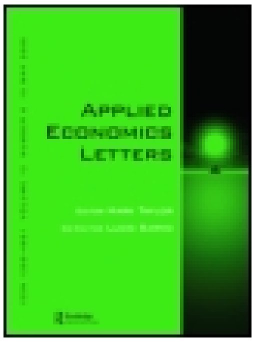

Applied Economics Letters

ISSN: 1350-4851 (Print) 1466-4291 (Online) Journal homepage: http://www.tandfonline.com/loi/rael20

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Rajeev K. Goel & James W. Saunoris

APPLIED ECONOMICS LETTERS, 2017
https://doi.org/10.1080/13504851.2017.1388907

ARTICLE

Seasonal U.S. beer demand: socio-economic determinants and relation with other products

Rajeev K. Goel[a,b] and James W. Saunoris[c]

[a]Department of Economics, Illinois State University, Normal, IL, U.S.A; [b]Kiel Institute for the World Economy, Kiel, Germany; [c]Department of Economics, Eastern Michigan University, Ypsilanti, MI, U.S.A

ABSTRACT
This article employs quarterly U.S. state-level data from 2009 to 2015 to estimate the demand for beer. Other contributions of this work involve the incorporation of demographic factors and wine prices. Results show beer demand to be inelastic, and beer and wine to be substitutes. Further, males, whites, and blacks were, *ceteris paribus*, likely to have greater beer demand. The income effects, however, were mixed, showing some support for beer being a normal good.

KEYWORDS
Beer demand; demographic effects; economic prosperity; elasticity; wine

JEL CLASSIFICATION
D12; L66

I. Introduction

The demand for alcohol has garnered interest due to alcohol products being ripe avenues for excise tax revenues and for alcohol products having spillovers on health and social behaviours. Over the years, numerous investigations have been conducted on the demand for alcohol, with the variations in size and scope of individual studies dictated by the nature and the quality of data (earlier studies are due to Hogarty and Elzinga (1972) and Manning et al. (1995); see Fogarty (2010) and Gallet (2007) for surveys). Consequently, there is wide variation in estimates of demand responsiveness (or elasticities) and this variation fails to provide adequate policy guidance. Indeed, the comprehensive survey by Fogarty (2010, p. 428) covering nearly 150 studies on alcoholic beverages notes that, '[the] reported elasticity estimates will be influenced by such factors as estimation technique, data frequency and time period under consideration.'

While most of the empirical literature on beer demand uses data for the United States (see Fogarty (2010) and Gallet (2007) for literature overviews), there are studies for other nations as well (e.g. see Tomlinson and Branston (2014) for beer demand in the UK and Clements and Johnson (1983) for a study for Australia). Further, the literature has evolved over time to consider the relationship of beer with other alcoholic products (Clements and Johnson 1983) and between alcohol and cigarettes (Goel and Morey 1995; Goel, Payne, and Saunoris 2016; Tauchmann et al., 2013). As the beer market has matured with product differentiation across beer types (e.g. the advent of craft beer), scholars have also recently considered the cross-relations across beer types (Toro-González, McCluskey, and Mittelhammer 2014).

The present work attempts to add to this line of inquiry by using recent quarterly data across U.S. states to estimate the seasonal demand for beer. Beer demand may be seasonal due to heightened consumption during certain events (e.g. the holiday season around the New Year) and a better understanding of seasonal variations would aid both the beer industry and policymakers to better target their efforts. The relevance of data frequency in demand analyses of alcoholic beverages has been noted earlier (see Fogarty (2010)). We further consider the importance of demographic groups in driving beer demand. Gender and cultural differences across population subgroups (e.g. males versus females, different racial groups, etc.) might affect their propensities to consume alcohol. Finally, the cross-demand relation with the wine market is considered. Wine may be a substitute for beer, although, given the longevity of wine, some non-wine drinkers might buy wine for investment purposes and for these individuals beer and wine might very well be complements. Details about the analysis, including the model and data follow.

CONTACT Rajeev K. Goel rkgoel@ilstu.edu Department of Economics, Illinois State University, Normal, IL 61790-4200, USA

II. Model and data

The basic model employed is a simple linear demand specification that includes beer price and income as basic controls for beer demand. This model is augmented by including demographic effects and wine prices. The setup can be seen as consistent with standard empirical demand models that consider own price, income, price of the substitute and non-monetary aspects as potentially significant drivers of demand (see Lee and Tremblay (1992) for an earlier study noting the importance of some of these determinants; and Fogarty (2010) and Gallet (2007) for literature surveys).

The empirical model used in this study takes the following general functional form:

$$BeerCons_{it} = f(BeerP_{it}, WineP_{it}, Income_{it}, Demographics_{ijt}, Inequality_{it}) \quad (1)$$

$$i = 1,\ldots,50$$
$$t = 2009Q2, \ldots, 2015Q1$$
$$j = MalePop,\ WhitePop,\ BlackPop$$

where *BeerCons* represents beer consumption per capita and is a function of beer price (*BeerP*), price of related products (*WineP*), income per capita (*Income*), demographics (*MalePop, WhitePop*, and *BlackPop*) and income inequality (*GINI*).

To operationalize Equation (1), we use a log-log specification, thus resulting in a linear demand equation where the coefficients are elasticities. The law of demand dictates that as the price of beer increases, the amount consumed should decrease. In contrast, alternative alcohol beverages, such as wine, can be viewed as readily available substituts for beer, thus an increase in the price of wine would encourage consumers to switch to beer. Finally, beer can be considered a normal good as higher income leads to an increase in beer consumption or inferior good as higher income prompts consumer to switch to alternate, more upscale, alcoholic products such as wine (e.g. Dom Perignon) or hard liquor (e.g. single malt Scotch). Besides the affordability aspect, greater income is positively related to greater literacy and this might induce moderation in drinking. Thus, the overall effect of income on beer consumption is ambiguous.

Other potential determinants of beer consumption observed in the literature include differences in demographics (see, e.g. Ornstein and Hanssens (1985)). As discussed in the introduction, population subgroups might vary in their attitudes towards alcohol and in their preferences towards the type of alcohol. For instance, to explore gender differences in drinking behaviour, we include the percent of population that is male (*MalePop*) and to account for racial differences we include the percent of the population that is white (*WhitePop*) and black (*BlackPop*), where race can proxy for socio-economic status and differences in culture that can influence beer consumption. Furthermore, disparities in income can also influence beer consumption. For example, affordability of beer, or the type of alcoholic beverage chosen, is determined partly by income (as well as the ability to seek treatment for subsequent alcohol addiction). For instance, Deaton (2003) shows a link between health deterioration and income inequality. Related to this idea, Connelly, Goel, and Ram (2010) consider smoking as a major health hazard but find that income inequality has little influence on cigarette consumption. Following the same logic, excessive beer consumption can be a health concern and thereby be potentially linked to income inequality.

Data

Unlike almost all the related literature that uses annual data, we are fortunate to have access to quarterly data on beer prices and sales or consumption. This enables us to consider the influence of seasonal factors. The sample for this study includes quarterly data from 2009Q2 to 2015Q1 for all 50 U. S. states – see Table 1 for variable details. In our sample, the mean beer price per six-pack across U.S. states was \$3.76 (constant 1982–84 dollars) and the average per capita consumption was 0.18 (barrels per capita). There was, however, significant variation across individual states with beer prices being the highest in Alaska (\$4.93) and beer consumption (per capita) being the highest in North Dakota (0.32).

III. Estimation and results

Estimation

We consider several procedural and econometric factors in estimating the demand relation outlined

Table 1. Variable definitions, summary statistics and data sources.

Variable	Description [Obs.; mean; SD]	Source
BeerCons	Log of state beer shipment volume (in barrels) per capita. [1173; 0.176; 0.036]	The Beer Institute http://www.beerinstitute.org/
BeerP	Log of price per 6-pack of beer (constant 1982–84 dollars). Beer price is based on Heineken's 6-pack of 12-ounce containers, excluding any deposit. Data missing for 2009Q4. [1090; 3.759; 0.257]	ACCRA Cost of Living Index from The Council for Community and Economic Research
WineP	Log of price per 1.5-l bottle of wine (constant 1982–84 dollars). Wine price is based on these brands: Livingston Cellars or Gallo Chablis or Chenin Blanc. Data missing for 2009Q4. [1090; 3.441; 0.510]	ACCRA Cost of Living Index from The Council for Community and Economic Research
Income	Log of state personal income per capita (000s) (constant 1982–84 dollars). [1173; 18.786; 3.194]	U.S.Bureau of Economic Analysis
GINI	The Gini coefficient which measures state income inequality such that higher numbers denote more inequality. Annual data available. [969; 0.606; 0.035]	Frank (2009)
MalePop	Percent of state population that is male. Annual data available. [1173; 49.341; 0.810]	Census Bureau
WhitePop	Percent of state population that is white. Annual data available. [1173; 80.799; 12.930]	Census Bureau
BlackPop	Percent of state population that is black. Annual data available. [1173; 12.155; 11.002]	Census Bureau

Notes: Unless otherwise noted, summary statistics are based on quarterly data from 2009Q2 to 2015Q1 for all 50 states for a total of 1173 observations. Statistics reported before log transformation. Nominal values converted to real values using the CPI (for all urban consumers (1984–82 = 100).

in Equation (1). We employ OLS using the fixed effects estimator, which provides consistent estimates of model parameters. The fixed effects estimator controls for time-invariant unobserved heterogeneity including, for example, culture, institutions, resource endowments, etc. However, if the unobserved individual effects are correlated with the regressors then the random effects estimator is more efficient. Consequently, we use the Hausman test to ascertain the correct estimation technique and report these results at the bottom of each table. The Hausman test for the baseline model indicates that random effects estimator is inconsistent; therefore, we proceed by estimating the remaining models using the fixed effects (within estimator), which is consistent under the null and alternative hypothesis.

In addition, we control for time-variant effects that influence beer demand in all states simultaneously such as business cycle fluctuations and changes in federal regulation. For example, during the sample period, there were a number of federal regulations passed affecting the beer industry that influence beer demand. Moreover, a major recession occurred during the sample period from 2007Q4 to 2009Q2 according to the National Bureau of Economic Research.[1] To account for these aspects we include year dummies in each model. To control for months/seasons with heavy alcohol consumption such major holidays (e.g. New Year, Halloween) as well as major sporting events (e.g. Super Bowl), we also include quarter dummies.

We also ran several other diagnostic tests to check for violations of the standard assumptions. First, we test for groupwise heteroscedasticity in the fixed effects regression model using a modified Wald test under the null hypothesis of homoscedasticity (see Greene (2000, p.958)). The results for this test reject the null in favour of heteroscedastic errors. Second, we test for first-order serial correlation following Wooldridge (2002). In all models (except Model 4.3), the null hypothesis is rejected in favour of significant first-order serial correlation. Finally, we use the Pesaran (2004) test for cross-sectional dependence in the residuals from fixed effects modelling. Aside from Table 3, the test results suggest significant evidence in favour of cross-sectional dependence in the residuals, and thus lead to biased test results. Given significant evidence of heteroscedasticity, serial correlation and cross-sectional dependence, we use Driscoll and Kraay (1998) SEs, which are robust to general forms of cross-sectional and time dependence.

Results

Baseline models

Model 2.1 in Table 2 reports the baseline results. The overall fit of the various models is quite decent as shown by the R-squared that is around 0.8. The coefficient representing the price elasticity of demand is negative and statistically significant, and the magnitude signifies that demand is inelastic, which is in line

[1]http://www.nber.org/cycles.html

Table 2. Seasonal U.S. beer demand: baseline models.

Dependent variable: beer consumption, BeerCons

			Demographic factors	
	(2.1)	(2.2)	(2.3)	(2.4)
BeerP	−0.119***	−0.146***	−0.103**	−0.087**
	(0.035)	(0.026)	(0.039)	(0.035)
Income	0.121*	0.129	0.033	0.129**
	(0.059)	(0.079)	(0.081)	(0.055)
GINI		−0.071		
		(0.131)		
MalePop			0.079***	
			(0.019)	
WhitePop				0.029**
				(0.013)
BlackPop				0.051***
				(0.015)
Quarter 2	0.174***	0.176***	0.175***	0.174***
	(0.003)	(0.003)	(0.003)	(0.003)
Quarter 3	0.171***	0.171***	0.172***	0.171***
	(0.004)	(0.005)	(0.004)	(0.004)
Quarter 4	0.005	−0.001	0.008	0.005
	(0.008)	(0.007)	(0.008)	(0.008)
Year 2010	−0.013***	−0.011***	−0.013***	−0.011**
	(0.004)	(0.003)	(0.004)	(0.005)
Year 2011	−0.038***	−0.037***	−0.037***	−0.035***
	(0.003)	(0.003)	(0.004)	(0.004)
Year 2012	−0.031***	−0.029***	−0.030***	−0.026***
	(0.003)	(0.005)	(0.004)	(0.006)
Year 2013	−0.051***	−0.051***	−0.053***	−0.045***
	(0.005)	(0.007)	(0.005)	(0.009)
Year 2014	−0.058***	0.000	−0.060***	−0.050***
	(0.005)	(0.000)	(0.005)	(0.010)
Diagnostic tests				
Heteroscedasticity	[0.000]	[0.000]	[0.000]	[0.000]
Serial correlation	[0.000]	[0.000]	[0.000]	[0.000]
Cross-sectional dep.	[0.000]	[0.211]	[0.001]	[0.001]
Hausman	[0.058]	[0.331]	[0.162]	[0.006]
R-squared	0.773	0.788	0.776	0.776
Observations	1090	894	1090	1090
Number of states	50	50	50	50

Notes: See Table 1 for variable details.
Each model is estimated using two-way state (not reported) and year fixed effects.
Driscoll–Kraay robust SEs are in parentheses and probability values are in brackets. Asterisks denote significance at the following levels: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

with the addictive nature of alcohol. This finding of inelastic beer demand is in contrast with earlier results using annual data (see Gallet and List (1998); Toro-González, McCluskey, and Mittelhammer (2014)). Quantitatively speaking, a 10% increase in the price of beer leads to a decrease in beer consumption by 1.2%. Gallet's (2007) meta-analysis of more than 100 studies on alcohol demand notes that beer demand elasticities tend to be more inelastic than elasticities for other alcoholic beverages.

The income elasticity of demand is positive and significant (in Models 2.1 and 2.4) and consistent with beer being a normal good.[2] Turning attention to the coefficients on the time dummy variables, the coefficients on quarters 2 and 3 are positive and significant, indicating an increase in beer shipments during these quarters relative to quarter 1, whereas the coefficient on quarter 4 is not significant. These results might reflect sellers' response to depleted inventories in quarter 1 due to events like the New Year and the Super Bowl by replenishing their inventories in the following two quarters. Interestingly, the negative and significant coefficients on the year dummies reveal a declining trend in beer consumption since 2009.

Another dimension of economic prosperity is considered by adding income inequality. Greater income inequality could have a bearing on beer demand via affordability and whether consumers view beer as complementary to leisure. Income inequality, measured by the Gini coefficient (GINI), augments Model 2.1 to account for the effects of income inequality on beer consumption. The results in Model 2.2 suggest that income inequality does not have a statistically significant effect on beer consumption and this is consistent with findings for cigarettes by Connelly, Goel, and Ram (2010).

Effects of demographic variables

Demographic factors may be important drivers of the beer market as certain population subgroups might be differently inclined towards certain products (see Lee and Tremblay (1992); Freeman (2011)). In Models 2.3 and 2.4, we control for several demographic variables that may affect beer consumption. In this regard, we consider the roles of gender and race.[3]

Although the main results withstand these model variations, they reveal interesting aspects of beer demand. The coefficient on *MalePop* is positive and significant, indicating states with a larger male population consume more beer (Model 2.3). In Model 2.4, the coefficients on *WhitePop* and *BlackPop* are positive and significant, with increased beer demand resulting from a larger black population relative to the white population.

Cross-relation between beer and wine

Beer consumption is likely related to other products, notably other alcoholic beverages (Clements and Johnson 1983). We study the interrelation between

[2]Freeman (2011) has found U.S. beer demand to be procyclical, and beer, being a normal good, is also supported by Lee and Tremblay (1992) and Toro-González, McCluskey, and Mittelhammer (2014).
[3]Goel and Zhang (2013) consider gender differences in smoking in Japan.

Table 3. Seasonal U.S. beer demand: effects of wine prices and robustness checks.

Dependent variable: beer consumption, BeerCons	Cross-relation with wine		Lagged beer prices	
	(3.1)	(3.2)	(3.3)	(3.4)
BeerP	−0.115***	−0.099***		
	(0.038)	(0.032)		
BeerP(t-4)			−0.123***	−0.104**
			(0.041)	(0.042)
Income	0.032	0.125**	0.036	0.089
	(0.083)	(0.057)	(0.084)	(0.081)
WineP	0.028**	0.025**		
	(0.010)	(0.011)		
MalePop	0.076***		0.057**	
	(0.019)		(0.026)	
WhitePop		0.028**		0.033*
		(0.013)		(0.018)
BlackPop		0.048***		0.060**
		(0.016)		(0.025)
Quarter 2	0.175***	0.174***	0.175***	0.174***
	(0.003)	(0.003)	(0.004)	(0.004)
Quarter 3	0.172***	0.170***	0.175***	0.174***
	(0.004)	(0.004)	(0.004)	(0.004)
Quarter 4	0.008	0.005	0.014	0.012
	(0.009)	(0.008)	(0.008)	(0.008)
Year 2010	−0.013***	−0.011**	0.051***	0.000
	(0.004)	(0.005)	(0.006)	(0.000)
Year 2011	−0.037***	−0.034***	0.024***	−0.026***
	(0.004)	(0.004)	(0.005)	(0.004)
Year 2012	−0.031***	−0.027***	0.030***	−0.018***
	(0.004)	(0.006)	(0.006)	(0.005)
Year 2013	−0.054***	−0.046***	0.008	−0.036***
	(0.005)	(0.009)	(0.006)	(0.006)
Year 2014	−0.062***	−0.052***	0.000	−0.042***
	(0.005)	(0.010)	(0.000)	(0.010)
Diagnostic tests				
Heteroscedasticity	[0.000]	[0.000]	[0.000]	[0.000]
Serial correlation	[0.000]	[0.000]	[0.000]	[0.000]
Cross-sectional dep.	[0.001]	[0.001]	[0.034]	[0.026]
Hausman	[0.248]	[0.019]	[0.560]	[0.069]
R-squared	0.776	0.776	0.771	0.772
Observations	1090	1090	894	894
Number of states	50	50	50	50

Note: See Table 2.

beer and wine markets. Wine is an alternative alcoholic beverage that is typically sold at the same outlets as beer and thus offers a readily available substitute for beer. Are beer and wine substitutes or complements in consumption? While the relation with liquor or spirits market also comes to mind in this context, the lack of comparable quarterly state-level liquor prices precludes us from considering the liquor market.

In Models 3.1 and 3.2 in Table 3, we account for cross-price effects from related products by augmenting Models 2.3 and 2.4 with the price of wine. The coefficient on the price of wine is positive and significant, consistent with wine and beer being substitutes. The cross-price elasticity is 0.03, meaning that a 10% increase in the price of wine leads to an increase in beer consumption by 0.3%. The finding of substitution between wine and beer is consistent with earlier results for the United States based on annual data (see Gallet and List 1998). Next, we perform some sensitivity checks to verify the validity of our findings.

Robustness check1: accounting for possible endogeneity of beer prices. Whereas our estimation setup takes beer demand (sales) to be driven by beer prices, it is quite possible that beer prices are in turn affected by beer demand. Thus, this potential endogeneity or simultaneity must be addressed. One method for dealing with this reverse feedback is to use instrumental variables; however, the lack of readily available external instruments preclude us from using this technique. An alternative is to use lagged values of the potentially endogenous variable (as lagging would make the variable predetermined).

To this end, we replace the contemporaneous beer price with its 1 year lagged value (or four quarters, given our quarterly data) and report the results in Models 3.3 and 3.4.[4] The coefficient on this variable is negative and significant in both cases. Further, the magnitude of the parameter estimate is similar to the baseline models in Table 2. Overall, these results support out main findings.

Robustness check2: checking for stationarity. As another robustness check, we focus on the stationarity of the variables. The results above can be spurious if the variables are nonstationary and not cointegrated; therefore, it is imperative to check the orders of integration of the variables. To test each variable for stationarity we rely on the Im, Pesaran, and Shin (2003) (IPS) panel unit root test. The IPS test uses the Dickey-Fuller regression form to estimate the autoregressive parameter under the null hypothesis that all panels contain a unit root with an alternative hypothesis that some panels are stationary. One of the main advantages of the IPS test over other unit root tests is that it relaxes the assumption that the autoregressive parameter is common across panels and instead assumes a heterogeneous autoregressive parameter. To control for serial correlation, we include lagged first differences of the variable of interest by allowing the Akaike

[4]We use the 1 year lag of beer price as opposed to the one quarter lag because lagging one quarter might not be enough to purge potential endogeneity.

Table 4. Seasonal U.S. beer demand – Effects on alcohol control versus free states.

Dependent variable: Beer consumption, BeerCons	*Free states*		*Control states*	
	(4.1)	(4.2)	(4.3)	(4.4)
BeerP	−0.113***	−0.120***	−0.032	−0.012
	(0.037)	(0.028)	(0.084)	(0.077)
Income	0.057	0.186**	−0.067	−0.146
	(0.092)	(0.069)	(0.168)	(0.159)
MalePop	0.095***		−0.144**	
	(0.022)		(0.068)	
WhitePop		0.019		0.119***
		(0.013)		(0.031)
BlackPop		0.062***		0.089*
		(0.015)		(0.044)
Quarter 2	0.175***	0.174***	0.176***	0.177***
	(0.004)	(0.003)	(0.004)	(0.004)
Quarter 3	0.160***	0.158***	0.195***	0.196***
	(0.004)	(0.004)	(0.004)	(0.004)
Quarter 4	0.006	0.002	0.013	0.015**
	(0.010)	(0.010)	(0.008)	(0.007)
Year 2010	−0.016***	−0.017***	−0.007	0.005
	(0.004)	(0.005)	(0.005)	(0.007)
Year 2011	−0.042***	−0.046***	−0.023***	0.003
	(0.004)	(0.004)	(0.005)	(0.009)
Year 2012	−0.036***	−0.042***	−0.009	0.030**
	(0.005)	(0.007)	(0.007)	(0.012)
Year 2013	−0.062***	−0.065***	−0.025***	0.027*
	(0.006)	(0.009)	(0.007)	(0.015)
Year 2014	−0.069***	−0.074***	−0.028***	0.037**
	(0.006)	(0.010)	(0.009)	(0.016)
Diagnostic tests				
Heteroscedasticity	[0.000]	[0.000]	[0.000]	[0.000]
Serial correlation	[0.000]	[0.000]	[0.116]	[0.005]
Cross-sectional dep.	[0.254]	[0.198]	[0.803]	[0.751]
Hausman	[0.012]	[0.005]	[0.360]	[0.208]
R-squared	0.759	0.757	0.822	0.827
Observations	700	700	390	390
Number of states	32	32	18	18

Note: See Table 2.

Information Criterion to choose the optimal lag length. The results showed that all the variables in the baseline model are stationary (details are available upon request). This finding instils further confidence in our estimation results.

Robustness check3: separating alcohol control states. A number of states in the United States exercise monopoly control over the sale of alcoholic products, including wine, beer and liquor (see https://en.wikipedia.org/wiki/Alcoholic_beverage_control_state for a recent listing).[5] These states are referred to as control states.[6] Since this type of government regulation would affect pricing decisions (and consequently, resulting elasticities), we separated control states from other ('free market') states and re-estimated Models 2.3 and 2.4 from Table 2 for both sets of states. These results are reported in Table 4.

The results showed that demand responsiveness indeed varied between control and free states, with the resulting price elasticity of beer demand being significant only for the free states (see Models 4.1 and 4.2 in Table 4). In terms of relative magnitudes, the price elasticity was greater for the free states (around −0.12), than control states. The income elasticity, although insignificant in both samples except for Model 4.2, suggests that beer is a normal good in free states and an inferior good in control states.

Finally, there are striking differences in the trends associated with beer consumption. There is a declining trend in beer consumption in free states and no significant trend seen in control states. This is partly due to the significant and negative price elasticities for free states. Overall, these results suggest that beer demand behaves very differently in free versus control states and this deserves unique policy prescriptions – i.e. one size does not fit all.

IV. Conclusions

Adding to the literature on beer demand, this article employs quarterly U.S. state-level data from 2009 to 2015 to estimate the demand for beer. Whereas the demand for beer has been studied before (see Fogarty (2010) for a useful survey), the use of quarterly data, demographic effects and consideration of cross effects with wine are some key contributions of this work.

Results show beer demand to be inelastic, and beer and wine to be substitutes. A 10% increase in the price of beer would reduce beer demand by about 1%, while a similar increase in the price of wine would boost beer sales by 0.3% (Models 2.1 and 3.1, respectively). Further, males, whites and blacks were, *ceteris paribus*, likely to have greater beer demand compared to control subgroups. There were, however, significant differences across subgroups. For instance, blacks were almost twice more likely to drink beer than whites, *ceteris paribus*.

[5]While all control states do not uniformly control the sale of the three alcoholic beverages (meaning some control one or two of the three), we considered a state as a control state if it controlled any alcoholic beverage.

[6]There are a total of 18 control states: Alabama, Idaho, Iowa, Maine, Maryland, Michigan, Mississippi, Montana, New Hampshire, North Carolina, Ohio, Oregon, Pennsylvania, Utah, Vermont, Virginia, West Virginia and Wyoming.

Although the statistical significance of the income effects was somewhat mixed, the results pointed to beer being a normal good. Our results were quite robust to a battery of robustness checks, including considerations of potential simultaneity and separation of control states.

There are several issues of policy importance from our findings. First, the inelastic demand for beer presents opportunities for lawmakers to raise additional revenues by taxing beer, while at the same time the gains from inducing reductions in beer drinking through higher taxes seem limited. Second, the finding of significant substitution between wine and beer suggests that policymakers need to coordinate their actions in regulating and taxing these two alcoholic drinks (see Tax Foundation (2015). Third, policies to control beer drinking would be more effective if they were tailored to specific demographic groups. While we have considered some groups based on gender and race, other groups, such as college age population, might also be important. Fourth, the indication of differences in beer demand across quarters might enable tax- and other enforcement bodies to further fine-tune their efforts. Finally, income taxes appear to be a weaker policy instrument in checking beer demand.

Acknowledgements

We are grateful to Michael Uhrich from the Beer Institute for providing us the data on beer sales and to Jim Payne for useful comments. Goel thanks Sapienza – Università di Roma for hospitality during a research visit. However, the views expressed are solely our own.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

Clements, K. W., and L. W. Johnson. 1983. "The Demand for Beer, Wine, and Spirits: A Systemwide Analysis." *Journal of Business* 56 (3): 273–304. doi:10.1086/296202.

Connelly, R. T., R. K. Goel, and R. Ram. 2010. "Income Inequality and Cigarette Consumption: Evidence from the United States." *Applied Economic Letters* 17 (5): 423–426. doi:10.1080/13504850701765135.

Deaton, A. 2003. "Health, Inequality, and Economic Development." *Journal of Economic Literature* 41 (1): 113–158. doi:10.1257/jel.41.1.113.

Driscoll, J. C., and A. C. Kraay. 1998. "Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data." *Review of Economics and Statistics* 80 (4): 549–560. doi:10.1162/003465398557825.

Fogarty, J. 2010. "The Demand for Beer, Wine and Spirits: A Survey of the Literature." *Journal of Economic Surveys* 24 (3): 428–478.

Frank, M. W. 2009. "Inequality and Growth in the United States: Evidence from a New State-Level Panel of Income Inequality Measures." *Economic Inquiry* 47 (1): 55–68. doi:10.1111/j.1465-7295.2008.00122.x.

Freeman, D. G. 2011. "Beer in Good Times and Bad: A U.S. State-Level Analysis of Economic Conditions and Alcohol Consumption." *Journal of Wine Economics* 6 (2): 231–251. doi:10.1017/S1931436100001620.

Gallet, C. A. 2007. "The Demand for Alcohol: A Meta-Analysis of Elasticities." *Australian Journal of Agricultural and Resource Economics* 51 (2): 121–135. doi:10.1111/j.1467-8489.2007.00365.x.

Gallet, C. A., and J. A. List. 1998. "Elasticities of Beer Demand Revisited." *Economic Letters* 61 (1): 67–71. doi:10.1016/S0165-1765(98)00146-3.

Goel, R. K., and M. J. Morey. 1995. "The Interdependence of Cigarette and Liquor Demand." *Southern Economic Journal* 62 (2): 451–459. doi:10.2307/1060696.

Goel, R. K., J. E. Payne, and J. W. Saunoris. 2016. "Spillovers from the Beer Market to U.S. Cigarette Demand." *Economic Modelling* 55: 292–297. doi:10.1016/j.econmod.2016.02.022.

Goel, R. K., and X. Zhang. 2013. "Gender Dynamics and Smoking Prevalence in Japan." *Journal of Economics and Finance* 37 (4): 622–636. doi:10.1007/s12197-012-9238-7.

Greene, W. H. 2000. *Econometric Analysis*. New York: Prentice-Hall.

Hogarty, T. F., and K. G. Elzinga. 1972. "The Demand for Beer." *Review of Economics and Statistics* 54 (2): 195–198. doi:10.2307/1926282.

Im, K. S., M. H. Pesaran, and Y. Shin. 2003. "Testing for Unit Roots in Heterogeneous Panels." *Journal of Econometrics* 115 (1): 53–74. doi:10.1016/S0304-4076(03)00092-7.

Lee, B., and V. J. Tremblay. 1992. "Advertising and the U.S. Market Demand for Beer." *Applied Economics* 24 (1): 69–76. doi:10.1080/00036849200000104.

Manning, W. G., L. Blumberg, and L. H. Moulton. 1995. "The Demand for Alcohol: The Differential Response to Price." *Journal of Health Economics* 14 (2): 123–148. doi:10.1016/0167-6296(94)00042-3.

Ornstein, S. I., and D. M. Hanssens. 1985. "Alcohol Control Laws and the Consumption of Distilled Spirits and Beer." *Journal of Consumer Research* 12 (2): 200–213. doi:10.1086/208509.

Pesaran, M. H., 2004. General Diagnostic Tests for Cross Section Dependence in Panels. Cambridge Working Papers in Economics #0435, University of Cambridge.

Tauchmann, H., S. Lenz, T. Requate, and C. M. Schmidt. 2013. "Tobacco and Alcohol: Complements or

Substitutes?” *Empirical Economics* 45 (1): 539–566. doi:10.1007/s00181-012-0611-3.

Tax Foundation, 2015. State Sales, Gasoline, Cigarette, and Alcohol Tax Rates by State. pp. State2000–2014 (Washington, DC). http://taxfoundation.org/article/state-sales-gasoline-cigarette-and-alcohol-tax-rates.

Tomlinson, P. R., and J. R. Branston. 2014. “The Demand for UK Beer: Estimates of the Long-Run On- and Off- Trade Beer Price Elasticities.” *Applied Economics Letters* 21 (3): 209–214. doi:10.1080/13504851.2013.848022.

Toro-González, D., J. J. McCluskey, and R. C. Mittelhammer. 2014. “Beer Snobs Do Exist: Estimation of Beer Demand by Type.” *Journal of Agricultural and Resource Economics* 39 (2): 179–187.

U.S. Bureau of Economic Analysis. 2014. *Statistical Abstract of the United* States. Washington, DC: U.S. Bureau of Economic Analysis.

Wooldridge, J. M. 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.