values for each of the 20 quarters in the analysis data.

P72ipkt is the price of 72-oz packages of brand i and promotion status p in market k in quarter t. Similarly, P144ipkt and P288ipkt are the prices of 144- and 288-oz packages of brand i and promotion status p in market k and quarter t, respectively. The average real-unit price for each volume (72 , 144, and 288 oz) was generated by taking the average price (weighted by unit sales) of each unit in each market and quarter separately by promotion status.

COMPijpkt is the price of the competitor brand to brand i, package type j, and promotion status p in market k and quarter t. The competitor price was generated by calculating the average price of the most prevalent brand (by unit sales) in each market and quarter for each unit size. For the most prevalent brand in each market and quarter, the competitor price was characterized as the average price of the second most prevalent brand in that market and quarter. OWNPijpkt– 1 and OWNPijpkt11 are the price of brand i, package type j, and promotion status p in market k and quarter t1 and t11, respectively. INCkt is the per capita income of market k in quarter t. Market-level per capita income was calculated as the population-weighted average third quarter county-level per capita income. As such, INC varies annually, not quarterly, but the quarterly time subscript is used for simplicity of notation. Per capita income estimates were obtained from the Bureau of Economic Analysis for 1995–1999. Xijkt is a vector of indicator variables that include indicators for promotion status, beer brand, market, year, and quarter.

Because we do not observe the duration of promotions, the indicators for promotion status, beer brand, market, year, and quarter play a critical role in our empirical analyses. The duration of promotions is an important omitted variable in our analyses that may bias our estimated price elasticities. If the duration of promotions is assumed to be constant across all observations, then the promotion status indicator is sufficient to correct for this omitted variable bias. The more variability in the duration of promotions, however, the more likely is that omitted variable bias is present in our results. Because shorter duration promotions are likely associated with deeper price discounts and account for a smaller proportion of total sales in the quarter, the likely effect omitting the duration of promotions is to bias our estimated coefficients on prices toward zero. The indicators for beer brand, market, year, and quarter help to control for differences in the duration of promotions across brands and time, but likely do not completely control for this variation.

Because Equation (1) is estimated separately by packaging type and is specified as a double log model, b1 represents the own-price elasticity for 72-oz packages in the 72-oz package regression and is a cross-price elasticity in the 144- and 288-oz regressions. Similarly, b2 and b3 are own-price elasticities in the 144- and 288-oz regressions, respectively, and are cross-price elasticities otherwise. The own-price elasticity for beer calculated in this model allows for brand switching as well as for substitutability between different volume sizes within the same brand. Therefore, the own-price elasticity represents a much more price-responsive trade-off than is normally estimated in price elasticity studies and is expected to be orders of magnitude higher than previous estimates of the price elasticity of beer or alcohol that represent an all-or-nothing decision. The competitor price elasticity measured by b4 estimates the impact on sales of a change in the price of a brand’s competitor and is therefore also likely to be of a much larger magnitude than previous elasticity estimates.

All models were estimated using the xtreg command in Stata version 8.2 (StataCorp, 2003), with fixed effects for each brand/package type within a market and quarter (i.e. each ijkt index combination). Because we used fixed effects for each brand/package type within a market and quarter, our elasticity estimates were identified using the variation between promoted and nonpromoted sales and prices for each brand/package type.

3.1. Policy simulations

We used Equation (1) to conduct policy simulations investigating the effect of legislation eliminating differential volume pricing and, as a point of comparison, the effect of an increase in the federal beer tax. The first set of policy simulations examined eliminating differential pricing between volume sizes for the same brand. For example, on average, a 72-oz package (6-pack) of Budweiser costs $3.92, or about 5.5 cents per ounce; a 144-oz package (12-pack) of Budweiser costs $7.25, or about 5.08 cents per ounce, an 8% decrease in price per volume relative to a 72-oz package. An equivalent price differential exists between 144-oz packages and 288-oz packages. To simulate the elimination of volume-based pricing, we conducted three separate simulations. The first simulation set the prices of 144-. and 288-oz packages to the volume-price equivalent of a 72-oz package. We used same-brand prices to preserve any brand differential in price, and we used the average nonpromoted price for nonpromoted observations and the average promoted price for promoted observations to preserve any nonvolume-based promotions. We also conducted policy simulations that standardized all prices to those of 144-oz packages and 288-oz packages, using a similar methodology as with the 72-oz standardization. Finally, we simulated an increase in the federal excise tax on beer from $18 per barrel to $28 per barrel. This increase is equivalent to raising the average price of a 144-oz package (12-pack) by 5%. Because the double-log specification of Equation (1) predicts log sales, a smearing factor was used to retransform predicted values to natural units in all policy simulations (Duan, 1983; Manning, 1998). In each simulation, sales revenues were simulated by multiplying the simulated price by the estimated sales. Simulated sales revenues reflect the average retail value of the beer sold and not industry profits.

4. RESULTS

Table II. Summary statistics

Variables	Volume		
	72 oz ($N = 7038$)	144 oz ($N = 7038$)	288 oz ($N = 7038$)
Unit sales	25 811	52 011	13 158
	(47 076)	(82 174)	(19 067)
72-oz price	$3.92	$3.92	$3.92
	(0.70)	(0.70)	(0.70)
144-oz price	$7.25	$7.25	$7.25
	(1.20)	(1.20)	(1.20)
288-oz price	$13.36	$13.36	$13.36
	(2.23)	(2.23)	(2.23)
Real competitor price	$4.20	$7.44	$13.17
	(0.79)	(1.04)	(2.22)
Per capita income	$24 787.90	$24 787.90	$24 787.90
	(5216.10)	(5216.10)	(5216.10)

Note: Standard deviations are shown in parentheses.

Table III. Regression results by volume package size

	Volume regressions		
	72 oz	144 oz	288 oz
72-oz price	−5.070***	1.173***	1.232***
	(0.234)	(0.155)	(0.195)
144-oz price	1.902***	−5.008***	0.244
	(0.347)	(0.235)	(0.293)
288-oz price	0.406	1.496***	−4.543***
	(0.308)	(0.207)	(0.265)
Real competitor price	0.365***	−0.004	0.167
	(0.099)	(0.087)	(0.101)
Lagged real-unit price	0.175	0.609***	0.419***
	(0.101)	(0.092)	(0.112)
Lead real-unit price	0.202	0.664***	0.008
	(0.128)	(0.09)	(0.068)
Promoted dummy	−3.376***	−0.588***	−0.136***
	(0.041)	(0.028)	(0.033)
Per capita income	5.733***	−0.231	2.968**
	(1.284)	(0.863)	(1.094)
Adjusted R^2	0.703	0.548	0.479
N	7038	7038	7038

Note: Standard errors are shown in parentheses. Each model also includes indicator variables for year, quarter, brand, and market area. ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

Table II presents summary statistics for the variables used to estimate Equation (1) separately for 72-, 144-, and 288-oz packages, averaged across promotion status, market, and quarter. Average quarterly sales ranged from 13 158 units for 288-oz packages to 52 011 units for 144-oz packages. These are averages across both promoted and nonpromoted sales, and across both large and small markets, thereby accounting for the substantial variation in sales reflected in the large standard deviations. On average, the real price of a 72-oz package was $3.92, the price of a 144-oz package was $7.25, and the price of a 288-oz package was $13.36. The prices for the larger-volume packages represent normal volume-based discounts of 7.5 and 14.8%, respectively. Average per capita income across all markets is $24 787.90. Recall that because per capita income is an annual, market-level variable, it has the same average across all package types.

Table III presents the results from estimating Equation (1) for 72-, 144-, and 288-oz packages. Overall, the demand for any specific brand or package size is extremely price elastic. The own-price elasticity of demand for 72-oz packages was estimated to be –5.07; own-price elasticity was estimated to be –5.008 for 144-oz packages and –4.543 for 288-oz packages. Recall that these elasticities represent substitution with a different package size of the same brand of beer or with another brand, so the elasticities are not unexpectedly large. Estimates of the cross-price elasticities suggest that individuals are more likely to buy a larger-volume package in response to a price change than they are to buy a smaller-volume package or to switch brands. Specifically, increases in the price of a 72-oz package significantly increase the within-brand sales of both 144- and 288-oz packages, with cross-price elasticities of 1.173 and 1.232, respectively. Increases in the price of a 144-oz package significantly increase within-brand sales of 72-oz packages, with an estimated cross-price elasticity of 1.902, but they do not significantly increase sales of 288-oz packages. Finally, increases in the price of a 288-oz package do not significantly increase sales of 72-oz packages but do increase sales of 144-oz packages, with a significant cross-price elasticity of 1.496. The price of a competitor brand was significantly associated with sales only for 72-oz packages, with an estimated cross-price elasticity of 0.365.

Importantly, the cross-price elasticities also suggest different behaviors among consumers based on packaging type. For example, based on the 72-oz regression results, 6-pack buyers will readily switch to 12-packs (144-oz package) (significant cross-price elasticity of 1.902); they do not, however, switch to cases (288-oz package) (insignificant cross-price elasticity of 0.406). Individuals who purchase 12-packs, on the other hand, will switch between either 6-packs or cases quite readily (significant cross-price elasticities of 1.173 and 1.496, respectively). Finally, case buyers will switch to 6-packs (significant crossprice elasticity of 1.232) but will seldom switch to 12-packs (insignificant cross-price elasticity of 0.244).

To put these results into context, consider a 10% decrease in the average price of a 6-pack, everything else held constant. Six-pack sales would increase by 50.71%, 12-pack sales would decrease by 11.73%, and 24-pack sales would decrease by 12.32%. Applying these changes to the mean unit sales reported in Table II, we find an increase in 13 086 6-packs, a decrease in 6101 12-packs, and a decrease in 1621 24-packs. Converting all units to 6-packs, this is equivalent to a net decrease in 5600 (5 13 086–12 202–6484) 6-packs, or about 3% of total sales.

Similarly, a 10% decrease in the average price of a 12-pack would lead to a 19.02% decrease in 6- pack sales, a 50.08% increase in 12-pack sales, and a 2.44% decrease in 24-pack sales. This is equivalent to a net increase in 22 337 12-packs or about 24% of total sales. A 10% decrease in the average price of a 24-pack would lead to a 4.06% decrease in 6-pack sales, a 14.96% decrease in 12-pack sales, and a 45.43% increase in 24-pack sales, which is equivalent to a net increase in 1826 24-packs or 4% of total sales.

Therefore, the results predict that a decrease in 10% in the average price of a 6-pack would actually slightly decrease total beer sales because more sales are taken away from 12-packs and 24-packs than are replaced by increased sales of 6-packs. A 10% decrease in 12-pack and 24-pack prices would increase total beer sales, with a decrease in 12-pack prices having a much larger effect.

Proper interpretation of the promoted dummy variable warrants discussion. Recall that we constructed a data set that contains two observations per brand, packaging type, market, and quarter. The first observation represents nonpromoted sales (denoted by a value of 0 for the promoted dummy), and the second represents promoted sales (denoted by a value of 1 for the promoted dummy). Because promotions typically are conducted for only a short time, promoted sales only account for approximately 30% of total sales even though promotions increase sales during the promotion period. This explains why the coefficient on the promoted dummy is negative and statistically significant. The promoted dummy is not capturing the increase in sales that would be expected from a sales promotion. It is measuring the fact that promoted sales account for a fraction of total sales. As previously discussed, the promoted dummy captures fully the effects of the duration of promotions under the assumption that the duration of promotions is constant. The likely effect of violations of this assumption is to bias our estimated elasticities toward zero.

The estimated coefficients for lagged and lead unit prices are positive in all three models, but statistical significance varies. Neither the lagged price nor the lead price are significant in the 72-oz model, both lagged and lead prices are significant in the 144-oz model, and only the lagged price is significant in the 288-oz model. Because only about 10% of drinkers are alcohol dependent, we are not surprised that the estimated coefficients for lagged and lead prices do not conform to the theory of rational addiction. The positive estimated coefficients for lag and lead prices are consistent with shifts in the intertemporal demand for beer, however: an increase in either the lag or lead price results in increased sales during the current period, as drinkers substitute away from the higher-priced period. Finally, income is significantly and positively related to sales of 6-packs and 24-packs, but it is negative and insignificant in the 12-pack regression. Although we interpret these results to imply that beer sales do follow standard theories of consumer demand, income is measured annually at the market level and not at the brand and promotion level, so we caution readers against using our estimates to calculate income elasticities for beer.

Table IV and Figures 1 and 2 present the results of the policy simulations, in which multiple price changes occur simultaneously. When investigating the effect of a $10 per barrel increase in the federal beer tax, equivalent to a 5% increase in the average price of a 144-oz package, annual sales of all three unit sizes fell. Averaged for the 5-year period of the study, the total number of barrels of beer sold annually fell by roughly 500 000 barrels, while the share of total volume sales accounted for by each package size varied only slightly. Sales revenues (net of the tax increase) fell by approximately 9.5%. Strictly speaking, this simulation represents a price increase in supermarkets only and does not account for sales lost to other outlets or to other alcoholic beverages, such as wine or liquor. Thus, the simulation results should not be used to calculate an overall price elasticity for beer.

Table IV. Policy simulation results

Size	Baseline	Tax simulation	Standardized volume pricing simulations		
			72-oz standard	144-oz standard	288-oz standard
Predicted annual beer sales in barrels (in thousands)					
72 oz	659	602	804	927	1120
144 oz	2659	2443	2311	2612	2938
288 oz	1346	1151	708	859	1346
Total	4664	4196	3822	4398	5404
Share of sales					
72 oz	14%	14%	21%	21%	21%
144 oz	57%	58%	60%	59%	54%
288 oz	29%	27%	19%	20%	25%
Predicted annual revenues (millions of dollars)					
72 oz	149	136	183	195	216
144 oz	535	492	507	528	551
288 oz	245	211	151	171	245
Total	929	839	840	894	1012

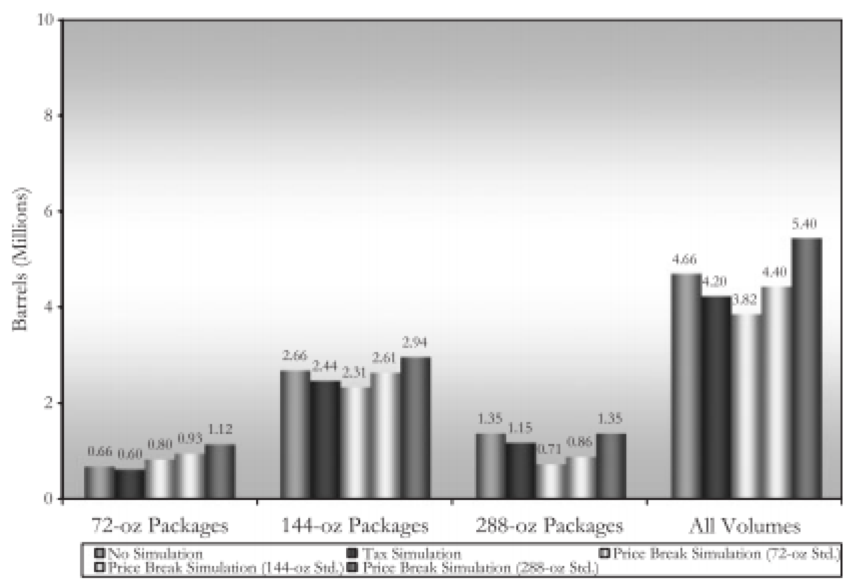

Figure 1. Predicted annual beer sales (millions of barrels) by volume package size

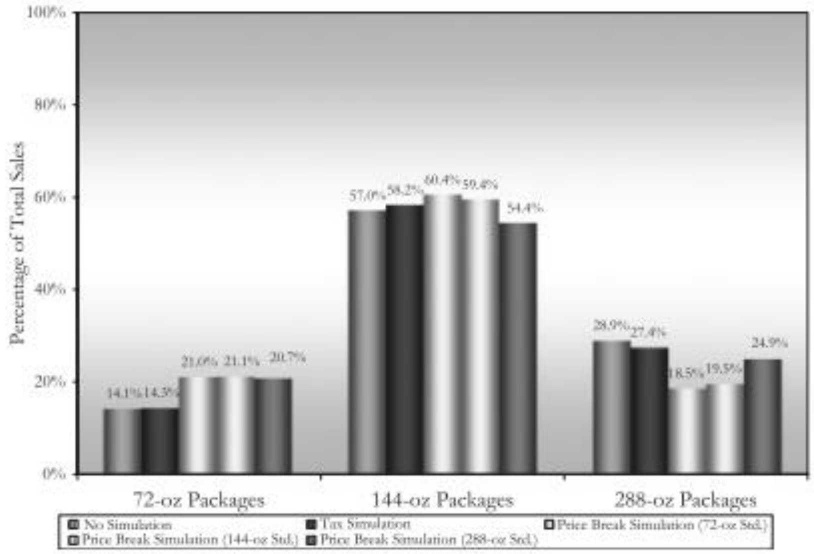

Figure 2. Shares of predicted annual sales by volume package size

Standardizing volume price across all packaging types to the volume price of a 72-oz package decreased the total annual number of barrels of beer sold by almost 1 million barrels. In contrast with the tax change simulation, the distribution of sales across the different unit sizes changed substantially, with the share of total volume sales for 72- and 144-oz units increasing but the share for 288-oz units decreasing. Thus, not only were overall sales lower, but sales shifted from larger-volume packages to smaller-volume packages. The decrease in sales more than offset the higher volume price so that total sales revenues decreased by approximately 9.5%. Similar results were seen when standardizing the 144- oz package volume prices. If volume prices are standardized to those of 288-oz Packages – the lowest volume price of all package types considered – then overall sales increase by nearly 16%, but the distribution of sales again shifts markedly toward lower-volume packaging. This could imply that consumers would prefer to purchase beer in smaller quantities than 288-oz packages, and they only purchase larger-volume packages because the lower price overcomes their preference for smaller packages. Standardizing to the 288-oz average prices results in an increase in revenue generated of approximately 9%.

5. CONCLUSION

Alcohol consumption is the third leading cause of preventable death in the United States (Mokdad et al., 2004), and alcohol abuse is associated with many behavioral and social problems (USDHHS, 1994, 2000). Despite these negative consequences, alcohol is widely marketed and promoted. One common form of alcohol promotions, point-of-purchase promotions, can be found in nearly 90% of stores that sell alcohol (Terry-McElrath et al., 2003) and may increase beer sales in supermarkets by between 2.9 and 17% (Beverage Industry Magazine, 2001). Furthermore, evidence suggests that large-volume packages of beer are more heavily promoted in grocery stores than are smaller-volume packages (Bray et al., 2007), suggesting that high levels of promoted sales for large-volume beer packages may result in increased beer consumption.

This paper used supermarket scanner data to estimate brand- and packaging-specific own- and crossprice elasticities for beer. Analyses show that the demand for a specific brand and package type of beer is highly price elastic, with own-price elasticities of approximately –5 for 72-oz packaging, 144-oz packaging, and 288-oz packaging. Although these estimates are orders of magnitude higher than the commonly accepted price elasticity for alcohol in general (approximately –0.3) (Leung and Phelps, 1993), they are not unreasonably high. Previous estimates of alcohol price elasticity typically combine all alcohol consumption into a single category or, at best, separate beer, wine, and liquor into categories. The price elasticities presented here represent switching from one beer brand to another or from one package type to another within brand. Thus, the elasticities represent a much more priceresponsive trade-off and therefore are expected to be considerably larger in magnitude than previous estimates. Cross-price elasticity estimates confirm the plausibility of the own-price elasticity estimates because they suggest that individuals' responses to price result from switching among packaging sizes within brand. Cross-price elasticities for packaging sizes within brand were often greater than 1 and in one case approached 2.

Taken as a whole, our estimates suggest that the high levels of promotion for 144-oz packaging observed by Bray et al. (2007 induce more buyers to switch from 6-packs than from cases, and our policy simulations confirm this conclusion. Policy simulations found that total volume sold decreased if prices were standardized to either 72- or 144-oz pricing. The decrease came from decreased sales of 144- and 288-oz packages and increased sales of 72-oz packages. Our simulations illustrate that individuals do not make volume-for-volume substitutions between packaging sizes, and they will in fact buy less beer overall if the volume price of 6-packs is equal to the volume price of 12-packs. Importantly, our simulations allowed price-based discounts, but required equal volume pricing across all package types.

At first blush, our results seem to suggest that when suppliers price discount higher volume packaging, they are in essence stealing higher profit sales from themselves. However, the estimated elasticities and policy simulations show that any loss in revenue associated with consumers switching away from 6-packs toward lower priced 12-packs and cases is more than offset by the increased revenues associated with higher overall sales. Furthermore, the objective of the supplier is to maximize total profits, not average profits, and so inducing consumers to buy more 12-packs at the expense of 6-pack sales may be profit maximizing depending on the marginal cost structure faced by suppliers. Using our estimated results, we explored changes in profits associated with a 10% reduction in the price of a 12-pack for a variety of marginal cost assumptions. Assuming a constant marginal cost per barrel of beer (regardless of retail packaging), we found that a 10% decrease in the price of a 12-pack increases overall profits as long as marginal costs do exceed 70% of the price of a case of beer. This marginal cost implies a 30% profit margin on cases (shared across retailer, distributor, and brewer). Although it is possible to discount prices to the point that total profits are reduced, this does not necessarily mean that discounting higher volume packing reduces overall profits. Indeed, for a broad range of marginal cost and price discount scenarios, discounting of 12-packs and cases actually increases overall profits.

In light of these findings and given the results of our policy simulations, our results raise the question of why beer is not sold at the lower case price, and we suspect that strategic behavior on the part of oligopolistic suppliers combined with an attempt to price discriminate is likely leading supermarkets to sell beer at varying volume prices. The game theoretic structure is complicated by many factors. First, the structure of the retail beer market is very complicated. Although beer producers and distributors are oligopolies, supermarkets are not. Capturing the effect of two levels of oligopolistic supply on retail sales that occur in a competitive environment is likely to be quite difficult. Second, consumer behavior complicates the model as well. Our measure of competing brand price is very gross and misses many subtleties in the beer market. For example, it is unlikely that Budweiser is a substitute for Heineken among all buyers, and some buyers purchase cases every week as a household staple, whereas others purchase only 6-packs on an infrequent basis. We suspect that suppliers at all levels of the market are attempting to price discriminate among these different types of consumers, but because suppliers have imperfect information and face imperfect competition they may be forced to use suboptimal pricing strategies.

In light of this discussion, we speculate that the beer industry is a potentially fruitful area for an industrial organizational research agenda given its unique market structure consisting of brewers, distributors, and retailers; a structure that is heavily influenced by federal, state, and local regulation. Given the complicated structure of the beer market, however, we suggest that the next step along an industrial organization research agenda is to do develop a complete theoretical model of the market to yield testable hypotheses about the implications of this market structure for the optimal behavior of suppliers.

Although this paper is the first to look at the extent to which price determines the choice of packaging size in beer purchases, some limitations should be noted. First, the data are from supermarkets only and therefore our results may not generalize to other retail channels for beer, such as small grocery stores, liquor stores, and convenience stores. We note, however, that supermarkets are an important outlet for beer, capturing almost as much of the market (40%) as convenience stores (23%) and liquor stores (21%) combined (National Association of Convenience Stores, 2004). Furthermore, the sample restrictions that we placed on the data limit the generalizability of our results to the 25 brands and three package types we consider.

Second, the analysis did not consider possible substitution between beer and other alcoholic beverages, such as malt liquor, wine, or spirits. Although the substitution between beer and other alcoholic beverages is an important conceptual issue, previous research suggests that it is not a major empirical one. Studies that estimate the extent of substitution from beer to wine or liquor find conflicting and often statistically insignificant results (Leung and Phelps, 1993). Despite empirical problems with many of the estimates, a general conclusion is that, while many wine and liquor drinkers will switch to beer when faced with a price increase, few beer drinkers will switch to wine or liquor (Leung and Phelps, 1993). Based on the results in this paper, it appears that beer drinkers most likely switch package size when faced with a price change.

Third, it is important to note that prices and promotions are potentially endogenous. This would imply that the price effects estimated here do not only reflect a shift in the supply curve, but also capture movement along the supply curve. The result would be that the price elasticities are underestimated. Although endogeneity is always an issue with aggregate data, our approach is the first to attempt to separate demand and supply by including separate observations for promoted and nonpromoted sales, which we hypothesize represent a shift in the supply curve and therefore identifies the demand curve.

Despite these limitations, our results have clear implications for policy makers. Differential pricing of large-volume packaging of beer, often achieved through retail promotions, most likely does not induce consumers to switch from one brand to another while keeping the amount of beer sold constant. Rather, such pricing and promotion strategies most likely induce individuals to buy more beer overall. Although increased beer sales do not necessarily imply increased rates of consumption, marketing studies point to increased consumption as a likely result (Wansink, 1996). Future studies should examine the extent to which in-store promotions of large-volume packaging results in increased rates of intoxication, alcohol abuse, and other public health outcomes, such as car accidents. Even without these studies, the adverse health and social consequences associated with increased alcohol consumption suggest that policy attention needs to focus more on volume-based pricing for beer.

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REFERENCES

Becker GS, Murphy KM. 1998. A theory of rational addiction. *Journal of Political Economy* 96(4): 675–700.

Beverage Industry Magazine. 2001. *POP Proves its Worth*, July 2001.

Bray JW, Loomis BR, Engelen M. 2007. Correlates of in-store promotions for beer: differential effects of market and product characteristics. *The Journal of Studies on Alcohol and Drugs* 68(2): 220–227.

Deaton A, Muellbauer J. 1985. *Economics and Consumer Behavior*. Cambridge University Press: Cambridge.

Duan N. 1983. Smearing estimate: a nonparametric retransformation method. *Journal of the American Statistical Association* 78: 605–610.

Federal Trade Commission (FTC). 1999. *Self Regulation in the Alcohol Industry: A Review of Industry Efforts to Avoid Promoting Alcohol to Underage Consumers*. Available from: http://www.ftc.gov/reports/alcohol/ alcoholreport/htm.

Information Resources Incorporated (IRI). 2000. InfoScan reviews, grocery channel, beer & malt beverages category. *64 Market Report, 1995– 1999*.

Leung SF, Phelps CE. 1993. 'My kingdom for a drink…'?. In *Economics and the Prevention of Alcohol-Related Problems, Research Monograph 25*, Hilton ME, Bloss G (eds). US Department of Health and Human Services, Public Health Service, National Institutes of Health, National Institute on Alcohol Abuse and Alcoholism: Rockville, MD; 1–32.

Manning WG. 1998. The logged dependent variable, heteroscedasticity, and the retransformation problem. *Journal of Health Economics* 17: 283–295.

Midanik LT, Chaloupka FJ, Saitz R et al. 2004. Alcohol-attributable deaths and years of potential life lost – United States, 2001. *Morbidity and Mortality Weekly Report* 53(37): 866–870.

Mokdad AH, Marks JS, Stroup DF, Gerberding JL. 2004. Actual causes of death in the United States, 2000. *The Journal of the American Medical Association* 291(10): 1238–1245.

National Association of Convenience Stores. 2004. *SOI Highlights: The Convenience Store Industry's 2003 Performance*. National Association of Convenience Stores. 2004. Available from:. http://www.nacsonline.com [accessed April 2005].

StataCorp. 2003. *Stata Statistical Software, Release 8.2*, Stata Corporation, 2003, College Station, TX.

Terry-McElrath YM, Harwood EM, Wagenaar AC et al. 2003. Point-of-purchase alcohol marketing and promotion by store type – United States, 2000–2001. *Morbidity and Mortality Weekly Report 52*(14): 310–313.

US Department of Health and Human Services (USDHHS). 1994. Eighth special report to the US Congress on alcohol and health from the secretary of health and human services. *NIH Publication No. 94-3699*, Washington, DC, US Department of Health and Human Services.

US Department of Health and Human Services (USDHHS). 2000. Tenth special report to the US Congress on alcohol and health from the secretary of health and human services. *NIH Publication No. 00-1583*, Washington, DC, US Department of Health and Human Services.

Wansink B. 1996. Can package size accelerate usage volume? *Journal of Marketing* 60: 1–14.