Journal of Agricultural and Resource Economics 39(2):174–187 ISSN 1068-5502

Beer Snobs Do Exist: Estimation of Beer Demand by Type

Daniel Toro-González, Jill J. McCluskey, and Ron C. Mittelhammer

Although mass-produced beers still represent the vast majority of U.S. beer sales, there has been a significant growth trend in the craft beer segment. This study analyzes the demand for beer as a differentiated product and estimates own-price, cross-price, and income elasticities for beer by type: craft beer, mass-produced beer, and imported beer. We verify that beer is a normal good with a considerably inelastic demand and also find that the cross-price elasticity across types of beer is close to zero. The results suggest that there are effectively separate markets for beer by type.

Key words: craft beer, demand analysis, differentiated products

Introduction

The craft brew revolution has transformed the beer industry. Thirty years ago, there were only a handful of specialty craft breweries. In 2011, there were 1,970 microbreweries in the United States offering a wide variety of differentiated products (Bradford, 2012) in almost every form and flavor imaginable.[1] With this increasing focus on variety, taste, and quality, a new term entered our vocabulary: the beer snob, a term given to those consumers who enjoy craft beers. Beer snobs are often accused of looking down on those who drink mass-produced beers (see Urbandictionary.com). A typical beer snob would rather drink nothing than drink a mass-produced beer.

Beer as a product can be placed in one of three broad categories in the U.S. market: mass-produced beer, craft beer (microbrews), and imports.[2] Mass-produced beers are traditional American lagers, which are produced on a mass production scale. In particular, mass-produced beers have similar characteristics of lightness, use bottom-fermenting yeast, and sometime use adjuncts, such as corn or rice. Imported beers are those produced abroad. The Brewers Association defines the craft beer segment as beer made by independently owned brewers with annual production of six million barrels or less and who use traditional ingredients without adjuncts to lighten the taste. The product differentiation across beer categories is horizontal rather than vertical, meaning that different consumers prefer each category.

Although mass-produced brews still account for the vast majority of beer sales, sales of craft beers have also grown steadily for many years. According to the Brewer's Association, craft brewers' share of sales grew by 20% to an estimated $14.3 billion in retail sales. This constitutes an estimated

Daniel Toro-González is an assistant professor in the School of Economics and Business, Universidad Tecnologica de Bolivar, Colombia; Jill J. McCluskey is a professor and Ron C. Mittelhammer is dean of the College of Agricultural, Human, and Natural Resource Sciences and regents professor in the School of Economic Sciences at Washington State University.
The authors wish to thank Rebecca Hellerstein for information provided on variables related to beer characteristics; Luis Castro and Bret Noble for consultations on the brewing production process and effects of beer characteristics; and Jia Yan, Karina Gallardo, Vic Tremblay, Julian Alston, Jo Swinnen, and two anonymous reviewers for helpful comments.
Review coordinated by Christopher S. McIntosh.

[1] For example, "Beard Beer" by Rogue is brewed with yeast created from their brewmaster's beard.

[2] The mass-produced beer category has been further partitioned by marketers into "premium," "popular," and "light" subcategories (as discussed in Hausman, Leonard, and Zona, 1994). The premium beers have a premium brand image based on persuasive advertising and constitute a high percentage of the market, while the popular beers charge discounted prices and light beers are low calorie beers.

14.3% of sales in the U.S. beer market. This growth occurred while overall U.S. beer sales were down an estimated −1.9%. Imported beer sales have been flat: down an estimated −0.6% in 2013 while up 1.3% in 2012 (Brewers Association, 2014). Consumers may choose imported beers based on Veblen effects and identification with their ancestral heritage (e.g., consumers with an Irish ancestry may choose Guinness). According to Tremblay, Iwasaki, and Tremblay (2005), factors such as the homogenization of mass-produced brewed beer, changes in local demand conditions, and a more favorable regulatory environment have created profitable niches in many local markets for microbrewery beer. Younger consumers are driving the increase in consumption of craft beer (Voight, 2013). Hence, as more millennials reach legal drinking age, one might expect for the craft segment to grow as a percent of the market.

Advertising has played a key role in the development of the industry, especially in the mass-produced and imported sectors. Beer advertising has generally been persuasive rather than informative about product characteristics. As a result, leading brewers acquired "brand personalities" that target the market with which they want to be associated (Choi and Stack, 2005). One could argue that advertising in the mass-produced beer category has been predatory at the brand level with mega-brewers gaining market share,[3] but the effect at the category level is flat. In contrast, the craft brewers market primarily through festivals, social media, other websites, at brewpubs, with t-shirts, and through word of mouth. With exceptional growth in craft beers, one could argue that these grassroots marketing strategies are not predatory within the craft category. In fact, strategies such as festivals encourage consumers to taste many different brands and leverage marketing efforts across brands.

Although all three categories of beer are considered to be the same product, one could argue that they are not close substitutes for each other. In general, beer is a product that one develops a taste for, suggesting an "exposure" effect. If a loyal Budweiser drinker tries a Dogfish Head 90 Minute India Pale Ale (IPA) for the first time, he or she will likely be unappreciative of the taste. Similarly, a craft beer snob would likely prefer to drink nothing over a light American lager. We explore whether different categories of beer are substitutes by estimating demand for beer by category. A testable hypothesis is that cross-price elasticities are close to zero.[4]

Many studies have analyzed the demand for beer (Hogarty and Elzinga, 1972; Tegene, 1990; Lee and Tremblay, 1992; Nelson, 1999; Freeman, 2001), and some authors have estimated brand-level elasticities (Hausman, Leonard, and Zona, 1994; Rojas and Peterson, 2008; Bray, Loomis, and Engelen, 2009). However, to our knowledge, cross-price elasticities differentiated by category (i.e., craft, mass-produced, and imported) have not been presented in the literature.[5] The availability of data and computational power allow us to evaluate these particular parameters with the confidence that they will help marketers and producers to be more aware of market characteristics and to help them to design better and more effective selling techniques. In addition, the microbrew movement is consistent with a more general shift in food preferences. There is an increasing desire for variety, taste, and local products. Thus, the main idea that highly differentiated products are not substitutes for each other is applicable to other categories of horizontally differentiated products.

The objective of this article is to identify the price, income, and cross-price elasticities for craft mass-produced, and imported beers, accounting for consumer valuation of product-specific unobserved (by the econometrician) quality and other attributes such as freshness, bitterness, and sweetness. The analytical framework follows Berry (1994) in estimating aggregate demand functions with unobservable product characteristics. We use a detailed scanner database from Dominick's supermarkets in Chicago to perform the analysis. This database contains approximately

[3] Beer advertising is a major topic of inquiry; an incomplete list includes Lee and Tremblay (1992); Iwasaki, Seldon, and Tremblay (2008); Nelson (2003); and Rojas and Peterson (2008).

[4] Some caveats include that the preference for consumption of beer may be affected by the context in which it is consumed. For example, on a hot day at the beach, a Corona might be preferable to a Guinness for a consumer who in other circumstances likes Guinness.

[5] Hausman, Leonard, and Zona (1994) estimate segment elasticities for light, popular, and premium beers within the mass-produced segment as an intermediate step to obtain their brand-level elasticities.

seven years of store-level data for more than 700 beer products distributed in a 100-store chain and includes information on product and consumer characteristics.[6]

Literature Related to Analyses of Beer Demand

Researchers have followed several approaches to study demand for beer, with many studies including the effect of advertising. The Almost Ideal Demand System (AIDS) model (Deaton and Muellbauer, 1980) has been applied frequently to estimate demand for beer (Clements and Johnson, 1983; Heien and Pompelli, 1989; Blake and Nied, 1997). Clements and Johnson (1983) show that when the consumer's utility function is appropriately separable in alcoholic beverages and all other goods, it is possible to confine attention to the three main categories of alcoholic beverages (wine, beer, and spirits) and ignore all other goods. Heien and Pompelli (1989) estimate a demand system that considers all beverages simultaneously while incorporating the effect of demographics. Blake and Nied (1997) use an AIDS model to estimate demand for beer in the United Kingdom.

Other empirical approaches evaluate factors that are expected to influence beverage consumption. Levy and Sheflin (1985) utilize a Cobb-Douglass consumption function in which per capita consumption of alcoholic beverages depends on real per capita disposable personal income and the relative price of alcoholic beverages to personal income to analyze demand in the period between 1940 and 1980. They find that total demand for alcoholic beverages is inelastic and discover weak evidence of a higher propensity to consume alcoholic beverages by those under the age of twenty-one. Fenn, Antonovitz, and Schroeter (2001) build on Becker and Murphy's 1988 theory of rational addiction to analyze an intertemporal utility maximization problem leading to a demand equation in which consumption depends on prices and past and expected future consumption linearly.

We follow Berry (1994); Berry, Levinsohn, and Pakes (1995); and Nevo (2001) in implementing a differentiated product-market identification strategy for analyzing beer demand, in which it is assumed that consumers' preferences are described by an indirect utility function that is a function of observed and unobserved (by the econometrician) product and individual characteristics. Berry's approach addresses the model dimensionality problem induced by the existence of a large number of underlying differentiated beer products by projecting the products onto a product characteristics space. The method also accommodates the possibility that prices are correlated with unobserved demand factors within a cross section of markets while allowing estimation to proceed via a traditional instrumental variables approach.

Data

The Dominick's scanner dataset used in this study was obtained from the Kilts Center for Marketing at the University of Chicago Booth School of Business. The database consists of approximately 1.4 million observations providing information on weekly sales of 484 universal product codes (UPCs) for 343 different beer products sold in sixty stores over seven years (from 1991 to 1997), a period of steep increase in the number of craft beer manufacturers. The dataset contains product information as well as information about the distribution of the sociodemographic variables for the areas where each store is located. In particular, the total quantities sold of each beer product in each store are known as well as the price of the item, the brand and particular product within the brand, the type (craft, mass or American Lager or imported), the number of units in the bundle, and the alcohol content. Other product characteristics (see table 1) were constructed by crossreferencing the brand and product with information available from ratebeer.com and beeradvocate.com.

The vast majority of sales correspond to mass-produced beer, comprising 86.4% of the market share. Imported beer accounts for 8.2% of sales, and the remaining 5.3% is the market share for

[6] The data set contains weekly information on beer sales beginning on 06/06/1991 and ending on 05/07/1997.

Table 1. Product Descriptive Statistics

Variable	Description	Mean	Std. Dev.
Price per unit	$ per single unit		
craft		$0.80	
mass		$0.54	
import		$0.95	
Mass	market share	0.053	
Craft	market share	0.864	
Import	market share	0.082	
Bundle size	bottles	9.286	6.343
Alcohol Content	% Alcohol	4.777	0.798
Ale	1 if ale, 0 otherwise	0.164	0.370
Fruit	1 if fruit, 0 otherwise	0.023	0.151
Low Alcohol	1 if low alcohol, 0 otherwise	0.013	0.115
Oktoberfest	1 if Oktoberfest, 0 otherwise	0.025	0.155
Seasonal	1 if seasonal, 0 otherwise	0.018	0.135
Smoked	1 if smoked, 0 otherwise	0.026	0.160
Steam	1 if steam, 0 otherwise	0.001	0.039
Stout	1 if stout, 0 otherwise	0.020	0.142
Wheat	1 if wheat beer, 0 otherwise	0.016	0.126

craft beers (see table 1). Prices are notably different across beer types. The least expensive category is mass-produced beer at an average price of $0.54 per unit. The lower price is partially explained by the economies of scale generated through mass production and distribution and the use of lower-cost grains such as corn and rice.[7] In contrast, craft beers command an average price premium of $0.26 per unit over the price of mass-produced beers, reflecting in part the higher cost of more specialized ingredients and the smaller scale of production. The average price premium for imported beers is $0.41 cents, reflecting additional costs such as greater transportation costs and import taxes.

We examine demand for the most common unit of production, twelve-ounce units (either cans or bottles), bundled in different numbers, from four-unit bundles up to thirty-unit bundles. By far, the most common choice of package is a six-unit bundle with 54% of the market share. Mass-produced beer can be differentiated from craft and imported beers on the basis of packaging strategy. While most of the craft and imported segments are sold in six packs, where market shares are 93% and 86%, respectively, more than half of the total mass-produced beer (57%) is sold in bundles of more than twelve units. In terms of the style of beer,[8] most of the beers sold are pale lagers or lagers (90%) produced by large breweries. Ales represent about 6%, stouts represent 0.8%, and the remaining share of the market is distributed across a wide array of beer types. Mass-produced beers have lower alcohol by volume (ABV) with an average level of 4.5%, followed by imported beers with 4.6% ABV and craft beers with 4.9% ABV.[9]

In terms of sociodemographic variables, the average income and home values for the neighborhoods surrounding each store as well as the percentage of black and Hispanic residents, the percentage of college graduates, and the average size of the household are available. The socioeconomic variables represent average values for the neighborhoods surrounding each store. The average household across all stores has 2.6 members, an income of almost $43,000, and a home value of approximately $150,000. The percentage of the neighborhood populations who had

[7] However, because the cost of ingredients is a small share of total cost (only about 4%), the scale economy argument is the dominant explanation on the supply side.

[8] Classification according to Michael Jackson's criteria (see http://michaeljacksonthebeerhunter.blogspot.com/).

[9] ABV represents the portion of the total volume of liquid that is alcohol. Information on this variable was constructed from different sources including ratebeer.com, beeradvocate.com, and personal communications with Rebecca Hellerstein.

Table 2. Descriptive Statistics of Consumer Characteristics

Variable	Mean	Std. Dev.	Min	Max
Income	42,612	12,652	19,285	75,826
House Value	146.694	46.986	64.348	267.390
HH Size	2.680	0.281	1.554	3.309
Education	0.220	0.112	0.050	0.518
Ethnic	0.150	0.179	0.024	0.996

Source: Dominick's dataset, calculations by the authors.
Notes: Income is the average for the sample of the median income; House Value is average house value in thousands of dollars; HH Size is the average number of members in each household for the area; Education is the average percentage College Graduates; and Ethnic is the average percentage of Blacks and Hispanics.

graduated from college is 22%, and the average proportion of blacks and Hispanics living in the community is 15% (see table 2).

There are notable differences in the levels of some consumer characteristics relating to beer sales. For example, average income level is higher by an average of $900 in those neighborhoods in which more craft beers are sold compared to neighborhoods where more mass-produced beer is sold. The increase in average income for neighborhoods in which more imported beers are sold is $1,200 compared to neighborhoods that sell more mass-produced beer. These sociodemographic differences suggest that demographics may be useful explanatory factors regarding the demands for the different types of beer. We underscore that consumers' demographics in the Dominick's dataset are based on U.S. Census data, so they vary across store locations but do not vary over time. However, there is substantial heterogeneity across the different neighborhoods surrounding the stores, both in terms of demographics and beer consumption. For example, the share of mass-produced beer sold by stores ranges from a low of 7.7% to a high of 88%. In the case of craft beers, sales range from 4% to 40%; for imported beers the market share varies between 7% and 51%.

Modeling Framework

We adapt Berry's 1994 approach to model the market for beer as one with differentiated products, where each store operates in a market composed of the neighborhood surrounding the store and each brand of beer is considered as a product within a discrete choice framework. Following Berry, we assume that consumer i's utility for product j depends on the price per unit (bottle or can), product characteristics, and the consumer's tastes, $U(x_j,\xi_j,p_j,\epsilon_{ij},\theta_i)$, where x_j and ξ_j refer to the observed and unobserved product characteristics, respectively. The price of each product is represented by p_j. The unobservable consumer-specific terms affecting utility are represented by ϵ_{ij}, and parameters of the utility function—which ultimately appear in the demand functions as coefficients on observables—are given by θ_i. Among the observed product characteristics we explicitly account for the size of the bundle (number of units); the ABV; whether the beer type is craft, mass-produced, or imported; the style (ale, fruit, low alcohol, Oktoberfest, seasonal, smoked, steam, stout, wheat); and the price per bottle/can (p_j).

According to Feenstra and Shapiro (2003), one should consider that a seller may maintain prices zones[10] with different pricing strategies depending on the presence of other stores in the area. We control for this by including indicator variables to identify the zone in which each store is located, using the fifteen predefined zones from the Dominick's database.[11] The unobserved product characteristics (ξ_j) represent all of the product attributes that the econometrician cannot measure or

[10] Stores from a single supermarket chain in a city are partitioned into zones, with retail prices varying across zones (Besanko, Dube, and Gupta, 2005).

[11] As documented by Pofahl, Capps, and Love (2006), as well as additional references contained therein, the fact that Dominick's pursues a zone pricing strategy is well documented, as is the contention that consumer demographics have more to do with the choice of Dominick's pricing zones than horizontal competition. Based on these findings, Pofahl, Capps, and Love assumed that stores within each price zone were local monopolists, and that any price discrimination that may have been pursued was the result of responding to varying consumer price sensitivities.

observe but that the consumer takes into the account when making their choice. Examples include the quality of the ingredients used in brewing, the freshness of the product, bitterness, sweetness, and all the possible flavors and aromas that can be generated in the brewing process, as well as such things as labels and bottle shapes.

Proceeding to the empirical implementation of the model, consider a specification for utility that depends on, among other factors, unobserved consumer-specific taste effects represented by the error terms ϵ_{ij}:

$$u_{ij} = x_j\beta - \alpha p_j + \xi_j + \epsilon_{ij}. \tag{1}$$

In distinguishing what can be interpreted as two error terms in this model, ξ_j is interpreted as the (unobserved) mean of the consumers' valuations of the unobserved product characteristics for product j, and the error term ϵ_{ij} is reflective of the distribution of the consumers' preferences around the mean value ξ_j.

Given the linear index nature of the model, it is assumed that the marginal effects of changes in product attributes adjust mean levels of consumer preferences (as set by the specific sociodemographics of a given consumer type and other observed explanatory variables) in like manner and that the error term is independently and identically distributed (i.i.d.) from an extreme value distribution. Berry (1994) demonstrates that market share for product j can then be represented by the multinomial logit (MNL) model as

$$s_j = \frac{e^{\delta_j}}{\sum_{k=0}^{J} e^{\delta_k}}, \tag{2}$$

where $\delta_j = x_j\beta - \alpha p_j + \xi_j$ represents the mean utility for product j and $k = 0$ refers to an "outside good" that represents the consumer's expenditure on all other goods besides beer. A difficulty in the estimation of this logit specification is that the unobserved product characteristics enter the relation nonlinearly. Moreover, prices and the unobserved characteristics are correlated. Berry (1994) provides a solution to these issues by transforming the model so that the unobserved characteristics enter linearly, and the endogeneity issues can be addressed in a relatively standard way.

By normalizing the mean utility of the outside good to zero and assuming the relationship between observed and predicted market shares is invertible; Berry represents the share relation in the following linear-in-log-difference form:

$$\ln(s_j) - \ln(s_0) = \delta_j = x_j\beta - \alpha p_j + \xi_j. \tag{3}$$

Prices will be correlated with unobservable product characteristics, and the explanatory variables are not all exogenous to the model, resulting in an identification problem due to endogeneity that needs to be addressed. For example, on an average per unit basis, small breweries use greater quantities and varieties of hops and fewer adjuncts such as corn or rice but more malted grains such as barley. The use of these ingredients increases production costs, and thus prices are positively correlated with factors that are unobservable in our dataset.

An advantage of Berry's representation of market shares is that instrumental variables (IV) can be used to account for endogeneity of prices. As instruments in this case, we follow Hausman (1996) in utilizing the prices of the same products in other markets[12] under the assumption that product valuations are independent across markets (recall the substantial heterogeneity of demand across markets) so that prices of product j outside of a given market will be correlated with the price of product j within the market due to the product's common marginal costs, but the outside prices will be uncorrelated with internal market-specific valuations of the product. We assess the appropriateness of this choice of instruments via a statistical test of instrument validity.

[12] In our case, "other market" refers to a different store in a different price zone.

As an alternative specification, we follow Berry (1994) in modifying the MNL model to account for potential correlation between consumer and product characteristics within types of beer, which are expected *a priori* to be the principal types of interactions between these characteristics. In particular, we adopt a nested logit (NL) type of specification, which enables the preservation of the assumption that consumer tastes follow an extreme value distribution while allowing those tastes to be correlated across products of a particular type. The NL model allows for more flexible substitution patterns in comparison to the MNL model. We motivate the plausibility for nesting with a simple choice example: if a consumer wishes to purchase an American lager, he or she will consider alternatives such as Coors, Budweiser, or Miller, but not an IPA or other beer choice outside the American lager type. Consequently, removing IPA and other beers, outside of American lagers, from the choice set would not change the consumer's probabilities of choosing from among the mass-produced beers, and a nested view of the decision process makes sense.

Pursuing the NL formulation, Berry (1994) groups products into mutually exclusive and exhaustive subsets, $g = 0, 1, 2, \dots, G$, in which the outside good $j = 0$ is assumed to be the only member of group $g = 0$. Denoting the set of products in group g as g_g, the utility of consumer i for product $j \in g_g$ is represented by

$$u_{ij} = \delta_j + \zeta_{ig} + (1 - \sigma)\epsilon_{ij}, \tag{4}$$

where again $\delta_j = x_j\beta - \alpha p_j + \xi_j$ and ϵ_{ij} is i.i.d. extreme value. For a given consumer i, the variable ζ is constant and common to all products in group g and its distribution function depends on σ, with $0 \leq \sigma < 1$. As $\sigma \to 0$ or 1, the within-group correlation of utility levels approaches 0 or 1, respectively. One can interpret equation (4) as a random coefficients model involving random coefficients ζ_{ig} only on group-specific indicator variables. That is, if d_{jg} is an indicator variable equaling 1 for $j \in g_g$ and 0 otherwise, then equation (4) can be written as

$$u_{ij} = \delta_j + \sum_g d_{ig}\zeta_{ig} + (1 - \sigma)\epsilon_{ij}. \tag{5}$$

An analytic expression involving mean utility levels that represents an expanded version of equation (3) is then given by[13]

$$\ln(s_j) - \ln(s_0) = \delta_j \equiv x_j\beta - \alpha p_j + \sigma \ln(\bar{s}_{j/g}) + \xi_j, \tag{6}$$

where $\ln(\bar{s}_{j/g})$ is the natural log of product j's within-group share ($\bar{s}_{j/g}$). However, as in the case of prices, the within-group share is expected to be related to the unobserved characteristics because unobserved product characteristics influence the market share within each category. Thus, $\bar{s}_{j/g}$ is endogenous, suggesting the need for additional instrumental variables for the within-group share.

We use product variety, indicated by the number of products available in each market, as an instrumental variable, which is correlated with the within-group product share but not with the unobservable product attributes. Economic theory provides support for the use of the number of products within the market as an instrument by framing the situation as a sequential-decision game.[14] The decision made by each firm about the number of products is made before the realization of consumer preferences. At this stage, firms do not know consumer preferences. Hence, the number of products is not related to the consumers' valuations of the unobservable product attributes. Alternatively, the number of products may be considered exogenous because in Illinois, as in most of the United States, brewers are not allowed to sell directly to retailers, configuring the "three-tier system."[15] Hence, the variety of products available in the market at a given point in time is not an outcome of the market but a result of distributors' decisions.

[13] For details refer to Berry (1994, p. 253).

[14] We acknowledge that supermarkets and consumers might alternatively be playing a repeated game (not a simple dynamic game), making the number of products predetermined rather than exogenous.

[15] The three-tier system (producers, distributors, and retailers) was introduced after Prohibition to inhibit contact between producers and retailers.

Table 3. Variable Descriptions

Variable	Definition
Market Share Ratio	$[\ln(s_j) - \ln(s_0)]$ is the dependent variable and represents the market share ratio between each market and the outside good market share.
Price	Unit price (twelve-ounce bottle or can)
Size	Number of units in the bundle
Alcohol	Percentage alcohol content
Beer Type Indicators	Mass, Craft, Import representing each beer category
Ethnic	Percentage of Hispanic and black populations in the neighborhood
Education	Percentage of college graduates in the neighborhood
HH Size	Average household size in the neighborhood
Income	Mean household income
Beer Characteristic Indicators	Ale, Fruit, Low alcohol, Oktoberfest, Seasonal, Smoked, Steam, Stout, Wheat
Zone_1 to 15	Indicators of pricing zones defined by Dominick's
Price Tier	Indicator for stores designated as a "CUB-Fighter" by Dominick's, where CUB Foods is a supermarket chain in direct competition with Dominick's stores

Estimation Results

The empirical model is based on yearly aggregated observations, per store, on variables contained in equations (3) and (6), resulting in 12,066 annual observations on beer products sold over seven years across the sixty stores. The results of estimating ordinary least squares (OLS), MNL and NL models are presented in table 4. The coefficients for the MNL and NL models were obtained by an application of two-stage least squares (2SLS). The model estimated by OLS incorporates no correction for endogeneity and is estimated as a base model for comparing the effects of the endogeneity corrections and alternative functional models on estimated results. The definitions of all of the variables used in estimating the model are provided in table 3.[16]

The explanatory power of the estimated model increased substantially when the within-group product shares were accounted for via the NL model. In the case of the MNL model, the R^2 statistic is 0.45, whereas for the NL model, the R2 statistic increases to 0.73. The estimated parameters of the MNL model and the NL model have the same signs and high levels of statistical significance (all at the 0.01 level), but the magnitudes of the parameter estimates in many cases differ notably between the models.

For both the MNL and NL models, the product characteristics of package size and alcohol content have a positive effect on demand. A market location in a neighborhood with greater proportions of black and Hispanic population has a negative effect, while a location in a neighborhood with a greater percentage of college graduates also negatively affects beer consumption. A negative effect was also observed for the case of larger families. The income effect on demand is positive. A host of other statistically significant effects relating to beer characteristics and price zones can be deduced from the results presented in table 4. The agreement in signs across all of the explanatory factors associated with statistically significant effects in both the MNL and NL models promote confidence in the directions of those effects. However, given the substantially higher goodness of fit, as well as the additional substitution flexibility provided by the NL model, we henceforth focus on the NL results for presenting and interpreting elasticity results.[17]

Mean level estimated own-price and cross-price elasticities as well as income elasticities are presented in table 6. Confidence intervals for the elasticities are presented in table 5. The

[16] Other identification strategies—such as Control Function approach—were tested, with similar results.

[17] We follow Nevo (2000) in defining the own- and cross-price elasticities as follows:

$$\eta_{jk} = \frac{\partial s_j p_k}{\partial p_k s_j} = \begin{cases} -\alpha p_j (1 - s_j) & \text{if } j = k \\ \alpha p_k s_k & \text{otherwise} \end{cases}.$$

Table 4. Results for OLS, Multinomial Logit (MNL) and Nested Logit (NL)

Variable	BASE (OLS)	MNL-IV	NL-IV
Price	−9.98E-06***	−0.2915***	−0.2372***
	0.000	0.0000	0.0000
Size	9.04E-06***	0.0537***	0.0046***
	0.000	0.0000	0.0000
Alcohol	−2.84E-06***	0.0265***	0.0570***
	0.004	0.0058	0.0000
Craft	−1.78E-05***	−0.3210***	−5.3313***
	0.000	0.0000	0.0000
Import	−1.75E-05***	−0.2035***	−5.2005***
	0.000	0.0000	0.0000
Ethnic	−8.75E-07	−0.0016	−0.0209
	0.918	0.9771	0.5970
Education	−1.04E-04***	−0.4022**	−1.0543***
	0.001	0.0331	0.0000
Household Size	−1.14E-05*	−0.2193***	−0.1724***
	0.051	0.0000	0.0000
Incomes	2.32E-07***	0.0028***	0.0040***
	0.004	0.0000	0.0000
Ale	−8.17E-07	−0.0794***	−0.0586***
	0.525	0.0003	0.0066
Fruit	1.47E-07	−0.0474	−0.0935**
	0.936	0.2003	0.0113
Low Alcohol	−2.99E-05***	0.0560	0.1645***
	0.000	0.4087	0.0000
Oktoberfest	9.35E-07	0.1732***	0.2032***
	0.649	0.0000	0.0000
Season	−5.69E-06**	0.1203***	0.1620***
	0.012	0.0049	0.0004
Smoked	−3.70E-06**	−0.2046***	−0.2426***
	0.013	0.0000	0.0000
Steam	2.12E-06	0.0465	−0.0296
	0.610	0.7035	0.8128
Stout	3.41E-06**	0.0003	−0.0456
	0.042	0.9935	0.2147
Wheat	−2.20E-06	−0.2915***	−0.3558***
	0.278	0.0000	0.0000
Price Tier	−2.69E-05**	−0.3087***	−0.4009***
	0.025	0.0000	0.0000
σ			0.9050***
			0.0000
Observations	12,066	12,066	12,066
R^2	0.2061	0.4500	0.7345

Notes: Single, double, and triple asterisks (* ,**, ***) indicate p-values of <0.1, <0.05, and <0.01, respectively. Price zone estimated coefficients are not reported but available upon request.

Table 5. 95% Confidence Intervals for Elasticities

	Price Elasticity Matrix											
	Mass			Craft			Import			Income Elasticity		
	LB	**Coeff**	**UB**	**LB**	**Coeff**	**UB**	**LB**	**Coeff**	**UB**	**LB**	**Coeff**	**UB**
Mass	−0.1378	−0.1260	−0.1142	0.0004	0.0004	0.0004	0.0003	0.0003	0.0003	0.4645	0.5701	0.6756
Craft	0.0017	0.0019	0.0020	−0.2323	−0.2124	−0.1925	0.0004	0.0005	0.0005	0.4826	0.5923	0.7020
Import	0.0018	0.0020	0.0022	0.0004	0.0004	0.0005	−0.2458	−0.2247	−0.2037	0.4740	0.5818	0.6896
				LB	**Coeff**	**UB**				**LB**	**Coeff**	**UB**
Overall				-0.1936	-0.1771	-0.1605				0.4727	0.5801	0.6875

Notes: LB = Lower Bound and UB = Upper Bound. We also test for equal elasticity coefficients across types of beer using a standard difference tests based on an asymptotic normal t-distribution. The results for the null hypothesis of equal elasticities by type are:

Mass vs. Craft: 3.7891598; P-value: 0.00007568
Mass vs. Import: 3.7948849; P-value: 0.00007396
Craft vs. Import: 2.211208; P-value: 0.01351339

Table 6. Estimated Elasticities

	Price Elasticity			Income
	Mass	Craft	Import	Elasticity
Mass	−0.1260	0.0004	0.0003	0.5701
S.E.	5.90E-03	1.16E-05	1.35E-05	5.28E-02
Craft	0.0019	−0.2124	0.0005	0.5923
S.E.	8.73E-05	9.94E-03	2.26E-05	5.48E-02
Import	0.0020	0.0004	−0.2247	0.5818
S.E.	9.24E-05	2.05E-05	1.05E-02	5.39E-02
Overall		−0.1771		0.5801
S.E.		8.29E-03		5.37E-02

Table 7. Comparisons with Elasticity Results from Other Studies

Source	Price Elasticity	Income Elasticity
Hogarty and Elzinga (1972)	−0.889	0.430
Ornstein and Hanssens (1985)	−0.142	0.011
Tegene (1990)	−0.768	0.731
Lee and Tremblay (1992)	−0.583	0.135
Gallet and List (1998)	−0.730	−0.545
Nelson (1999)	−0.200	0.760
Nelson (2003)	−0.174	−0.032
This study	−0.177	0.580

Source: Tremblay and Tremblay (2005, table 2.2).

overall estimated demand for beer is highly inelastic with a mean level elasticity of −0.1771 when considered across all beer types. With respect to other studies, estimation results consistently find beer demand to be inelastic, but the variation across estimates is considerable, ranging from −0.142 to −0.889 (see table 7). Our estimates are in the lower part of the range.

Within each beer type, demands for particular types are own-price inelastic, but there are differences between types. We test for equal elasticity coefficients across beer types using a standard difference tests based on an asymptotic normal t-distribution. Results indicate that the null hypothesis of equal elasticities by type of beer is rejected with high levels of confidence in all cases, hence the parameter elasticities are different from each other by beer type. Mass-produced beer has the lowest own-price elasticity at −0.1260. A possible explanation for this insensitivity to price is high brand loyalty among consumers to their particular brands of mass-produced beers. Advertising rivalries in the mass-produced segment have traditionally been intense (Nelson, 2003). In addition, contributing to the inelastic nature of demand for beer could be factors such as the social, habit-forming, and addictive qualities that beer evokes in some consumers. Both craft and imported beers are also substantially own-price inelastic at −0.2124 and −0.2247, respectively, although demand for these beer types is notably more price responsive compared to mass-produced beer. A similar explanation for the price insensitivity may be that consumers are traditionally loyal to the craft category and specific imported brands. Moreover, stores that sell larger quantities of craft and imported beers in our data et are surrounded by neighborhoods with higher average incomes, and thus craft and imported beer consumers may be less sensitive to changes in price.

Our major result in table 5 is that the cross-price elasticity estimates across the three types of beer are near zero, as is evident from the ranges of values encompassed by the 95% confidence intervals for these elasticities. This suggests that there is little substitution across types of beer and implies, for example, that if a consumer desires to buy a six pack of Budweiser, the fact that IPA craft beer is on sale will have little to no effect on his choice, on average. As another example, regarding the relatively more price responsive craft and imported beer types, if there is a notable increase in price, craft or imported beer drinkers will reduce their consumption of craft or imported beer somewhat, but will substitute little or no alternative types of beer in their place, perhaps substituting wine, spirits, or other beverages. While all of the cross-price effects are significant statistically, they are essentially insignificant in magnitude and effect, suggesting that the markets for the different types of beer are nearly independent of one another.

The independence of each market suggests intense differences among beer consumers in each category. With respect to the craft beer market, as we point out previously, the phenomena of increasing demand with higher average prices might be explained by differences in quality but also as described by Kastanakis and Balabanis (2011) as evidence of the existence of "snob" consumers, for whom the acquisition of scarce goods generate "signaling effects" on consumption, increasing their utility when the good consumed is uncommon and generates status (Veblen goods).

In terms of income elasticities, beer is a normal good regardless of the type (see tables 6 and 5). Across all beer types, beer is income inelastic at 0.5801. Regarding specific types of beer, income are all very similar, ranging from a low of 0.5701 for mass-produced beer to 0.5818 for imported beer and a high of 0.5923 for craft beer. The demand for all types of beer increases as income increases. However, with the information available, we were unable to verify the hypothesis that subpremium mass-produced beer is an inferior good, as suggested by Tremblay and Tremblay (2011).

We conducted tests to analyze the appropriateness of the model specification and estimation approach and assess the validity of the preceding results. To verify that the prices and within-market product shares are endogenous regressors in the model, we calculate the difference-in-Sargan test statistic for exogeneity. Under the null hypothesis that the variables are exogenous, if the test statistic is significant, the variables being tested (prices and the within-market shares) must be treated as endogenous. According to the results of the test, the null hypothesis is rejected with 99% confidence, suggesting that the variables are in fact endogenous.

The variables used as instruments include prices of the same product in different markets and product variety, which are represented by the number of products available in each market. Since the number of instruments exceeds the parameters to be estimated, the model is over-identified. We calculated Hansen's 1982 J-statistic to test the hypothesis that the instruments were uncorrelated with the error term of the share models (ξ_j). Based on the test, we cannot reject the hypothesis that the variables are uncorrelated at any conventional level of type I error, which—when coupled with the fact that the variables are correlated with the endogenous explanatory variables in the model—supports the validity of the instruments. Given the outcomes of the preceding tests, it could be expected that the base model (OLS) results would exhibit a degree of bias, and estimated coefficients do result in substantially different implied effects, such as the near nil price effect, providing additional support for the alternative models.

Conclusions

Although a number of researchers have estimated demand for beer and other alcoholic beverages, this study estimates demand for particular types of beer and identifies the price, cross-price, and income elasticities among craft, mass-produced, and imported beers based on supermarket scanner data. The results indicate that beer is a normal good with a demand that is inelastic to changes in prices and almost no substitution across types of beer. Although the own-price elasticity is quite inelastic within types, the category that is the least price-responsive is mass-produced (American lager) beer, which supports the hypothesis that consumers who purchase American lagers are highly loyal. In contrast, consumers are relatively more responsive to price for the craft and imported beer categories, indicating more of a willingness to change consumption levels as prices change. The increased demand responsiveness may be due in part to the significantly higher prices of craft and imported beers, in addition to the fact that wide availability of craft beers is a relatively new phenomenon, with consumer tastes likely still in formative stages.

There are some limitations to this study that should be underscored. The geographical region analyzed was limited to the Chicago area, so we cannot claim that our conclusions generalize geographically. For example, it is expected that stronger preferences for craft beer would be identified in a region such as the U.S. Pacific Northwest, given that the more developed and longer craft brew culture—and thus the inelastic nature of demand, reflective of craft beer loyalty—would likely be more pronounced. On the other hand, there are other major U.S. cities with similar demographic compositions for which the results may be relevant. A second limitation is the period of study. Following the time period covered by the data, the craft beer industry continued to expand throughout the United States as well as worldwide. A comparison across time periods would be useful for understanding how preferences continued to develop over time. The craft beer movement is consistent with a broader trend in food marketing that products are becoming increasingly differentiated and customized.[18] An understanding of the evolving consumption patterns for the craft beer segment could have implications for other newly developing differentiated food product categories.

[Received June 2013; final revision received June 2014.]

References

Becker, G. S., and K. M. Murphy. "A Theory of Rational Addiction." *Journal of Political Economy* 96(1988):675–700.

Berry, S. T. "Estimating Discrete-Choice Models of Product Differentiation." *RAND Journal of Economics* 25(1994):242–262.

Berry, S. T., J. Levinsohn, and A. Pakes. "Automobile Prices in Market Equilibrium." *Econometrica* 63(1995):841–890.

Besanko, D., J. P. Dube, and S. Gupta. "Own-Brand and Cross-Brand Retail Pass-Through." *Marketing Science* 24(2005):123–137.

Blake, D., and A. Nied. "The Demand for Alcohol in the United Kingdom." *Applied Economics* 29(1997):1655–1672.

Bradford, D. "Craft Beer Surges." *All About Beer Magazine* 32(2012).

Bray, J. W., B. R. Loomis, and M. Engelen. "You Save Money When You Buy in Bulk: Does Volume-Based Pricing Cause People to Buy More Beer?" *Health Economics* 18(2009):607–618.

Brewers Association. "National Beer Sales & Production Data." 2014. Available online at http://www.brewersassociation.org/pages/business-tools/craft-brewing-statistics/facts.

Choi, D. Y., and M. H. Stack. "The All-American Beer: A Case of Inferior Standard (Taste) Prevailing?" *Business Horizons* 48(2005):79–86.

Clements, K. W., and L. W. Johnson. "The Demand for Beer, Wine, and Spirits: A Systemwide Analysis." *Journal of Business* 56(1983):273–304.

Deaton, A., and J. Muellbauer. "An Almost Ideal Demand System." *American Economic Review* 70(1980):312–326.

Feenstra, R. C., and M. D. Shapiro. *Scanner Data and Price Indexes*. Chicago: University of Chicago Press, 2003.

Fenn, A. J., F. Antonovitz, and J. R. Schroeter. "Cigarettes and Addiction Information: New Evidence in Support of the Rational Addiction Model." *Economics Letters* 72(2001):39–45.

Freeman, D. G. "Beer and the Business Cycle." *Applied Economics Letters* 8(2001):51–54.

Gallet, C. A., and J. A. List. "Elasticities of Beer Demand Revisited." *Economics Letters* 61(1998):67–71.

[18] In fact, in a preliminary follow up on a reviewer's suggestion, we find there is a negative trend in the annual estimation of cross-price elasticity within our time period. This is an interesting topic for future research.

Hansen, L. P. "Large Sample Properties of Generalized Method of Moments Estimators." *Econometrica* 50(1982):1029–1054.

Hausman, J. A. "Valuation of New Goods under Perfect and Imperfect Competition." *Studies in Income and Wealth* 58(1996):209–237.

Hausman, J. A., G. Leonard, and J. D. Zona. "Competitive Analysis with Differentiated Products." *Annales d'Economie et de Statistique* (1994):159–180.

Heien, D., and G. Pompelli. "The Demand for Alcoholic Beverages: Economic and Demographic Effects." *Southern Economic Journal* 55(1989):759–770.

Hogarty, T. F., and K. G. Elzinga. "The Demand for Beer." *Review of Economics and Statistics* 54(1972):195–198.

Iwasaki, N., B. Seldon, and V. Tremblay. "Brewing Wars of Attrition for Profit (and Concentration)." *Review of Industrial Organization* 33(2008):263–279.

Kastanakis, M., and G. Balabanis. "Bandwagon, Snob and Veblen Effects in Luxury Consumption." In D. W. Dahl, G. V. Johar, and S. M. J. van Osselaer, eds., *Advances in Consumer Research,* 38. Duluth, MN: Association for Consumer Research, 2011, 609–611.

Lee, B., and V. J. Tremblay. "Advertising and the U.S. Market Demand for Beer." *Applied Economics* 24(1992):69–76.

Levy, D., and N. Sheflin. "The Demand for Alcoholic Beverages: An Aggregate Time-Series Analysis." *Journal of Public Policy and Marketing* 4(1985):47–54.

Nelson, J. P. "Broadcast Advertising and U.S. Demand for Alcoholic Beverages." *Southern Economic Journal* 65(1999):774–790.

———. "Advertising Bans, Monopoly, and Alcohol Demand: Testing for Substitution Effects Using State Panel Data." *Review of Industrial Organization* 22(2003):1–25.

Nevo, A. "A Practitioner's Guide to Estimation of Random-Coefficients Logit Models of Demand." *Journal of Economics and Management Strategy* 9(2000):513–548.

———. "Measuring Market Power in the Ready-to-Eat Cereal Industry." *Econometrica* 69(2001):307–342.

Ornstein, S. I., and D. M. H. Hanssens. "Alcohol Control Laws and the Consumption of Distilled Spirits and Beer." *Journal of Consumer Research* 12(1985):200–213.

Pofahl, G. M., O. Capps, and H. A. Love. "Retail Zone Pricing and Simulated Price Effects of Upstream Mergers." *International Journal of the Economics of Business* 13(2006):195–215.

Rojas, C., and E. B. Peterson. "Demand for Differentiated Products: Price and Advertising Evidence from the U.S. Beer Market." *International Journal of Industrial Organization* 26(2008):288–307.

Tegene, A. "The Kalman Filter Approach for Testing Structural Change in the Demand for Alcoholic Beverages in the U.S." *Applied Economics* 22(1990):1407–1417.

Tremblay, C. H., and V. J. Tremblay. "Recent Economic Developments in the Import and Craft Segments of the US Brewing Industry." In J. F. M. Swinnen, ed., *The Economics of Beer,* Oxford: Oxford University Press, 2011, 141–160.

Tremblay, V. J., N. Iwasaki, and C. H. Tremblay. "The Dynamics of Industry Concentration for U.S. Micro and Macro Brewers." *Review of Industrial Organization* 26(2005):307–324.

Tremblay, V. J., and C. H. Tremblay. *The U.S. Brewing Industry: Data and Economic Analysis*. Cambridge, MA: MIT Press, 2005.

Voight, J. "Big Beer Brands Are Fooling Us with Their Crafty Looks." *AdWeek* (2013).