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Fiscal Impacts and Cross-Border Effects of a Change in State Liquor Policy

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Abstract

This paper analyzes the economic effects of the 2012 change in liquor policy (Initiative 1183) in Washington State in the United States. This policy increased the availability of liquor but also increased taxes on liquor in Washington. This research provides some evidence that the quantity of liquor sold in both Washington and Idaho increased, suggesting that availability/convenience effects can outweigh tax/price effects. Furthermore, the cross-border spillover effects are isolated to the nearest store to the border.

Keywords: fiscal impacts, liquor policy, regulation, spatial spillovers, vertical restraints

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Introduction

Liquor policy in the United States has had a contentious history; federal, state, and local governments at various times have all attempted to simultaneously promote temperance while also viewing liquor as an important industry and a valuable source of tax revenue.[1] Due to this dual nature, there are a variety of strategies employed across jurisdictions to regulate liquor sales including "sin taxes," "blue laws," alcohol level limits, point-of-sale restrictions, and full-on state ownership and monopolization of liquor stores. While the federal government has historically (and infamously) exerted influence on liquor regulation and some local jurisdictions have voted to be "dry" and outlaw the sale of liquor outright, the vast majority of liquor controls now reside with individual state governments. Regulatory strategies that individual states employ can also change over time and can vary widely between bordering states. One such example of the differences in liquor laws is between Washington and Idaho, the result of a 2012 policy change in Washington. We analyze liquor (here defined as a beverage sold for human consumption that exceeds 24% alcohol by volume) data from 2010–2014 and quantify the effects of this change in both Washington and Idaho.

U.S. Liquor Policy Background

Liquor policy in the United States has been a central component of the larger domestic food policy for decades (Rorabaugh, 1991; Hogeland, 2010).[2] After the repeal of Prohibition in 1933, domestic liquor policy and regulation were largely left to individual states and even local jurisdictions. Subsequent to the repeal of Prohibition, liquor laws varied widely between bordering states, counties, and even townships, creating significant border effects, which have been well documented in the literature (Asplund, Richard, and Wilander, 2007; Chiou and Muehlegger, 2008). More specifically, there has also been a limited previous literature on border effects and spatial spillovers in liquor demand. Beatty, Larsen, and Sommervoll (2009) find evidence for tax avoidance behavior across international borders in Europe. Stehr (2007) finds significant in-state and cross-state effects of a repeal in Sunday liquor sales policies.

More recently, the U.S. government has attempted to reign in some of the variation in liquor policy across states and regions, most notably in the area of minimum drinking age. Prior to the National Minimum Drinking Age Act of 1984, the legal age to consume alcohol varied greatly from state to state. This created additional border effects, where underage drinkers in one state could drive across the border to consume alcohol in a bordering state, creating drunk driving and public safety concerns. The act used tax incentives and penalties, especially federal disbursements of transportation funding, to ensure that all states abide by the guidelines to keep their minimum drinking age at 21, thus reducing some of the border effect problems.

[1] One of the charges of the Idaho State Liquor Division (the legal regulatory board for the state of Idaho) is to "curtail the intemperate use of alcoholic beverages" (Section 010.11 of Idaho Administrative Code 15.10.01).

[2] Liquor was also responsible for one of the first federal food quality standards in the U.S. food industry. A decade before the more famous Pure Food and Drug Act of 1906, the Bottled in Bond Act of 1897 established food quality standards and liquor taxation regulations for U.S. whiskey production (High and Coppin, 1988).

However, states and local jurisdictions are still granted wide latitude in liquor taxation and regulation. As of early 2020, seven states (Alabama, Idaho, New Hampshire, North Carolina, Pennsylvania, Utah, and Virginia) outright restricted liquor sales to state-owned (and/or state-regulated) liquor stores. Until 2012, the state of Washington was also in this group. An additional ten states (Iowa, Maine, Michigan, Mississippi, Montana, Ohio, Oregon, Vermont, Wyoming, and West Virginia) permit liquor to be sold in private stores, but the state controls the distribution and wholesale of liquor in the state, effectively controlling the minimum price of liquor in the state. Further, three states (Maryland, Minnesota, and South Dakota) currently allow local jurisdictions and municipalities to establish control of their liquor distribution and sales. Due to the heterogeneity of liquor policies across states and local jurisdictions, liquor provides some opportunities to look how policy changes effect behaviors and demand for a food and beverage product. While previous literature on tax differentials between adjacent municipalities have shown little effect on consumer behavior (Burge and Rogers, 2011; Rogers, 2004), this study analyzes not only a change in liquor taxation but also a change in liquor management across a state border. This policy change had a significant effect on the real price of liquor between the states but also introduced increased convenience in liquor purchase in Washington.

Specific Policy Addressed

Voters in the state of Washington passed a liquor privatization law (Initiative 1183) in November 2011; the law took effect on June 1, 2012. Prior to this change in regulation, liquor (technically referred to as "spirits" in Washington State statutes is defined as having over 24% alcohol by volume) in Washington was exclusively sold in state owned and regulated liquor stores. Initiative 1183 dismantled the state-owned system and allowed privately owned stores to acquire a license to sell liquor. Further, the initiative placed few restrictions on who could acquire a liquor license, and many existing convenience stores and grocery stores began selling liquor in addition to newly opened private liquor stores.

For comparison, in 2010, 1 year prior to the law change, there were 226 state-owned or contracted liquor stores in Washington. By 2013, the number of establishments permitted to sell liquor for off premise consumption grew by a factor of 6, to 1,422 licensed vendors of liquor. Conversely, Idaho has maintained a state-run liquor system in which all liquor must be sold through dedicated liquor stores, most of which are owned and operated by Idaho; a small minority of the liquor stores in Idaho are privately owned and operated but still subject to state pricing and operational constraints.

Initiative 1183 had a significant effect on the price of liquor in Washington. After factoring in all applicable taxes and fees—including all liquor taxes—the average retail price per liter of liquor in Washington jumped 15% from January 2012 (before the law took effect) to January 2013 (after the law took effect). The new taxes included a retail license (with both fixed and variable costs), increased penalties for sale violations, and a distributor license fee (Ferraro, 2015). This change in liquor policy in Washington State represents a natural experiment which enables us to formally analyze how liquor policy changes affect neighboring jurisdictions and how those neighboring jurisdictions respond to their neighbors' actions. We are also able to estimate fiscal impacts of the policy change on both Washington and Idaho.

While previous studies have found an impact on demand for liquor in Idaho due to Washington's policy change (Winfree and Watson, 2015; Ye and Kerr, 2016), this study uses more detailed and disaggregated data to calculate exactly where and how the impacts occurred and how liquor sales changed in Washington. Not only did an increase in taxes change the price of liquor in Washington, but it also changed the way liquor was sold. After the initiative, liquor was more available to consumers since it was sold in privately owned stores, including many grocery stores. This changed the market and made liquor more convenient to purchase and therefore changed demand. This study shows that after the policy there was both an increase in demand for liquor in Washington and a price increase. Therefore, we disaggregate the changes in Washington tax revenue due to the shift in demand and the price change. Adding complexity and interest to this analysis, months after the policy change took place in Washington, in response, Idaho built a new liquor store very close to the border. This study more closely estimates how much of the change in revenues in Idaho was due to Washington's policy change and how much was due to Idaho's response in building a new store.

The policy change had an impact on both supply and demand for liquor in Washington State. We assume that given the market structure, the supply of liquor is flat and depends upon the tax structure. We assume that supply of liquor is flat for our region because, as opposed to the demand for liquor which is highly localized and distribution is highly regulated, the supply of liquor is highly competitive and competes in global market, of which our region represents a very small portion. Therefore, the policy change causes supply of liquor to increase from S_1 to S_2, as shown in Figure 1. We also assume that demand for liquor in grocery stores is higher than demand for liquor at state-run liquor stores due to increased convenience, and therefore goes from D_1 to D_2 . This implies that the policy change increased the price of liquor but the directional change in quantity depended on the elasticity of demand.

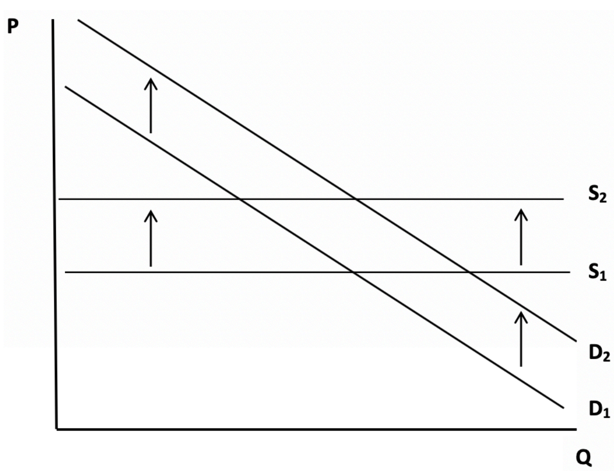

Figure 1. Change in Supply and Demand of Liquor in Washington State from Policy Change

There is a long literature on spatial spillovers resulting from policy changes in adjoining jurisdictions (Anselin, Varga, and Acs, 1997; Ying, 2000; Geys, 2006; Feng and Patton, 2017). These spillover effects are often estimated on proximal (e.g., contiguous or nearest) jurisdictions (e.g., states, counties, regions) using spatial econometric techniques. However, very few analyses have the establishment-level spatial data needed to estimate the geographic extent to which these spatial spillover effects extend. While it is commonly understood that policy changes in one jurisdiction will affect neighboring jurisdictions, these effects are almost always estimated as an aggregate effect across the entire neighboring jurisdiction. In the case of state liquor policies, it may be that spatial spillovers extend across the entire state, may be limited to neighboring counties, or may be limited to specific stores that are closest to the border. The specific dataset employed here allows us to estimate how far the spatial spillover effect of a change in Washington liquor policy extends into Idaho.

The first step in analyzing those effects is to understand the nature of the demand for liquor in both Washington and Idaho. Relative to previous studies of the demand for liquor, the analysis presented here uses much more disaggregated data and allows for a more robust investigation into the determinants of demand for liquor and the fiscal impacts of state policy changes. More specifically, we are able to isolate the effect of the policy change on specific stores in Idaho and determine the spatial extent of the impacts of the policy change on Idaho and evaluate the effectiveness of Idaho's response to Washington's change in liquor policy. After estimating the demand for liquor in both states, we then estimate the fiscal and economic impacts of changes in Washington's liquor laws and investigate the effectiveness of Idaho's response to the policy changes in Washington. The various impacts are important for both researchers and policy makers.

Liquor Demand Background

The demand for liquor has been extensively estimated using a variety of frameworks and estimated across many nations (Selvanathan and Selvanathan, 2005). Demand for liquor has often been estimated in a system of equations with the assumed substitutes of beer and wine (Gallet, 2007). In a meta-analysis of beer, wine, and spirits studies, Fogarty (2010) found that, while there is a significant difference in own-price and income elasticity estimates for liquor, there was no statistically significant difference based on methodology employed by the various studies, including single time frame cross-sectional studies, versus other demand estimates nor between panel data models versus simultaneous equation models.

Fogarty (2010) reported own-price elasticities ranging from −0.3 to −1.7; own-price elasticities and income elasticities were found to be becoming less inelastic over time. Fogarty (2010) also reports that there is little substitution between types of alcoholic beverages and that consumers respond to prices changes by stocking up on preferred liquors. Even within different products in the same category, Toro-González, McCluskey, and Mittelhammer (2014) 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 (mass, craft, and import). A particularly noteworthy study by Baltagi and Griffin (1995) used panel data for aggregate liquor consumption and process across 43 U.S. states and 23 years. Their results found an own-price elasticity of aggregate liquor demand of −0.7 and very small positive income elasticities.

Ruhm et al. (2012) argue that many previous studies of liquor demand are unreliable due to their suspect data source for liquor prices and quantities or because of their dependence on liquor tax data as a proxy for liquor sales volume and prices. They indicate that scanner data is needed to provide an accurate and reliable estimate of liquor demand. Additionally, many previous studies have relied on ACCRA data of quarterly index prices for liquor across approximately 300 metropolitan areas in the United States (Williams, Chaloupka, and Wechsler, 2005; Arcidiacono, Sieg, and Sloan, 2007). However, as many studies have pointed out, these data are subject to numerous limitations and measurement error issues (Young and Bielinska-Kwapisz, 2003).

The income and employment relationship with liquor demand is also a point of controversy in the literature. Some studies have found that alcohol consumption is positively correlated with job losses and losses in income (Mulia et al., 2014; Cotti, Dunn and Tefft, 2015), while other studies have found alcohol consumption to be a normal good, where demand rises with income and job stability (Ruhm, 2007; Evans and Moore, 2012). The study described in this paper differentiates itself from this literature in the detail of the data, both in geographic resolution and in the specificity of the liquor transactions.

Data and Model

For this study, we use monthly liquor transaction data for both Washington and Idaho. Data from Washington are aggregate monthly data of total state-wide liquor sales across a 10-year period. The data for Washington were provided by the Washington State Liquor and Cannabis Board and consisted of 127 total observations of monthly liquor sales and prices in liters from November 2003 to May 2014.[3] Due to these data limitations, the model for Washington is somewhat simpler, with our unit of observation consisting of the quantity (in liters) of liquor sold in Washington in month *k*, and year *l*. The Washington model is estimated as a reduced linear functional form as follows:

$$(1) \quad \ln\left(Q_{kl}\right) = \propto + \beta \ln\left(P_{kl}^{o}\right) + \gamma \ln\left(I_{kl}\right) + \delta \ln\left(E_{kl}\right) + \vartheta \ln\left(P_{kl}^{s}\right) + \varphi\left(W_{kl}\right) + \psi\left(M_{k}\right) + \omega\left(T_{l}\right) + \mu,$$

where Q_{kl} is the quantity of liquor sold in liters in month *k* and year *l*, P_{kl}^{o} is the own price of liquor, I_{kl} is real per capita personal income, E_{kl} is the unemployment rate, P_{kl}^{s} represent price index vectors for beer and wine included as prices of substitute goods, W_{kl} is an indicator variable equal to 1 if it is after the Washington initiative was enacted and 0 otherwise, M_{k} is a month fixed effect, and T_{l} represents both a linear monthly trend and a quadratic monthly trend variable. μ represents a random error with 0 mean and constant variance.

[3] Data are also available for June and July 2014; however, there seem to be anomalies in the data. Therefore, those two observations were dropped. This does not change the statistical significance of any variable.

The data for Idaho are more detailed and represents every liquor transaction at every liquor store over a 5-year period in Idaho. The Idaho data have many advantages over data used in previous studies of the demand for liquor. As opposed to the scanner data used in Ruhm et al. (2012) and Toro-González, McCluskey, and Mittelhammer (2014), the Idaho data are detailed to the individual bottle (brand, type, and size) and capture all liquor transactions at the store level of detail across the entire state, including both urban and rural areas. Minimum sales prices of liquor in Idaho are set by the Idaho State Liquor Division. Individual stores have the latitude to charge a higher price than the state minimum but not a lower price. In practice, only a very small fraction of stores ever charge a different price for a given bottle than the state minimum.

The Idaho data for this study came from the Idaho State Liquor Division and represent all of the individual liquor store transactions that took place from July 2009 through June 2014. We aggregated these transactions so that our unit of observation is quantity of liquor sold by type (*i*),[4] store (*j*), month (*k*), and year (*l*), which gives us 63,219 observations. Data on unemployment were obtained from the U.S. Bureau of Labor Statistics; per capita income data and consumer price index values for beer and wine were obtained from the U.S. Bureau of Economic Analysis.

The model for Idaho is as follows:

$$\ln\left(Q_{ijkl}\right) = \propto + \beta \ln\left(P_{ijkl}^{o}\right) + \gamma \ln\left(I_{jkl}\right) + \delta \ln\left(E_{jkl}\right) + \vartheta \ln\left(P_{kl}^{s}\right) + \varphi\left(W_{kl}\right) + \rho\left(S_{j}\right) + \psi\left(M_{k}\right) + \omega\left(T_{l}\right) + \lambda\left(L_{i}\right) + \mu, \quad (2)$$

where Q_{ijkl} is the quantity of type *i* liquor sold in liters in store *j* in month *k* and year *l*, P_{ijkl}^{o} is the own price of liquor,[5] I_{jkl} is real per capita personal income in the county where the store is located, E_{jkl} is the unemployment rate in the county where the store is located, P_{kl}^{s} represent price index vectors for beer and wine included as prices of substitute goods, W_{kl} is an indicator variable equal to 1 if it is after the Washington initiative was enacted and 0 otherwise, S_j is a store fixed effect, M_k is a month fixed effect, T_l is a linear and quadratic monthly trend, and L is a liquor type fixed effect.[6] For reasons explained later in the text, one store (store #304) was split into three indicator variables. μ represents a random error. Both estimations used robust standard errors.

Results

Summary statistics for the variables used in the Washington and Idaho analysis are presented in Tables 1 and 2, respectively. The results of the demand model for Washington are presented in Table 3, and the results for the demand model in Idaho are presented in Table 4. Table 3 shows an own-price elasticity estimate of −0.978 for Washington liquor, which is quite close to the estimate of −1.008 for Idaho shown on Table 4. Table 3 and Table 4 show income effects are positive and

[4] This includes American whiskey, Irish whiskey, blends, Canadian whisky, Scotch whisky, brandy, rum, gin, vodka, specialties, crème liqueurs, cordials, schnapps, vermouth, fortified wine, and tequila. For the analysis, American whiskey was the omitted variable type.

[5] This price represents an average that is weighted by volume.

[6] County-specific demographic variables such as religious adherence, race, and rurality were initially considered but were replaced with store-level fixed effects to control for the broadest set of geographically specific effects possible.

significant for both states. The effect of unemployment on liquor sales is negative and significant in Idaho but positive and not significant in Washington. Liquor is not a statistically significant substitute for either beer or wine in Washington, but liquor is a statistically significant substitute for wine in Idaho. Both estimations show a dramatic increase in liquor demand in December.

Table 1. Summary Statistics for Variables in the Washington Model (N = 127)

Variable	Mean	Std. Dev.	Min.	Max.
Log of liters sold	14.90	0.15	14.58	15.32
Log of own price per liter	2.77	0.05	2.63	2.91
Log of per capita personal income	10.75	0.03	10.67	10.81
Log of unemployment rate	1.91	0.26	1.53	2.34
Log of consumer price index for beer	5.37	0.02	5.32	5.40
Log of consumer price index for wine	5.22	0.04	5.13	5.28
Policy dummy for months after privatization in WA	0.19	0.39	0	1
Trend	64	36.81	1	127

Table 2. Summary Statistics for Variables in the Idaho Model (N = 63,219)

Variable	Mean	Std. Dev.	Min	Max
Log of liters sold	12.31	1.47	5.93	16.82
Log of own price per liter	2.91	0.36	2.22	3.71
Log of population by county by year	11.47	1.26	8.95	12.96
Log of per capita personal income	10.53	0.17	10.13	11.19
Log of unemployment rate	2.02	0.31	1.31	3.02
Log of consumer price index for beer	5.38	0.01	5.36	5.40
Log of consumer price index for wine	5.18	0.04	5.13	5.26
Dummy for month 36 to 39 for store 304	<0.01	0.03	0	1
Dummy for month 40 to 60 for store 304	0.01	0.07	0	1
Policy dummy for months after privatization in WA	0.11	0.32	0	1
Trend	30.53	17.31	1	60

Policy Impacts on Washington

First we estimate the impacts of the policy on Washington State. The estimates from Table 3 show that there was an increase in demand for liquor after the policy change that is statistically significant at the 5% level but not the 1% level. Presumably this illustrates that demand for liquor stores is higher at grocery stores than compared to stores that only sell liquor, which increased demand by 12.41%.[7] This may be due to the convenience of grocery stores relative to dedicated liquor stores, which have more limited hours and require a separate trip. However, the policy also increased prices, so changes in quantity demanded are less pronounced. Although far less liquor transaction data are available for Washington than for Idaho, the available data allows us to

[7] $e^{0.117} - 1 = 0.1241$.

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estimate both the shift and movement along the demand curve from the change in policy. Figure 2 shows that even with increased prices, volume sold increased, is in line with the statistically significant increase in demand. Figure 3 illustrates that there was a change in the average price to consumers (including the liquor specific taxes paid by consumers at the point of sale) immediately after the policy change. Figure 4 shows that there may have also been a slight increase in tax revenue after the policy, but it is important to keep in mind that the policy impacted many types of taxes; these data may not account for all the taxes in the same manner, pre- and post-policy. It is therefore difficult to know the actual changes in tax revenue.

Table 3. Determinants of Demand for Liquor in Washington (*N* = 127)

Washington Model	Log of Liters Sold
Log of own price per liter	−0.978**
	(0.292)
Log of per capita personal income	0.729*
	(0.312)
Log of unemployment rate	0.039
	(0.047)
Log of consumer price index for beer	0.527
	(0.456)
Log of consumer price index for wine	0.090
	(0.411)
Policy dummy for months after privatization in Washington	0.117*
	(0.052)
Trend	0.004**
	(0.001)
$Trend^2$	−0.00001
	(0.00001)
	(0.030)
Constant	6.090
	(4.179)
R^2	0.92

Note: Single and double asterisks (*, ** indicate significance at the 5% and 1% level. Month fixed effects are included as controls but the results are not reported.

Before the change in policy, monthly average tax revenues were $19,330,072, and post policy they were $22,821,137 (in 2014 dollars). This represents an increase in tax revenue of 18.1%, or $3,491,065. However, since the price changed via taxes and availability went from liquor stores to grocery stores, the cause of this increase is not clear. In fact, if the tax revenue after the policy is accounted for differently, this may not be a reliable estimate. Therefore, we use the demand estimation to disaggregate the effects.

Given a prepolicy average monthly tax revenue of $19,330,072, an increase in demand of 12.41% is equal to $2,398,862. However, it is crucial to note that besides a shift in demand, prices also increased due to tax increases. The estimates from Table 3 also show the price elasticity of liquor in Washington State to be −0.978. Since the average tax rate before the policy was 42.28%, the

Table 4. Determinates of Demand for Liquor in Idaho (N = 63,219)

Idaho Model	**Log of Liters Sold**
Log of own price per liter	−1.008**
	(0.038)
Log of per capita personal income	0.349**
	(0.111)
Log of unemployment rate	−0.472**
	(0.025)
Log of consumer price index for beer	0.487
	(0.375)
Log of consumer price index for wine	0.767**
	(0.281)
Log of the county population by year	0.503**
	(0.169)
Policy dummy for months after privatization in Washington	0.013
	(0.007)
Dummy for month 36 to 39 for store 304	0.345**
	(0.050)
Dummy for month 40 to 60 for store 304	−0.284**
	(0.030)
Trend	0.003**
	(0.001)
$Trend^2$	−0.0001**
	(0.00001)
Constant	1.474
	(3.269)
R^2	0.92

Note: Single and double asterisks (*, ** indicate significance at the 5% and 1% level. Store, month, and liquor type fixed effects are included as controls but results are not reported.

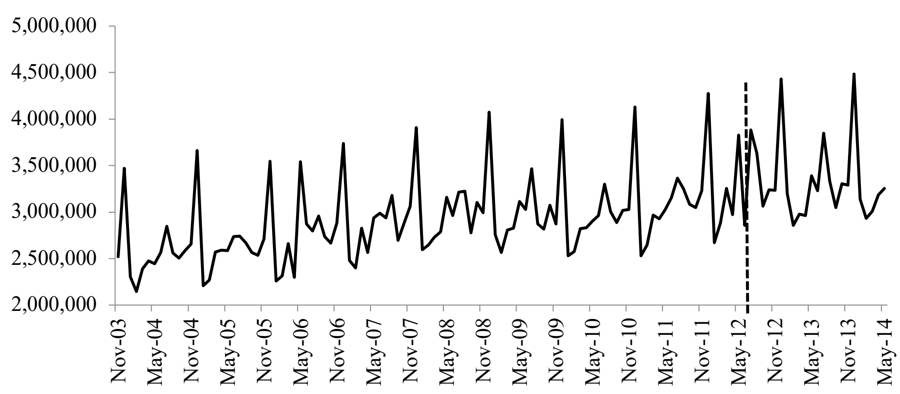

Figure 2. Liters Sold in Washington

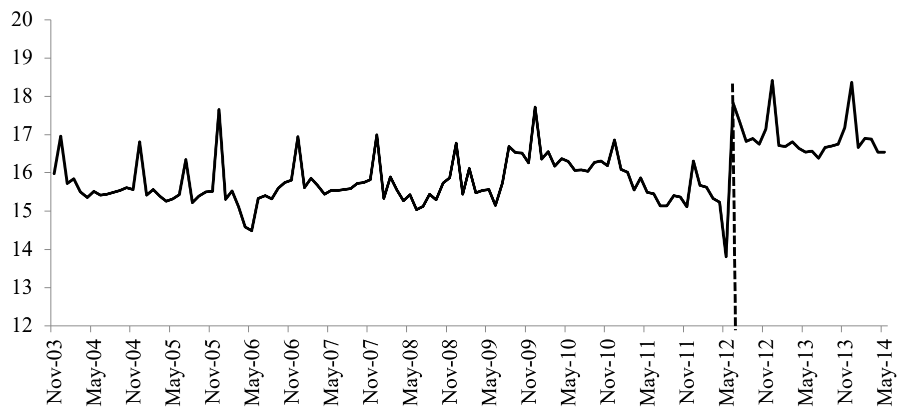

Figure 3. Average Prices in Washington

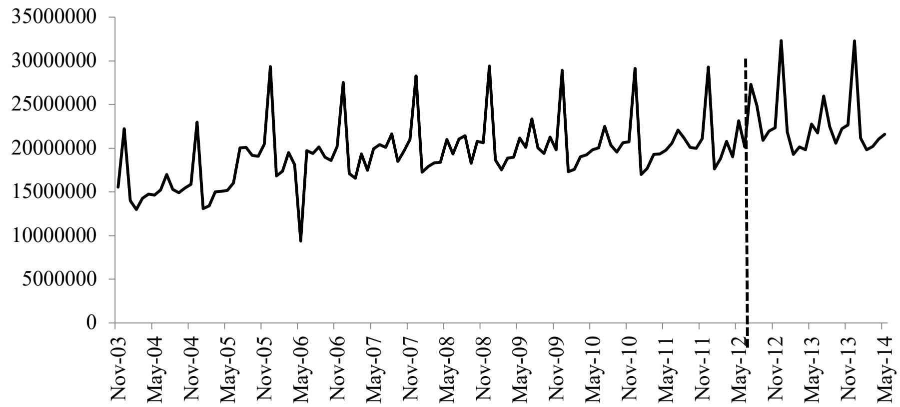

Figure 4. Real Tax Collections in Washington

elasticity with respect to taxes and output is −0.4135. This implies that, *ceteris paribus*, an increase in taxes increases tax revenue. The data show that average price before the policy change was \$15.74 and increased 7.58% to \$16.93. If this increase is all attributed to an increase in taxes, this represents a 17.93% increase in taxes.[8] Using the elasticity estimates, this increase in price should represent a 7.41% decrease in quantity.[9] These numbers estimate that the increase in tax revenue

[8] $0.0758 / 0.4228 = 0.1793$.

[9] $0.0758 \times 0.978 = 0.0741$.

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should be 9.19%,[10] or $1,776,702 per month. Therefore, the increase in tax revenue from the policy change was roughly half due to increases in demand and roughly half due to increases in taxes.

Policy Impacts on Idaho

The analysis shows no statistically significant general effect of the Washington policy on Idaho liquor sales; however, this is due to the statistical specification and a deeper examination of specific stores shows that there are effects and they vary widely. In other words, the substitution effect was not widespread and did not result in statistically significant increases. However, much of this is due to the change in the composition of stores after the policy change. More specifically, certain stores are controlled for more closely, eliminating the statistical significance of the other stores.

We first look at Kootenai County, Idaho, which is adjacent to Spokane County, by far the most populous Washington county adjacent to Idaho. What makes this county unique is that a new state-run liquor store (store #307) opened up in October 2012 in State Line, Idaho, approximately 50 feet from the Washington/Idaho border. It was built only 4 months after the Washington policy came into effect and has important implications for the analysis.

Before store #307 was built, the nearest Kootenai County liquor store to Washington was in Post Falls, ID (store #304), approximately 5 miles from the Washington/Idaho border. Therefore, in addition to having dummy variables for both store #307 and #304, we included a dummy variable for store #304 during the 4 months after the policy in the absence of store #307 and a dummy variable for store #304 after store #307 opened up. Table 4 shows that store #304 saw sales increase 34.5% after the policy. However, after store #307 was built, store #304 saw a statistically significant drop in sales to 28.4% below what they had been prior to the change in Washington policy. This implies that the opening of store #307 nearly cut sales of store #304 in half from their peak level.

Figure 5 shows the monthly revenues for store #304, store #307, and the average of the other seven state-run liquor stores in Kootenai County. This graph shows the spike in revenues in December, along with smaller spikes during the summer months. However, the policy change appears to have no impact on sales for stores that are not the closest to the border. The policy change did impact store #304, illustrating the 34.5% increase.

These numbers translate into $205,031 in increased monthly sales for store #304 for the 4 months immediately after the policy change. After store #307 opened, there was a net increase of monthly sales of $268,433 in comparison to prior to the policy change. This accounts for both the sales of store #307 and the loss in sales to store #304. Thus, the opening of store #307 created a net increase of monthly revenues of $63,402, which represents 14.7% of the total revenue for store #307. Conversely, 85.3% of the store's revenues represent lost revenues from store #304. Regardless,

[10] $1.1793 \times (1 - 0.0741) - 1 = 0.0919$.

Field Code Changed

these two stores alone account for an increase of over $3.2 million annually, which represents roughly two-thirds of the overall increase to the state (Winfree and Watson, 2015).

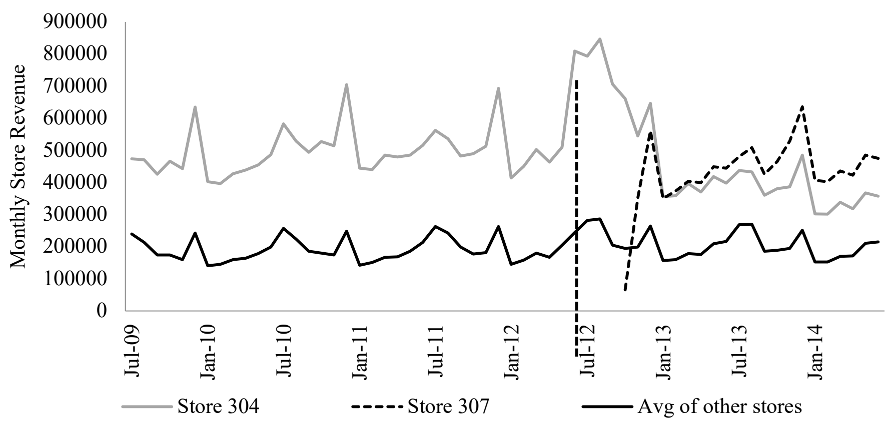

Figure 5. Kootenai County, Idaho, Liquor Sales

Next we analyze Latah County, Idaho. Figure 6 shows monthly revenues for the two state-owned liquor stores in Latah County. Store #303 is closer than store #309 to Washington. First, revenues for these stores decrease during the summer and do not have the same December spike, which is in contrast to the stores in Kootenai County. Presumably this is because Latah County and adjacent Whitman County in Washington both have very large universities and have a large student demographic. Figure 6 does show that store #303 increases over time relative to store #309. However, this change seems somewhat gradual, and there is no obvious shift at the time of the policy. So, while it does seem that the policy likely had an impact, the magnitude could be called into question.

Figure 6. Latah County, Idaho, Liquor Sales

Finally, we analyze Nez Perce County, Idaho (Figure 7). While this county has one state-run liquor store (store #301) right next to the Washington/Idaho border and one liquor store (store #321) farther away, there seems to no discernable difference in revenues for either store due to the Washington policy change. One possible explanation for this is that there is a large Costco Wholesale approximately 1 mile from store #301, but it is across the border in Washington. Before Washington's policy change, they were not allowed to sell liquor. After the policy change, Costco was allowed to sell liquor, albeit with high taxes in addition to the retail margin. Therefore, this increased availability of liquor may have counteracted any substitution effects from price.

These examples illustrate that any effects of the policy are far from uniform. As one might expect, stores very near the border and near population centers saw the biggest effects. Further, there was an apparent supply response from Idaho to capture more customers from out of state. Finally, not all "border stores" saw any impact from the policy change in Washington.

Figure 7. Nez Perce County, Idaho, Liquor Sales

Conclusions

It is unclear whether the liquor privatization policy change in Washington had the intended effect or if voters who approved it were happy with the outcomes (Subbaraman and Kerr, 2016). From this analysis, it is clear that the policy change to privatize liquor sales in Washington led to measurable and statistically significant positive effects on the amount of liquor sold in both Washington and Idaho. This is hypothesized to arise due to increased convenience of purchasing liquor in Washington, despite the average price of liquor actually increasing in the state. The finding that prices actually went up in Washington after privatization is somewhat novel, as previous literature has shown that average liquor prices were typically 6.9% lower after privatization (Siegel et al., 2013). The effect of the policy change in Washington was an increase in the register price (retail price plus taxes) of liquor in Washington which, *ceteris paribus*, would result in a decrease in the quantity of liquor demanded. However, this increase in price was coupled with an increase in the convenience of buying liquor, which, *ceteris paribus*, would lead to an increase in the quantity of liquor demand.

The fact that an overall increase in the amount of liquor sold was observed presents evidence that the increase in convenience was more valuable to consumers than was the cost increase was damaging. Additionally, by taking advantage of the increased convenience to increase the taxes on liquor sold in the state, Washington was able to increase the tax revenue generated by liquor sales. This has implications for other jurisdictions that are looking for polices to increase tax revenues; increasing the convenience of purchasing a taxed good can allow for more sales and more overall revenue, even in response to an increase in tax rate.

In Idaho, tax avoidance behaviors on the part of Washington consumers led to a cross-border effect that increased sales of liquor in Idaho. However, this effect was limited to the stores most proximal to the Washington border and did not extend into more interior stores. So, while there are spatial spillovers of the economic impact of the policy change, these are more focused on specific locations than a traditional county or regionally specified spatial autocorrelation model would accurately capture.

From a fiscal impact standpoint, the liquor policy change in Washington resulted in a measurable increase in tax revenues in Washington and, through these spatial spillover effects, an increase in tax revenues in Idaho as well. Therefore, while Washington did experience increased tax revenues associated with the policy change, they lost sales to Idaho; Idaho also experienced increased tax revenues associated with Washington's liquor policy change. The overall effect is that the policy change in Washington led to Washington consumers paying more in liquor taxes both inside the state and in the neighboring state of Idaho.

The findings of this study serve to inform researchers and policy makers about far tax avoidance spatial spillovers extend into neighboring jurisdictions. Additionally, Idaho responded to this policy change in Washington by building a new liquor store closer to the border, which in turn increased liquor sales even more. Because this store did not open until a few months after the implementation of the policy change in Washington, the border store was shown to have an additional marginal effect above and beyond the next closest store in the county. This result adds to the literature on spatial spillover effects of policy changes on neighboring jurisdictions and demonstrates that, at least in some cases, neighboring states anticipate some of the price effects and change behaviors to try to maximize the spillover effects.

Future work may examine whether there were heterogeneous substation effects across liquor types. For example, consumers may have substituted expensive liquor more than cheap liquor. This may help explain why substitution effects were larger in some areas. Similarly, this policy change may have had an impact on the composition of liquor sales and consumption.

The results are of use to both researchers and policy makers. When analyzing the effects of tax policies, it is important to analyze any changes in demand, changes in prices, and substitution effects. In this case, a strong cross-border effect was found; however, that effect is limited to a small number of establishments that are immediately proximal to the border. Future policy changes should incorporate all of these ideas to ensure the impacts align with the goal of the policy.

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Tennessee Consumer Willingness to Pay for Disposable Dinnerware Molded from Wheat Straw

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Abstract

Wheat straw, a wheat byproduct, can be used in making disposable dinnerware. This study uses a contingent valuation survey to measure consumer willingness to pay (WTP) for wheat straw dinnerware bowls (WSB). Consumers would pay a premium ($1.33) for a 25-count package of molded WSB over the same size package of conventional bowls. Target markets include those who spend more on disposable dinnerware but also those who have greater concern about reducing greenhouse gas (GHG) emissions and climate change. Recyclability, no plastic, USDA Certified Biobased, and compostability are more important attributes to consumers than no tree cellulose being used in making the disposable dinnerware.

Keywords: consumer, disposable dinnerware, preferences, wheat straw

Introduction

An estimated 1,740 million bushels of wheat were produced in the United States for 2017/2018 on 37.5 million acres (U.S. Department of Agriculture, 2018). Wheat straw—what remains after the wheat kernel is removed to make flour and cereal products—is a byproduct of producing wheat. An acre of wheat yields 1.5–2 tons of wheat straw (Gross, 2016). Most wheat straw is incorporated back into the soil, burned in the field, or perhaps used as animal bedding (U.S. Department of Agriculture, 1994).

Like trees, wheat straw can be broken down into several components—lignin, cellulose, and hemicellulose—with additional uses. Cellulose can be used to produce biofuels and can also be used to make other biobased products. One example is molded dinnerware products that can serve as substitutes for those made from tree cellulose or from plastic. In 2016, the U.S. paper cup and paper plate market was valued at $104 billion (Wood, 2017). In 2015, paper plates and cups represented 1,360,000 tons of municipal solid waste (MSW) (U.S. Environmental Protection Agency, 2018). For nondurable paper goods (including paper plates and cups), around 40% ends up landfilled. About 1,050,000 tons of MSW was generated from plastic plates and cups, of which 840,000 tons was landfilled (U.S. Environmental Protection Agency, 2018). If consumers substitute from plastic or paper disposables toward compostable disposable dinnerware and then compost this waste, landfilled plastic or paper disposable dinnerware could be reduced. Davis and Song (2006) suggested that some of the most significant impacts of substitution could be from changes in habits in developed countries, such as the United States, where per capita consumption of plastics is highest. Increasing consumer options for biodegradable disposable dinnerware could provide consumers with choices to substitute away from conventional paper or plastic disposable dinnerware.

The market for molded dinnerware that uses cellulose alternatives to tree cellulose is emerging. One type of molded cellulose dinnerware uses wheat straw as the source of its cellulose. A few dinnerware (plates, trays, and bowls) products have been registered through the USDA Bio-

Preferred Program (U.S. Department of Agriculture, 2019). These include products sourced from bamboo, sugarcane, palm leaves, and wheat straw. Molded wheat dinnerware tends to be heavyweight and sturdy. It also uses no trees for cellulose and is compostable, which likely appeals to environmentally concerned market segments. However, the market for molded wheat dinnerware is still not yet well developed and studies measuring consumer preferences for these products are lacking. In addition, few studies have examined how consumers perceive molded dinnerware made from crop-based cellulose sourced from byproducts compared with dedicated crops grown specifically for their use in making molded cellulose fiber products.

This study provides the emerging industry that uses alternative fibers to make molded dinnerware with market information about product pricing and market segments most likely to be interested in purchasing these products. The objectives of this study are to

- provide a measure of consumer WTP for disposable dinnerware (specifically bowls) molded from wheat straw;
- provide estimates of how demographics, expenditure patterns, and attitudes influence this WTP;
- provide measures of the importance of additional attributes in making disposable dinnerware purchase decisions (including whether the wheat straw is sourced from a dedicated crop or as a byproduct to grain production); and
- ascertain whether shoppers would exhibit differences in WTP across retail shopping outlet types.

Previous Research

Little research exists on disposable dinnerware made from alternative fibers, but several studies have examined consumer preferences for packaging and biobased products made from renewable sources. The following studies' findings include environmental attitudes, preferred attributes, and examples of premiums that are relevant to the research presented in this study.

Herbes, Beuthner, and Ramme (2018) studied consumer attitudes toward biobased packaging across the United States, France, and Germany. The recyclable material and bioplastics rated most highly by U.S. respondents were those made from renewable resources (other than bio-methane) that were biodegradable, while plastic made from bio-methane rated lowest. Herbes, Beuthner, and Ramme found that Germans raised ethical concerns about the use of agricultural land to produce biogas (Herbes, Beuthner, and Ramme, 2018). These results suggest that U.S. consumers may be receptive to recyclable products and have limited concerns about the use of agricultural land to produce inputs for biobased packaging. Barnes et al. (2011) studied Hawaiian consumers' preferences and WTP for nonplastic food containers. They separated responses into four classes based on stated preferences for attributes of the nonplastic food container. Some segments were found to prefer lower prices and water-resistant food containers, but certain classes more highly valued the containers being microwavable and/or locally produced. Barnes et al. hypothesized that respondents who most highly valued the nonplastic container (i.e., were willing to pay $0.37 more for the product being locally produced) were those that understood the local economic impacts of using sugarcane to produce food containers. Generally, respondents preferred an alternative food container that was made with sugarcane material (66.49%), microwavable (88.94%), water resistant (100%), locally produced (51.23%), and competitively priced. In addition, 97% of respondents stated that they would recycle or compost the container if given the choice, and 81% supported a ban on expanded polystyrene plastic. These relatively high percentages may be influenced by the fact that Hawaii is dealing with an issue of limited landfill space and experiences the impacts of marine plastic pollution firsthand. With widespread increased awareness of single-use plastic pollution, into the near future, consumer attitudes and preferences for product attributes may be influenced by this awareness (Barnes et al., 2011).

Kainz (2016) examined the impact of educating consumers about durable biobased plastic alternatives and associated labelling on their WTP for such a product. After conducting a series of experimental auctions, the investigators used a regression analysis to estimate consumer WTP. Kainz found that the information given to the consumer only partially influenced their WTP and that adding a label to the biopolymer during the auction experiment was most impactful and suggested that using raw materials that were collected locally and then labeling the product accordingly may increase consumer WTP.

Yue et al. (2010) examined consumer preferences for biodegradable plant containers. They evaluated price premiums consumers would pay for containers made from wheat starch, rice hulls, straw, coir, peat, and other materials. Yue et al. found that consumers were willing to pay 19.5 cents more for wheat starch containers than recyclable plastic containers. This suggests that containers from crop-based products are appealing to consumers. They found that female participants were willing to pay more for the biodegradable pots than for conventional plastic pots.

Kurka and Menrad (2009) conducted a survey on European consumers' attitudes toward and WTP for several biobased products, including orange juice packaged in a biobased container and soap labeled as biobased. The investigators found that consumers who indicated highest WTP for biobased soap had high sensitivity toward ecological issues, sustainability, and personal health. Consumers ranked their top reasons for purchasing bioplastics in order as: to be more ecofriendly, to conserve resources for future generations, for health reasons, to strengthen the regional economy, to get it for a low price, to set an example for others, and to ease one's conscience (Kurka and Menrad, 2009).

The results from each of the aforementioned studies provide insight into consumer preferences for environmentally friendly containers and packaging, but none directly examined consumer preferences for disposable dinnerware with ecofriendly attributes. Some results from prior research suggest that age will likely have a negative influence on WTP (Yue et al., 2010; Martinho et al., 2015), while other studies suggest age will exert a positive influence (Kainz, 2016). Findings from prior research also suggest that being female will have a positive influence on WTP (Casadesus-Masanell et al., 2009; Yue et al., 2010; Martinho et al., 2015; Kainz, 2016). Previous research suggests that residing in an urban area will have a negative influence on WTP (Casadesus-Masanell et al., 2009). The presence of children in the household and household size were previously found to positively impact WTP (Yue et al., 2010; Kainz, 2016). Some studies found education to positively impact WTP (Yue et al., 2010; Martinho et al., 2015), while others found education to have a negative impact (Casadesus-Masanell et al., 2009). Similarly, some studies found household income to positively impact WTP (Casadesus-Masanell et al., 2009; Yue et al., 2010), while others observed a negative impact (Kurka and Menrad, 2009; Kainz, 2016). Previous product knowledge was found to positively impact WTP (Kainz, 2016), as did a history of previously purchasing the product type investigated (Casadesus-Masanell et al., 2009). Overall, having positive environmental attitudes and positive attitudes toward sustainable products increased WTP (Kurka and Menrad, 2009; Martinho et al., 2015; Kainz, 2016). These findings provide a conceptual starting point for possible factors to be included in a WTP analysis of biodegradable WSB. A WTP analysis on consumer preferences for disposable dinnerware made from biobased materials is missing from the existing literature; the current study intends to fill this gap in the literature.

Economic Model

A referendum-style contingent valuation method was used to determine WTP for molded wheat bowls. The contingent valuation follows a random utility framework (McFadden, 1974). Let U_{CBi} represent the *i*th consumer's utility from choosing the conventional bowls and U_{WSBi} represent the *i*th consumer's utility from choosing the bowls molded from wheat straw (WSB). The *i*th consumer will choose WSB if $U_{WSBi} > U_{CBi}$. If these preferences are influenced by price (P_{WSBi}, P_{CBi}) as well as nonprice variables such as demographics, shopping patterns, or attitudes represented by the vector $\boldsymbol{X}_i$, then the *i*th consumer will choose WSB if

(1) $$\text{UiWSB } (\text{Xi}, P_{WSBi}) > \text{ UiCB } (\text{Xi}, P_{CBi}).$$

The probability of the *i*th respondent choosing the WSB is

(2) $$\Pr[WSB_i = 1] = F\left(\alpha + \boldsymbol{X}_i\beta + \beta_{PSWB} \times P_{WSBi}\right),$$

where α is a constant, β_{PWSB} is the price parameter, $\boldsymbol{\beta}$ is a vector of parameters on nonprice variables, and assuming a logit model, and *F* is the logistic distribution function (Greene, 2018).

The marginal effect of the *j*th variable X_{ij} on the probability of the *i*th respondent selecting the WSB over the conventional bowls is

(3) $$\frac{\Pr\left[WSB_i = 1\right]}{\partial X_{ij}} = f_i \times \beta_j,$$

where β_j is the parameter on X_{ij} and f_i is the logistic density function. The mean marginal effects and their associated standard errors are calculated using the Krinsky–Robb (1986) method with 5,000 replications.

WTP for WSB can be expressed as $\widehat{WTP}_{WSBi} = -(\alpha + \boldsymbol{X}_i\beta)/\beta_{PWSB}$. The means of the WTP and associated standard errors are also calculated using the Krinsky–Robb (1986) method with 5,000 replications. Further, the effects of each variable on WTP and their associated standard errors are calculated using the Krinsky–Robb. The effect of the *j*th nonprice explanatory variable on estimated WTP is calculated as

$$\frac{\partial\, \widehat{WTP}_{WSB}}{\partial X_j} = -\frac{\beta_j}{\beta_p}. \tag{4}$$

Survey Data

An online survey was administered through Qualtrics to 217 Tennessee respondents statewide aged 18 or older in late August 2018. The survey was reviewed through Internal Review Board procedures prior to administration. A pretest was conducted prior to administration of the full survey. The survey contained several sections, including information about wheat straw and its uses (see Figure 1).[1]

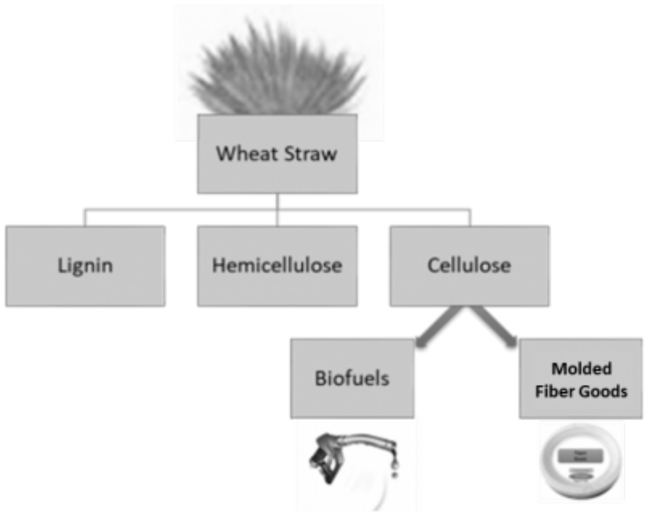
Figure 1. Wheat Straw Information Screen

This was followed by a screen regarding wheat straw's uses for its components, lignin, cellulose, and hemicellulose (Figure 2). In the next screen, respondents were informed they would be choosing between two 25-count packages of molded disposable dinnerware bowls. Note that

[1] Copies of the survey instrument are available from the authors upon request.

Wheat Straw Uses

Like trees, wheat straw can be broken down into several components that are useful for a variety of products. These components include lignin, cellulose, and hemicellulose. Cellulose can be used in making biofuels. It can also be used in making many other products, including molded products. Cellulose from wheat straw uses an agricultural byproduct as its source. Products made from wheat straw do not involve any cutting of trees. Also, products molded from wheat straw can be composted, rather than disposed.



Have you ever purchased any alternative fiber products (products molded from other fibers that substitute for cellulose from trees)?

- ○ Yes
- ○ No
- ○ Not Sure

Figure 2. Information Screen about Wheat Straw Uses

online surveys present respondents with a hypothetical choice; these surveys may therefore be subject to bias compared with actual purchase decisions.n order to reduce this bias, respondents were asked to consider their choices as realistically as possible (Blamey, Bennett, and Morrison, 1999) and reminded of their budget (Cummings and Taylor, 1999) (Figure 3).

These screens were followed by a choice set between two 25-count packages of molded disposable dinnerware bowls, one made from conventional cellulose from trees and the other from wheat straw cellulose (Figure 4). In this choice set, the respondents were asked to suppose they were shopping for disposable dinnerware bowls. The respondent could choose the WSB, the conventional bowls, or neither. The two product choices and a neither choice option were presented in tabular format. Adamowicz, Lloyd-Smith, and Zawojskia (2018) suggested an advantage of using a table format of information presentation over a text format. In our study, respondents were presented with a table choice from which they could choose the conventional product, wheat straw product, or neither (Carson et al., 1996).

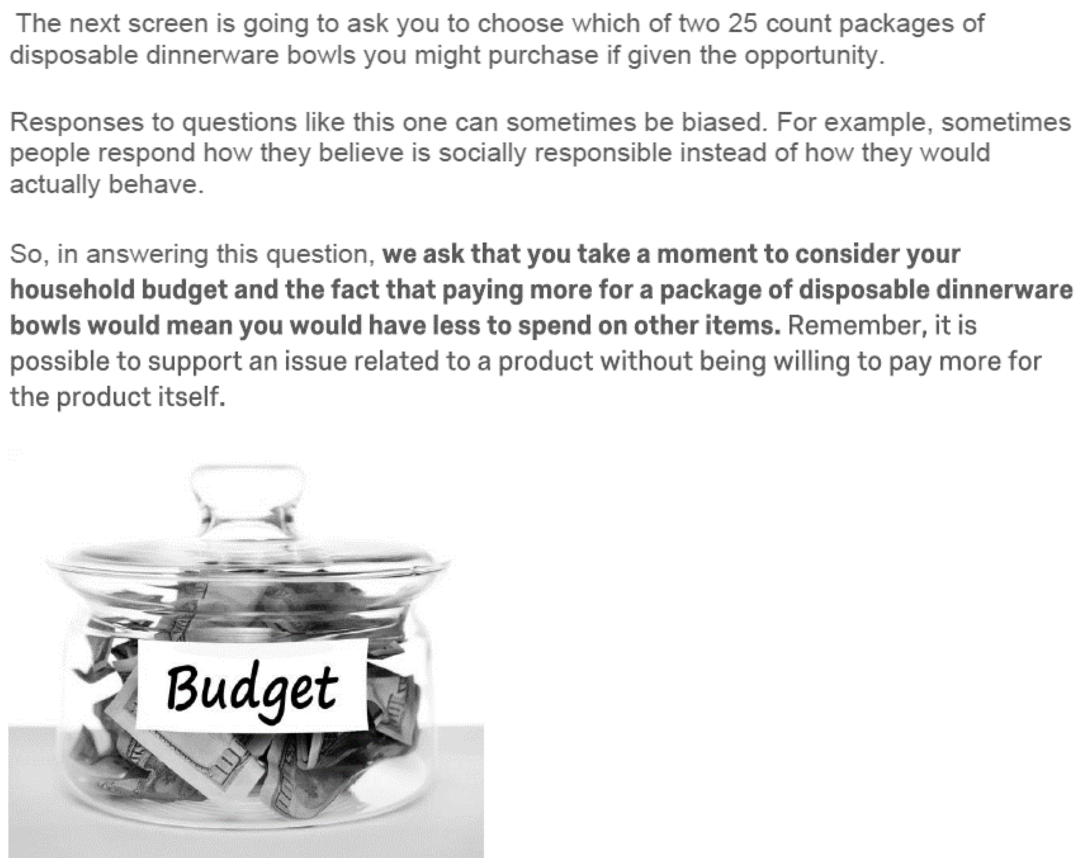


Figure 3. Budget Reminder Screen

The sample was divided into five equal price groups ($2.25, $3.25, $4.25, $5.25, $6.25) for a 25-count package of disposable dinnerware bowls molded from wheat straw, with 20% of the participants seeing each of the respective price points. The price of the base product was held constant at $2.25. The base price was derived from conventional molded dinnerware prices at major retailers at the time of the survey. The range of higher prices was based on specialty and alternative fiber molded dinnerware bowls sold through major online retailers (information collected in June/July 2018).

A "neither" choice was offered in order to identify if the respondent was unwilling to choose either product. The "neither" respondents are not included in the WTP estimation because they were unwilling to participate in the market even at the conventional product price. For example, a high percentage of "neither" respondents could indicate that the product pricing for both products, including the conventional product, was too high. In the case of this study, about 17% of participants selected neither product.

As a follow-up, respondents were asked about importance of additional potential attributes that might influence purchase decisions for disposable dinnerware. They were first provided an information screen about the USDA Certified Biobased designation (Figure 5). The respondents

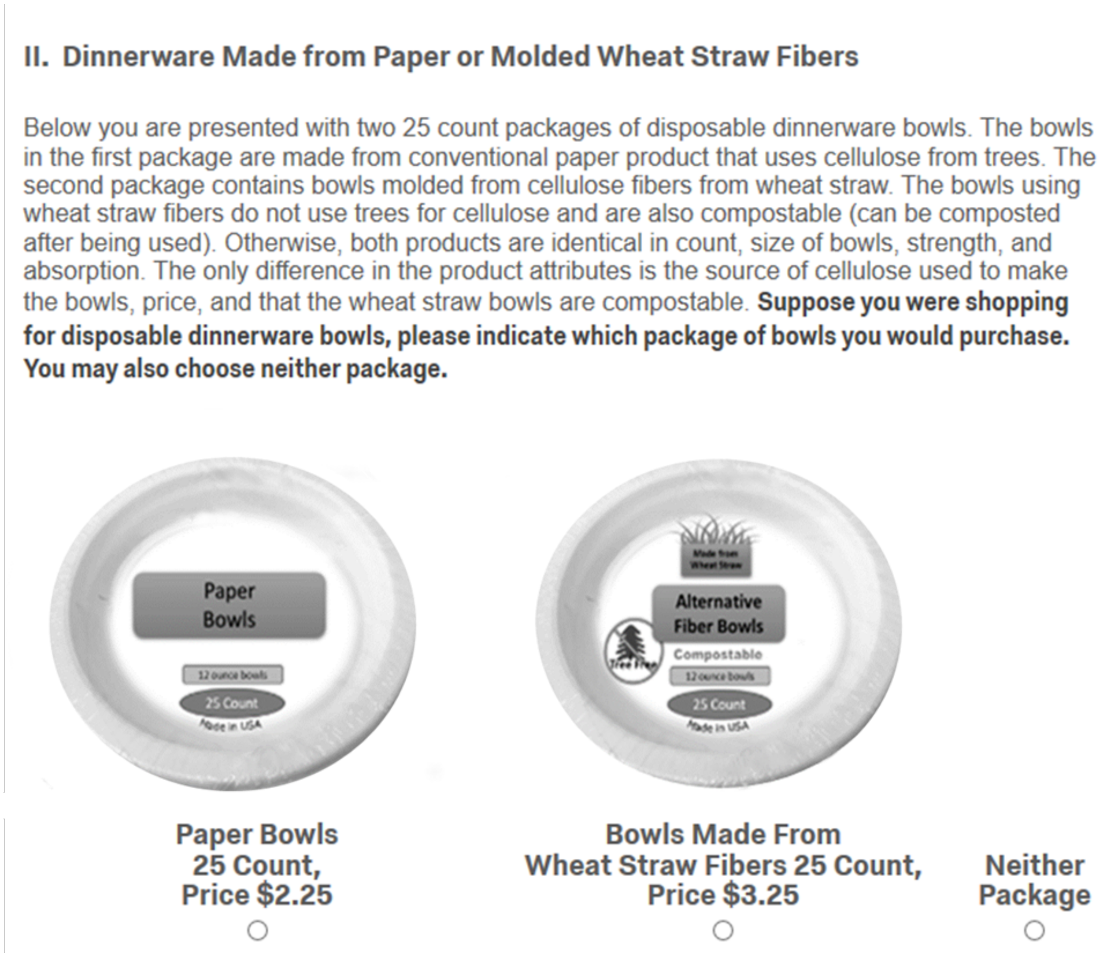


Figure 4. Labels on Disposable Dinnerware Bowls in Choice Set

were then asked about importance of the product not using trees, being USDA Certified Biobased, made in the United States, recyclability, compostability, the source of the cellulose being from agricultural crop grown for its cellulose, the source of the cellulose being from a byproduct of agricultural grain production, the product not being made from plastic, and the cellulose being organic. A 5-point Likert scale was used to measure respondents' importance rating for each attribute (from 1 = not important at all to 5 = extremely important). Table 3 reports the means of these ratings and means comparisons *t*-tests across whether respondents selected the WSB.

In addition, WTP estimates are also calculated using the individual response and the coefficients from the estimated logit model. To examine whether respondents who most often shop at particular retail outlet types might have differing WTP for the WSB, means of these WTP estimates were compared across where the respondent indicated they usually shopped for disposable dinnerware. *T*-tests were used to compare mean WTP across retail outlet types.

Questions asked in later sections of the survey included expenditure patterns on disposable dinnerware, attitudes, and demographics. The attitude questions assessed respondents' agreement

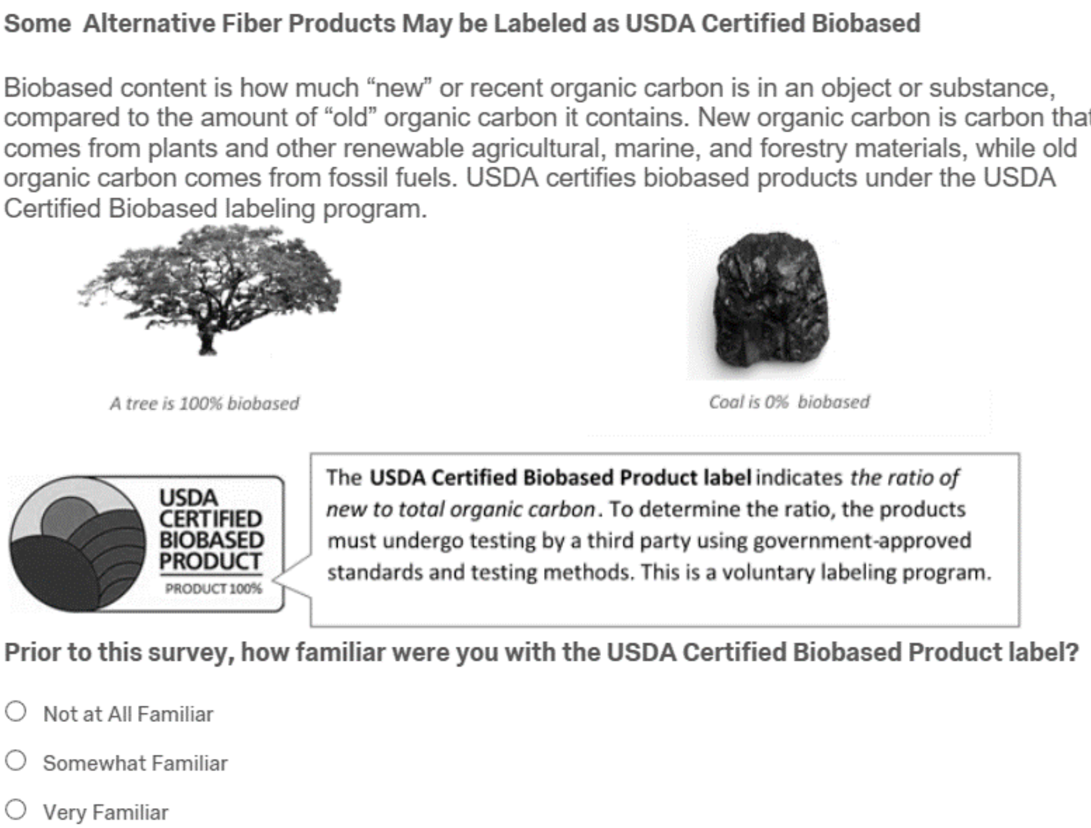


Figure 5. Information Screen for USDA Certified Biobased Labeling

with statements about the environment and climate change on a five-point Likert scale (where 1 = strongly disagree to 5 = strongly agree), including:

- Protecting the world’s forests is critical to the environment,
- We have a responsibility to future generations to protect the environment,
- Responses to this survey could cause dinnerware manufacturers to offer more alternative products that don’t use trees,
- Consumers can influence the environment with their product choices,
- There is urgent need to take measures to prevent climate change, and
- There is urgent need to reduce greenhouse gas emissions.

To reduce the number of opinion variables, we calculated indices for the opinion variables with high correlations between each other. Cronbach’s alpha is used to test for validity of using an index (average of the Likert rating scales) of the correlated opinion variables. Cronbach’s alpha assesses the reliability of using a rating scale, such as an average, of multiple Likert variables to represent that variable list (Cronbach, 1951). If the reliability score, α, is at least 0.80, then the average of the scale is considered to be a reliable representation of the variables in the list. These resultant indices are discussed in the results section.

Results

Sample Demographics

The average age of respondents included in the logit model was 43.42 years, and 78% were female (Table 1). About 67% had attended college or were college graduates and the pretax household income for 2017 was $52,080. Compared with Tennessee residents generally, our respondents are on average somewhat older than Tennessee residents generally and a larger percentage were female relative to the state population of 52% (U.S. Census Bureau, 2019). However, this could in part be due to the nature of the survey, which is more likely to be completed by a primary food shopper due to the subject matter. We did not select for primary food shoppers, but there was likely some self-selection bias toward primary food shoppers. This could have been the result of the title of the survey, which was “Your Views of Dinnerware Made from Wheat Straw.” The median household income for the state in 2017 was $51,340 (U.S. Census Bureau, 2019), while the sample average was $52,080. About 67% of the sample had attended college or were college graduates, somewhat higher than for the state’s population. Hence, the sample tended to be a higher percentage female, somewhat older, and higher percentage college graduates than the overall Tennessee population.

Indices for Environmental and Climate Change Opinion Variables

Agreement with each of the following statements was highly correlated:

- Protecting the world’s forests is critical to the environment,
- We have a responsibility to future generations to protect the environment,
- Responses to this survey could cause dinnerware manufacturers to offer more alternative products that don’t use trees, and
- Consumers can influence the environment with their product choices.

The Cronbach’s scale reliability coefficient, α, is equal to 0.87 for this grouping of four opinion variables. Hence, an average rating scale is created from these variables, the Environmental Concern Index.

Agreement with each the following two statements was highly correlated:

- There is urgent need to take measures to prevent climate change, and
- There is urgent need to reduce greenhouse gas emissions.

The Cronbach’s scale reliability coefficient, α, is equal to 0.79 for this pair of statements. Hence, an average rating scale is created from these variables, the GHG/Clim Chng Concern Index. These two indices (Environmental Concern Index and GHG/Clim Chng Concern Index) are used as explanatory variables in the logit model of WTP for the disposable dinnerware bowls made from wheat straw fibers.

Logit Model of WTP

Of the 217 who participated in the product choice question, 17% chose neither molded dinnerware product. Of the remaining 179 who did select between the two products, 41% chose the WSB,

Table 1. Variable Names, Definitions, and Means for the Logit Model of Probability of Choosing Wheat Straw Molded Dinnerware Bowls

Variable Name	**Variable Definition**	**Variable Means (*N* = 173)**
ChooseWheat	=1 if chose 25-count package of wheat straw molded bowls, 0 otherwise	0.410
Price	Price of 25-count package of disposable dinnerware bowls, \$2.25, \$3.25, \$4.25, \$5.25, \$6.25	4.244
Age	Age in years	43.416
Female	=1 if female, 0 otherwise	0.780
Urban	=1 if resides in urban area, 0 otherwise	0.197
Middle	=1 if resides in Middle Tennessee, 0 otherwise	0.312
Children	=1 if have children under 18 in household, 0 otherwise	0.428
College	=1 if attended college or graduated from college, 0 otherwise	0.671
Household Income Thous	2017 household income (pre-tax) in thousands of dollars	52.080
Ann Expend Disp Dinnerware	Annual expenditures on disposable dinnerware in dollars	98.150
Heard of Wheat Straw	=1 if have heard of wheat straw before, 0 otherwise	0.595
Purch Alt Fiber Prod	=1 if have purchased alternative fiber products before, 0 otherwise	0.197
Heard of Wheat Straw× Purch Alt Fiber Prod	=1 if have heard of wheat straw and purchased alternative fiber products before, 0 otherwise	0.150
Environ. Concern Index	Index from Cronbach's alpha on environmental concern Likert variables (1 = strongly disagree to 5 = strongly agree)	4.260
GHG/Clim Chng Concern Index	Index from Cronbach's alpha on GHG/climate change concern Likert variables (1 = strongly disagree to 5 = strongly agree)	3.711

while 59% chose the conventional bowls. A total of 173 respondents answered all questions needed to estimate the logit model (Table 2). The likelihood ratio statistic suggests that the covariates included in the model explain the purchasing decision. The model correctly classified 78% of the observations. Variables with significant influences on selection of the WSB include *Price* (-), *College* (-), *Household Income Thous* (-), *Ann Expend Disp Dinnerware* (+), *Heard of Wheat Straw* (+), *Heard of Wheat Straw×Purch Alt Fiber Prod* (+), and *GHG/Clim Chng Concern Index* (+). Some studies found that education positively impacts WTP (Yue et al., 2010; Martinho et al., 2015), while other studies have found negative impacts (Casadesus-Masanell et al., 2009) on purchasing decisions for environmentally friendly packaging or containers. Similarly, findings regarding the effects of income have been mixed as both positive (Casadesus-Masanell et al., 2009; Yue et al., 2010) and negative (Kurka and Menrad, 2009; Kainz, 2016). The effects of prior knowledge about wheat straw and the effects of alternative fiber products purchases align with prior research findings (Casadesus-Masanell et al., 2009; Kainz, 2016). The finding regarding the

Table 2. Logit Results: Probability of Choosing Wheat Straw Molded Dinnerware Bowls (*N* = 173)

Variable	Est. Coeff.	Marginal Effect on Pr WheatStraw=1	Est. Effect on WTP ($)
Intercept	**1.271**		
Price	**-1.189*** **	**-0.163*** **	
Age	0.007	0.001	0.006
Female	0.310	0.043	0.260
Urban	-0.163	-0.022	-0.137
Middle	0.033	0.005	0.028
Children	-0.151	-0.021	-0.127
College	**-1.006** **	**-0.138** **	**-0.846**
Household Income Thous	**-0.011***	**-0.002***	-0.009
Ann Expend Disp Dinnerware	**0.005** **	**0.001*** **	**0.004**
Heard of Wheat Straw	**1.138** **	**0.156** **	**0.957**
Purch Alt Fiber Prod	-1.303	-0.179	-1.100
Heard of Wheat Straw×Purch Alt Fiber Prod	**2.413***	**0.331***	2.030
Environ. Concern Index	0.202	0.028	0.170
GHG/Clim Chng Concern Index	**0.467** **	**0.064*** **	**0.393**
LLR Test (14 df)	**87.25*** **		
Pseudo-R^2	0.3725		
Percentage correctly classified	78.03		
Est. WTP $3.58 Mean $3.14 LCL $3.94 UCL			

Note: Single, double, and triple asterisks (*, **, ***) indicate significance of α at the 10%, 5%, and 1% level. Estimated effects on WTP that are significantly different from 0 at the 95% confidence level are bolded.

positive effect of GHG/climate change concern on WTP is similar to those from other studies (Kurka and Menrad, 2009; Martinho et al., 2015; Kainz, 2016).

The marginal effects in the third column of Table 2 show the effects of each variable on the probability of choosing the WSB. Notably, a $1 increase in price decreases the probability of choosing the WSB by 0.16. Being college educated (*College*) decreases the probability by 0.14. While a $1,000 increase in household income (*Household Income Thous*) decreases the probability of choosing the WSB by 0.002, a $1 increase in expenditures on disposable dinnerware (*Ann Expend Disp Dinnerware*) increases this probability by 0.001. If the respondent had heard of wheat straw (*Heard of Wheat Straw*), this increases the probability of choosing the WSB by 0.16. Further, if the respondent had both heard of wheat straw and purchased an alternative fiber product in the past (*Heard of Wheat Straw×Purch Alt Fiber Prod*), the probability increase by an added 0.33. Greater importance of reducing GHG and climate change (*GHG/Clim Chng Concern Index*) to the respondent increases the probability of choosing the WSB by 0.06.

The effects of each of the variables on WTP are shown in the fourth column of Table 2. Those that are bolded have confidence intervals showing a significant difference from 0 at the 95% confidence level. If the respondent had at least attended college (*College*), this decreased their WTP by nearly

$0.85. An increase in annual expenditures on disposable dinnerware (*Ann Expend Disp Dinnerware*) of $1 increases WTP by $0.004, and a $10 per year increase would increase WTP by $0.04. If the respondent had heard of wheat straw (*Heard of Wheat Straw*), their WTP increases by nearly $0.96. Further, if GHG and climate change reduction (*GHG/Clim Chng Concern Index*) were of greater importance to them, WTP increases by $0.39.

The mean WTP is estimated to be $3.58, a premium over the base price of $2.25. The 95% confidence interval was calculated using the Krinsky–Robb method at 5,000 iterations and has a lower bound of $3.14 and an upper bound of $3.94. A histogram of the WTP values is shown in Figure 6 (Krinsky and Robb, 1986). This WTP estimate is for the 83% of respondents who would at least pay the base price of $2.25. Note that if those who chose neither product were included in the dependent variable as 0s, the estimated WTP value would decline from $3.58 to $3.13.

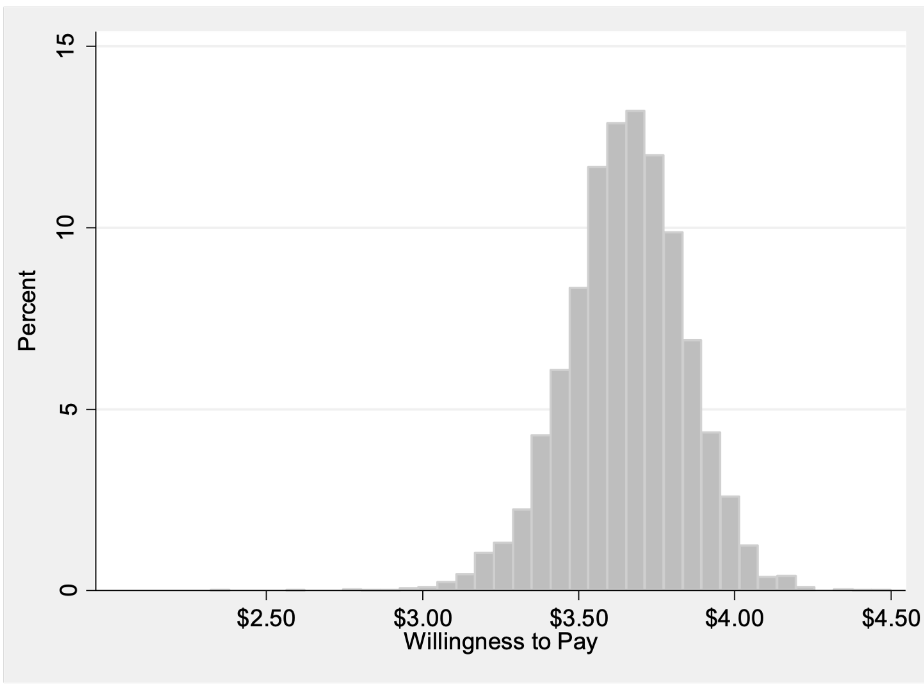


Figure 6. Estimated WTP for WSB

Responses among Those Who Did Not Choose the WSB or Chose Them at the Same Price as Conventional Bowls

The respondents who chose a package of bowls but either did not choose the WSB or chose the WSB at $2.25, were asked whether they would pay any amount more for the WSB. Among this group, 34% would pay some amount more, while 60.90% supported development of wheat straw disposable dinnerware but would not pay any more, and only 5% did not support development of wheat straw disposable dinnerware. Among those who said they would not pay any more, the most commonly cited reason was that they could not afford to pay any more, followed by that they did not purchase disposable dinnerware bowls enough to pay attention to the materials from which they are made.

Importance of Disposable Dinnerware Attributes

In general, the respondents who chose the WSB felt the potential disposable dinnerware attributes were more important than those who did not select the WSB (Table 3). However, statistical difference in the mean ratings at the 95% confidence level was found only for disposable dinnerware being compostable. In this case, the group that selected the WSB felt this attribute to be of greater importance than the group that did not select the WSB.

Table 3. Importance of Disposable Dinnerware Attributes across Respondents Who Chose and Did Not Choose the WSB

	Mean Rating of Importance (1 = Not at All, …, 5 = Extremely)	
Attribute	**Did Not Choose WSB (N = 102)**	**Chose WSB (N = 71)**
Does not contain trees	2.58[b]	2.89[b]
USDA Certified Biobased	2.82[ab]	3.15[a]
U.S. made	3.04[a]	3.08[ab]
Recyclable	3.04[a]	3.22[a]
Compostable	2.80[ab]	3.14**[a]
Cellulose from dedicated ag crop	2.99[a]	3.10[ab]
Cellulose from byproduct of a crop	2.94[a]	3.00[ab]
Does not contain plastic	2.94[a]	3.18[a]
Cellulose organically produced	3.00[a]	2.97[ab]

Note: Double asterisks (**) indicate significant difference in means across the two groups at 95% confidence level. Within each group, means followed by the same letter indicate no significant difference between the means at the 95% confidence level.

In addition to comparing the means across the two groups, mean ratings were compared within each group. The same letter beside two means in Table 3 indicates that these two means are not statistically different from each other at the 95% confidence level. For those who did not select the WSB, the mean importance ratings of attributes in disposable dinnerware are not significantly different from each other except for the product attribute of “no trees.” This attribute is rated significantly lower than the product being U.S. made, recyclable, made from cellulose that is organically produced, made from cellulose from a dedicated energy crop or a byproduct of crops, and not being made from plastic. For those who selected the WSB, products being recyclable, not containing plastic, USDA Certified Biobased, and compostable are rated significantly higher in importance than the product containing no cellulose from tree fibers. The relative importance of each potential attribute is shown in bar charts for the two groups in Figure 7. Interestingly, for both groups of respondents, the mean importance rating of the product being made from cellulose from a dedicated crop is not statistically different from mean importance rating of the crop being made from cellulose as byproduct of grain production. This result is similar to those reported by Herbes, Beuthner, and Ramme (2018) that U.S. consumers are less likely to express concerns about agricultural land use for bioenergy production.

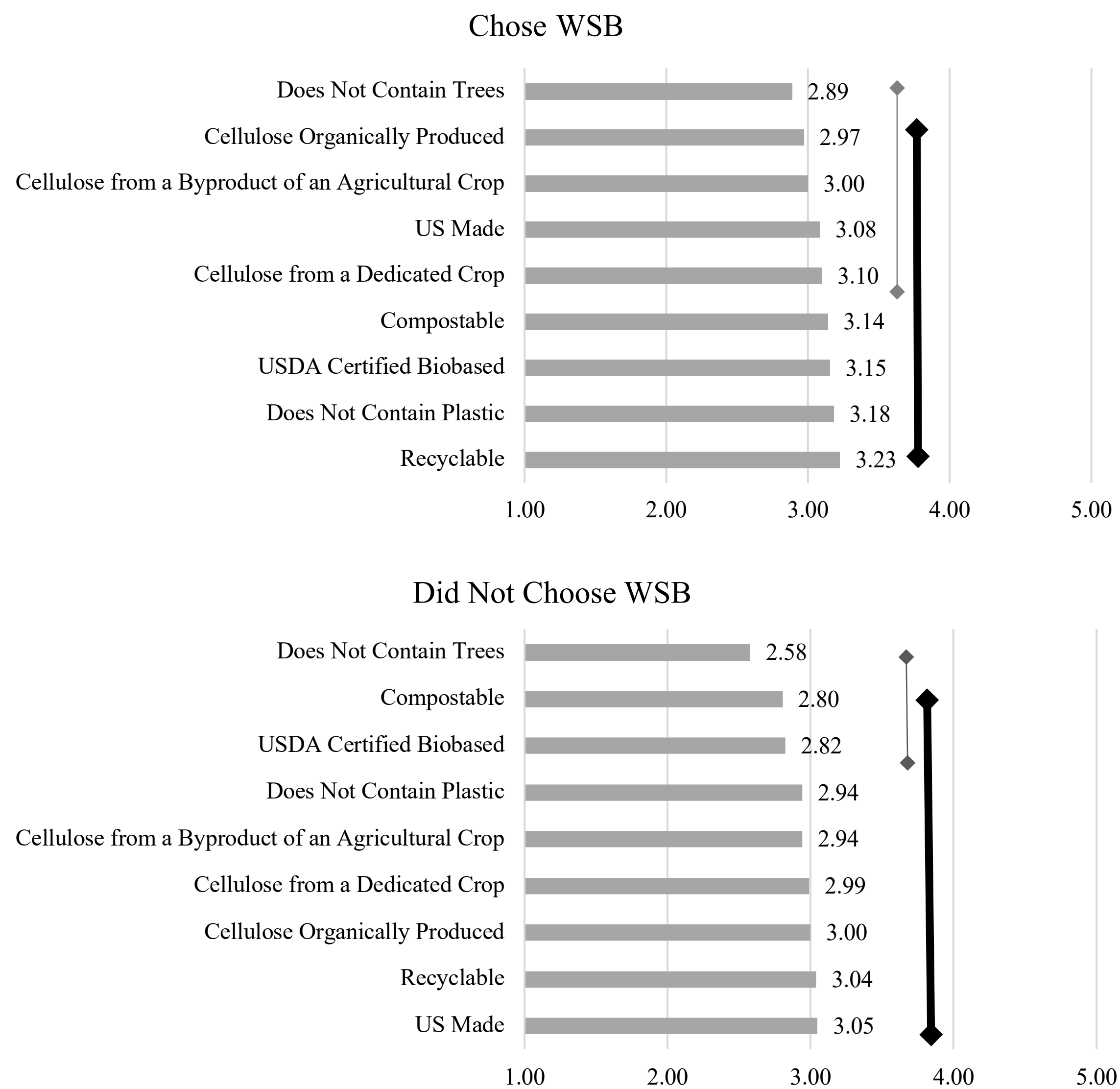


Figure 7. Importance of Disposable Dinnerware Attributes, Respondents Who Chose and Did Not Choose the WSB

= No significant difference among means at 95% confidence level.

= No significant difference among means at 95% confidence level.

WTP and Retail Outlet Type

One question inquired where respondents usually shopped for disposable dinnerware. About 41.1% most often shopped for disposable dinnerware at big box type stores (e.g., WalMart or Target). About 28% most often shopped for the product at grocery stores, while 24% most often purchased disposable dinnerware at warehouse clubs (e.g., Sam's Club or Costco). Less than 10% purchased at other outlets, which included online, convenience stores, and other sources. To ascertain whether shoppers at different types of retail outlets might exhibit differing WTPs for the

WSB, the average WTP for the WSB was compared across where the respondent most often shopped for disposable dinnerware. Average WTP differed across those who usually purchased disposable dinnerware at grocery stores and those who purchase it at other sources such as online or in convenience stores (Table 4). However, for most of the retail types, no significant differences in average WTP were found, suggesting that the molded dinnerware from wheat straw could be marketed at the same price across a variety of retail outlet types. The exception is grocery store outlets, for which those respondents who usually purchase at grocery stores would be willing to pay less for the WSB than those who purchased through other sources.

Table 4. Willingness to Pay and Importance of Attributes across Type of Store Where Most Often Shop for Disposable Dinnerware

	Average WTP (in dollars) if Most Often Shop at Store Type ($N = 173$)	
Type of Store Where Most Often Purchase Disposable Dinnerware	**Yes**	
Other (Warehouse Clubs, Online, Convenience)	\$4.24	a
Big Box (WalMart, Target, etc.)	\$3.75	a,b
Discount (Dollar General, Dollar Tree, etc.)	\$3.68	a,b
Grocery (Kroger, Publix, etc.)	\$3.37	b

Note: Like letters indicate no significant difference found in means at the 90% confidence level.

Conclusions and Implications

Results from this study suggest that consumers would pay a premium price of \$3.58 for a 25-count package of bowls molded from wheat straw fiber compared with a price of \$2.25 for the same size package of conventional molded bowls from tree cellulose. Results from this study also show certain market segments would be more likely to choose the WSB. These include those who spend more on disposable dinnerware, have heard of wheat straw, have purchased alternative fiber products in the past, and are more concerned about reducing GHG and climate change. These results suggest consumers who spend more on disposable dinnerware but are still more concerned about the environment may be target markets. Respondents who have heard of wheat straw or have purchased alternative fibers in the past are likely to choose the wheat straw molded disposable dinnerware. This could indicate that educating consumers about wheat straw as a cellulosic fiber could be helpful in marketing wheat straw cellulosic fiber products. The results could also indicate that repeat customers of "alternative fiber" products may be an additional target market. Surprisingly, lower education and income levels have positive influences. These results are somewhat perplexing. Research examining drivers of expenditures on disposable dinnerware (for example convenience and time constraints) and then subsequently the potential for purchasing wheat straw molded dinnerware among the differing levels of disposable dinnerware expenders may provide additional explanation for these results.

The results from this study suggest that among those choosing the WSB or not choosing them, the attribute with the least importance was that the product contains no cellulose fibers from trees.

This result suggests that "tree free" labeling may be of little value in building premiums. The result could also suggest that consumers believe cellulose from trees can be sustainably sourced. However, additional research would be needed to further investigate these motivations. The result that the respondents viewed cellulose from agricultural crops similarly whether it comes from a dedicated crop or a crop byproduct may suggest that consumers are about equally receptive to planting dedicated crops as sources of cellulose for disposable products as they are to cellulose sourced as a crop byproduct.

For those who selected the WSB, the products not containing plastic and being recyclable, USDA Certified Biobased, and compostable were rated significantly higher in importance than the product containing no cellulose from tree fibers. Adding these attributes could bring additional premiums among those willing to purchase a WSB. However, measuring the relative WTP for these attributes is beyond the scope of this study. Additional research might incorporate multiple attributes into choice sets through a conjoint or best-worst analysis.

As to what types of retail outlets through which WSB's might be marketed, it does not appear that consumers exhibited a large difference in WTP across various types of shopping outlets. An exception is that grocery shoppers are willing to pay less than those who usually buy their disposable dinnerware through sources other than grocery, big box, or discount stores.

This study has several limitations. First, the study was conducted in a limited region, Tennessee. Consumers' preferences for disposable dinnerware from wheat straw fibers could vary greatly across regions of the United States. Additional research should be conducted across a wider geographic region to provide a better understanding of the product's national market potential.

A second limitation of this study is that the survey was conducted online and involved a hypothetical choice. With private goods, survey respondents have an incentive to overstate their WTP for a private good in hopes it will influence the market offering (Carson and Groves, 2007, 2011). We did provide information screens to remind respondents to answer as realistically as possible, however, the potential for this bias remains. It should be noted that we asked for respondents' level of agreement with a statement about survey consequentiality ("responses to this survey could cause disposable dinnerware manufacturers to offer more alternative fiber products that don't use trees") (Vossler and Watson, 2013), but a dummy variable representing their agreement with this statement was not found to be significant in the model. Additional research should likely evaluate consumer preferences for disposable dinnerware from wheat straw fibers via in-store experiments. However, this type of analysis was beyond the scope of this study.

An additional limitation was that the WSB labels contained several attribute components (e.g., compostable, no trees, and made from wheat straw fibers) shown on the hypothetical product label. In some cases, attributes are combined by virtue of the nature of the product; for example, if a product is completely made from wheat straw fibers, it would contain no tree fibers. Also, it should be noted that some paper-based disposable dinnerware can be compostable. Additional research would be needed to truly elicit the values that each of these attributes contributed to consumers' WTP for the WSB.

Acknowledgment

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Exploring the Hierarchy of Product Attributes in U.S. Pecan Consumption

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Abstract

The U.S. pecan industry has continued to experience global growth, but domestic consumption has remained flat over the last decade. Understanding that U.S. consumers continually search out healthy foods and food products, this research evaluates factors that influence their consumption. Making use of survey data from 509 adult participants and utilizing classification and regression tree (CART) analysis, we use a nonparametric modeling approach to identify factors that affect pecan consumption. We find that perceived health benefits are the most significant factor in the hierarchy of variables that affect pecan consumption, with perceived value, overall pecan attributes, and nutritional information following close behind.

Keywords: CART analysis, consumption, decision tree, health benefits, pecans

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Introduction

Pecan trees (*Carya illinoinensis*) are native to North America and are either the native or seedling type or improved varieties. The trees have been used for centuries by Native Americans both as food and timber sources (Hall, 2000). U.S. Department of Agriculture (USDA) data show that 1 in 10 consumers eats tree nuts (almonds, walnuts, pecans, pistachios, cashews, and others) on any given day. Pecans are sold whole, in pieces, or as meal and are commonly used in desserts, candies, ice cream, and breakfast cereals worldwide. However, the amount eaten in the United States is fairly small (Lin et al., 2001).

Pecans are high in antioxidants and have been shown to reduce or prevent diseases such as coronary heart disease (Rajaram et al., 2000), gallstones, obesity, metabolic syndrome, cancer, inflammation, hypertension, and diabetes in women (Ros, 2010; McKay et al., 2018; Moser, Raffaelli, and McFadden, 2011; Ortiz-Quezada, Lombardini, and Cosmerps-Zevallos, 2011). They also have been identified as having phenolic compounds (Villarreal, Lombardini, and Cisneros-Zevallos , 2007), which act as antioxidants that have been tied to a decrease in chronic diseases such as Alzheimer's, Parkinson's, and other degenerative diseases (Mertens-Talcott and Percival, 2005). Pecans are an excellent source of monounsaturated fats ("good" cholesterol), have a protective effect against coronary heart disease (Lin et al., 2001; McKay et al., 2018; Rajaram et al., 2000), and have just recently been identified as a "heart healthy" food by the American Heart Association.

U.S. production of pecans remained between 264.2 million and 221 million pounds from 2012 through 2018 (U.S. Department of Agriculture, 2015b). In 2018, the majority of U.S. pecans were produced in Georgia (56 million lb), New Mexico (90 million lb) and Texas (28 million lb) in 2018 (U.S. Department of Agriculture, 2019d).

The United States has exported pecans to Mexico at an increasing rate, from 36 million lb in 1990 to over 95 million lb in 2018. Mexico has also continued to export in-shell pecans to the United States, from 4.6 million lb in 1990 to over 50 million lb in 2018. North America continues to dominate the world pecan market, producing 99.3% of total world production (195 million lb). Increased domestic production has also been supported by exports, increasing significantly from just over 4 million lb in 1980 to nearly 69 million lb in 2018 (U.S. Department of Agriculture, 2019). Pecan demand has increased globally, as indicated by the growth in the export markets for shelled and in-shelled pecans and processed products (U.S. Department of Agriculture, 2015a).

U.S. consumers have incorporated tree nuts—especially almonds—into their daily diets. Almond growers have been very successful, raising domestic consumption from 0.42 lb in 1980 to 2.06 lb in 2016/17, a 394% increase in consumption over 30 years. Alternative tree nuts have also experienced some growth: walnuts (14%), pistachios (780%). Overall U.S. tree nut consumption has increased from 1.38 lb per person in 1970 to 3.69 lb per person in 2017. Promotional programs focused on the nutritional benefits of a diet rich in tree nuts, including their beneficial levels of vitamin E and omega fatty acids, have increased awareness and demand for tree nuts, contributing to the growth in per capita nut consumption (U.S. Department of Agriculture, 2019a).The aggregate rates of growth are impressive and demonstrate the U.S. consumer's demand for tree nuts.

Despite the growth in global demand and aggregate U.S. consumption of tree nuts, pecan consumption in the United States has increased only slightly. Figure 1 illustrates the per capita consumption of pecans over the last 35 years. Average per capita pecan consumption between 1980 and 2017 has seen minimal change from a high of 0.62 lb in 1988–1989 to a low of 0.34 lb in 2015–2016, most recently 0.44 lb in 2017. Domestic pecan consumption has struggled to gain consumer support compared to all other major U.S. tree nuts on a per capita basis: walnuts (0.57 lb), pistachios (0.43 lb), and almonds (2.27 lb) (U.S. Department of Agriculture, 2019c). The consumption rate of pecans has been stable and does not reflect the general trend of increased consumption of all tree nuts. This lack of growth has been of great concern for the U.S. pecan industry.

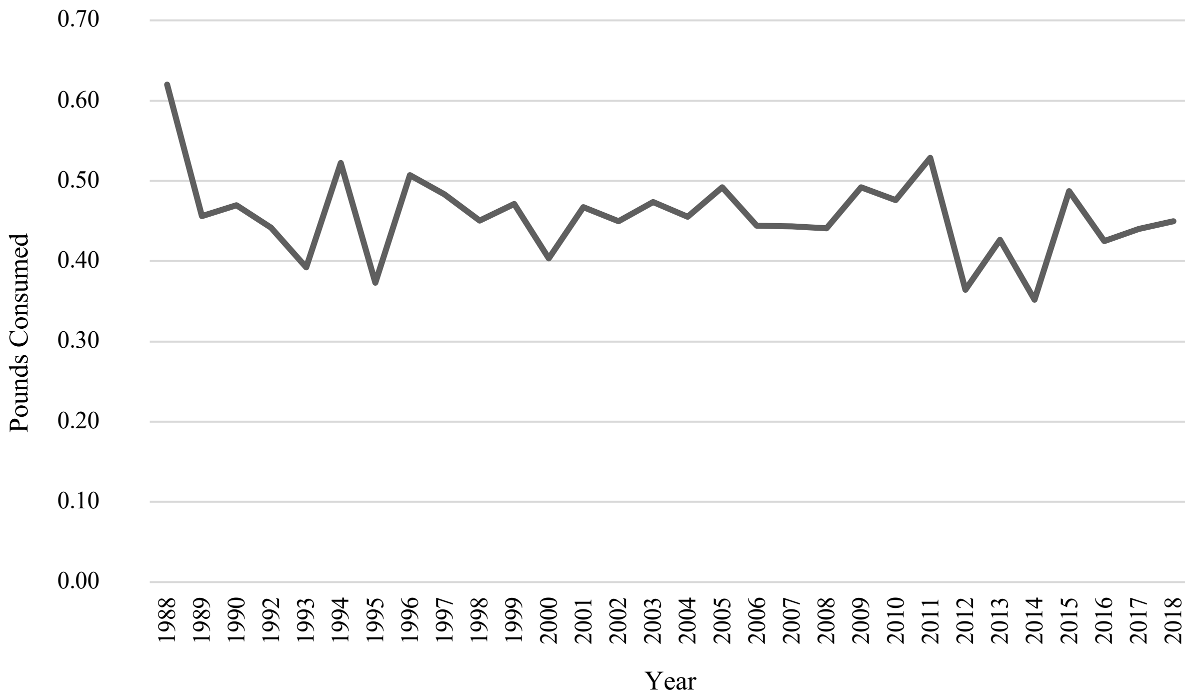

Figure 1. U.S. per Capita Consumption of Pecans

Source: U.S. Department of Agriculture, *Fruit and Tree Nut Yearbook,* 2018.

To better understand U.S. consumers and their reasons for consuming pecans, it is necessary to comprehend the behavioral, psychological, and demographic factors affecting demand. Recognizing the impact of extrinsic cues such as price and country of origin—along with intrinsic cues of health benefits, taste, and nutrition—while also considering the impact of ethnocentrism on consumption will provide a better understanding of pecan consumers. This will shed light on the factors affecting the consumption of pecans and inform marketing opportunities for the U.S. pecan industry.

This research examines pecan consumer subgroups and their perceived homogeneity based on behavioral, psychological, and demographic characteristics that respond differently to ethnocentrism and extrinsic and intrinsic cues. Specifically, we describe current product attributes and perceptions associated with pecan consumption, determine the hierarchy of variables that influence current pecan consumption, and identify the primary variables in that hierarchy. This research makes use of survey data from 509 adult participants and employs classification and regression tree (CART) analysis, a nonparametric modeling approach developed by Breiman et al. (1984), to identify how U.S. pecan consumption varies with the demographic profile of survey respondents. CART has advantages over traditional regression techniques and has been successfully applied in previous consumer segmentation literature (Cardoso and Mountinho, 2004; Liu, Kanter, and Messer, 2013; Payne, Messer, and Kaiser , 2009).

CART analysis is a decision tree statistical method that allows researchers to separate independent variables into homogeneous groups and determine how these subgroups influence the dependent variable. CART analysis results are tested independently through validation or cross-validation and can reveal how being part of a characteristic group influences the dependent variable and allows for survey respondents to be members of multiple characteristic subgroups. Utilizing the CART analysis allows for simultaneous consideration of multiple interacting independent variables. These findings could assist marketers in segmenting and targeting homogeneous groups of consumers (Hoffman and Novak, 1996; Aaker and Lee, 2001).

Literature Review

The survey instrument used in this study contains elements for measuring consumer behavior, attitude, and consumption frequencies for pecans. This instrument was employed utilizing an online survey panel. Research on U.S. pecan consumers has been limited; however, some initial research establishes a foundation for considering the pecan CART decision tree approach.

Existing pecan consumption research provides some understanding of consumer perceptions and demographics for potential marketing strategies and opportunities to improve overall pecan consumption. Lin, Frazao, and Allshouse (2001) reported that researchers conducted 14,262 in-person interviews asking respondents to recall food and beverage consumption in the previous 24-hour period. The researchers identified characteristics and demographics of pecan consumers but were unable to provide any explanation of what product attributes motivated them to consume pecans.

Based on interviews of U.S. consumers, Wolfe et al. (2007) concluded that pecan purchasers are on average older, more affluent, and more well-educated; 43% attained a degree beyond high school. Asians were identified as being less likely to purchase pecans, whereas Native Americans and people of multiracial backgrounds are more likely to purchase pecans. The researchers suggested a potential marketing strategy for pecans would be to develop pecan products that fit with the active and busy lifestyles of younger consumers and be distributed through convenience stores and other retailers currently not selling pecans. However, this research also failed to provide a clear understanding of the decision process for consuming pecans and only speculated on potential areas for consumption growth.

Lombardini, Waliczek and Zajicek (2008) reported results based on a survey of attendees at the annual Texas Master Gardener Conference in May 2006. The survey included questions concerning pecan nutrition, storage, purchasing attitudes and consumption, consumption of fresh fruits and vegetables, and demographic questions. This research provided evidence that taste was the main reason people ate pecans, followed by the perception that they were eating something healthy. This research identified the need for nutritional education about pecans, but overall the good eating habits and positive attitude toward pecans provided additional direction for further research.

A more recent article by Lillywhite, Simonsen, and Heerema (2014) explored U.S. pecan consumption and how pecan consumers typically purchase and consume pecans. The researchers explored the demographics of pecan consumers, gauged their current tree nut nutrition knowledge, and examined the preferences surrounding their pecan purchases. The authors identified several key variables that were found statistically significant, including education level, income, gender, age, and overall awareness of pecans and pecan nutrition. However, the relationship between these variables and the hierarchy of influence has not been determined and still leaves significant gaps in the understanding of the decision process to consume pecans and how to appropriately identify variables of significant influence on consumption.

Palma, Collart and Chammoun (2015) explored consumers' perceptions of the difference between native and improved pecan varieties when labels were present to indicate the difference. The results of this discrete conjoint analysis provided evidence that consumers are not heterogeneous in their selections of pecans and that taste, size, status, origin, and variety all vary across respondents. Selection of native pecans over improved pecan varieties is only based on perceptions and perceived quality because of ambiguous label claims that direct consumers to assume native is the more natural option. In a similar study, Moser, Raffaelli, and McFadden (2011) determined that consumers' buying choices were primarily driven by private attributes associated with taste and concerns for their own benefits.

These previous research articles have identified several variables affecting pecan consumption: quality, shopping experiences, perceptions of value, perceptions of nutrition, health benefits, country of origin, and general consumer demographics. However, researchers have struggled to explain the hierarchy of these variables using traditional methodologies and only reveal the "average person." This hurdle can be overcome using CART analysis.

Experimental Design

An online panel survey was conducted over March 3–9, 2016, to collect primary data regarding consumers' pecan preferences and purchasing behavior. The survey was administered by an independent global online market research panel managed by Cint, an independent corporation with U.S. offices in Atlanta, Georgia, and Los Angeles, California. The sample included 1,033 adult consumers living in the United States. All respondents were asked to answer each of the questions in order to proceed to the next question.

Upon completion of the data collection process, attention was focused on respondents who spent 4 or more minutes to complete the survey, passed both strategically placed attention checks within the survey tool, and indicated they were "current pecan consumers." In total, 509 of the 1,033 surveys were identified as successfully completed by "current pecan consumers" and were included in the statistical analysis and CART decision tree. Table 1 reports the demographic breakdown for these 509 respondents.

Table 1. Demographic Characteristics of the Sample (N = 509)

Variable	Category	Sample Frequency	Sample Percentage
Gender	Male	231	45.4
	Female	278	54.6
Age	< 20	140	2.7
	20–34	210	28.8
	35–54	97	40.2
	55–64	53	17.2
	65–79	0	10.8
	≥ 80	0	0.2
Education	2-year degree	54	10.6
	4-year degree	146	28.7
	Doctoral degree	8	1.6
	High school/GED	80	15.7
	Less than high school	6	1.2
	Master's degree	68	13.4
	Professional degree	12	2.4
	Some college	135	26.5
Ethnicity	American Indian/Alaskan	4	1.2
	Asian	28	6.7
	Black/African American	27	7.2
	Hispanic/Latino	33	6.4
	Native Hawaiian/Pacific Islander	0	0.1
	White/Caucasian	406	76.8
	Other	11	1.7
Marital status	Divorced/widowed/separated	68	13.3
	Married	278	53.4
	Single	149	31
	Other	14	2.3
Household income	< $24,999	75	14.7
	$25,000–$49,000	154	30.3
	$50,000–$99,999	193	37.9
	$100,000–$149,000	62	12.2
	≥ $150,000	25	4.9

The instrument included 22 statements relating to pecan consumption and associated activities. These statements were grouped based on subject to create the scale and tested for their internal reliability using the Cronbach's alpha (α). The statements are considered reliable when $\alpha \geq 0.70$, indicating that respondents understand the question. Each variable was measured by using a five-point Likert-type scale anchored with either "strongly agree" and "strongly disagree" or "very important" to "very unimportant." Each scale was selected based on historical use and ability to measure the selected consumption subject.

The consume pecan scale was derived from the *U.S. Consumer Preferences & Nutritional Knowledge of Pecans* (Lillywhite, Simonsen, and Heerema. 2014) and included the following six statements, measured using a five-point Likert-type scale anchored with "very important" and "very unimportant":

i. They taste good.
ii. They are a nutritious food.
iii. They have specific health benefits I am interested in.
iv. They are a good value.
v. They are included in recipes and/or prepared meals.
vi. My doctor advises me to consume nuts.

These six items were used to create the consume pecans scale and were found to be reliable (Field, 2014; Cronbach's $\alpha = 0.803$).

The pecan health benefits scale was developed using Rezai et al. (2014) and included four statements, measured using a five-point Likert-type scale anchored with "strongly agree" and "strongly disagree":

i. I believe that consuming pecans creates a healthy diet for me.
ii. I believe that consuming pecans will help to prevent and reduce the risks of specific health conditions.
iii. I believe that by consuming pecans, I can have a balanced diet.
iv. I believe that consuming pecans can lower the risk of specific health conditions.

The pecan health benefit scale was found to be reliable (Field, 2014; Cronbach's $\alpha = 0.911$).

The consumer food shopping scale was originally published by Botonaki and Konstadinos (2009) and includes two statements, measured using a five-point Likert-type scale anchored with "strongly agree" and "strongly disagree":

i. I try to do my food shopping as quickly as possible.
ii. I do not like spending too much time shopping for food.

These two statements were used to create the construct for shopping and were found to be reliable (Field, 2014; Cronbach's $\alpha = 0.85$).

To measure consumers' perceived value of buying pecans, we developed a scale specifically for this research. This scale included three statements, measured using a five-point Likert-type scale anchored with "strongly disagree" and "strongly agree":

i. Buying pecans are a good value for the money.
ii. When buying tree nuts, pecans seem to be a good buy.
iii. Pecans are a fairly cheap alternative compared to other nuts.

Overall reliability of the perceived value scale was confirmed (Field, 2014; Cronbach's $\alpha = 0.852$).

The next two variables were included based on the current world pecan-producing regions: the United States and Mexico, which currently produce over 99% of the world's pecans. To determine consumers' interest in pecans produced in Mexico, the Mexico country-of-origin construct was employed. This scale was first published by Parameswaran and Pisharodi (1994) and includes three statements, measured using a five-point Likert-type scale anchored with "strongly disagree" and "strongly agree":

i. The pecans from Mexico are a good value.
ii. The pecans from Mexico are easily available.
iii. The pecans from Mexico are a prestigious product.

The Mexico country-of-origin scale was found to be reliable (Field, 2014; Cronbach's $\alpha = 0.737$).

Similar to the Mexico country-of-origin scale, we asked questions to develop a U.S. country-of-origin construct, again using Parameswaran and Pisharodi's (1994) approach and including three statements, measured using a five-point Likert-type scale anchored with "strongly disagree" and "strongly agree":

i. The pecans from the U.S. are a good value.
ii. The pecans from the U.S. are easily available.
iii. The pecans from the U.S. are a prestigious product.

The U.S. country-of-origin scale was found to be reliable (Field, 2014; Cronbach's $\alpha = 0.705$).

To understand pecan consumers' interest in nutritional details, each participant was asked to respond to the following statement: "Do you read the nutrition facts label printed on the food packages you consume?" This construct used a five-point Likert-type question anchored by "always" and "never." Additional demographic questions were included in the instrument to allow for additional understanding of pecan consumers. Table 2 reports supplementary details for all of the scales.

Classification and Regression Tree Analysis (CART)

CART has been an effective tool to investigate consumer heterogeneity and to segment consumers (Lu, Kadane, and Boatwright, 2008). The decision tree procedure creates a tree-based classification model, which assigns cases into groups or predicts values of a dependent variable

Table 2. Survey Scale Description

Title	Study	α	Measurement
1. Shopping: consumer food shopping (modified) • I try to do my food shopping as quickly as possible. • I do not like spending too much time shopping for food.	Botonaki and Konstadinos (2010)	0.85	Strongly disagree – strongly agree
2. Perceived value: price perception scale • Generally speaking, the higher the price of the product, the higher the quality. • The old saying "You get what you pay for" is generally true. • The price of a product is a good indicator of its quality. • You always have to pay a bit more for the best.	Lichtenstein, Ridgway, and Netemeyer (1993)	0.842	Strongly disagree – strongly agree
3. Consume "Pecans": U.S. consumer preferences and nutritional knowledge of pecans • They taste good. • They are a nutritious food. • They have specific health benefits I am interested in. • They are a good value. • They are included in recipes and/or prepared meals. • My doctor advises me to consume nuts.	Lillywhite, Simonsen, and Heerema (2014)	0.803	Very important – very unimportant
4. "Pecan" Health Benefits • I believe that consuming pecans creates a healthy diet for me. • I believe that consuming pecans will help to prevent and reduce the risks of specific health conditions. • I believe that by consuming pecans, I can have a balanced diet. • I believe that consuming pecans can lower the risk of specific health conditions.	Rezai et al. (2014)	0.911	Strongly disagree – strongly agree

Table 2. (continued)

Title	Study	α	Measurement
5. Value of "pecans" • Buying pecans are a good value for the money. • When buying tree nuts, pecans seem to be a good buy. • Pecans are a fairly cheap alternative compared to other nuts.	n/a	0.852	Strongly disagree – strongly agree
6. Mexico origin "pecans": country-of-origin scale • The pecans from Mexico are a good value. • The pecans from Mexico are easily available. • The pecans from Mexico are a prestigious product.	Parameswaran and Pisharodi (1994)	0.737	Strongly disagree – strongly agree
7. U.S. origin "pecans": country-of-origin scale • The pecans from the U.S. are a good value. • The pecans from the U.S. are easily available. • The pecans from the U.S. are a prestigious product.	Parameswaran and Pisharodi (1994)	0.705	Strongly disagree – strongly agree
8. Nutrition label: Do you read the nutrition facts label printed on the food packages you consumer?			Always – never
9. Pecan consumption: On average, how often do you consume pecans?			Very often – very rarely
10. Gender: male/female			1–2
11. Household income: categorical			1–6
12. Number of members of household: categorical			1–4
13. Number of children under 18: categorical			1–5
14. Race: categorical			1–7
15. Age: categorical			1–6
16. Marital status: categorical			1–4
17. Education level: categorical			1–8

based on values of independent variables (SPSS Inc., 2001a). CART analysis is unique: It not only identifies optimal splits in continuous independent variables that allow for the greatest possible explanation in a dependent variable but also allows for simultaneous consideration of multiple interacting independent variables (Payne, Messer, and Kaiser, 2009).

This procedure can identify consumer segmentation, stratification, and prediction. Identifying key determinants allows strategic decisions to be made based on the segments. This type of information would be ideal for pecan marketers, food manufacturers, and pecan producers to assist them in understanding each of the homogeneous groups of pecan consumers based on their behavioral, psychological, and demographic characteristics (Payne, Messer, and Kaiser, 2009).

CART analysis begins with a dependent variable—in this case "frequency of pecan consumption"—to develop the CART decision tree. Identifying the dependent variable, the analysis evaluates each of the independent "binary" variables and determines which of these variables will produce the greatest reduction in error variance in the dependent variable. Specifically, the CART analysis identifies the independent variables and creates a binary split from a continuous variable or uses a binary split from an established binary variable. Either of these "splits" are confirmed to produce the greatest dependent-variable separation and are only allowed for binary decisions. This removes the potential to measure misclassification and the properties of the final tree selected (Liu, Kanter, and Messer, 2013, Payne, Messer, andKaiser, 2009). Reducing the error variance in the dependent variable by accounting for the binary independent variable is considered an "improvement score." This improvement score is the pooled, weighted estimate of variance between subgroups that is obtained by determining the least squared deviation or weighted variance for each group:

(1) $$Variance(t) = \frac{1}{N(t)} \sum_{i \epsilon t} (y_i - \overline{y}(t))^2,$$

where $N(t)$ is the number of people in a particular group, y_i is the frequency of pecan consumption of the *i*th person in the group, and $\overline{y}(t)$ is the mean frequency of pecan consumption. The variance and associated variance of the subgroups are subtracted from the variance of the parent group:

(2) $$Improvement = Rp(t) - p_t R(t_t) - p_b R(t_b),$$

where $Rp(t)$ is the variance of frequency of pecan consumption (*t*) multiplied by the ratio of people (p) in the group to total people in the population; $p_t R(t_t)$ is the variance of subgroup (*t*) multiplied by the ratio of people (p_t) in the highest-ranking subgroup to total people in the population; and $p_b R(t_b)$ is the variance of a subgroup (t) multiplied by the ratio of people (p_t) in the lowest subgroup to total people in the population (Payne, Messer, and Kaiser, 2009; SPSS Inc., 2001b).

Results

In this CART analysis, 22 variables were used as candidate variables for possible classification of homogeneous groups of pecan consumers (see Table 2 for variable/scale descriptions). Participants' frequency of pecan consumption is the dependent (target) variable. Figure 2 illustrates the initial classification tree generated by the CART analysis. Each subgroup (node) indicates a significant variable in the decision process and consists of the mean, standard deviation, and number of observations for each split. Through the initial CART analysis three variables—health benefits, perceived value, and product attributes—were among the largest splits of homogeneous groups of pecan consumers, with health benefits being the highest level in the hierarchy.

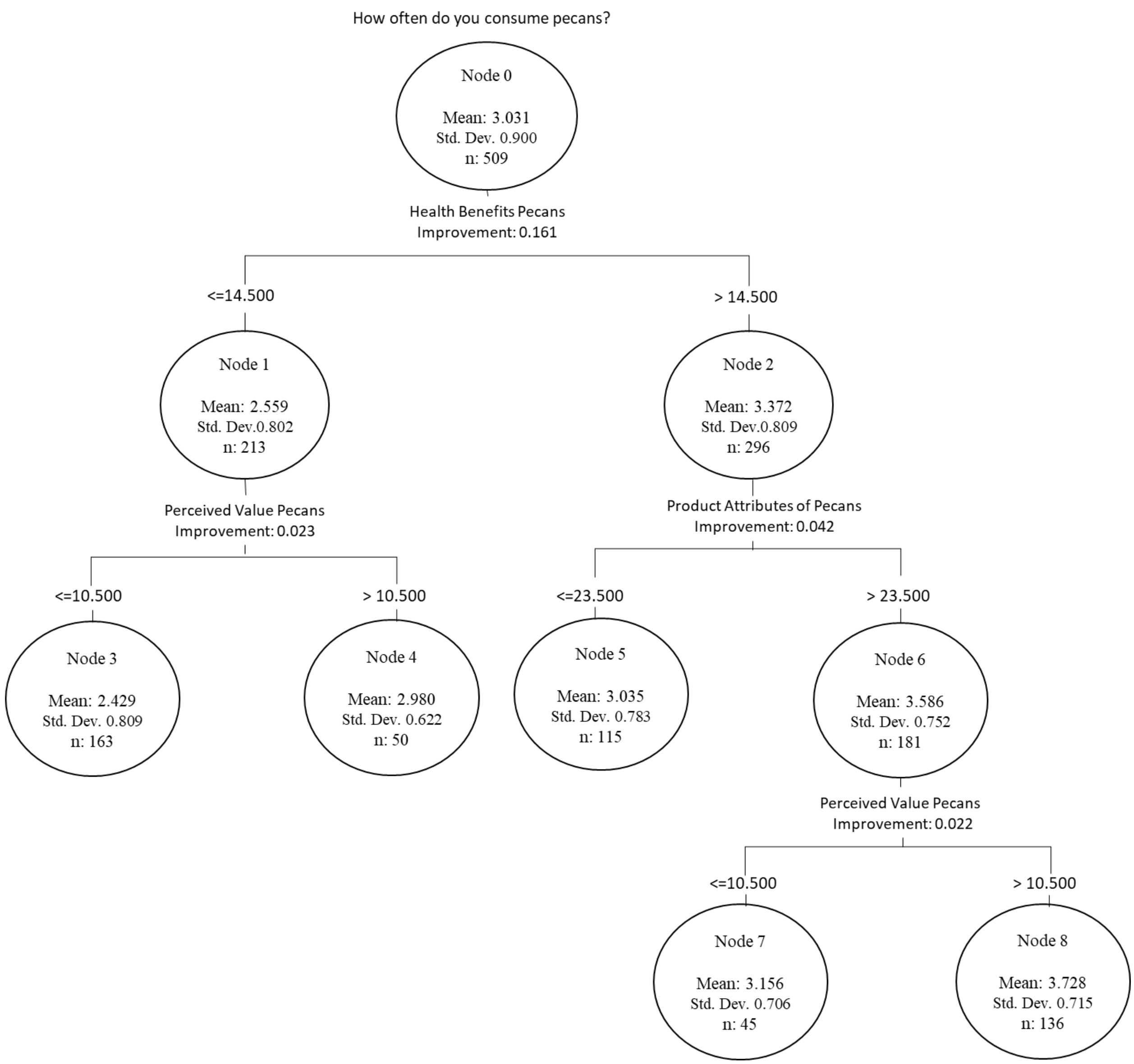

Figure 2. CART Analysis – Health Benefit Split

The first split is the health benefit variable, which indicates participants' pecan consumption is separated by their perceptions of the health benefits of pecans. This separation ranked highest in the tree and indicates the importance of health benefits to the decision process. Node 2, the 296 participants who agree or strongly agree that pecans are healthy, indicated that 58.2% of the sample perceived pecans as a healthy item. The remaining participants who ranked pecans as less than "agree" that pecans are healthy were reported in Node 1 and represented 41.8% of participants. Node 1 also had a split and led to further classification into Nodes 3 and 4. The participants from Node 1 were also concerned with the value of pecans. In total, 163 (32%) of these individuals considered pecans to be expensive or a poor value, while just under 10% considered them to be a good value by indicating they "agree" or "strongly agree." Understanding the relationship between these two splits provides some intuitive understanding of pecan consumption.

To further our understanding, we split Node 2 into Nodes 5 and 6, where participants who are aware of pecans' health benefits also consider pecan attributes to be a significant reason for consumption. Interestingly, Node 5 represents a split, with 115 participants indicating they were "neutral" or less concerned with pecan attributes with a mean of 3.035. The 181 participants in Node 6 indicated it was "important" or "very important" for pecans to taste good, be nutritious, have health benefits, are a good value, easy to use in their recipes, and have been mentioned by their doctor to consume more. This node had a mean of 3.586 and represents a total of 35.6% of all participants and 61% of those who consume pecans because of their health benefits (Node 2).

The "perceived value" variable is also significant at the Node 6 split indicating the individuals who consume pecans because of their health benefits and who enjoy the product's attributes, such as taste and nutrition, also consider their perceived value, as indicated in Nodes 7 and 8. The 136 pecan consumers in Node 8 indicated they generally perceive pecans are a good value to other tree nuts, are considered a good buy in general and are a cheap alternative to other tree nuts. The mean of Node 8 was 3.728 with a standard deviation of 0.715. This split also reflected a smaller group of pecan consumers, Node 7, that were either neutral or less when considering the perceived value of pecans. This population was significantly smaller than its sister node, with only 45 participants.

Considering the splits of this CART decision tree with a total of 509 observations a close evaluation of the distribution is necessary to truly understand the significance of each of these variables and how they influence consumption. The top level of the decision tree, Node 3 with 163 (32%), has the lowest level of pecan consumption. This node represents a group of pecan consumers that consider the cost of pecans to be too expensive, even considering their health benefits. This same "perceived value" variable also is found to be involved in the more enthusiastic pecan consumers in Nodes 7 and 8. Consumers of pecans recognize the value of pecans and acknowledge the influence of value on their consumption. Table 3 shows the distribution of observations into different groups. This CART analysis accounts for a 16.1% of the unexplained variance in frequency of pecan consumption.

Moving this research forward and recognizing the importance of product origin, two additional CART analyses were done to examine the change in the decision tree when using the variables "U.S. origin pecans" or "Mexico origin pecans" to generate a decision tree. Figures 2 and 3 illustrate the differences. These two variables provide an opportunity to examine the influence of product origin when evaluating consumers' consumption of pecans. As was initiated in the general

Table 3. Classification of Participants' Pecan Consumption Gain Summary for Nodes

Percentage	Mean
26.7	3.73
8.8	3.16
22.6	3.03
9.8	2.98
32.0	2.43

Note: Growth method: CRT. Dependent variable: On average, how often do you consume pecans?

pecan consumption decision tree (Figure 2), all 22 variables were included in each of the origin forced CART analyses. These two different decision trees reflect the significance of product origin on the decision process.

Reviewing the U.S. country-of-origin decision tree (Figure 3) demonstrates the importance of the health benefits on consumption of pecans in the United States. Nodes 1 and 2 indicate the effect of pecan origin on consumption and at the point of the split, the value of 10.5 indicates the importance of health when forcing the initial split. This initial split results in the sample distribution of 58.5% (Node 1) and to 41.5% (Node 2).

From Node 1, the next significant variable is health benefits of pecans. The consumers who consider the product origin to be less important or neutral, consistent with the initial model, indicated the overall importance of the health benefits of pecans. Node 3 represents 135 participants, while Node 4 represents 163. Node 4 continues to split, identifying "perceived value" as the next significant variable. This split is also consistent with the general decision tree and reflects the participants perceived value concerns of pecans. Node 7 represents 115 respondents who answered with "neutral" to "very unimportant" when asked about the value of pecans. These 115 respondents demonstrate the consumers concern for the price of pecans in relations to other tree nuts and alternatives nuts. Node 8 represents only 48 participants who indicated that they "agree" or "strongly agree" that pecans are a good value, are a good buy compared to other tree nuts, and are a cheap alternative compared to other nuts.

This U.S. country-of-origin decision tree deviates from the initial general decision tree beginning with Node 2. Node 2 splits, with consumers indicating the importance of the health benefits of pecans. Splitting into Nodes 5 and 6 representing a total of 211 participants, divided at the point of "agree" or "strongly agree" on the health benefits of eating pecans, with a mean of 3.412. Node 6 represents the consumers who believe consuming pecans to be healthy for their diet, will help prevent and reduce the risks of specific health conditions, helps maintain a balanced diet, and can lower the risk of specific health conditions (mean 3.791). Node 6 also splits into Nodes 9 and 10, which focus on the importance of the nutrition facts label on packaging. Node 10 represents 44 respondents with a mean of 4.091, while Node 9 has a mean of 3.511 and represents 47 respondents. Table 4 reports the distribution of the observations and the gains summary. This result provides evidence and direction for pecan marketers that consumers do in fact use the nutritional label on the packaging. Understanding that current pecan consumers consider the health benefits of pecans and do reference the nutrition facts label on the packaging provides pecan producers with additional information on how to influence consumption of U.S.-grown pecans. This CART

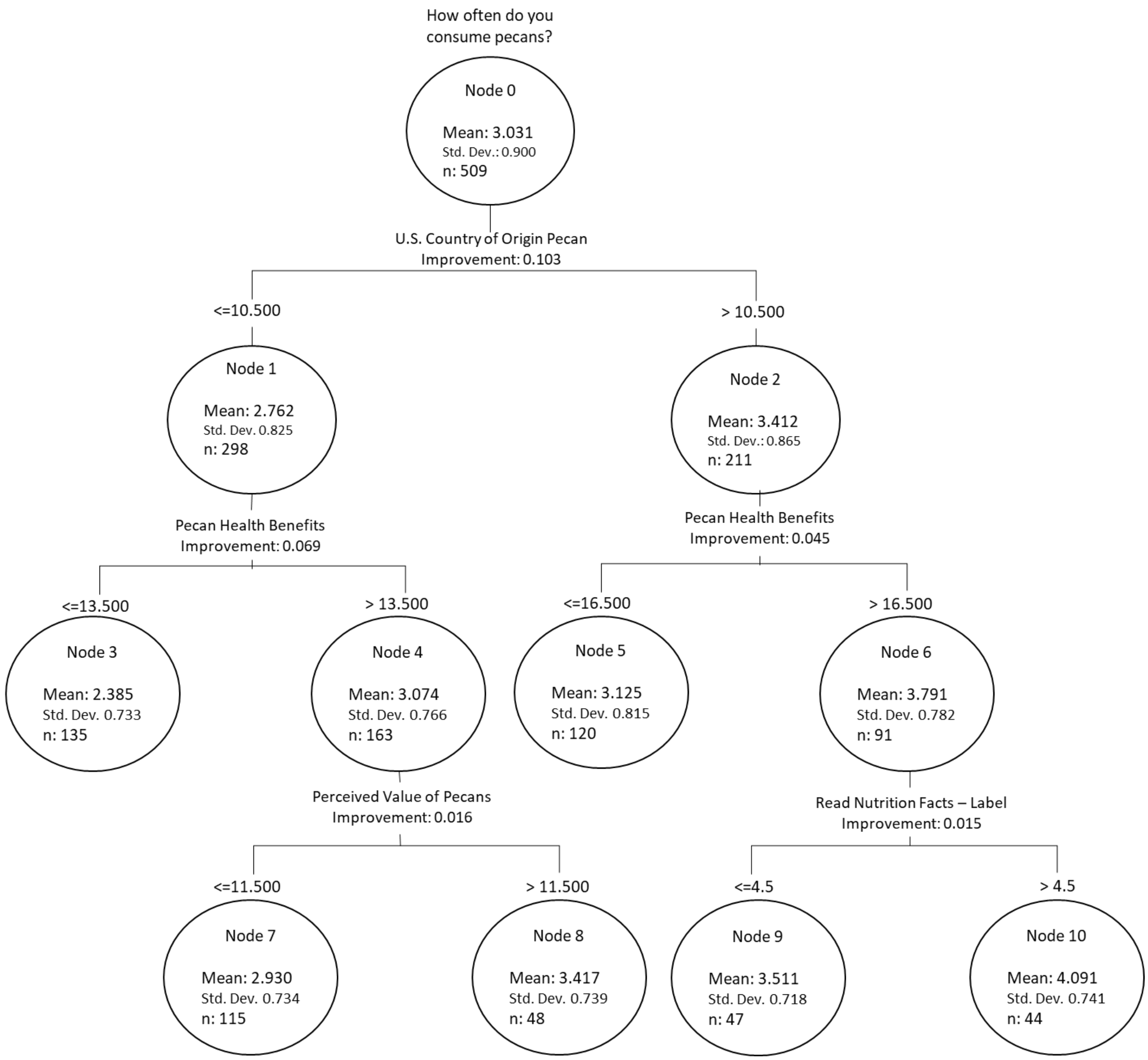

Figure 3. CART analysis – U.S. Country of Origin Split

Table 4. Classification of U.S. Pecan Origin Gains Summary for Nodes

Percentage	Mean
8.6	4.09
9.2	3.51
9.4	3.42
23.6	3.13
22.6	2.93
26.5	2.39

Note: Growth method: CRT. Dependent variable: On average, how often do you consume pecans?

analysis accounts for 10.3% of the unexplained variance in frequency of pecan consumption when forcing the U.S. pecan origin variable to be the first split.

The final CART analysis, the Mexico country-of-origin decision tree, also provides evidence of the effects of different variables' impacts on the pecan consumption. Applying the same 22 independent variables to the consumers' pecan consumption dependent variable, while forcing the initial split to be on the Mexico country-of-origin variable demonstrates a change of the ranking of several of the key variables and their influence on consumption. Figure 4 provides the illustration of the decision tree and CART analysis for the Mexico country-of-origin variable.

Forcing the initial split to utilize the Mexico country-of-origin variable rather than the U.S. country-of-origin CART analysis provided a very different perspective of respondents. The initial split, Node 1 and Node 2, was divided at "neutral" to "strongly disagree" that Mexico-grown

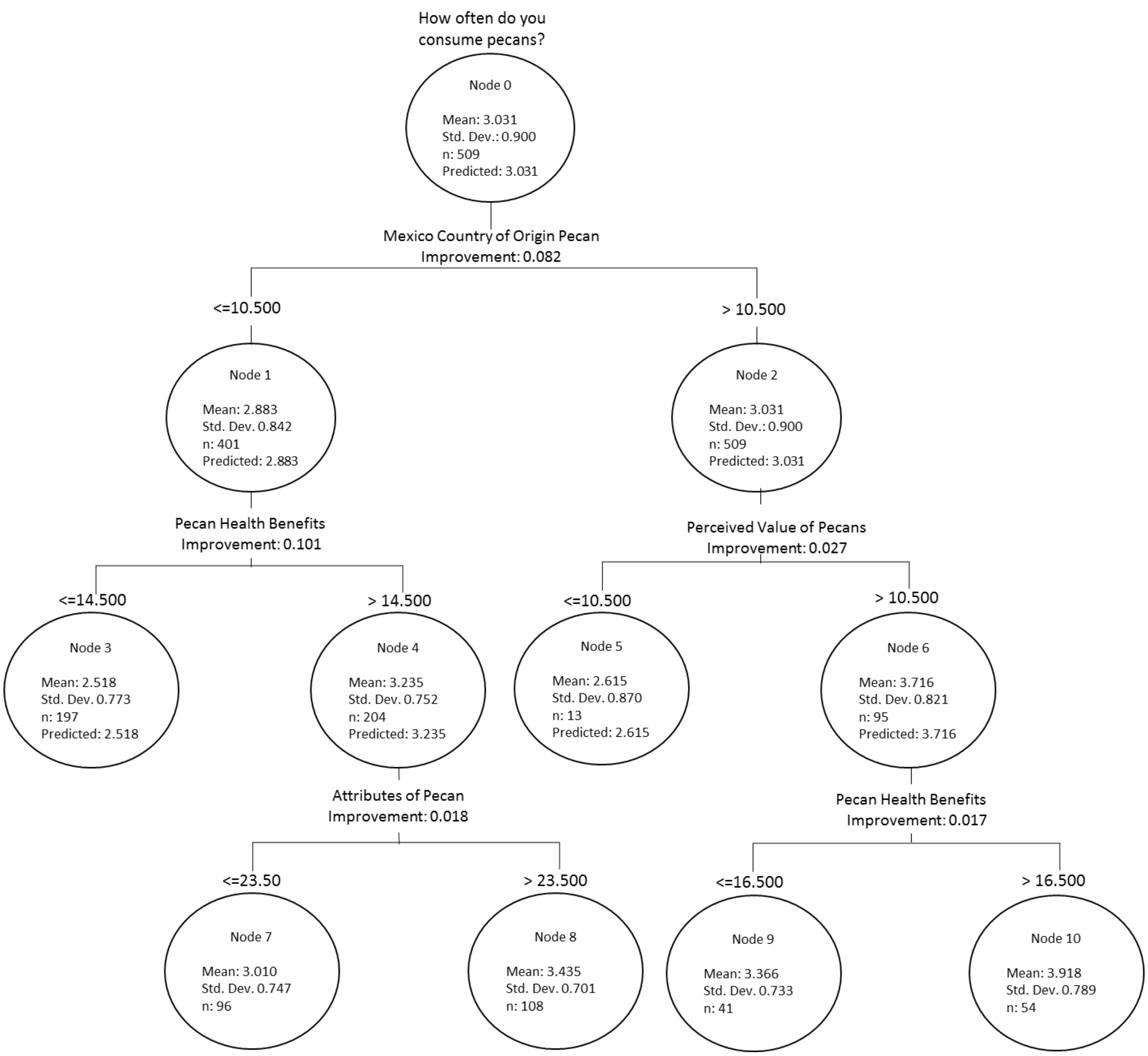

Figure 4. CART Analysis – Mexico Country of Origin Split

pecans are a good value, easily available, and are a prestigious product (Node 1: mean = 2.883, *n* = 401). Node 1 further splits into Nodes 3 and 4, representing the "health benefit" variable. Node 3 (mean = 2.518; *n* =197) represents a group of respondents that indicated they were "neutral" to "strongly disagree" that consuming pecans creates a healthy diet, will prevent and reduce the risks of specific health conditions, helps maintain a balanced diet, and can help lower the risk of specific health conditions. Node 4 (mean = 3.235; *n* = 204), also based on the same scale, was categorized in the "agree" to "strongly agree" groups concerning the health benefits of consuming pecans. Node 4 was further split into Nodes 7 and 8 by the pecan attributes variable. Node 8 (mean = 3.435; *n* = 108) indicates the importance of the actual attributes of pecans: taste, nutrition, and specific health benefits.

Node 2 had only 108 respondents, who indicated they "agree" or "strongly agree" that Mexico-grown pecans were a good value, easily available, and a prestigious product (mean = 3.583; *n* = 108). This split progresses to include the "perceived value" of pecans in Nodes 5 and 6. Node 6 is significant (mean = 3.716; *n* = 95), representing the group that responded with "agree" to "strongly agree" that pecans are a good value, a good buy compared to other tree nuts. and a fairly cheap alternative to other nuts. Node 6 further splits to Nodes 9 and 10 with the health benefit variable. These final nodes were split, with 41 respondents in Node 9 (mean = 3.366) and Node 10 reporting "neutral" to "strongly agree" that consuming pecans creates a healthy diet helps prevent and reduce the risks of specific health conditions, helps maintain a balanced diet, and lowers the risk of specific health conditions (mean = 3.981). The gains summary in Table 5 breaks down each Node division and reports the means. CART analysis accounts for 8.2% of the unexplained variance in frequency of pecan consumption when forcing the Mexico pecan origin variable to be the first split.

Table 5. Classification of Mexico Pecan Origin Gains Summary for Nodes

Percentage	Mean
10.6	3.98
21.2	3.44
8.1	3.37
18.9	3.01
2.6	2.62
38.7	2.52

Note: Growth method: CRT. Dependent variable: On average, how often do you consume pecans?

Several key variables were found to be significant in all three of these CART analyses: health benefits, pecan attributes, and perceived value. However, they each failed to find any of the specific demographics variables—age, income, marital status, education, and ethnicity—to be significant.

Conclusion

This work provides evidence, through CART analysis, of homogeneous characteristics of consumers who currently consume pecans. This CART analysis was applied to data from a nonstudent online survey asking participants to provide details about their current pecan consumption, shopping perceptions, health perceptions, and demographic details. This data along with the statistical approach followed allows researchers to explore how consumers in diverse groups have different hierarchical vales for product perceptions and pecan attributes. This CART analysis produced three different decision trees that indicated several key variables that were consistent throughout this research. The most significant evidence was the ranking of perceived health benefits, which was the first split for all three decision trees. Perceived value, pecan attributes, and nutrition label details all trailed perceived health benefits but were found to be significant.

Understanding how consumers perceive the health benefits of pecans and how they view their own health could provide additional opportunities to increase domestic consumption. The scales that included health and the perceived health benefits of pecans were found to be significant in all three CART analyses. These results are largely consistent with the current literature on pecan consumer demographics but provides evidence of the hierarchical status of the perceptions of health benefits. With this evidence and an effort to emphasize health benefits within the marketing activities may provide the desired growth for domestic consumption. A potential direction for pecan marketers could be to provide consumers with additional information about how consuming pecans may improve their health. Messages focused on how pecans are a good source of “good cholesterol,” are “heart healthy,” and provide a good source of naturally occurring antioxidants and minerals may connect with potential new consumers.

To further the discussion on increasing consumption, consumer perceptions of value ranked below perceived health benefits, providing evidence for marketers to communicate the overall value of consuming pecans. The perception of value was significant in all three decision trees but ranked in different node levels. Pecan producers and marketers must understand the significance of this variable and how it can negatively affect overall pecan consumption. Producers and marketers must be careful to price pecans competitively relative to other tree nuts, while realizing that consumers have many options for consuming healthy nuts. Substitution of other nuts based on pricing should be closely monitored and considered when considering how to expand U.S. consumption of pecans.

Unique only to the U.S. pecan origin decision tree was the variable concerning the nutrition facts label. The significance of this variable, splitting from the health benefits of pecans, confirms that these consumers are reading the nutrition fact label on the packaging. They are searching for nutrition information on pecans and should be open to receive new facts about pecans benefits. This outcome provides evidence that current U.S. pecan consumers are searching for information on pecans.

This study also suggests that factors which have been commonly accepted as variables to increase pecan consumption—such as income, gender, education level, ethnicity—were not primary determinants of the frequency of pecan consumption. These results indicate some of the inconsistencies among the current understanding of the pecan consumer. These inconsistencies may be mitigated through additional research of pecan consumers through the recruitment of additional research participants, restructuring the online survey to target more specifically the relationship between demographics and consumption, and further application of CART analysis technique.

Overall, the CART analysis confirmed that respondents enjoy pecans. They like their taste, know they are nutritious and can be part of a healthy diet, and are more likely to view U.S.-grown pecans as a good value. Increasing U.S. consumption of pecans could be as easy as the inclusion in a new healthy snack item, a feature in a health-focused magazine or website, or product development of a new line of easy-to-prepare meals with healthy pecans as a feature source of protein. Consumers will continue to consume pecans as long as the price of the product is competitive to other tree nuts and they continue to be viewed as part of a healthy diet.

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Uncommon Alternative: Consumers' Willingness to Pay for Niche Pork Tenderloin in New England

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Abstract

Opportunities for retail niche meat are emerging as consumer awareness of and demand for regional food are on the rise. This study investigated consumer valuation of meat raised in New England, focusing on pork tenderloin. Specialty market retail customers were surveyed to estimate their willingness to pay (WTP), prioritize production characteristics, and evaluate meat eco-labeling understanding. Significant predictors of WTP centered on pork purchase and preference, organic production, and eco-label recognition. Participants were concerned with added hormones, subtherapeutic antibiotics, and living conditions. Participants recognized federal eco-labels but did not understand production differences among federal and private labeling programs.

Keywords: animal welfare, consumer preferences, eco-labeling, livestock production practices, local meat, pastured pork

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Introduction

Overview

Consumers are becoming more interested in the practices used to raise livestock for meat products (Innes and Cranfield, 2009; Umberger, Thilmany McFadden, and Smith, 2009; Gracia, de Magistris, and Nayga, 2012; Muringai, 2017). Consumer awareness of conventional and alternative agricultural production is contributing to heightened concerns for animal welfare, food safety, economic viability of farm and community, and environmental sustainability. These broader categories of concerns are associated with socio-environmental credence attributes of meat production that include local, organic, natural, humanely raised, pastured, grass-finished, no routine use of antibiotics, no added hormones, and raised on small- to medium-scale farms with known origin (Honeyman et al., 2006; National Pork Board, 2017). Consequently, there is growing demand for meat produced with those process attributes (O'Donovan and McCarthy 2002; Wheatley, 2003; Honeyman et al., 2006; Greene, 2013; Torres, Barry, and Pirog, 2015). For example, between 2008 and 2010, natural and organic red meat sales in the United States increased 15%, while overall red meat sales increased only 1.7% (Curtis, McKissick, and Spann, 2011). The most current values of sales, as measured by the U.S. Department of Agriculture (USDA) in 2014, were $4,914,970 for organic hogs and pigs and $12,579,879 for organic beef cows (USDA, 2016). Comparing 2014 and 2008 sales, these values represent growth of 13% in organic hogs and pigs and 98% in organic beef cows and (USDA, 2010, 2016; authors' calculations). Looking at the overall food system, sales of organic food account for more than 4% of total U.S. food sales (estimated value of $34.8 billion in 2014) (Greene, 2015).

Without direct interaction with a producer or value-chain partner, retail shoppers can reference the meat label in order to make purchase decisions based on these credence attributes. For meat, poultry, or egg products sold in the United States, the USDA Food Safety and Inspection Service (FSIS) requires up to eight specific identifiers on each label; these include the product name, inspection legend and establishment number, handling statement, net weight statement, ingredients statement, address line, nutrition facts, and safe handling instructions (USDA, 2007). In addition, a meat product label may voluntarily include other process characteristics, such as improved animal welfare and environment-friendly practices used to raise the animal. Eco-labels are a typical market instrument used by food companies to reduce information asymmetry externality between the consumer and the producer (van Amstel et al., 2007). As a policy instrument, eco-labels can also increase market transparency by verifying the product claims of socio-environmental qualities (credence attributes) that cannot easily be determined or experienced directly by the consumer. When comparing labeled and nonlabeled food products, consumers associate environmental quality with the eco-label (Brécard, 2013). Thus, eco-labels may increase consumer confidence that their food purchase aligns with more environment-friendly practices (Gutierrez and Thorton, 2014). At the time of this publication, there were 59 eco-labels associated with food, representing a subset of 463 eco-labels in 199 countries and 25 industry sectors (Ecolabel Index, 2019).

Given the trends within differentiated meat demand and process attribute labeling, the specific purpose of this study was to estimate consumers' willingness to pay (WTP) for regionally raised New England pork tenderloin. Our secondary objectives were to identify meat cuts and production characteristics most important to retail consumers and to evaluate consumer recognition of meat eco-labeling. These secondary objectives met the needs identified within the regional meat industry while helping us build a robust model to explain WTP.

Literature Review

Previous research has examined consumers' WTP for differentiated meat products with specific credence attributes related to farm management styles. Conducted in the United States and Europe, these case studies examined consumer preferences toward animal welfare; meat traceability and transparency; and small-scale, natural, or organic production methods (Dickinson and Bailey, 2002; Grannis and Thilmany, 2002; Lagerkvist, Carlsson, and Viske, 2006; McMullen, 2006; Lusk, Nilsson, and Foster, 2007; Gwin and Hardesty, 2008; Innes and Cranfield, 2009; Umberger, Thilmany McFadden, and Smith, 2009; Liljenstolpe, 2011; Gracia, de Magistris, and Nayga, 2012; McKendree et al., 2013; Wheatley, 2003). These studies were typically based in stated preference methods using either contingent valuation or choice experiments; data were collected using mail or Internet surveys with sample sizes ranging from 35 to 1,400 participants. Overall, these studies found that consumers were willing to pay price premiums for process characteristics associated with differentiated meat production. For some analyses, consumer WTP was associated with class membership relating to purchase history of local and nonconventional meat products, shopping location, agricultural awareness, and demographics (Umberger, Thilmany McFadden, and Smith, 2009) or segmented by price consciousness, naturalness, and animal health (Innes and Cranfield, 2009). Many of these studies were localized, answering research questions specific to areas such as the western United States (Dickinson and Bailey, 2002; Grannis and Thilmany, 2002; Gwin and Hardesty, 2008; Umberger, Thilmany McFadden, and Smith, 2009) and the Midwest (McMullen, 2006) as well as the counties of Canada (Innes and Cranfield, 2009), Spain (Gracia, de Magistris, and Nayga, 2012), and Sweden (Lagerkvist, Carlsson, and Viske, 2006; Liljenstolpe 2011) for explicit cuts of meat.

Given that consumer demographics as well as agricultural knowledge and preference for meat or production characteristics vary, the estimation results may not be applicable to other regions. Literature summarized by Dobbs et al. (2016) and Carpio and Isengildina-Massa (2009) supports the contention that WTP premiums for locally grown foods vary by state and by product. Regional price variation within local and regional direct sales outlets was also found by Low et al. (2015). For these reasons, we decided to build upon these previous case studies to analyze consumer preferences and WTP for niche pork raised in New England that would be sold in retail specialty markets. The U.S. region of New England is of particular interest for this study because of the recent growth in regional aggregation for primal cuts and value-added charcuterie (Lewis, 2014). Further, New England continues to serve as an innovation center for the local and regional agricultural movement of food hubs (aggregation for wholesale and retail) and direct marketing through farmers' markets, community supported agriculture, and farm to institution (Donahue et al., 2014).

With the increasing demand in regionally produced meat (USDA, 2012), this study presents a unique opportunity to examine potential consumer interest to the development of a retail value chain with New England producers, processors, and aggregators. New England was appropriate for this study because meat processors and aggregators in the region had expressed strong interest in selling local meat within the retail sector; however, the ability of consumer demand to sustain a profitable supply chain for such a product was not known. Further, localized animal production poses special challenges because of existing limited capacity in slaughter and processing (Lewis and Peters, 2011; Reinvestment Fund, 2017). For these reasons, this study provided a unique opportunity to integrate the interests and needs of these stakeholders into the design and execution of the project in order to provide critical information for establishing a meat value chain partnership within the region. For farmers and processors, third-party certification programs using eco-labels are added cost and labor. Our informants shared with us their concerns about balancing these costs against whether future customers of niche meat would recognize and understand existing labeling programs and whether such recognition would be beneficial to their marketing of local-differentiated meat.

Following from Grannis and Thilmany (2002) and others, we used a contingent valuation framework for estimating consumers' WTP for a product—regionally produced pork tenderloin—that does not currently exist in the retail marketplace in the Boston metropolitan area. Although previous literature focused on ham, pork chops, or deli lunch meat, we chose pork tenderloin after consulting with experts who work in New England's meat value chain. As aggregators, processors, and distributors, these experts have access to various markets for selling lower-cost ham and chops. Of particular interest is the potential retail marketplace for the highest-valued pork cut, the tenderloin. Thus, this study extends the meat WTP literature by estimating premiums for a high-value cut in an emerging regional specialty meat market under alternative conditions.

Study Methodology

Research Question and Hypotheses

Our central research question centered on consumers' WTP for New England regionally raised niche pork tenderloin. For the purpose of this study, niche pork referred to pigs raised in a known location, on vegetarian feed, without subtherapeutic antibiotics or added growth hormones. The New England location attribute was of primary concern, thereby distinguishing this product from other differentiated pork products raised elsewhere, such as the midwestern United States.

To answer our primary research question and build the final estimation model explaining variation in WTP, we first explored several hypotheses concerning consumers' WTP for New England pork tenderloin as an individual function of the following: (i) demographics for households without children eating at home; (ii) previous purchase of local or organic pork; (iii) concerns with specific production practices for raising swine; and (iv) meat eco-label recognition. These potential predictors for differences in WTP were based on the literature cited above as well as observations in the field and feedback from value chain representatives.

First, we hypothesized that households with higher disposable income or smaller families would have a higher WTP for local pork (Gwin and Hardesty, 2008; Umberger, Thilmany McFadden and Smith, 2009). This hypothesis was supported in the beef literature, which showed that households without children were more likely to consume grass-fed beef (Lin, 2013) or higher-cost cuts like steak and roasts more often (Reicks et al., 2010). Second, we postulated that those who previously bought local pork or organic meat through direct marketing channels like farmers' markets would have a higher WTP for pork purchased through a specialty retail market (Grannis and Thilmany, 2002). Third, we proposed that those concerned with tight living conditions, like gestation crates, would have a higher WTP for these products (Innes and Cranfield, 2009; Liljenstolpe, 2011; McKendree et al., 2013). Finally, we hypothesized that consumers who correctly recognize meat eco-labels would have a higher WTP for niche pork. This assumption was based on the perceived superiority of eco-labeled alternatives to conventional food products (Grankvist and Biel, 2001) and positive preferences toward sustainability labeling for chicken (Van Loo et al., 2014).

For the secondary objectives, we anticipated that the avoidance of growth hormones and antibiotics would be very important production issues for the consumers. This hypothesis was based on similar findings from Dickinson and Bailey (2002), Grannis and Thilmany (2002), Gwin and Hardesty (2008), Liljenstolpe (2011), and McKendree et al. (2013). Conversely, we expected that organic production would not be highly regarded, based on previous work by McMullen (2006), Gwin and Hardesty (2008), Umberger, Thilmany McFadden, and Smith (2009), and Liljenstolpe (2011). With regard to meat cut preferences, we assumed the participant responses would follow the current retail market offerings of boneless chicken breast (either sold as organic or natural) and ground beef (either marketed as grass-fed or organic). Last, we hypothesized that participants would recognize the USDA's national eco-labeling program but would not understand program production specifications. We based this assumption on van Amstel et al. (2007), USDA (2012), and Brécard (2013).

Contingent Valuation and Econometric Framework

Consumer preference data for New England pork tenderloin were analyzed using stated preference methodology, for two main reasons. First, niche pork production has associated public good characteristics. Survey methods using stated preference are particularly well-suited for eliciting WTP for changes in the availability of credence attributes associated with public goods (Khaw et al., 2015). Second, regionally produced niche pork is not currently available in the metro-Boston marketplace through commercial retail outlets (and only in a very limited amount through direct sales on-farm or at farmers' markets). As noted by Brown (2003), survey instruments used with stated preference methodology can describe new goods, such as retail specialty foods, thus offering valuation possibilities beyond those estimated with revealed preferences methods.

Of the various stated preference methods, contingent valuation (CVM) is the most established in the economic literature (Carlsson, 2011) and the most widely used approach to estimate benefits associated with public goods (Khaw et al., 2015). CVM has been used in thousands of valuation studies in more than 130 countries, across a wide range of cultural, environmental, and health issues (Carson, 2012). While discrete choice experiments (DCEs) have increased in popularity when analyzing stated choice of food products in recent years (Carlsson, 2011), the analytical properties of the two methods are roughly equivalent when the variation of interest is in only one attribute other than price (Carson and Louviere, 2011; Carson and Czajowski, 2014), as is the case here, and CVM questions can generally be administered with a lower time burden for respondents.

A primary motivation for this work is to determine whether regional pork can be economically produced and distributed in the region. Therefore, we are focused on the total premium for regional production—an application for which CVM is particularly well-suited. We recognize, however, that drawbacks to CVM exist (Carson, 2000; Grannis and Thilmany, 2002). For example, since CVM estimates represent total WTP, comparisons among attributes may not be meaningful (Liljenstolpe, 2008). Further, the validity of contingent valuation is potentially limited by biases induced by the stated preference nature of the exercise. Incentives to misrepresent responses can occur when participants deliberately respond to questions to shape the outcome of the study and serve their own interest (strategic bias) or to please the interviewer by providing a WTP value that differs from their true WTP amount (interviewer bias) (Mitchell and Carson, 1989). In addition, starting-point or range biases may happen with a predefined range of WTP options acting as implied value cues (Mitchell and Carson, 1989; Teitenberg and Lewis, 2012).

To avoid WTP misrepresentation, we stressed with the participants the importance of truthful responses since people often overstate their amount if they are not actually buying the product. This explicit discussion of potential hypothetical bias with the participants, known as “cheap talk” methodology, was based on the approach suggested by Cummings and Taylor (1999). To mitigate implied values, we framed the WTP range on current pricing of similar products. Such conservative limits on WTP options was based on elicitation guidelines set by Arrow et al. (1993). We designed and implemented our CVM survey following the guidelines recommended by Arrow et al. as well as those developed by Carson (2000). For instance, we carefully pretested the questionnaire to evaluate comprehension of new and technical information and to validate the range of prices used in the study. It was our goal to provide enough information within the survey for participant to make an informed decision without being overwhelmed or confused by technical details (Carson, 2000). We also administered the survey face-to-face with trained researchers, rather than through mail or telephone interviews, as recommended by Carson and Arrow et al.

The WTP estimation for New England pork tenderloin was elicited through a payment card style, which was bounded by premiums ranging from \$0 to \$6 per pound (Figure 1). We based this payment card design on previous methodology developed by Grannis and Thilmany (2002) and subsequently used by Umberger, Thilmany McFadden, and Smith (2009). In addition to using an established payment card style, another advantage was the ease of use by the participants in the survey instrument. However, disadvantages of the payment card included less freedom to identify the exact WTP amount and cognitive demand of the surveyed participants (Guerriero 2019).

As design elements, premiums for the New England region were conditioned on the willingness to buy a product not currently available. Since New England does not have a comparative advantage in production, we did not examine premiums below the actual market price. The lower value was therefore set at a \$0/lb premium to correspond to the current benchmark price (\$12/lb)

Pork tenderloin raised in the Midwest costs $12.00/pound										
Additional cost premium per pound of LOCAL pork tenderloin –>	$0	$0.50	$1	$1.50	$2	$3	$4	$5	$6	Would NOT purchase
Reasonable to pay this amount	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Figure 1. WTP Payment Card

of niche Midwestern tenderloin that was sold at a nearby national greengrocer chain not participating in the study. The upper value was determined by two factors: first, our pretesting concluded that a $6/lb premium over the benchmark price was considered too expensive for nonorganic pork products in our focus groups; and second, certified organic pork tenderloin from outside New England (raised in Canada) was priced at $18/lb at a nearby regional supermarket chain. Moreover, the conservative approach to this upper value increased the reliability of the WTP estimate by not offering more extreme values that enlarge estimates (Arrow et al., 1993). In addition to these payment choices, we also offered a "would not purchase" option, based on the Arrow et al. guidelines.

The dependent variable used in subsequent regressions, WTP for New England tenderloin, is considered in a two-step process estimated using a Cragg truncated normal hurdle model (Cragg, 1971; Wooldridge, 2010). Such models are appropriate when the decision to participate in a (simulated) market can be decoupled from decisions regarding how to much spend (Garcia, 2013; Okoffo et al., 2016). In the first stage, we model whether respondents are willing to purchase the New England product as a function of their interest in purchasing the (actually available) analogous Midwestern product as well as whether they eat pork and their liking of the specific cut under consideration (i.e., tenderloin). This first stage also allows for explicit consideration of truncation at the upper-bound of our observable range (i.e., $18, or a premium of $6/lb over the cost of Midwestern product).

In the second stage, we estimate WTP within our effective censored range of $12 to $18 as a function of the following categories of variables:

$$\text{WTP} = \beta_0 + \beta_1 \mathbf{x}_1 + \beta_2 \mathbf{x}_2 + \beta_3 \mathbf{x}_3 + \beta_4 \mathbf{x}_4 + u, \tag{1}$$

where WTP is willingness to pay per pound of niche New England pork tenderloin; β_i are the coefficients associated with vector of variables $\mathbf{x}_i$, where $i = 1, \ldots, 4$; $\mathbf{x}_1$ are the variables associated with consumer demographics (first hypothesis); $\mathbf{x}_2$ are the variables describing meat purchase history (second hypothesis); $\mathbf{x}_3$ are the variables describing process attribute preferences (third hypothesis); and $\mathbf{x}_4$ are the variables describing meat eco-labeling recognition (fourth hypothesis).

Specific variables are detailed in the next section and follow the order asked in the survey instrument. Standard errors in the second stage of estimation were clustered on the location where consumers were interviewed to account for unobserved heterogeneity at the store level. All analysis was conducted in Stata 15, with the Cragg hurdle model estimated using the "churdle" routines (StataCorp, 2017).

Survey and Independent Variables

The customer questionnaire was pretested with focus groups and store owners prior to data collection. It consisted of six sections and was usually completed within 10 minutes. The first section (survey questions 1–4 in the Appendix) focused on purchase history for in-home consumption of pork and beef. These questions connected with our second hypothesis that those who had previously bought local or organic meat through direct marketing would have greater interest in retail niche pork. We then turned our focus to the pork tenderloin cut of meat (*Tenderloin)* and customer reasoning for not purchasing tenderloin (*Vegetarian, NoEatPork, NoCookMeat, NoLikeTenderloin).*

The second section (questions 5–7) asked about WTP for Midwestern and New England pork tenderloin as well as preferences for various cuts of regionally raised beef, chicken, and pork. We began with a hypothetical single-shot purchase question (*MidwestNiche)* that inquired about willingness to buy Midwestern niche pork tenderloin for $12/lb. We asked first about Midwestern pork since a similarly produced product from New England was not offered in the retail setting. In the survey, we defined this product as boneless pork tenderloin that is raised in the Midwest on vegetarian feed with no subtherapeutic antibiotics or growth hormones. Transitioning from the Midwest to New England, we posed a payment-card WTP question for local tenderloin, with similar process attributes except the location of production. The payment card included a "would not purchase" option, which was used to define the participation hurdle in our estimation procedure. The final question of this section explored general interest in 11 other cuts of locally raised pork, chicken, and beef. The question was informed by gray literature from the New England region that recognized the lack of data on consumer demand for specific cuts and species of meat products (State of Vermont, 2001; Dickenson, Joseph and Ward, 2013).

The third section (questions 9–11) focused on customers' personal characterizations of "local" and "natural." We solicited their personal definition for local meat as being raised within the state of Massachusetts (*LocalMA)*, the region of New England *LocalNE)*, or within 100 miles of their location *(Local100).*

The fourth section (question 12) asked participants to categorize meat production characteristics in terms of most and least important. These process attributes connected with our third hypothesis that those concerned with livestock rearing practices would have greater interest in niche pork. In total, 12 characteristics reflected general categories of animal welfare, environmental sustainability, and geographic production. Although the 12 process attributes were the same, we provided two separate opportunities for participants to identify the three characteristics that were most important and three characteristics that were least important to them. These variables were incorporated in the WTP estimation and represented by "More" if a top three production characteristic and "Less" if a bottom three characteristic. The 12 production characteristics included (i) knowing the name of the farm that raised the pork (*MoreFarmName, LessFarmName)*

(ii) whether it was regionally produced in New England (*MoreNEProd, LessNEProd*), (iii) locally produced in Massachusetts (*MoreMAProd, LessMAProd*), (iv) no use of growth hormones (*MoreNoHormones, LessNoHormones*), (v) no use of subtherapeutic antibiotics (*MoreNoAntibiotics, LessNoAntibiotics*), (vi) no genetically modified (GMO) feed (*MoreNoGMO, LessNoGMO*), (vii) certified organic pig farm (*MoreOrganic, LessOrganic*), (viii) proper management of manure (*MoreManureMang, LessManureMang*), (ix) no tight confinement (e.g., no crates) (*MoreNoConfine, LessNoConfine*), (x) raised with access to the outdoors (*MoreOutdoors, LessOutdoors*), xi) Small herd size (small to mid-size farm) (*MoreSmallHerd, LessSmallHerd*), and (xii) heritage breed of pig (*MoreHeritage, LessHeritage*).

The fifth section (questions 13–16) concentrated on recognition of meat eco-labels associated with some of the production characteristics from the previous section in the questionnaire. These eco-labels included USDA Process Verified, USDA Organic, Animal Welfare Approved, Certified Humane, Global Animal Partnership, as well as a fabricated label (Figure 2). We asked participants whether they knew the differences between the labels (*KnowDiffLabel)*. If they found the eco-labels confusing, we followed up with possible reasons for such uncertainty, including (i) not knowing what the labels represents with regard to animal agriculture (*DontKnowProd*); (ii) not trusting the label as it could be misleading or dishonest (*DontTrust*), and (iii) not understanding the relationship between the label and the meat company or farmer (*DontKnowRelationship*). From these measures we constructed a dichotomous measure of "correct" familiarity with existing labels (*CorrectRecognition)* in which respondents who recognized at least one of the existing labels were coded separately from those who either failed to recognize any label or falsely recognized the fabricated label. This section was associated with our fourth hypothesis that eco-labeled products have positive premiums.

Figure 2. Meat Eco-labels

Labels (clockwise from top left):
1. USDA Process Verified, http://www.ams.usda.gov/AMSv1.0/processverified [Accessed February 16, 2014].
2. Animal Welfare Approved, http://animalwelfareapproved.org [Accessed August 18, 2015].
3. Certified Humane, http://certifiedhumane.org [Accessed August 18, 2015].
4. Cage-Free Meat Certified, created by the authors for the purpose of this study.
5. Global Animal Partnership, www.globalanimalpartnership.org [Accessed August 18, 2015].
6. USDA Organic, www.usda.gov/wps/portal/usda/usdahome?navid=organic-agriculture [Accessed August 18, 2015].

The sixth and final part (questions 17–21) contained socioeconomic questions regarding household size and makeup (*EatHomeAdults, EatHomeKids*), gender *(Female*), education level *(YrsEd)*, race (*White)*, and income (*Income).* The demographics related to our first hypothesis that households with greater disposable income or smaller family size would have increased WTP for this high-priced specialty cut. Regarding total household income, we based the mean of the five categories on the U.S. Census average of household income for the area. Although the participants selected from a range of categories, we calculated the average value for the range indicated by their categorical response.

Data Collection

The customer-intercept questionnaire was administered at three specialty retail grocery stores in metro-Boston, Massachusetts (USA), in early summer 2014. Of the three stores, one was located in Boston and the other two were in suburbs near Boston. The stores were chosen based on their current availability of regionally produced food products, such as fresh fruits and vegetables, bakery items, dairy, and nonpork livestock products. These stores already had value chain partnerships established with other local and regional purveyors, thus were receptive to alternative supply chain structures should New England pork products be marketed in the future. We collected data for 1 week in each of the three stores. We strived to reach diverse populations by administering the survey during all major periods of business hours (early morning, lunch hour, late afternoon, evening rush hour, and late night). By being physically present in the stores, we were available to answer questions from the participants, thus potentially reducing information bias for unknown attributes. We used a computer tablet-assisted survey administered with Qualtrics Research Suite software, which was both an appealing format for approaching potential respondents and also simplified data entry. Study participants were compensated with a small thank-you gift (a beeswax-based lip balm with an estimated value of $1 US). Approximately half of shoppers who we approached to participate in our study chose to take the survey, resulting in 388 participants, with 100, 141, and 147 surveys at the three stores.

Survey participants were encouraged to answer all questions, especially the WTP questions for Midwestern and New England pork, even if objection to pork consumption was identified earlier in the survey. This was deliberately allowed so that participants could indicate interest in purchasing niche pork for others within the household, or for themselves even if they do not currently eat pork resulting from objections that may be due to perceptions of conventional pork production rather than disinterest in eating pork under any circumstance. During pretesting of the survey, we found that nonpork consumers, such as some vegetarians, buy pork for family members and guests. Others who do eat meat shared that they would buy New England niche pork if it were available but currently do not eat pork because of their concerns with how commodity pork is raised. Thus, we asked nonpork consumers to complete the survey to capture this potential market should niche New England pork be offered in the future.

The vast majority of surveys were complete. Only 15 surveys had several unanswered questions and were removed from the data. The question set regarding past purchases of local and organic beef and pork (question 2) resulted in several blanks. For this question, we assumed that they did not previously purchase if they did not respond, leaving any question blank within this set. This assumption resulted in a "no previous purchase" for 35 organic pork, 40 local pork, 32 organic beef, and 48 local beef responses. Our final sample size was 373 completed surveys, which came very close to our target of 385. We chose this number of observations because Mitchell and Carson (1989) found this number of observations helped approximate true WTP.

Results

The findings of this study were organized around our main objectives to estimate the WTP for New England pork tenderloin. In order to consider pork WTP, we began with the descriptive results of independent variables, such as demographics, purchase history, process attributes preferences, meat eco-labeling knowledge, and WTP for Midwestern and New England niche meat products. Details associated with our secondary objectives for learning preferences of meat cuts, production characteristics, and eco-label recognition were described to better contextualize knowledge and preference of our participants. Selected variables were incorporated into the final WTP model for New England pork tenderloin and described in the final portion of this section.

Descriptive Statistics of Independent Variables

Demographics

As shown in Table 1, our study's participants formed a relatively homogeneous group, as we anticipated based on the type and location of retail stores where data were gathered. On average, participants were from small households with 2.1 adults and 0.6 children eating dinner at home. They were college-educated, having earned at least an undergraduate college degree, with a relatively high household income. The majority of respondents self-identified as being female (66%) and white. Some demographics of our sample aligned well with the general metro-Boston population, which included the counties of Suffolk, Norfolk, and Middlesex weighted by population for each of the three counties. For instance, mean 2018 household income of the metro-Boston area was $89,204 (U.S. Census Bureau, 2019), whereas for our study it was $95,783. Likewise, the 2018 racial makeup of this tri-county area was 74% white, compared with our sample of 82% white. On the other hand, educational attainment census estimates for bachelor's degree or higher for the tri-county population was 52%, contrasted with our sample's 88%. Although not generalizable to the average Bostonian, this sample represented the population that shops at specialty retail markets in the greater Boston area where differentiated meat products are available and therefore was assumed to represent a substantial portion of the demand for niche pork products.

Purchase History

Regarding previous meat purchases for home consumption, 39% of our participants had previously purchased organic pork and 58% had purchased organic beef. Fewer reported having bought locally raised pork and beef (33% and 40%, respectively). For the organic meats, most customers purchased the products at a retail grocery store (72% for pork and 74% for beef). The second most popular method for buying organic meat was through direct marketing (DM), such as a farmers'

Table 1. Descriptive Statistics

Variable	Description	Mean	Std. Dev.	Min.	Max.
Demographics					
EatHomeAdults	Number of adults eating dinner at home	2.11	0.80	1	6
EatHomeKids	Number of children eating dinner at home	0.60	1.08	0	5
Female	= 1 if female, 0 otherwise	0.66	0.47		
Yrs_Ed	Total number of years of education	16.69	1.62	10	18
White	= 1 if white, 0 otherwise	0.82	0.38		
Income	Total household income	$95,783	$42,863	$12,500	$150,000
Purchase History					
HomePorkConsump	Number of weeks per year consume pork at home	20.44	21.78	0	52
OrgPork	= 1 if purchased organic pork in the past, 0 otherwise	0.39	0.49		
LocalPork	= 1 if purchased local pork in the past, 0 otherwise	0.33	0.47		
OrgBeef	= 1 if purchased organic beef in the past, 0 otherwise	0.58	0.49		
LocalBeef	= 1 if purchased local beef in the past, 0 otherwise	0.40	0.49		
AgreeLocalAvail	= 1 if strongly agree or agree with statement, 0 otherwise[a]	0.26	0.44		
Tenderloin	= 1 if purchased tenderloin for home consumption, 0 otherwise	0.49	0.50		
Vegetarian	= 1 if vegetarian, 0 otherwise	0.11	0.31		
NoEatPork	= 1 if does not eat pork, 0 otherwise	0.11	0.31		
NoCookMeat	= 1 if does not cook meat or know how to cook meat at home, 0 otherwise	0.04	0.20		
NoLikeTenderloin	= 1 if does not like pork tenderloin, 0 otherwise	0.03	0.18		
WTP Midwestern and New England Niche Meats					
MidwestNiche	= 1 if WTP $12/lb for Midwestern tenderloin, 0 otherwise	0.40	0.49		
WTPvalue	WTP New England tenderloin	9.46	6.73	0	18
WTPnobuy	= 1 if would not purchase New England tenderloin at any price, 0 otherwise	0.33	0.47		
CertaintyWTP	= 1 if very certain or somewhat certain in WTP decision, 0 otherwise	0.79	0.41		

continued on following page

Table 1. (continued)

Variable	Description	Mean	Std. Dev.	Min.	Max.
Local Meat Definition					
AgreeRaiseSlaughter	= 1 if strongly agree or agree with statement, 0 otherwise[b]	0.75	0.43		
LocalMA	= 1 if local was defined by state boundaries, 0 otherwise	0.17	0.38		
LocalNE	= 1 if local was defined by regional boundaries, 0 otherwise	0.60	0.49		
Local100	= 1 if local was defined within 100 miles of farm, 0 otherwise	0.23	0.42		
Meat Eco-Labeling Knowledge					
USDAProcesLabel	= 1 if specific label was recognized, 0 otherwise	0.72	0.45		
AWALabel	= 1 if specific label was recognized, 0 otherwise	0.16	0.37		
USDAOrgLabel	= 1 if specific label was recognized, 0 otherwise	0.89	0.31		
CertHumLabel	= 1 if specific label was recognized, 0 otherwise	0.26	0.44		
GAPLabel	= 1 if specific label was recognized, 0 otherwise	0.10	0.30		
WrongLabel	= 1 if specific label was recognized, 0 otherwise	0.15	0.36		
SameGuidelines	= 1 if labels represent same guidelines for raising animals, 0 otherwise	0.03	0.18		
UnsureGuidelines	= 1 if unsure whether the guidelines are the same for raising animals, 0 otherwise	0.50	0.50		
KnowDiffLabel	= 1 if guidelines were known, 0 otherwise	0.12	0.32		
DontKnowProd	= 1 if production practices of label were not known, 0 otherwise	0.55	0.50		
DontTrust	= 1 if label was not trusted, 0 otherwise	0.26	0.44		
DontKnowRelationship	= 1 if relationship between certification and farmer was not known, 0 otherwise	0.32	0.47		

Notes: [a] Locally raised meat is readily available for purchase at the grocery store where you most regularly shop.
[b] Locally raised meat means that the animals were raised from birth through slaughter in the local area.

markets or community supported agricultural enterprises (25% for pork, 20% for beef). However, for local meats, the opportunity with direct marketing increased. Local beef purchases were similar between the grocery store (47%) and DM (44%). As anticipated, the majority sourced local pork through direct marketing (49% DM vs. 43% for grocery store). We expected locally sourced pork to be purchased through DM, as retail fresh pork was not available at any of the three stores when the survey was conducted, nor at any similar venues in the region to the best of our knowledge. This observation was affirmed by the participants, 74% of whom believed local meat was not readily available at the grocery store where they typically shopped. Focusing on the pork tenderloin cut, nearly half had purchased tenderloin in the past for home consumption. Others described reasons for not buying tenderloin. For this sample, 11% did not eat pork, 11% were vegetarian, 4% did not cook meat at home or know how to prepare meat, and 3% did not like tenderloin.

Process Attribute Preferences

The most important production characteristics for animal agriculture centered on the use of technology such as "no added hormones" (68% of participants indicated this attribute in their top three), "no subtherapeutic antibiotics" (57%), followed by "no genetically engineered feed" (39%), as shown in Table 2. Secondary concerns emerged with the themes of housing and space allocation as attributes of "no tight confinement" and "access to the outdoors" were chosen by 40% of the population. On the other hand, raising the animals in Massachusetts (8%), "knowing the name of the farm" (8%), and "using heritage breeds" (4%) scored the lowest. Learning these results met our study's secondary objectives and provided visual context for understanding the WTP model.

Table 2. Production Characteristic Preferences

Most Important Attribute	**Preference for Attribute (% of sample)**
No added hormones	68
No subtherpuetic antibiotics	57
No tight confinement	40
Outdoor access	40
No GMO in feed	39
Raised in New England	25
Organic certification	15
Proper manure management	14
Small herd size	12
Raised in Massachusetts	8
Knowing farm name	8
Heritage breed	4

Notes: In the survey, participants could choose three attributes of greatest importance. Values in this table represent those who indicated a given production characteristic as most important. Thus, values do not sum to 100%.

The location process attribute was asked in two areas of the survey: production characteristics described above and personal definitions of local agriculture. The findings were similar. For instance, that animals were raised in the region of New England was more important than that they were raised within the state boundaries of Massachusetts. This result paralleled how participants defined "local." Our sample viewed the attribute "local" as raised in New England (60%) as opposed to Massachusetts (17%) or within 100 miles (23%). Culturally, strong regional identity and place attachment exist in New England as demonstrated in this study and others (Conforti, 2001; Walker and Ryan, 2008).

Meat Eco-Labeling Knowledge

When presented with visual labels, the majority of participants recognized the two labels from the USDA (Organic, 89%, and Process Verified, 72%). However, the third-party certification programs were not as popular, even though they are used on numerous livestock products ranging from bacon to eggs. Of these three icons, Certified Humane was the most familiar (26%), followed by Animal Welfare Approved (16%). Interestingly, more respondents acknowledged the fictitious Cage-Free Meat Certified label (15%) than the extant Global Animal Partnership icon (10%). Aggregating label knowledge, 79% of participants identified at least one of the five existing labels and correctly detected the false meat label. When examining the meat eco-labels as a whole, 88% of participants did not know the production differences among the labels. We asked about possible sources of confusion; they could list more than one reason. More than half (55%) did not know what the label represented with regard to animal agriculture, 32% did not understand the relationship between the label (certification) and the meat company or farmer, and 26% did not trust the label because they see it as misleading or dishonest.

WTP for Midwestern and New England Niche Meat Products

Within the survey, niche process attributes were explicitly bundled as animals that were raised in a certain region, on vegetarian feed, without subtherapeutic antibiotics or added growth hormones. Nearly 40% stated they would purchase Midwestern niche tenderloin at $12/lb. This price was approximately double the retail cost of commodity pork tenderloin at the time the survey was administered. Shifting to New England production while keeping constant the other process attributes, 33% indicated that they would not purchase the New England product at the comparison price of $12/lb. Among those who would purchase the New England product, the average WTP was $14/lb. This value does not represent those participants who indicated that they would not purchase the New England pork tenderloin; these respondents may or may not be willing to purchase this specific pork product at a discounted price. Whether they would buy the local pork, the majority (79%) reported certainty in their New England WTP decision. The implied demand curve of specialty market customers for New England tenderloin is shown in Figure 3; this implied demand curve was derived from the inverse cumulative distribution function for responses to the WTP question in our survey. The y-axis represents the proportion of respondents willing to pay at least the indicated amount on the x-axis. Finally, for these related questions, we expanded the list of locally raised cuts of meat beyond pork to include beef and chicken. Although specific premiums were not investigated, participants responded for each cut of meat knowing it would be sourced locally with an additional cost. Chicken dominated the list, following by beef and then pork, which are shown in order of selection in Figure 4. These results were important to our regional meat producers, aggregators, and distributors since consumer demand for specific cuts and species of meat products was not available.

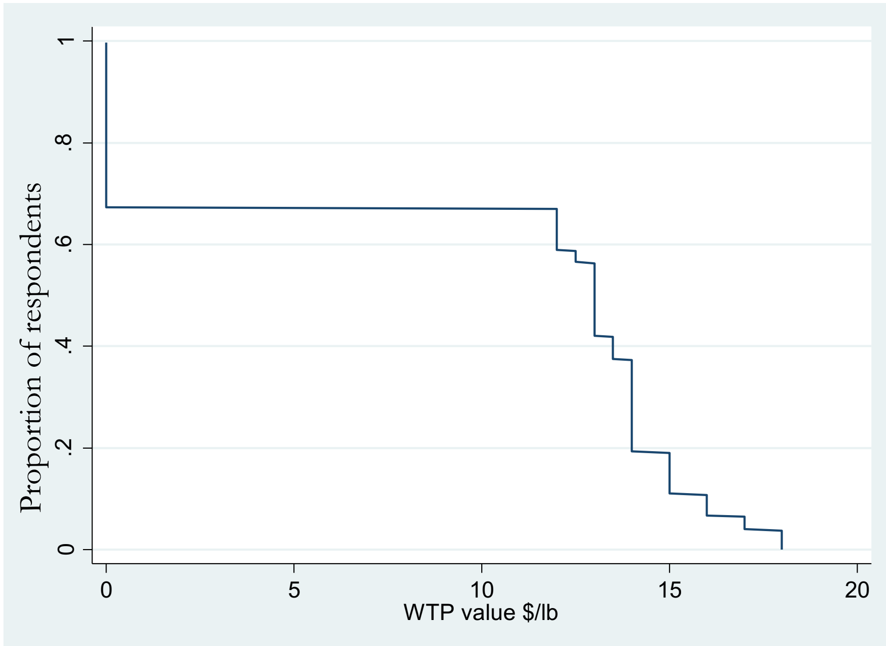

Figure 3. Implied Demand Curve for New England Pork Tenderloin

Notes: *x*-axis represents respondents' WTP value ($/lb). *y*-axis represents the proportion of respondents that would be willing to pay that amount or less per pound of niche pork tenderloin.

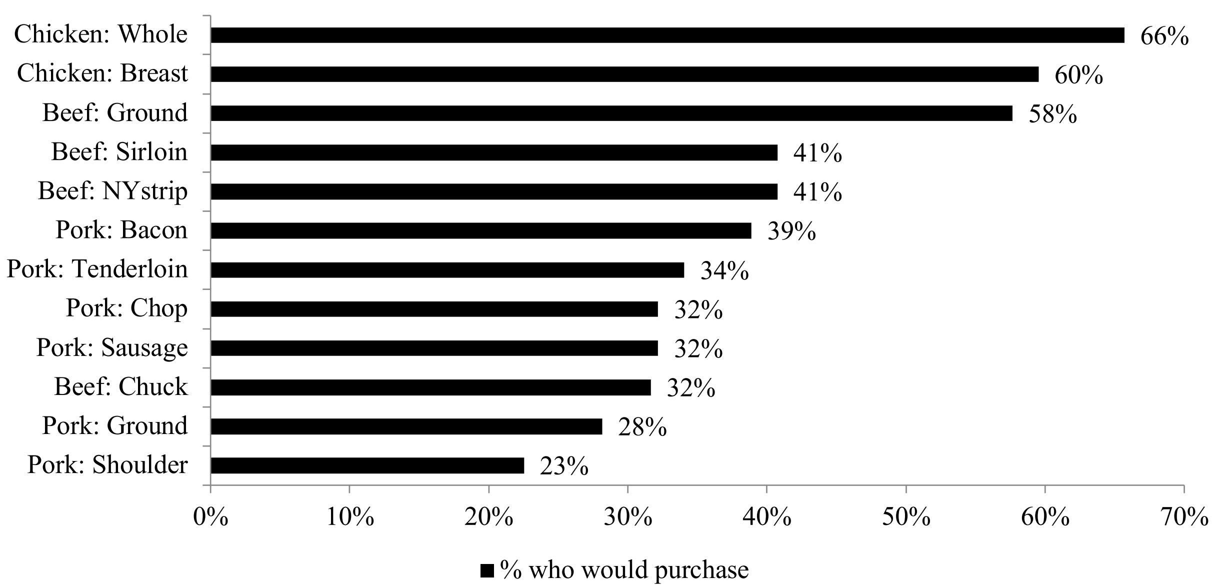

Figure 4. Preference for Locally Raised Meat Cuts

Cragg Hurdle Regression Model

These descriptive findings for consumers' purchase history, preferences, and eco-label knowledge were integrated into our regression model (Tables 3 and 4). The variables used for selection into the market for New England tenderloin in the first stage of the model were willingness to purchase the Midwest tenderloin (*MidwestNiche*), aversion to tenderloin (*NoLikeTenderloin*), and pork (*NoEatPork*). As expected, this first-stage selection, as shown in the lower portions of Table 3, found that those who would buy the comparable and actually available Midwest product were likely to participate in the market for the hypothetical New England product, whereas those who do not eat pork or do not like tenderloin were less likely (i.e., have a WTP less than that of the $12 price of the comparable Midwestern product). The upper limit estimation allows for simultaneous consideration of the upper-bound truncation of our survey instrument in the estimation; as expected, respondents who indicated they do not eat pork or do not like tenderloin were also less likely to be at this upper bound available on the payment card.

Following equation (1), the specific independent variables for the second-stage WTP model (*WTPValue*, representing the total willingness-to-pay for the New England product, i.e., the indicated premium plus $12) included measures of pork purchasing frequency (*HomeYear, HomeWeek, HomeMonth*), belief in available local meat (*AgreeLocalAvail*), tenderloin preferences (*Tenderloin*), local meat preferences (*PorkTenderloin, PorkChop*), demographics (*Income, Yrs_Ed, Female, White),* process attributes (*MoreNoHormones, MoreNoAntibiotics, MoreNoConfine, MoreNoGMO, LessOrganic, MoreOrganic*), and correct recognition of meat eco-labels (*CorrectRecognition*). Appropriate tests (not shown) did not indicate any concerns with multicollinearity with this set of explanatory variables. The three retail store locations (*Store*) were used to cluster the standard errors to account for unobservable differences by location. These regression variables corresponded to our original hypotheses that focused on pork purchase history, preference for process attributes, and household characteristics.

The most significant findings were generally focused on pork purchase and preference as well as organic production and eco-label knowledge (Table 3). In particular, participants who typically ate pork weekly at home had higher WTP for New England pork ($0.22/lb) compared to those who purchase pork less often ($0.12/lb for monthly and $0.15/lb for yearly at-home consumption of pork; WTP results for these less frequent purchases were not significantly different from 0). Likewise, customers who shopped at stores with readily available local meat and those who valued locally raised pork chops and organic production methods had positive WTP for New England pork tenderloin ($0.17/lb, $0.36/lb, and $0.37/lb, respectively). Those who correctly recognized the meat eco-labeling also had positive WTP for New England pork tenderloin ($0.27/lb). Conversely, participants who regularly ate conventional pork tenderloin had negative WTP (−$0.22/lb) for the premium New England product. It is worth noting that in investigating alternative specifications, demographic variables—such as number of adults and children eating at home, household income, and years of formal education—that were found to be important predictors of WTP in other studies (e.g., Grannis and Thilmany (2002); Umberger, Thilmany McFadden and Smith (2009); Dickinson and Bailey (2002) were not significant here (not shown).

Table 3. Cragg Hurdle Regression Model of WTP for New England Pork Tenderloin ($N = 373$)

Variable	**Coefficient**	**Robust SE**	***p*-value**	**95% Confidence Interval**	
HomeWeek	0.677	0.078	0.000***	0.524	1.254
HomeMonth	0.371	0.351	0.291	−0.317	0.830
AgreeLocalAvail	0.509	0.053	0.000***	0.404	1.058
Tenderloin	−0.650	0.231	0.005***	−1.102	0.613
PorkTenderloin	0.284	0.394	0.471	−0.488	−0.197
PorkChop	1.089	0.476	0.022**	0.156	1.055
Income	0.000	0.000	0.184	0.000	0.000
Yrs_Ed	0.012	0.064	0.850	−0.114	0.138
Female	0.082	0.154	0.595	−0.219	0.383
White	0.237	0.580	0.683	−0.900	1.375
MoreNoHormones	−0.342	0.600	0.569	−1.517	0.834
MoreNoAntibiotics	0.025	0.527	0.962	−1.007	1.058
MoreNoConfine	−0.570	0.655	0.384	−1.855	0.714
MoreNoGMO	0.493	0.295	0.096	−0.087	1.072
LessOrganic	−1.052	0.223	0.000***	−1.489	−0.615
MoreOrganic	1.104	0.479	0.021**	0.165	2.044
CorrectRecognition	0.806	0.134	0.000***	0.543	1.069
_cons	12.024	0.609	0.000	10.830	13.218
selection_ll					
NoEatPork	−1.234	0.256	0.000***	−1.737	−0.731
NoLikeTenderloin	−1.164	0.113	0.000***	−1.386	−0.943
MidwestNiche	1.659	0.091	0.000***	1.481	1.837
_cons	12.169	0.071	0.000	12.030	12.308
selection_ul					
NoEatPork	−3.594	0.219	0.000***	−4.024	−3.164
NoLikeTenderloin	−3.622	0.171	0.000***	−3.957	−3.287
MidwestNiche	−0.343	0.254	0.178	−0.842	0.156
_cons	16.449	0.093	0.000	16.266	16.631

Notes: Double and triple asterisks (**, ***) denote significantly different than 0 at the 5% and 1% levels, respectively. Pseudo-$R^2 = 0.150$.

Implications and Conclusions

We designed this study not only to examine the potential retail market interest in regionally produced meat products but also to develop a better understanding of consumer preference of meat cuts and process attributes and recognition of meat eco-labels. Regarding our original WTP hypotheses, we had mixed findings. For the first hypothesis, our sample's demographics, particularly those households without children, did not lend much to our understanding of drivers of WTP. This was certainly due at least in part to our sample being fairly homogeneous, and focusing on those consumers who had already self-selected their presence in the specialty stores

Table 4. Cragg Regression Model Marginal Effects

Variable	dy/dx	Delta-method SE	*p*-value	95% Confidence Interval	
HomeYear	0.148	0.121	0.223	−0.090	0.386
HomeWeek	0.224	0.039	0.000***	0.148	0.299
HomeMonth	0.122	0.109	0.262	−0.091	0.336
AgreeLocalAvail	0.168	0.004	0.000***	0.160	0.176
Tenderloin	−0.215	0.101	0.034**	−0.413	−0.017
PorkTenderloin	0.094	0.129	0.467	−0.159	0.347
PorkChop	0.360	0.125	0.004***	0.115	0.604
Income	0.000	0.000	0.147	0.000	0.000
Yrs_Ed	0.004	0.022	0.852	−0.038	0.046
Female	0.027	0.051	0.598	−0.073	0.127
White	0.078	0.184	0.670	−0.282	0.438
MoreNoHormones	−0.113	0.188	0.548	−0.481	0.256
MoreNoAntibiotics	0.008	0.174	0.962	−0.334	0.350
MoreNoConfine	−0.188	0.210	0.369	−0.600	0.223
MoreNoGMO	0.163	0.100	0.103	−0.033	0.358
LessOrganic	−0.348	0.059	0.000***	−0.463	−0.232
MoreOrganic	0.365	0.190	0.054	−0.007	0.736
CorrectRecognition	0.266	0.071	0.000***	0.127	0.405

Notes: Double and triple asterisks (**, ***) denote significantly different than 0 at the 5% and 1% levels, respectively.

in which this study was conducted. With our second hypothesis, we anticipated and found meat purchase history and tenderloin preferences to be strong predictors for differences in WTP for New England tenderloin. Regarding our third hypothesis, most process attributes were not significant predictors of WTP. However, organic certification, which was significant, would require many of the other production characteristics of niche meat. Given that participants identified with existing eco-labels (fourth hypothesis), perhaps these customers recognized organic as a general umbrella qualification that included other process attributes, such as restrictions on antibiotics and GMO feed. Those consumers who could correctly recognize at least some currently used labels did indicate higher WTP for the New England specialty product than those who were not knowledgeable about labels.

Organic preferences are related to preferences regarding the use of hormones, antibiotics, and GMO feed within livestock production. Since some of our participants did not consume pork, we asked them to respond to the production characteristic questions for any livestock product that they purchase. “Raised without added hormones” was a top concern for our sample and a significant predictor of WTP. Although USDA federal regulations prohibit the use of added hormones in pork or chicken, these findings may be important for regional beef producers and aggregators who market to specialty retail grocers.

Immediately following "added hormones," the second most important production attribute was "raised without subtherapeutic antibiotics." Although antibiotic use was an important factor in other studies (e.g., Grannis and Thilmany, 2002), it was not a strong predictor of differences in WTP here. Because this attribute was a top concern for most participants, we believe that the null outcome here reflected the lack of variation in our sample of specialty food market customers.

Finally, we expected concern with use of GMO feed, such as transgenetic corn and soybean meal, to contribute significantly to WTP estimation. Informed by the regional supply chain, GMO-free feed has been a critical factor for New England producers and aggregators who market directly to consumers (such as farmers' markets or on-farm sales). Our results imply that different customer bases have different priorities. New England producers can utilize this information to prioritize management options to meet customer preferences for specific markets. Process attributes may cost additional time or money. For instance, within New England, GMO-free feed is typically more expensive and can be difficult to source. Hence, we believe that such preference information is valuable to supply chain players for allocating limited resources.

Reflecting upon our WTP methodology and results, we can evaluate the design and survey implementation to improve future studies as well as draw market implications. We were concerned *a priori* that some respondents might have been confused by asking about premium amounts rather than total price. To remedy potential confusion, enumerators were available and trained to clarify survey questions and participant interpretation. We used a two-stage conditional model specifically to examine the feasibility of introducing this niche meat product at a price premium into specialty grocery stores. More than 67% of our respondents responded positively to New England pork tenderloin priced at or above the $12 minimum estimated by an industry informant to successfully retail this product (personal communication with Sean Buchanan, president of Black River Meats of North Springfield, Vermont, July 23, 2013). For those willing to purchase the local product, the average premium was $2 above this minimum feasibility price of $12/lb.

Should industry costs reduce through scale of production or increased efficiency or consumer awareness increase through marketing outreach, it is plausible for retail local tenderloin to be economically viable in the future. Differentiated pork production has room for improvements, as demonstrated in our companion study with pork farmers (Picardy et al., 2017). We found the niche system produced 15% fewer weaned piglets and finished 12% fewer hogs per bred sow per year than the conventional system due to fewer breeding cycles, smaller litters, higher piglet mortality, and a need for 18 additional days for finishing to standard slaughter weight in alternative production. At this time, regional suppliers may instead focus retail efforts on other cuts of pork (such as lower priced chops or sausages) or different species (e.g., chicken or beef) to close the price gaps. Further exploration is needed to estimate the WTP for these other meat products, but our preliminary results from Figure 2 provide insight into priorities for product introduction.

Concerning eco-labeling, our findings support recent literature. The meat eco-labels that we presented to our sample apparently did not make the market more transparent for these participants; 88% of our respondents self-reported that they did not understand the differences in production methods across these labels (also found in van Amstel et al., 2007). Thus, meat eco-labeling within our sample does not provide additional information to understand attributes associated with the certification programs. Our participants did not understand the complexities of agricultural practices and process attributes (also reported by USDA, 2012; Brécard, 2013). For these reasons, information asymmetry within this analysis was not reduced because consumers did not know what the eco-labels represented.

Our results suggest that consumers who reference meat eco-labels may benefit from additional packaging information that clearly describes the practices associated with process attributes and the relationships between the certification agency and meat company or farmer. Such results point toward the direction of production descriptions (such as "raised with outdoor access" and "without subtherapeutic antibiotics") incorporated on the meat package as opposed to costly certification programs using established eco-labels. Additional outreach effort is needed to gain consumer trust of the labeling claims or certification agencies. Such trust though, may be challenged by a range of terms and claims that are not regulated by a governmental agency, possibly leading to company misuse (Animal Welfare Approved, 2011). Confusion compounds when animal raising claims are similar to commonly approved claims. Within the United States, animal raising claims include *naturally raised, naturally grown, antibiotic free, humane,* and *hormone free* (USDA FSIS 2016). As recommended by Umberger, Thilmany, and Smith (2009), all value chain partners have a responsibility to provide credible, transparent evidence of their labeling claims to avoid deceit. Without trustworthy communication, consumer confusion may override confidence in process attributes, impacting food purchase decisions (Abrams, Meyers, and Irani, 2010; Hobbs and Goddard, 2015; Rihn and Yue, 2016).

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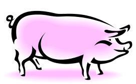
Appendix: Meat Consumer Survey

Directions:
PLEASE ANSWER ALL QUESTIONS TO THE BEST OF YOUR KNOWLEDGE. Feel free to ask us any questions that you may have. Thank you for your time.

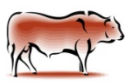
1. How often does your family consume pork (*such as pork tenderloin, chops, bacon, roast or ground pork*) at home?
   Please circle your answer

   Never **Once a year** **Once a month** **Once a week** **Other:___________**

2. In the past, have you ever purchased any of the following? If yes, where did you *last purchase* the meat?



Organic pork:	**YES**	**NO**............................	Location: _______________
Local pork:	**YES**	**NO**............................	Location: _______________
Organic beef :	**YES**	**NO**............................	Location: _______________
Local beef:	**YES**	**NO**............................	Location: _______________



3. Do you agree with this statement? *Mark the circle that best represents your opinion.*
   Locally-raised meat is readily available for purchase at the grocery store where you most regularly shop.

   ○———○———○———○———○
   strongly agree — agree — neutral — disagree — strongly disagree

4. Do you ever buy pork tenderloin for home consumption? **YES** **NO** *Circle your answer*

   If yes, please go to the next question. If no, why not? _______________________________

5. Now, suppose you are considering purchasing boneless pork tenderloin that is **raised in the Midwest** on vegetarian feed with no sub-therapeutic antibiotics or growth hormones. The cost for this pork in the Metro-Boston area is $12/lb.

   Would you be willing to pay $12/lb for this meat? **YES** **NO** *Circle your answer*

6. Compared to the average price ($12/lb), how much of a premium would you pay for a similar pork tenderloin product that was **raised in New England** on vegetarian feed with no sub-therapeutic antibiotics or growth hormones. The ONLY difference between the two products is the location WHERE the animals were raised.

Keep in mind that people often overstate their amount willing to pay because they are not actually buying the product. For this reason, please respond truthfully, as if you are buying the pork tenderloin.

Pork tenderloin raised in the Midwest costs $12.00/pound										
Additional cost premium per pound of LOCAL pork tenderloin -->	$0	$0.50	$1	$1.50	$2	$3	$4	$5	$6	Would NOT purchase
Reasonable to pay this amount	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

How certain are you of your answer above?
Please mark the circle

○ very certain ○ somewhat certain ○ not certain

7. What cuts of meat would you prefer come from a more **LOCAL source**, knowing it may cost more? *Please circle all that apply*

beef NY strip	ground beef	pork tenderloin	pork bacon
beef top sirloin	ground pork	pork chop	whole chicken
beef chuck roast	pork sausage	pork shoulder roast	boneless chicken breast

8. Do you agree with this statement? *Mark the circle that best represents your opinion.*
Locally-raised meat means that the animals were raised from birth through slaughter in the local area.

○ strongly agree ○ agree ○ neutral ○ disagree ○ strongly disagree

9. How would you define "local" meat?
   - ○ Raised within Massachusetts
   - ○ Raised within New England region
   - ○ Raised within 100 miles
   - ○ Other: ______________________

10. If you were to buy FRESH (not frozen) local meat, what is its shelf life? *In other words, how long will it safely last in your home's refrigerator?*

○ 1 to 3 days ○ 7 to 9 days
○ 4 to 6 days ○ 10 days or more

11. What does "natural meat" mean to you? or how would you define "natural meat"?
____

12. For this question, think about a pig farm that produces the meat you consume. In order to align with YOUR priorities and values, which production practices should they focus on? **Please circle the 3 characteristics as MOST IMPORTANT to you.**
Ask us if you want explanations or need clarification for any of these items! Please identify your priorities even if you don't eat pork!

Knowing the farm's name that raised the pork	***Certified organic pig farm***
Regionally-produced in New England	***Proper management of manure***
Locally-produced in Massachusetts	***No tight confinement (no crates)***
No use of growth hormones	***Raised with access to the outdoors***
No use of sub-therapeutic antibiotics	***Small herd size (small to mid-size farm)***
No genetically-modified (GMO) feed	***Heritage breed of pig***

Now, please circle the 3 characteristics as **LEAST IMPORTANT** to you:
Ask us if you want explanations or need clarification for any of these items! Please identify your priorities even if you don't eat pork!

Knowing the farm's name that raised the pork	***Certified organic pig farm***
Regionally-produced in New England	***Proper management of manure***
Locally-produced in Massachusetts	***No tight confinement (no crates)***
No use of growth hormones	***Raised with access to the outdoors***
No use of sub-therapeutic antibiotics	***Small herd size (small to mid-size farm)***
No genetically-modified (GMO) feed	***Heritage breed of pig***

13. Please look at the following labels and indicate whether you recognize the label on a meat product.

USDA PROCESS VERIFIED

- ○ Yes, I have seen this label
- ○ No

Animal Welfare APPROVED

- ○ Yes, I have seen this label
- ○ No

CERTIFIED HUMANE RAISED & HANDLED

- ○ Yes, I have seen this label
- ○ No

Global Animal Partnership	USDA Organic	Cage-Free Meat Certified
◯ Yes, I have seen this label	◯ Yes, I have seen this label	◯ Yes, I have seen this label
◯ No	◯ No	◯ No

14. Do these labels represent the same guidelines for raising animals? **YES NO UNSURE** *Circle your answer*

15. Do you know what each of these labels (below) means? *In other words, do you know the differences between these labels?*

YES NO *Circle your answer*

16. If no, what about the above labels is confusing? *Check all that apply*

◯ I don't know what the labels represent with regard to animal agriculture

◯ I don't trust the label (could be misleading/dishonest)

◯ I don't understand the relationship between the label (certification) and the meat company/farmer

◯ Other: ____

17. Typically, how many people eat dinner together in your home?
_____# of adults _____# of children

18. What is your gender? *please circle* FEMALE MALE OTHER

19. What is the highest level of education that you have completed? *please check appropriate circle*

◯ primary school ◯ high school degree/GED ◯ undergraduate degree

◯ some high school ◯ some undergraduate college ◯ graduate degree

20. What is your total household income? *please check appropriate circle*

◯ Less than $25,000 ◯ $50,001 to 75,000 ◯ $100,001 to $150,000

◯ $25,000 to $50,000 ◯ $75,001 to $100,000 ◯ More than $150,000

21. What is your race? *please check the most-appropriate circle for which you self-identify*

◯ Asian
◯ Black or African American
◯ Hispanic, Latino or Spanish origin
◯ Native American (American Indian)
◯ Pacific Islander or Hawaiian
◯ White or European American
◯ Some other race: ____________________________

....

You have reached the end of this survey.
THANK YOU for your PARTICIPATION, KNOWLEDGE, and TIME!

Please return completed survey to Jamie Picardy or Emily Nixon before you leave the grocery store.

If you would like to receive project results and register for the raffle,
please clearly PRINT your email address here: ______________________________________

If you have any other feedback for Jamie, please add here:

____

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California's Wage Rate Policies and Head Lettuce Prices

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Abstract

We develop an *ex ante* analysis of labor wage regulatory impacts on the head lettuce industry to estimate the impact of future California wage rate increases. We construct an equilibrium displacement model based on 2006 and 2017 head lettuce case studies to estimate the direction and size of changes in head lettuce quantity and prices given presumed changes in labor costs based on California's legislated wage rate increases. We find that a 20% increase in the wage rate for California agricultural labor will increase the retail price of head lettuce by 7.7% and reduce the quantity demanded of head lettuce by 4.3%.

Keywords: equilibrium displacement model, farm labor wages, lettuce, regulations

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Introduction

Lettuce represents the sixth largest crop (in terms of total revenue) produced in California, with a 2017 farmgate value of $2.41 billion and 199,100 harvested acres. Head lettuce represents 42% of that production, with 83,500 acres and a farmgate value of nearly $1 billion. Head lettuce production is highly seasonal because of the need for warm (but not hot) days and cool nights. Hence, monthly head lettuce regional harvests (primarily between California and Arizona) only marginally overlap (Figure 1). Moreover, California produces 64% of all head lettuce shipped in the United States, with most production occurring between April and October. In addition, head lettuce is a highly labor-intensive crop, especially during the harvesting process.

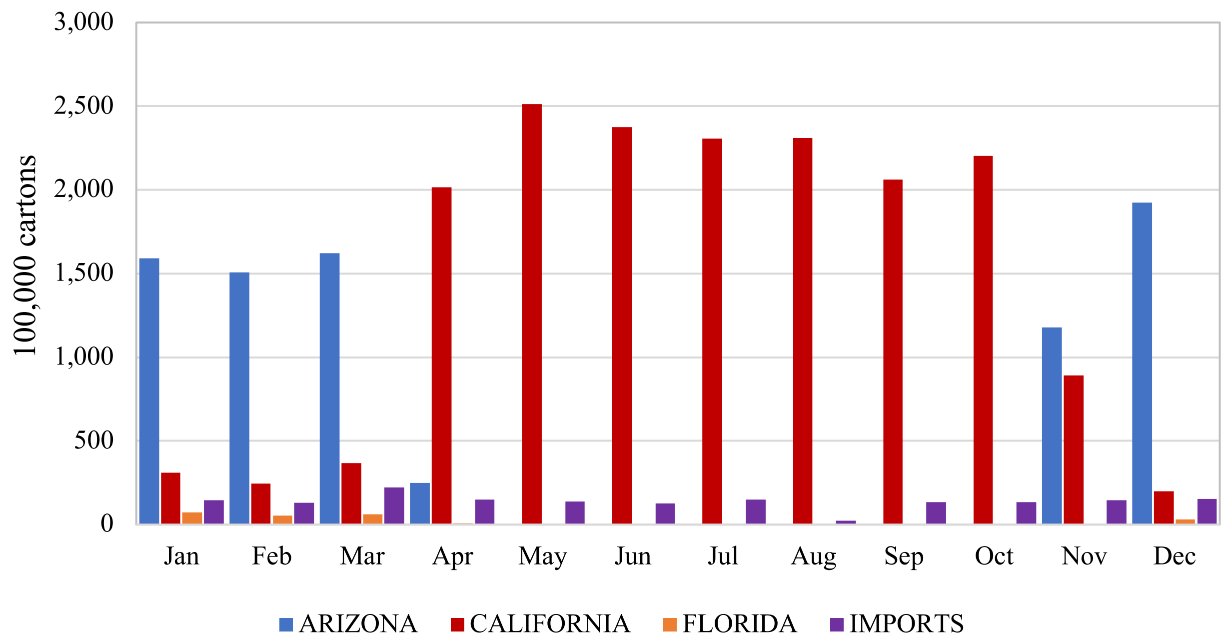

Figure 1. Iceberg Lettuce Shipments by Origins and Months

Over the past two decades, a variety of factors have limited the supply of agricultural labor in the United States (Kostandini, Mykerezi, and Escalante, 2014; Fan et al., 2015; Charlton and Taylor; 2016; Richards, 2018). In addition, increased regulatory policies with respect to human resources in California production agriculture have increased labor costs. New California wage and overtime regulations related to agricultural labor will further increase labor expenses, which may ultimately reduce the acreage of labor-intensive crops such as head lettuce. This will increase head lettuce prices and reduce the quantity demanded of head lettuce, further reducing the likelihood of meeting various governmental recommendations regarding increased consumption of vegetables. U.S. consumers currently consume fewer vegetables than recommended in the U.S. Department of Agriculture's's *Dietary Guidelines* (Wells and Buzby, 2008; Center for Science in the Public Interest, 2015).

We document the likely increases in labor costs as the result of new wage requirements in California using case studies and the regulatory policies that are currently being implemented. We then use an equilibrium displacement model to evaluate the impact of increased labor wages on head lettuce prices and consumption.

California Agricultural Wage Policies

The California regulatory environment is constantly evolving in response to new laws, policies, and legislative mandates. Regulations can provide benefits to the agricultural industry and society at large by improving food safety, air and water quality, and working conditions for farm workers. However, regulations also impose compliance costs on agricultural businesses. Regulatory costs can be classified as either direct, involving a cash outlay in response to the regulation, or indirect, involving an opportunity cost to the business or industry as a result of the regulation.

Both federal and state laws have dramatically increased labor costs for California producers. The Affordable Care Act (ACA) of 2010, which went into effect in 2014, requires all employers with 50 or more full-time or full-time-equivalent employees to provide health care coverage for their workforce and file requisite paperwork regarding that coverage to both the U.S. Internal Revenue Service and employees. This regulation likely affects the largest lettuce production firms, which represent over 67% of California's head lettuce production (Table 1). Other regulations, however, are not dependent on firm size. Human heat stress and illness prevention measures were adopted by the California Occupational Safety and Health Administration (Cal OSHA) in 2006 for those in outdoor occupations, including agriculture. In 2015, the standards were strengthened and required employers to provide shade structures that provide coverage for all employees when air temperatures exceed 80ºF. In addition, employers must provide clean, cool drinking water and preshift heat stress training to remind workers to drink sufficient water and take work breaks. Farming operations are subject to unannounced compliance inspections by Cal OSHA, with fines assessed for any violations.

Table 1. 2017 Farm Size and Number of Head Lettuce Operations

Farm Size (acres)	Acres Harvested	Number of Operations
0.1–0.9	92	381
1.0–4.9	137	74
5.0–14.9	139	17
15.0–24.9	135	7
25.0–49.9	258	7
50.0–99.9	1,623	24
100–249	7,395	46
250–499	11,009	30
500–749	8,718	14
750–999	6,227	7
≥1,000	66,174	38
Total	101,907	645

Source: U.S. Department of Agriculture (2017).

Payroll costs have also increased in California. In 2016, AB 1513 affected employers of piece-rate workers. The California Labor Code was amended to establish separate wage calculations to compensate for rest or other nonproductive time so as not to penalize workers for taking rest breaks. Additionally, AB 1522—the Healthy Workplace Healthy Families Act of 2014—requires employers to provide paid sick leave for any employee who works 30 or more days within a year, including part-time and temporary workers. Employees earn at least one hour of paid sick leave for every 30 hours worked (California Department of Industrial Relations, 2019).

Perhaps the more costly regulatory changes are those that have yet to be fully implemented. In 2016, California passed SB 3, which mandates an increase in minimum wages to $15/hour by 2022. The increase will be phased in over time; California employers with 26 or more employees were required to pay a minimum of $10.50/hour in 2017 with incremental increases each year thereafter. Employers with 25 or fewer employees have an additional year to phase in the increases. Another state law requiring agricultural workers to receive overtime wages after 40 hours, rather than the current limit of 60 hours, was also passed in 2016. AB 1066 began to change overtime wages in January 2019 such that workers now receive overtime pay after 9.5 hours/day or 55 hours/week. By January 1, 2022, the law will be fully implemented with overtime pay occurring for work exceeding 8 hours/day or 40 hours/week (California Department of Industrial Relations, 2019). These recent laws are expected to pose significant costs to the agricultural industry.

This paper presents a follow-up of a 2006 study of regulatory costs for a large Salinas Valley lettuce grower (Hamilton, 2006). In the months following the original study, an historic *E. coli* outbreak in spinach substantially changed the regulatory landscape for leafy greens food safety with the implementation of the Leafy Greens Marketing Agreement, followed several years later with the Produce Rule of the Food Safety Modernization Act. This follow-up study provides the basis for estimating the impacts of increased agricultural labor costs on head lettuce production given the passage of SB 3.

Head Lettuce Production

We calculate the direct impact of costs associated with new wage policies and estimate their effects on head lettuce production and prices. Hamilton and McCullough (2018) document both the direct cash and indirect costs of regulatory compliance in 2017 and compare them to 2006 costs for the same lettuce grower. The 2006 study found that total regulatory compliance costs totaled $109.16/acre, or 4.25% of cultural costs and 1.26% of total production costs (Hamilton, 2006). In addition, 56% of regulatory costs were associated with labor and wage laws.

In the follow-up case study, labor-related regulatory costs increased from $61.57/acre to $721.57/acre. The increase can be primarily attributed to substantial increases (470%) in workers' compensation premiums, the value of nonproductive time, the time spent completing paperwork associated with each regulation, and the implementation of the Affordable Care Act (ACA). Because of these cost increases and the relatively limited availability of farm labor, California agricultural producers have been substituting capital for labor whenever technology allows for an economical substitution. Head lettuce, unlike other leafy greens, grows too close to the ground for mechanized harvesting using current technologies. Although new technologies are being developed, far fewer capital-labor substitutions have occurred in harvesting head lettuce relative to many other fruit and vegetable crops. The general increase in labor costs and other market effects have caused a fundamental shift in the types of leafy greens grown in California. Figure 2 indicates that leaf lettuce and romaine lettuce acreages have remained relatively flat over the past decade (California Department of Food and Agriculture, 2018). However, head lettuce acreages have declined by 36% over the same period. Some of the reduction may be a function of consumers gravitating toward value-added salad products, many of which can be mechanically harvested. Increased labor costs, however, have probably also contributed to the reduction in head lettuce acreage.

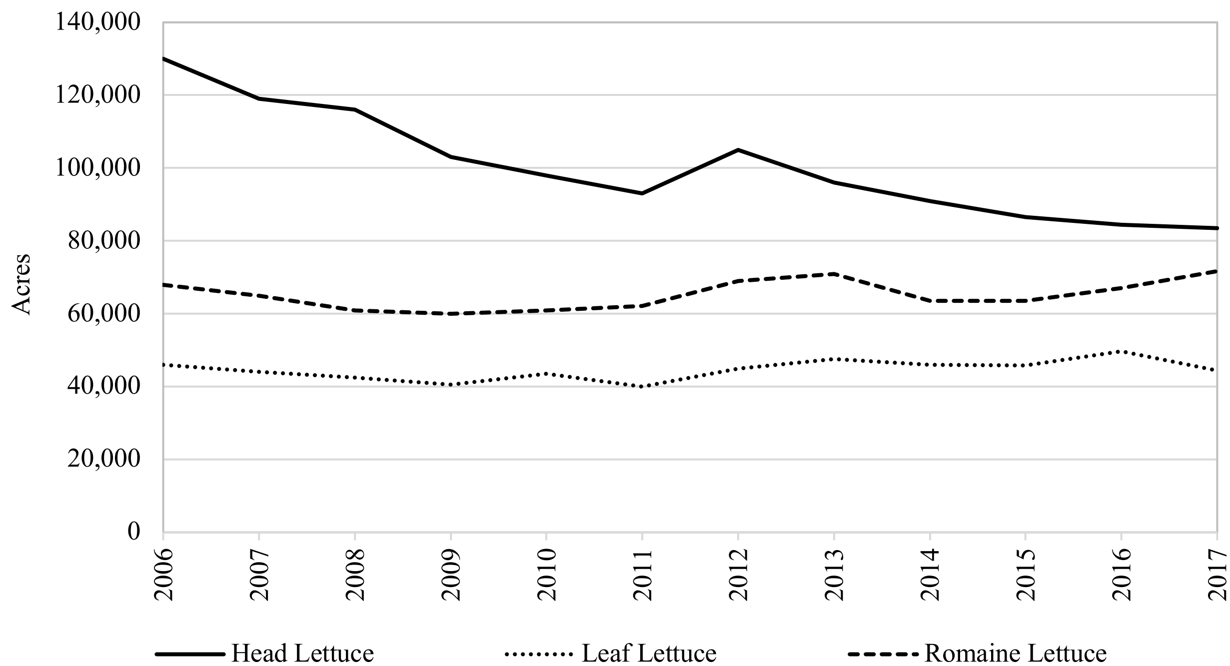

Figure 2. California Harvested Lettuce Acres

Labor costs associated with head lettuce harvesting are sufficiently large that they can exceed a shutdown price, commonly referred to as the "red line" in the lettuce industry. It is increasingly common to see high-quality head lettuce unharvested because harvest costs (for which labor is a major component) exceed lettuce prices. Because of the need for timely harvests, some head lettuce is simply destroyed during the process of preparing soil for the next crop. This is a type of food loss, which is an issue of growing importance as American diets are increasingly scrutinized (Boys and Rickard, 2019).

Table 2 presents total cash head lettuce production costs from a 2017 case study (Hamilton and McCullough, 2018). Seed, chemicals, irrigation, machine and labor cultivation time, harvest costs, and cash overhead costs (land rent, office expenses, and liability insurance attributable to head lettuce production) total nearly $11,000/acre. Approximately half of total cash costs are expenses related to harvesting head lettuce including manual field packing, cooling and palletizing, and marketing and sales fees. These costs total $6.42/carton. If the weekly farmgate price of head lettuce falls below the marginal harvest costs of $6.42/carton, farmers choose to not harvest during that week. Head lettuce that was ready to be harvested during a given week deteriorates to the point that it has to be abandoned. Figure 3 shows the average weekly shipping point price of head lettuce for the last 6 years and average harvest costs per carton as generated by our case study (United States Department of Agriculture Agricultural Marketing Service, 2018). For the 6-year period, there were 11 weeks in which harvest costs exceeded shipping point prices.

Table 2. Head Lettuce Cash Costs per Acre

Operating Costs	Quantity/ Acre	Unit	Price or Cost/Unit	Value or Cost/Acre
Fertilizer				$410.00
Custom				$434.00
Seed				$200.00
Herbicide/insecticide/fungicide				$711.00
Irrigation				$600.00
Machinery				$780.00
Labor				
Equipment operator labor	10.51	hours	$21.85	$229.64
Irrigation labor	13.00	hours	$17.80	$231.40
Non-machine labor	9.52	hours	$16.90	$160.89
Harvest[a]				
Cool/palletize	850.00	cartons	$1.06	$900.00
Harvest-field pack	850.00	cartons	$4.61	$3,922.50
Harvest-market/sales fee	850.00	cartons	$0.75	$637.50
Total operating costs/acre				$9,216.93
Total cash overhead costs/acre				$1,760.00
Total cash costs/acre				$10,976.93

Note: [a]Labor rates do not include regulatory costs associated with piece-rate harvesting labor.

Table 2 and Figure 3 do not account for regulatory costs associated with piece-rate harvesting labor. During the case study interview, regulatory costs associated with labor and wage rates were intentionally separated from the base wage rate so that a pre- and post-regulatory cost comparison could be made. Table 3 presents per acre regulatory costs for the case study grower. Some of the regulatory costs are fixed within a production cycle. Hence, those costs are presented on a per acre (rather than a per carton) basis. However regulatory requirements associated with the ACA, labor health and safety, labor wages, and workers' compensation are also calculated on a per carton basis because they are avoidable costs if harvest does not occur. Assuming harvest occurs, regulatory costs increase head lettuce production by $0.82/carton. When these costs are included, harvest costs exceed shipping costs in 26 weeks over the 6-year time span (Figure 3).

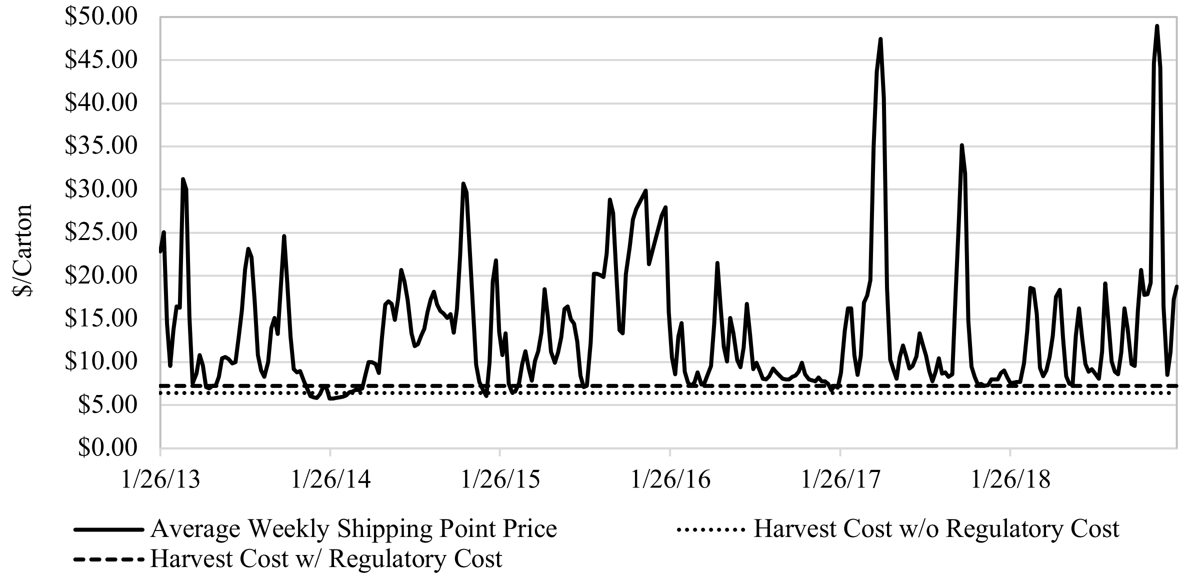

Figure 3. Head Lettuce Shipping Point Price and Average Harvest Cost (Nominal), With and Without Regulatory Costs

Table 3. 2017 Regulatory Costs per Acre and Carton for the Case Study Grower

Regulatory Category	Per Acre	Per Carton
ACA requirements	$141.19	$0.17
Air quality requirements	$5.26	
Assessments	$14.88	
Department of pesticide regulation	$35.55	
Education/training for regulatory compliance	$26.31	
Food safety - LGMA and PR	$181.48	
Labor health & safety requirements	$28.72	$0.03
Labor wage requirements	$189.10	$0.22
Water quality requirements	$18.57	
Workers' compensation	$336.23	$0.40
Totals	$977.30	$0.82

Note: For a full discussion of the regulatory cost categories and computations, see Hamilton and McCullough (2018).

An Equilbrium Displacement Model

We develop an equilibrium displacement model (EDM) to quantify the impacts of increased labor costs on the price and quantity demanded of head lettuce. The basic EDM is constructed following Atwood and Brester (2019), Gardner (1990), and Wohlgenant (1993) as

(1) $$E(q_d) = \eta_d E(p_d);$$

(2) $$E(p_s) = \sum_j K_j\, E(w_j^d);$$

(3) $$E\left(x_i^d\right) = E(q_s) + \sum_j K_j\, \sigma_{ij} E\left(w_j^d\right), i = 1,2, \ldots, n;$$

(4) $$E(x_i^s) = \sum_j \varepsilon_{ij}\, E\,(w_j^s);$$

where q_d is the quantity demanded of head lettuce, p_d is the consumer demand price of head lettuce, p_s is the producer supply price of head lettuce, q_s is the quantity supplied of head lettuce, x_i^d represents lettuce production sector's quantity demanded for factor inputs, w_j^d represents factor demand prices, x_i^s represents the quantity supplied of factor inputs, w_j^s represents factor supply prices, σ_{ij} is the Hicks–Allen elasticity of substitution between factors i and j, ε_{ij} are own- and cross-price elasticities of factor supplies, η_d is the own-price elasticity of demand for head lettuce, K_j represents factor cost shares ($K_j = \frac{w_j x_j^d}{w x^d}$) such that $\sum_j K_j = 1$, and $E(\cdot)$ represents percentage changes such that $E(\cdot) = \frac{d(\cdot)}{(\cdot)}$. Silberberg (1990) notes that $\sum_j K_j\, \sigma_{ij} = 0$ is necessary to make the system of equations "add up" or, more precisely, be homogeneous of degree 0 in input and output prices. This logical condition is analogous to the concept of a lack of "money illusion" in consumer theory. That is, the homogeneity condition implies that no output response should occur if all input prices were, say doubled, along with the output price. Hence, only relative input and output prices influence production behavior as opposed to absolute prices. In the absence of this condition, EDM outcomes are not consistent with economic theory.

Equation (1) represents the demand for head lettuce and equation (2) represents the supply of head lettuce. Equation (3) represents the production technology used to produce head lettuce in terms of factor inputs, the quantity supplied of lettuce, and factor prices. Equation (4) represents input factor supply functions.

We use the simplifying assumptions that only two inputs are being used (i.e., labor and a composite input representing all other factor inputs) and that factor input supply quantities are functions of only their own-factor prices rather than influenced by the price of the other factor in the system. It seems reasonable to assume that the impact of the price of all other production inputs (w_2) would have a *de minimis* influence on the supply of labor (x_1) and vice versa. Hence, we assume that $\varepsilon_{12} = \varepsilon_{21} = 0$. In addition, head lettuce has a short shelf life, so it is reasonable to assume that an equilibrium price (i.e., $p = p_d = p_s$) clears the market such that the quantities demanded and supplied are equal (i.e., $q = q_d = q_s$). Therefore, a one output, two-factor input EDM for the head lettuce industry can be written as

(5) $$E(q\ ) = \eta_D E(p) + E(\theta_1);$$

(6) $$E(p) = K_1 E(w_1) + K_2 E(w_2) + E(\theta_2);$$

(7) $$E(x_1) = E(q) + K_1 \sigma_{11} E(w_1) + K_2 \sigma_{12} E(w_2) + E(\theta_3);$$

(8) $$E(x_2) = E(q) + K_1 \sigma_{21} E(w_1) + K_2 \sigma_{22} E(w_2) + E(\theta_4);$$

(9) $$E(x_1) = \varepsilon_1 E(w_1) + E(\theta_5);$$

(10) $$E(x_2) = \varepsilon_2 E(w_2) + E(\theta_6).$$

Equation (5) represents consumer demand for head lettuce in which all arguments other than own-price of output are held constant. Equations (6)-(8) represent the head lettuce sector's aggregate production function and the first-order conditions for the sector's profit maximization problem. Equation (9) represents the supply of labor (factor input 1) and equation (10) represents the supply of all other inputs used in the production of head lettuce (factor input 2).

Equations (5)-(10) represent an EDM that can be used to model several types of exogenous shocks. Specifically, the model can be used to estimate changes in equilibria that result from (positive or negative) shocks to consumer demand (θ_1) and/or input supplies (θ_5, θ_6). Exogenous shocks to production technologies can be modeled using θ_2, θ_3, and θ_4, although these percentage changes are not independent of one another.

Regulatory Wage Policies

Policy-related actions are modeled within an EDM framework by placing a wedge between specific equilibrium conditions. For example, a regulatory action that places a price floor on wages represents a quantity wedge that is placed between the quantity demanded of labor and the quantity supplied of labor as indicated in Figure 4.

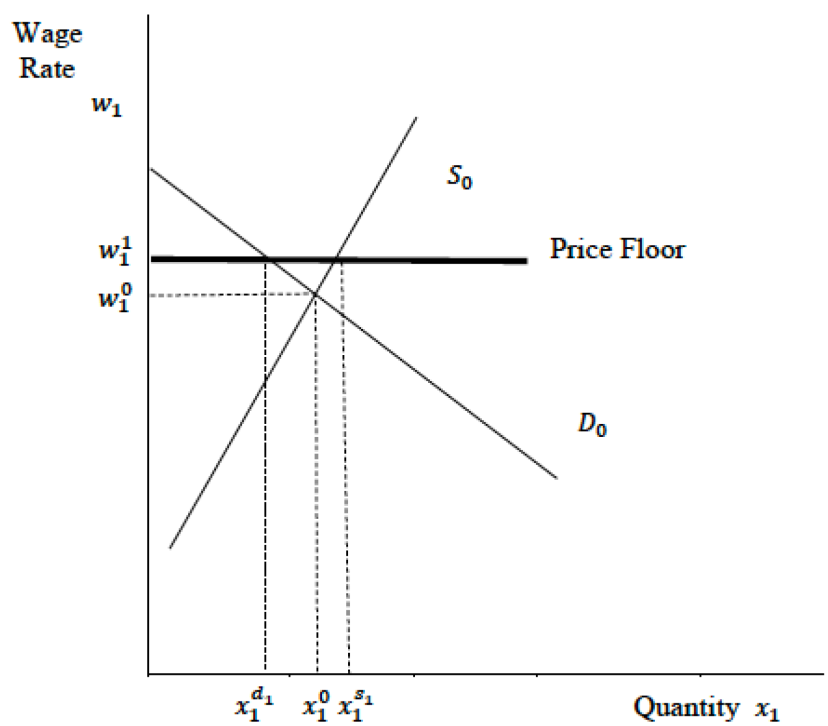

Figure 4. A Price Floor in the Labor Market

That is, prior to the implementation of the wage policies described above, the equilibrium wage rate is given by w_1^0 and the equilibrium quantity demanded and supplied are equal at x_1^0. The new, binding price floor is illustrated by the horizontal solid line at w_1^1 in Figure 4. The price floor generates a difference between the quantity demanded of labor ($x_1^{d_1}$) and the quantity of labor that workers would be willing to supply at the higher wage rate ($x_1^{s_1}$). We note that, in the absence of regulations on the quantity of labor hired, the quantity of labor actually hired will be determined by lettuce producers' derived demand for labor (i.e., $x_1^{d_1}$). The size of the quantity wedge between these two values is endogenously determined by the interaction of supply and demand given the regulatory intervention. The model endogenously determines the size of this wedge (and, hence, the values of $x_1^{d_1}$ and $x_1^{s_1}$) by including an additional constraint. The process is analogous to the use of Lagrangean equations as a means for adding constraints to an optimization process. The addition of a new constraint requires that a new endogenous variable representing the size of the quantity wedge (i.e., the amount of "surplus" labor in the market at the legislated price floor) be added to the system for the purpose of system identification.

The EDM in equations (5)-(10) must be altered to account for the legislated imposition of new wage rate policies. Because these policies create a difference between the quantity demanded and supplied of labor, the term x_1 in equation (7) is changed to x_1^d to reflect the quantity *demanded* of labor by California's head lettuce production sector:

$$E\left(x_1^d\right) = E(q) + K_1\sigma_{11}E(w_1) + K_2\sigma_{12}E(w_2) + E(\theta_3). \tag{11}$$

Further, the term x_1 in equation (9) is changed to x_1^s to reflect the quantity of labor that workers would be willing to supply at various prices (i.e., the quantity supplied of labor):

$$E(x_1^s) = \varepsilon_1 E(w_1) + E(\theta_5). \tag{12}$$

The quantity wedge driven between the quantity supplied of labor and the quantity demanded of labor by the minimum wage legislation is represented by

$$E(x_1^s) = E\left(x_1^d\right) + E(\lambda), \tag{13}$$

where λ is the endogenously determined size of the quantity wedge between x_1^s and x_1^d. Finally, an equation must be added to represent the legislated price floor that generates the wedge between quantity supplied of labor and the quantity demanded of labor:

$$E(w_1) = E(\theta_8), \tag{14}$$

where $E(\theta_8)$ is the percentage increase in the price of labor resulting from the wage rate legislation.

Head Lettuce Produced Outside of California

California produces 64% of U.S. head lettuce. Arizona produces most of the remainder, with Florida, Mexico, Canada, and Peru contributing modest amounts. Although California and Arizona's seasonal production cycles generally do not coincide, we consider all non-California head lettuce production as an additional sector in the EDM. We assume that the supply of "non-California" head lettuce (q_{nc}) is a function of the price of non-California head lettuce (p_{nc}). Assuming that non-California produced head lettuce is a perfect substitute for California head lettuce, the price of non-California head lettuce is deemed to be identical to the price of California head lettuce which allows for the supply of non-California head lettuce to be written as

(15) $$q_{nc} = q_{nc}(p).$$

Converting equation (15) into a differential elasticity form while assuming that the quantity demanded of head non-California lettuce production is equal to the quantity supplied of non-California head lettuce production yields

(16) $$E(q_{nc}) = \varepsilon_{nc}E(p) + E(\theta_7).$$

The amount of head lettuce available in the United States (q) is now a combination of California production (q_c) plus the quantity of non-California production (q_{nc}):

(17) $$q = q_c + q_{nc}.$$

Totally differentiating equation (17) yields

(18) $$dq = dq_c + dq_{nc}.$$

Dividing each term in equation (18) by q results in

(19) $$\frac{dq}{q} = \frac{dq_c}{q} + \frac{dq_{nc}}{q}.$$

To convert to elasticities and proportional market shares, we multiply the first term on the right side of equation (19) by $\left(\frac{q_c}{q_c}\right)$ and the second term by $\left(\frac{q_{nc}}{q_{nc}}\right)$, which yields

(20) $$\frac{dq}{q} = \left(\frac{q_c}{q}\right)\frac{dq_c}{q_c} + \left(\frac{q_{nc}}{q}\right)\frac{dq_{nc}}{q_{nc}}$$

or

(21) $$E(q) = \mathcal{R}_c E(q_c) + \mathcal{R}_{nc} E(q_{nc}),$$

where $\mathcal{R}_c$ represents California's production quantity share of head lettuce and $\mathcal{R}_{nc}$ represents the quantity share provided by all non-California head lettuce sources. Note that because head lettuce cannot be stored, $\mathcal{R}_c + \mathcal{R}_{nc}$ must sum to 1.0.

The complete EDM consists of equations (5), (6), (11), (8), (21), (16), (12), (10), (13), and (14), giving

(22) $$E(q) = \eta_D E(p) + E(\theta_1);$$

(23) $$E(p) = K_1 E(w_1) + K_2 E(w_2) + E(\theta_2);$$

(24) $$E(x_1^d) = E(q_c) + K_1\sigma_{11}E(w_1) + K_2\sigma_{12}E(w_2) + E(\theta_3);$$

(25) $$E(x_2) = E(q_c) + K_1\sigma_{21}E(w_1) + K_2\sigma_{22}E(w_2) + E(\theta_4);$$

(26) $$E(q) = \mathcal{R}_c E(q_c) + \mathcal{R}_{nc} E(q_{nc});$$

(27) $$E(q_{nc}) = \varepsilon_{nc} E(p) + E(\theta_7);$$

(28) $$E(x_1^s) = \varepsilon_1 E(w_1) + E(\theta_5);$$

(29) $$E(x_2) = \varepsilon_2 E(w_2) + E(\theta_6);$$

(30) $$E(x_1^s) = E(x_1^d) + E(\lambda);$$

(31) $$E(w_1) = E(\theta_8).$$

The EDM model presented in equations (22)–(31) is operationalized by moving the endogenous variables to the left side and then placing the resulting equalities into matrix form:

(32) $$\begin{bmatrix} 1 & -\eta_D & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & -K_1 & -K_2 & 0 & 0 \\ 0 & 0 & 1 & 0 & -1 & 0 & -K_1\sigma_{11} & -K_2\sigma_{12} & 0 & 0 \\ 0 & 0 & 0 & 1 & -1 & 0 & -K_1\sigma_{21} & -K_2\sigma_{22} & 0 & 0 \\ 1 & 0 & 0 & 0 & -\mathcal{R}_c & -\mathcal{R}_{nc} & 0 & 0 & 0 & 0 \\ 0 & -\varepsilon_{nc} & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -\varepsilon_1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & -\varepsilon_2 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 1 & -1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} E(q) \\ E(p) \\ E(x_1^d) \\ E(x_2) \\ E(q_c) \\ E(q_{nc}) \\ E(w_1) \\ E(w_2) \\ E(x_1^s) \\ E(\lambda) \end{bmatrix} = \begin{bmatrix} E(\theta_1) \\ E(\theta_2) \\ E(\theta_3) \\ E(\theta_4) \\ 0 \\ E(\theta_7) \\ E(\theta_5) \\ E(\theta_6) \\ 0 \\ E(\theta_8) \end{bmatrix}.$$

In a general form, equation (32) can be written as

(33) $$\boldsymbol{Ay} = \boldsymbol{x},$$

where $\boldsymbol{A}$ is a 10×10 matrix of parameters, $\boldsymbol{y}$ is an 10×1 vector of endogenous variables, and $\boldsymbol{x}$ is an 10×1 vector of exogenous shocks. After parameterizing the $\boldsymbol{A}$ matrix, the system's endogenous variables can be solved for any exogenous shock (θ_i) as

(34) $$\boldsymbol{y} = \boldsymbol{A}^{-1}\boldsymbol{x}.$$

Parameterizing the Model

The matrix $\boldsymbol{A}$ is parameterized using an own-price elasticity of demand (η_D) of −0.56 (Mahish, 2018). We use an estimate of the own-price elasticity of labor supply (ε_1) for factor (x_1) of 0.15, which is the simple average of estimates for male and female agricultural laborers (Hill, 2016, 2019). The own-price elasticity of factor supply (ε_2) for input 2 (x_2) is assumed to be highly elastic because lettuce production is a relatively small part of U.S. agricultural capital, herbicide, and machinery input use. We arbitrarily set this value to 10. Based on the per acre cash costs reported in Table 2, the factor shares of x_1 (K_1) and x_2 (K_2) are 0.414 and 0.586, respectively. We also (initially) assume that the Allen elasticities of substitution are $\sigma_{12} = \sigma_{21} = 0.20$, which indicates that the substitution between labor and all other inputs is relatively limited. The assumption is based on the current paucity of mechanical harvesting technologies. Although the terms σ_{11} and σ_{22} have no economic meaning as elasticities of substitution, they must be included in the model if the economic system is to be homogeneous of degree 0 in prices and allow for the system to add up (Silberberg, 1990). These values are calculated as $\sigma_{11} = -\frac{K_2 * \sigma_{12}}{K_1} = -\frac{0.586*0.20}{0.414} = -0.283$ and $\sigma_{22} = -\frac{K_1 * \sigma_{21}}{K_2} = -\frac{0.414*0.20}{0.586} = -0.141$. Because California head lettuce production represents 64% of total U.S. consumption, the value of $\mathcal{R}_c$ is set equal to 0.64 and the value of $\mathcal{R}_{nc}$ is set to 0.36. Using these values, the matrix $\boldsymbol{A}$ in equation (32) is parameterized as

(35) $$\boldsymbol{A} = \begin{bmatrix} 1 & 0.56 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & -0.414 & -0.586 & 0 & 0 \\ 0 & 0 & 1 & 0 & -1 & 0 & 0.12 & -0.12 & 0 & 0 \\ 0 & 0 & 0 & 1 & -1 & 0 & -0.08 & 0.08 & 0 & 0 \\ 1 & 0 & 0 & 0 & -0.64 & -0.36 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -0.15 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & -10.0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 1 & -1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \end{bmatrix}.$$

The EDM is used to estimate the impacts of an exogenous shock in labor costs resulting from several legislated wage rate policies. That is, SB 3 will increase the minimum wage to $15/hour by 2022, AB 1513 requires employers to pay for nonproductive time, and AB 1066 will increase overtime pay by reducing normal working hours to 40 hours/week. Although previous wage regulations were nonbinding, wage rates for H-2A immigrant labor in California were legislated to be $13.18/hour in 2017 and have since risen to $13.92/hour. Employers who hire H-2A workers must pay all of their workers the same wage, even if only a small portion of the workforce is designated as H-2A workers. SB 3 represents a 17% increase in the current equilibrium wage rate, although this increase will be gradually phased in over several years. Combined with additional piece-rate and overtime rules (estimated to be approximately 3% in the 2017 case study), we consider the impact of a 20% increase in labor wage rates above current equilibrium values. The impact of a 20% increase in wage rates on the endogenous variables is operationalized by setting the value of $E(\theta_8)$ to 0.20 such that the exogenous shock vector becomes

(36)
$$\boldsymbol{x} = \begin{bmatrix} 0.0 \\ 0.0 \\ 0.0 \\ 0.0 \\ 0.0 \\ 0.0 \\ 0.0 \\ 0.0 \\ 0.0 \\ 0.20 \end{bmatrix}.$$

Results

Using equation (34) and the exogenous shock indicated in equation (36), a 20% increase in labor costs results in the following percentage changes in the vector of endogenous variables:

(37)
$$\boldsymbol{y} = \begin{bmatrix} E(q) \\ E(p) \\ E(x_1^d) \\ E(x_2) \\ E(q_c) \\ E(q_{nc}) \\ E(w_1) \\ E(w_2) \\ E(x_1^s) \\ E(\lambda) \end{bmatrix} = \begin{bmatrix} -0.043 \\ 0.077 \\ -0.136 \\ -0.094 \\ -0.111 \\ 0.077 \\ 0.200 \\ -0.009 \\ 0.030 \\ 0.166 \end{bmatrix}.$$

The interpretation of these results is that a 20% increase in labor costs increases the retail price of head lettuce, $E(p)$, by 7.7%, which reduces the quantity demanded of head lettuce, $E(q)$, by 4.3%. The reduction in head lettuce production (i.e., that which coincides with the reduction in quantity demanded) could be the result of fewer acres planted and/or fewer cartons harvested. In addition, the price of labor, $E(w_1)$, increased by 20.0%, which represents the legislated increase in labor costs above the current equilibrium price. The labor price floor reduces the quantity demanded of labor, $E(x_1^d)$, by 13.6%. For the second (composite) factor, the increase in the price of labor causes the demand for all other inputs, $E(x_2)$, to decline by 9.4%, and the price of all other inputs, $E(w_2)$, to decline by a very small amount (−0.9%). The small decline in the price of all other inputs is the result of the assumed large elasticity of supply for all other inputs (i.e., 10.0). However, the reduction in the demand for this second input is negative rather than positive as would normally be expected for two inputs that are production substitutes. In this case, however, the assumed small elasticity of substitution between the two inputs causes the negative scale effect of lower production to overwhelm the positive (but small) substitution effect between the two factor inputs. Hence, the increase in labor wages causes a reduction in the production of head lettuce that also reduces the demand for the composite input. Although there are some substitution possibilities between labor and all other inputs, they are not sufficiently large to increase the demand for this second factor input.

The production of head lettuce in California, $E(q_c)$, declines by 11.1%, while production of head lettuce that is consumed in the United States from non-California sources, $E(q_{nc})$, increases by 7.7%. Because of the linearity of the EDM, the share weighted changes in production among the two "production regions" equals the overall decline in lettuce consumption (4.3%). Finally, note that the sum of the absolute value of the reduction in quantity demanded of labor (−13.6%) and the increase in the potential quantity supplied of labor (3.0%) is equal to the quantity wedge calculated by the model, $E(\lambda)$, of 16.6%. That is, the size of the quantity wedge that is driven between the quantity demanded and supplied of labor is provided by $E(\lambda)$. The reduction in the quantity demanded of labor is more than twice the increase in the quantity of labor that workers would be willing to supply at the higher wage rate because of the relatively inelastic own-price elasticity of labor supply.

Sensitivity Analyses

The EDM allows for a variety of sensitivity analyses. For example, the decrease in quantity demanded of head lettuce noted above is certainly influenced by estimates of its own-price elasticity of demand. Figure 5 presents the changes in quantity demanded of head lettuce caused by a 20% increase in agricultural wage rates for various demand elasticity estimates. Specifically, the elasticity of demand for head lettuce (η_D) in the parameter matrix $\boldsymbol{A}$ is set to values between −0.05 and −2.0, and equation (34) is solved for each selected elasticity. The results are recorded for each solution ($\boldsymbol{y}$). As the elasticity of demand for head lettuce becomes less inelastic (more elastic), the percentage reduction in quantity demanded increases from 0.4% to 13.8% in response to the wage rate increase.

Alternatively, consider the possibility that other production inputs become more substitutable for labor. Technologies are being developed that will eventually reduce labor requirements needed for the mechanical harvesting of head lettuce. To simulate the effect of such a technological change, we evaluate the impact of a 20% increase in labor wage rates while allowing the elasticity of substitution to vary from 0.0 (the case of fixed input proportions between labor and other inputs) to 3.0. Figure 6 shows that the marginal impact on quantity demanded of head lettuce to be quite small as the elasticity of substitution ranges from 0.0 to 3.0. Note that increases in the elasticity of substitution between labor and all other inputs do not alter the result that increasing wage rates will increase head lettuce prices and reduce the quantity demanded of head lettuce.

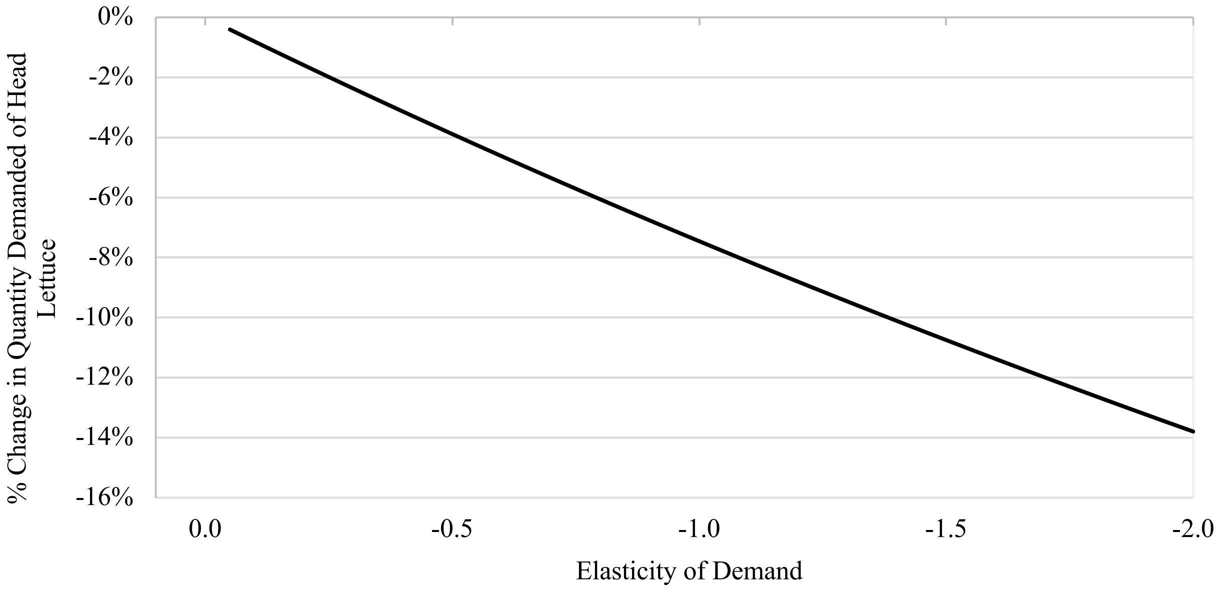

Figure 5. Percentage Decrease in Quantity Demanded of Head Lettuce for Various Own-Price Elasticities of Demand

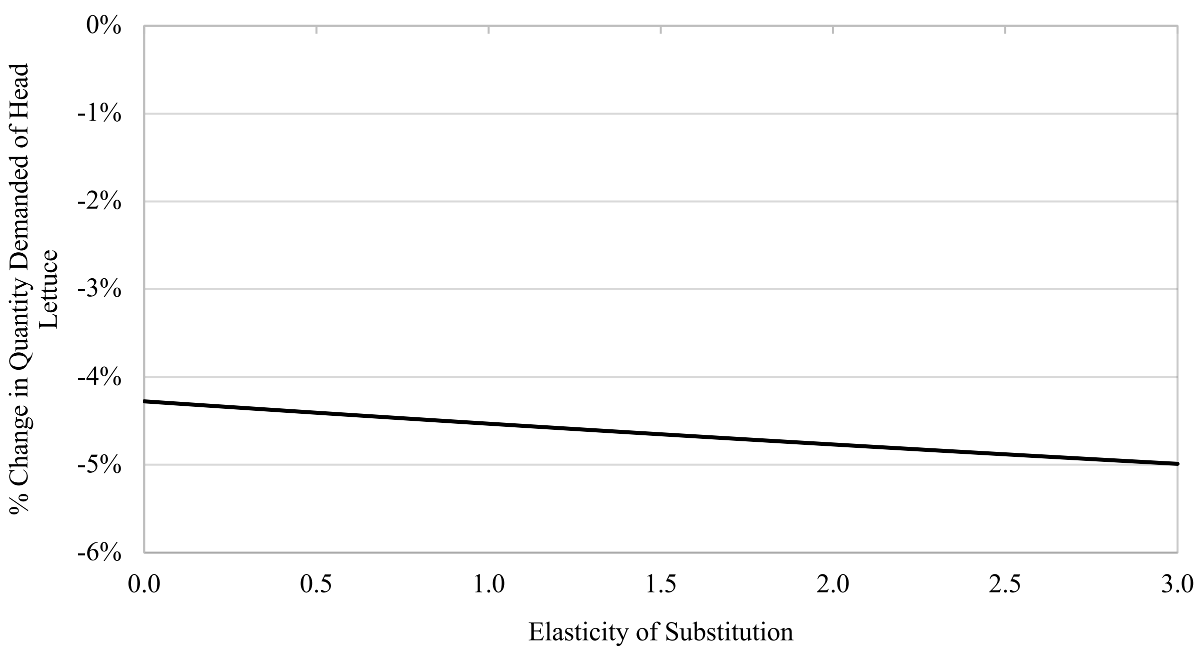

Figure 6. Percentage Decrease in Quantity Demanded of Head Lettuce for Various Elasticities of Factor Input Substitution

Conclusions

The supply of agricultural labor has been declining for many years. In addition, a variety of regulations (especially in California) have increased agricultural labor costs. To the extent possible, increases in labor costs encourage the substitution of other inputs for labor. Alternatively, if such substitution is limited, farmers adjust by switching to less labor-intensive crops.

Agricultural labor costs have been increasing over the past 2 decades. This is especially the case in California, which is the nation's largest fruit and vegetable-producing state. Recent legislation (SB 3, AB 1513, and AB 1066) will increase the minimum hourly wage for farm workers and requirements regarding piece-rate and overtime pay. These actions will increase labor costs, reduce the quantity demanded of labor, and reduce the U.S. production of labor-intensive agricultural products.

We use an equilibrium displacement model to estimate the impact of legislated increases in agricultural wage rates. We find that a 20% increase in agricultural labor wage rates will increase the retail price of head lettuce by 7.7% and reduce the quantity demanded of head lettuce by 4.3%. These effects are not mitigated by larger Allen elasticities of substitution between labor and other inputs.

Increases in labor costs will reduce head lettuce production and cause concomitant increases in the price of head lettuce and reductions in quantity demanded. Given that U.S. consumers already fail to consume the amount of vegetables recommended by the USDA, increases in labor wage rate regulations will exacerbate this deficiency.

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Consumer Preferences for Tennessee Milk

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Abstract

To support dairy farmers in the state of Tennessee, in 2018 the TN Department of Agriculture instituted a "TN Milk" logo that indicates the milk is entirely sourced, processed, and bottled in Tennessee. To examine consumer preferences for this logo, TN-milk-drinking households were surveyed. The contingent valuation method was used to assess consumer willingness to pay for milk labeled as TN Milk. A probit regression with 352 observations was used to estimate the characteristics of consumers who were more likely to purchase TN Milk. Results suggest consumers would pay a 12% premium for TN Milk.

Keywords: contingent valuation, fluid milk, local, willingness to pay

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Introduction

Packaged Facts (2015) estimated that local foods generated $12 billion in 2014 sales, accounting for 2% of total U.S. beverage and food retail sales. Recognizing this trend of increased consumer interest in purchasing local foods, the 110th Tennessee General Assembly passed legislation enacting the TN Milk logo (Tennessee Department of Agriculture, 2018). Enabled by this legislation, the Tennessee Department of Agriculture (TDA) instituted a TN Milk logo in September 2018 (TDA, 2018). This logo (Figure 1) was created with the goal of creating a marketing opportunity for TN dairy producers. The logo declares that the milk to be entirely sourced, processed, and bottled in Tennessee. As of 2019, the logo was in limited use and little was known about consumers' preferences for milk with the TN logo. In 2019, the logo was used by a regional chain of convenience stores that sell milk across East Tennessee, a University creamery in Middle Tennessee, and three other dairies that sell retail milk (TDA, 2018).

Figure 1. Tennessee Milk Logo

Part of the reason TDA introduced this label was to help the TN dairy industry; the number of TN dairy farms and milk cows has been declining over the past few decades. In 2011, there were 450 Grade A dairies in Tennessee (Moss et al., 2012). One-hundred percent of TN dairies are Grade A dairies, which means they sell fluid milk (USDA, 2019b); however, TN is considered a fluid milk "deficit" state, such that fluid milk sold in Tennessee is not solely from TN dairies (Moss et al., 2012). As of 2019, there were only 196 Grade A dairies in Tennessee, a decrease of 56% (TDA, 2019). The state's production of milk has also decreased by 31%, to only 693 million pounds from 2007 to 2017 (LMIC, 2019).

From 2007 through 2017, the number of milk cows in Tennessee decreased by 37%, with only 40,000 milk cows as of 2017 (U.S. Department of Agriculture (USDA), 2019a; Livestock Marketing Information Center (LMIC), 2019). TN dairy herds are smaller than the national average and have lower-producing milk cows (17,129 lb of milk per cow) than the national average (23,149 lb of milk per cow) (USDA, 2019; LMIC, 2019). It is difficult for the relatively smaller TN dairies to compete with larger dairies that have economies of size. In an attempt to offset these issues and to help support the TN dairy industry, TDA created the TN Milk logo.

The goal of this research is to determine whether TN consumers prefer milk carrying the TN Milk logo and whether they would pay a premium for this milk. In addition, this research aims to identify target market segments for milk with the TN Milk logo. To accomplish this, a survey of TN consumers was conducted using the contingent valuation method to estimate their preferences for milk carrying the TN Milk logo.

Previous Research

Several research articles have examined consumer preferences for local foods (Merritt et al., 2018; Dobbs et al., 2016; Adalja et al., 2015; Gracia, de Magistris, and Nayga, 2012; Carpio and Isengildina-Massa, 2009; Brown, 2003; Park and Gómez, 2011). These studies have used choice experiments, experimental auctions, and the contingent valuation method to infer that consumers will pay premiums for local foods ranging from produce (Carpio and Insengildina-Massa) to beef (Merritt et al., 2018; Dobbs et al., 2016), lamb (Gracia, de Magistris, and Nayga, 2012), and 2% fluid milk (Park and Gómez, 2011).

Past research has examined consumer preferences for milk products carrying a variety of labels (Forbes-Brown, Micheels, and Hobbs, 2016; Schott and Bernard, 2015; Akaichi et al., 2012; Wolf, Tonsor, and Olynk, 2011; Brooks and Lusk, 2010; Wong et al., 2010; Best and Wolfe, 2009; Bernard and Bernard, 2009). Forbes-Brown, Micheels, and Hobbs used a discrete choice experiment to examine Canadian consumer preferences for a 100% Canadian Milk label on ice cream made from 100% Canadian milk. They found that Canadian consumers would pay a premium for this label. Schott and Bernard (2015) conducted an experimental auction to examine how dairy farm size moderated consumer willingness to pay (WTP) for conventional, noncertified organic, and organic milk. Akaichi et al. (2012) conducted a multiunit Vickrey auction and found that consumers were willing to pay a premium for organic milk. Using a choice experiment, Wolf, Tonsor, and Olynk (2011) examined consumer preferences for a variety of fluid milk attributes. Among other results, they found that consumers were willing to pay substantial premiums for milk produced without the use of the recombinant bovine somatotropin (rBST) growth hormone. To examine the profile of Southeastern local shoppers who might prefer local dairy products, Best and Wolfe (2009) used a telephone survey. Wong et al. (2010) examined which consumers in the Southeast would be willing to pay a premium for grass-fed and organic milk using survey data. Finally, Bernard and Bernard (2009) conducted an experimental auction to determine consumer WTP for organic, rBST-free, no antibiotics used, and conventional milk.

In addition to consumer surveys that elicit milk preferences, studies have used scanner data to explore U.S. household demand for fluid milk (Chen, Saghaian, and Zheng, 2018; Hovhannisyan and Gould, 2012; Schrock, 2012; Chang et al., 2011; Alviola and Capps, 2010; Brooks and Lusk, 2010; Jonas and Roosen, 2008). For example, Chen, Saghaian, and Zheng (2018) used data from the Nielsen Homescan Panel to examine demand relationships between different types of milk. Among other results, they found that as household incomes increased, consumers were more likely to buy organic milk instead of conventional milk. We contribute to the literature on fluid milk demand by determining consumer preferences for milk labeled with the TN Milk logo.

In the past several years, research has documented that consumers (Merritt et al., 2018; Dobbs et al., 2016; Adalja et al., 2015; Gracia, de Magistris, and Nayga, 2012; Carpio and Isengildina-Massa, 2009; Brown, 2003) and restaurants (McKay et al., 2019a) would pay a premium for local foods. Within the category of local foods, researchers have specifically examined whether consumers would pay a premium for food labeled as produced within their own state. For example, Carpio and Isengildina-Masa (2009) used the contingent valuation method and found that South Carolina consumers would pay more for fresh produce and animal products if they were grown in South Carolina. Merritt et al. (2018) used a choice experiment and found TN consumers would pay more for steak and ground beef labeled as TN Certified Beef. Similarly, Dobbs et al. (2016) used the contingent valuation method and found that TN consumers would pay more for TN steak. Using the contingent valuation method, McKay et al. (2019a) found that restaurants in Tennessee would also pay a premium for TN Certified Beef steak and ground beef. Given that previous research has found consumers will pay more for state-branded labels on food products, the goal of this research is to determine whether consumers will pay more for fluid milk labeled as TN Milk.

Data

Survey Design

In June 2019, an online Qualtrics survey was distributed to TN residents over the age of 18 who were primary food shoppers for the household and whose household included consumers of cow's milk. A copy of the survey instrument is available from the authors upon request. The goal of the survey was to obtain TN consumer preferences for milk carrying the new TN Milk logo. Qualtrics collected surveys until a total of 409 completed surveys were obtained. This number of observations was chosen since previous research using similar contingent valuation and probit regression methods used a similar number of observations (McKay et al. 2019a,b). The survey contained several sections, including a contingent valuation question that elicited consumer preferences for TN milk, attitudes toward fluid milk, consumer milk expenditures, attitudes toward local foods, and demographics.

Prior to eliciting consumer preferences for TN Milk, the TDA definition and logo (Figure 1) for TN Milk were provided to participants (TDA, 2018). TN Milk was defined as follows:

> The Tennessee Milk logo is administered by the Tennessee Department of Agriculture and milk with this logo must be entirely sourced, processed, and bottled in Tennessee. This means milk with this logo is 100% from Tennessee dairy farms and is packaged and processed within the state.

Since the TN Milk logo was created almost a year prior to our survey, respondents were next asked how familiar they were with the TN Milk logo on a Likert scale (where 1 = not at all familiar and 5 = extremely familiar). Consumers were then provided a cheap talk script, which explained hypothetical bias and requested that participants make realistic choices regarding milk purchases (Cummings and Taylor, 1999). Consumers were next asked which type of milk they typically consumed (i.e., whole, 2%, 1%, skim, and lactose-free). Depending on which milk they selected, they were asked to assume that the next few questions were about this type of milk.

To examine consumer preferences for a gallon of milk with the TN Milk logo, consumers were next presented with a contingent valuation question involving two gallons of fluid milk with varying prices. The first gallon was labeled with the TN Milk logo and the second gallon was identical in all other respects except that it had no logo and a varying price. The survey respondent could select either gallon of milk or neither product. The gallon of milk with no logo was always priced at \$2.69/gallon. The gallon of milk with the TN Milk logo was given one of five prices: \$2.69, \$3.19, \$3.69, \$4.19, or \$4.69 (each price was offered to 20% of respondents). Each survey participant was randomly assigned to see one of the varying prices for the TN Milk. The base price and the range of prices for the gallon of milk with the TN Milk logo were determined according to the average and range of market prices for a gallon of milk at major retailers that were collected prior to the survey through TN grocery store observation and from the USDA Agricultural Marketing Service *Retail Milk Price Report* (USDA, 2019c). Figure 2 illustrates an example choice set. The remaining survey questions asked consumers about their attitudes toward fluid milk, monthly milk expenditures, attitudes toward local foods, and demographics.

Assume you are in the grocery store and you wish to purchase a gallon of cow's milk. Which of the following gallons of milk shown below would you pruchase? Please choose one of the two gallons of milk or choose the "neither of these" options.

Figure 2. Example Choice Set for Tennessee Milk

Economic Model and Conceptual Framework

Following McFadden's (1974) random utility model, a consumer will purchase one product over another if their utility for that product is greater than the utility derived from the other product. Thus, consumer *c* will choose milk labeled as TN Milk instead of an unlabeled gallon of milk if the expected utility from purchasing a gallon of TN Milk, represented by $E(U_{c,TN\_Milk})$, is greater than the expected utility from purchasing an unlabeled gallon of milk, represented by $E(U_{c,Milk})$ (i.e., $E\left(U_{c,TN\_Milk}\right) > E\left(U_{c,Milk}\right)$.

The probability (Pr) that a consumer will choose TN Milk is defined as

$$\text{(1)} \qquad \Pr\left[y_{c,TN\_Milk} = 1\right] = \Pr[E\left(U_{c,TN\_Milk}\right) > E(U_{c,Milk})] = \Pr\left[\boldsymbol{x_c}'\boldsymbol{\beta} + \varepsilon_c > 0|\boldsymbol{x}\right] = F\left(\boldsymbol{x_c}'\boldsymbol{\beta}\right),$$

where $\boldsymbol{x_c}'\beta$ are observable elements of the difference between the expected utility of the two gallons of milk, ε is the difference between the random elements, and F is a cumulative distribution function (Greene, 2012). A vector of independent variables, $\boldsymbol{x_c}$, consists of consumer demographics, TN Milk prices, consumer milk expenditures per month, perceived quality and economic benefits of TN Milk, familiarity with the TN Milk logo, and consumer preferences toward local foods and organic milk. The latent model depicting this choice is

$$\text{(2)} \qquad y^*_{c,TN\_Milk} = \boldsymbol{x_c}'\beta + \varepsilon_c,$$

where

$$\text{(3)} \qquad y_{c,TN\_Milk} = \begin{cases} 1 & \text{if } y^*_{c,TN\_Milk} > 0 \\ 0 & \text{otherwise} \end{cases}$$

because only the decision to purchase TN Milk is observed and not the actual utility.

The dependent variable of the regression model was equal to one if a consumer selected the gallon of milk with the TN Milk logo and was 0 if the consumer selected the unlabeled milk. A total of 20 participants selected neither milk and were excluded from the regression because they were considered to be non-purchasers of milk. The errors in the linear model in equation (2) are assumed to be normally distributed and have an expected value of 0 with a variance of 1 (Greene, 2012). The normal cumulative density function is assumed to estimate the probability of a consumer's decision to purchase the gallon of milk labeled as TN Milk:

$$\text{(4)} \qquad \Pr\left[y_{c,TN\_Milk} = 1 \mid \boldsymbol{x_c}\right] = F\left(\boldsymbol{x_c}'\beta\right) = \int_{-\infty}^{x_c'\beta} \phi\left(z\right) dz = \Phi\left(\boldsymbol{x_c}'\beta\right),$$

where $\phi(z)$ is the probability density function of the standard normal distribution. The log-likelihood function is

$$\text{(5)} \qquad \ln L = \sum_{c=1}^{352}\left[y_{c,TN\_Milk} \ln\Phi\left(\boldsymbol{x_c}'\beta\right) + (1 - y_{c,TN\_Milk})\ln\left\{1 - \Phi\left(\boldsymbol{x_c}'\beta\right)\right\}\right],$$

where the vector of βs maximizing equation (5) are the maximum likelihood estimates. Following Wooldridge (2002), the average marginal effects for the discrete and continuous variables were also calculated. Stata was used to estimate the probit regression using the probit command (StataCorp, 2017). The associated marginal effects were computed following the probit regression by using the Stata command margins. Of the 409 surveyed TN consumers who participated in the survey, 352 answered all of the questions included as variables in the probit regression.

Diagnostic Tests

Variance inflation factors (VIFs) and the conditional index test were used to examine the presence of multicollinearity in the model using the vif and coldiag2 Stata commands (Belsley, 1991; Gujarati and Porter, 2009; StataCorp, 2017). A VIF of under 10 indicates that multicollinearity is not a concern with the independent variables (Gujarati and Porter, 2009). A conditional index number of under 30 indicates multicollinearity is not a concern (Belsley, 1991).

Willingness to Pay Calculations

Results from the model were used to estimate average consumer WTP for milk labeled with the TN Milk logo with the formula

$$\widehat{WTP}_{c,TN\_Milk} = -\frac{\hat{\beta}_0 + \boldsymbol{x}_c{}'\hat{\beta}_{-p}}{\hat{\beta}_p}, \tag{6}$$

where $\hat{\beta}_0$ is the estimated intercept, $\hat{\beta}_{-p}$ is a vector of estimated parameters excluding the TN Milk price coefficient, z is the vector of independent variables excluding TN Milk price, and $\hat{\beta}_p$ is the estimated parameter for the price of TN Milk (Dobbs et al., 2016). WTP was determined as the average WTP evaluated for each consumer.

Independent Variables and Hypothesized Results

The independent variables hypothesized to impact a consumer's decision to purchase TN Milk appear in Table 2. It is assumed that as the price of TN Milk (*Price*) increases, consumers will be less likely to purchase TN Milk. This is consistent with previous contingent valuation studies that also found as price increases, consumer willingness to adopt a product decreases (McKay et al., 2019a,b). It is unknown if consumers who spend more on milk per month (*Milk_Spending*), will be more or less likely to adopt TN Milk. This variable was created by multiplying participant responses to how often they purchased milk in a month by the price they stated they paid for the container of milk they purchased at each visit. Bernard and Bernard (2009) found that as consumers purchased milk more frequently, their bids in an experimental auction for different types of milk had a higher variance. Even though the predicted sign of this variable is unknown, it is important to control for whether frequent milk shoppers would prefer TN Milk, since this would have large implications on the success of the label if frequent milk shoppers were more likely to purchase TN Milk.

A *Quality_Benefits* index was created to estimate consumer perceived quality of TN Milk. This variable was created by averaging consumer responses (based on a five-point Likert scale, where 1 = strongly disagree and 5 = strongly agree) to the following four statements:

i. Compared with other milk, TN Milk will likely be fresher,.
ii. Compared with other milk, TN Milk will likely be safer.
iii. Compared with other milk, TN Milk will likely be better for the environment.
iv. Compared with other milk, TN Milk will likely taste better.

It is hypothesized that consumers who consider TN Milk to be of higher quality would be more likely to purchase TN Milk. Sharma, Moon, and Strohbehn (2014) found that restaurants considered local foods to be of higher quality and were thus willing to promote local foods. However, McKay et al. (2019a) did not find the perceived quality of TN Certified Beef (TCB) to have an impact on a restaurant's decision to offer TCB ground beef or sirloin steak.

An *Economics_Benefits* index was created to estimate consumer perceived benefits of TN Milk to the TN and farmer economy. This variable was created by averaging consumer responses (based on a five-point Likert scale, where 1 = strongly disagree and 5 = strongly agree) to the following two statements:

i. Compared with other milk, TN Milk will likely help support TN dairy farmers' incomes.
ii. Compared with other milk, TN Milk will likely help support the state's economy.

It is hypothesized that consumers who consider TN Milk to have more economic benefits for TN dairy farmers and the state's economy (*Economics_Benefits*) will be more likely to purchase TN Milk.

Consumers were asked whether they were willing to pay a price premium for locally produced food (*Local_Premium*) (based on a five-point Likert scale, where 1 = strongly disagree and 5 = strongly agree). As consumers are more likely to pay premiums for locally produced foods, we hypothesize that they will be more likely to purchase TN Milk since it is a state-specific product. A dummy variable was created that was equal to 1 if consumers regularly purchase organic cow's milk (*Purchase_Organic*) and 0 otherwise. We hypothesize that consumers who value organic dairy production will also value local production and be more likely to purchase TN Milk. Previous research has found that some consumers associate attributes of organic products, such as no synthetic pesticides and nongenetically modified ingredients, with local foods (Campbell et al., 2014).

Consumers were asked how familiar they were with the TN Milk logo on a scale from 1 (not at all familiar) to 5 (extremely familiar) (*Logo_Familiar*). As consumers were more familiar with the TN Milk logo, it was expected that they would be more likely to choose the TN Milk. Similarly, Collart, Palma, and Carpio (2011) found that familiarity with two Texas state-sponsored plant logo programs had a positive influence on consumer willingness to pay for plants bearing the state-sponsored logo.

Previous research regarding consumer food preferences have controlled for demographics in their analysis (e.g., Brown 2003; Chen, Saghaian, and Zheng, 2018; Bernard and Bernard 2009; Dobbs et al., 2016; Hawkins, Vassalos, and Motallebi, 2019). Similarly, we controlled for farming background, income, gender, age, household size, and age in our probit regression. If someone in the household was raised on a farm or worked on a farm at some point (*Farmer*), it was hypothesized the family would be more likely to purchase TN Milk to support the dairy industry and fellow farmers. Brown (2003) found that households in which someone was raised on a farm (or had parents who were raised on a farm) had stronger preferences for locally grown food and were willing to pay a premium for locally grown food.

Chen, Saghaian, and Zheng (2018) found that as household incomes increased, consumers were more likely to buy organic milk instead of conventional milk. Bernard and Bernard (2009) found that individuals with higher incomes would pay more for recombinant bovine somatotropin-free (rBST-free) milk. Similarly, we hypothesized that as consumer incomes increased, consumers would be more likely to purchase TN Milk. Bernard and Bernard found that males and older individuals were less likely to pay more for organic milk. Dobbs et al. (2016) found that older consumers were less likely to choose TN steak. Similarly, we predict females and younger individuals will be more likely to purchase TN Milk.

Bernard and Bernard (2009) found that those with college degrees or higher were willing to pay more for recombinant bovine somatotropin-free (rBST-free) milk and milk with no antibiotics. Thus, we expect individuals with college degrees or higher to be more willing to purchase TN Milk.

We are uncertain, *a priori*, on how household size would impact a consumer's decision to purchase TN Milk. Dobbs et al. (2016) found that education and household size did not influence a consumer's decision to purchase TN beef. A study by Hawkins, Vassalos, and Motallebi (2019) of South Carolina branded programs found no significant difference in familiarity with the labels across household size. However, in a study of consumer purchases of "New Jersey Fresh"–labeled products, Govindasamy et al. (1998) found that households with a size of four or more were more likely to have bought Jersey Fresh products than households of smaller size. We are also uncertain, *a priori*, how race would impact a consumer's decision to purchase TN Milk. Best and Wolfe (2009) did not find race to be significant in determining southeastern consumer preferences for local dairy products.

Results

Survey Descriptive Statistics

Table 1 presents demographic averages for all participants, participants in each of the five TN Milk price levels, and the TN general population (U.S. Census Bureau, 2020). About 82% of respondents were female, higher than the state average of 51%, but this is expected since the sample was limited to primary food shoppers (U.S. Census Bureau, 2020). The average age of the respondents was just under 44 years, compared to the state median age of 39 (U.S. Census Bureau, 2020). Our sample had a slightly higher percentage of white participants than the TN average and a slightly larger average household size than the TN average. The percentage of individuals with a bachelor's degree or higher and household income were both slightly lower than the TN average. Demographics were consistent across all TN milk price levels.

Table 1. Participant Demographics Overall and by TN Milk Price Level (per gallon)

		Means						
Demographic	**Description**	**All Prices (*N* = 352)**	**$2.69 (*N* = 67)**	**$3.19 (*N* = 72)**	**$3.69 (*N* = 71)**	**$4.19 (*N* = 70)**	**$4.69 (*N* = 72)**	**TN population1**
Female	Percentage female	82.39%	80.60%	81.94%	78.87%	87.14%	83.33%	51%
Age	Age in years	43.61	44.54	40.53[a]	43.08	42.84	47.08[a]	39
Race	= 1 if white, 0 otherwise	86.36%	83.589%[a]	94.44%[a,b,c]	83.10%[b]	84.29%[c]	86.11%	77%
Household size	Number of household members	3.07	3.28	2.97	3.25	2.81	3.06	2.60
College grad	= 1 if bachelor's degree or higher, 0 otherwise	24.72%	26.87%	26.39%	23.94%	21.43%	25.00%	27.5%
Income	Household income level ($ 100 thousands)	0.46	0.50	0.51	0.43	0.41	0.46	0.52

Notes: If two means in a row have the same letter superscript, this indicates that two demographics means for given TN Milk price level are significantly different at the 5% level as judged by *t*-tests.
Source: U.S. Census Bureau (2020).

However, among respondents who were presented with the $3.19/gallon price level, a significantly higher percentage were white individuals than at most of the other price levels, as judged by a *t*-test at the 5% significance level. Since this percentage was only 8%–11% higher than the other categories, this is not likely to have an impact on results. The only other demographic that was significantly different across two TN milk price levels ($3.19/gallon and $4.69/gallon) was age (Table 1). However, the difference in age among these price categories was less than 7 years; thus, it is not likely to have any impact on the results.

Figure 3 shows the percentage of consumers who chose TN Milk instead of unlabeled milk at each price level. When TN Milk was the same price as the unlabeled milk, 85% of consumers chose the TN Milk. However, the percentage of consumers choosing TN Milk declined to 6% when it was $4.19/gallon.. Using a *t*-test at the 5% level of significance, the percentage of respondents who chose TN Milk versus unlabeled milk was not significantly different among the following price ranges: $3.19, $3.39, and $4.69; $4.19 and $4.69. When considering all price levels, 30% of consumers chose the gallon of milk labeled as TN Milk (Table 2).

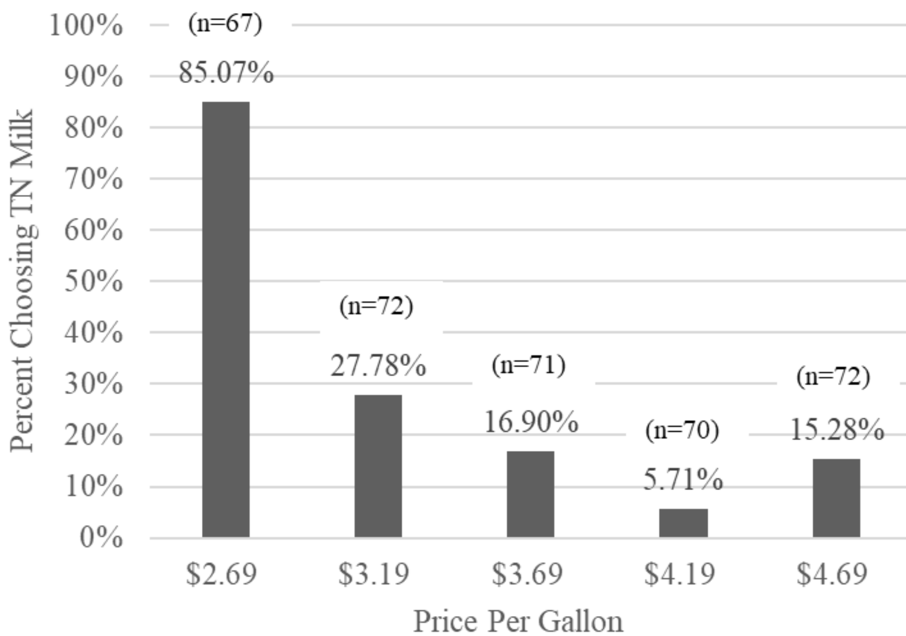

Figure 3. Percentage of Consumers Choosing TN Milk instead of $2.69 Per Gallon Unlabeled Milk

Note: Using a *t*-test, the percentage of respondents who chose TN Milk versus the unlabeled milk was not significantly different at the 5% level of significance among the following price ranges: $3.19, $3.39, and $4.69; $4.19 and $4.69.

Table 2 presents the probit regression dependent and independent variable means and standard deviations. On average, consumers spent $14.49 per month on milk (*Milk_Spending*). On average, consumers somewhat agreed that TN Milk would be of better quality (*Quality_Benefits*; average Likert score of 3.60). On average, consumers somewhat agreed that TN milk would help support TN dairy farmers' incomes and help support the state's economy (*Economics_Benefits*; average Likert score of 4.36).

On average, consumers neither agreed nor disagreed that they would pay a price premium for locally produced foods (*Local_Premium*; average Likert score of 2.91). About 15% of the sample regularly purchased organic cow's milk (*Purchase_Organic*). In terms of familiarity with the TN Milk logo (*Logo_Familiar*), participants were on average not very familiar with the logo (average Likert score of 1.60, where 1 = not at all familiar and 2 = slightly familiar). This suggests that the TN Milk logo could benefit from some type of educational or promotional campaign that allows TN consumers to learn about the logo and its definition.

In terms of demographics, approximately 44% of the sample said someone in their household had been raised on a farm or worked on a farm at some point (*Farmer*). Approximately 82% of the sample was female, 86% was white, 25% had earned at least a college degree, and the average household income was $46,321. The average participant was 44 years old and had a household size of 3.07 individuals.

Probit Regression Results

Table 3 reports the results of the probit regression and associated marginal effects. The VIFs were all less than 10 and the mean VIF was 1.25. The conditional index number was equal to 21.54. Thus, multicollinearity was not a concern in our estimated regression (Belsley, 1991; Gujarati and Porter, 2009).

As expected, the price of TN Milk negatively impacted a consumer's decision to purchase TN Milk rather than unlabeled milk. With a dollar increase in TN Milk price, a consumer, on average, was 29% less likely to purchase TN Milk (p <0.01). As consumers spent more money on milk per month (*Milk_Spending*), they were more likely to purchase TN Milk instead of unlabeled milk. If they spent $10 more per month on milk, they were 7% more likely to purchase TN Milk instead of unlabeled milk (p <0.05).

As consumers increased their agreement that TN Milk would be of higher quality (*Quality_Benefits*) by one point on the five-point Likert scale, they were 17% more likely to purchase TN Milk (p <0.01). This suggests that consumers place a premium on TN Milk because they believe it will likely be of higher quality. Meanwhile, consumer level of agreement that TN Milk would provide economic benefits to TN (*Economic_Benefits*) was not associated with a consumer's decision to purchase TN Milk. These results imply that while consumers agreed TN Milk would provide benefits to the TN economy and to farmers, this belief did not influence their decision to purchase TN Milk; however, their level of agreement with the perceived quality of TN Milk did influence their decision to purchase TN Milk. Thus, quality was a more important consideration to them than their potential positive impact on the local economy when deciding whether to purchase TN Milk.

As consumers were more willing to pay a premium for local foods (*Local_Premium*), they were 4% more likely to purchase TN Milk (p <0.01). If consumers purchased organic milk (*Purchase_Organic*), they were 12% more likely to purchase TN Milk (p <0.05). Thus, consumers who purchase local foods and organic milk were also more likely to purchase TN Milk. The level

Table 3. Probit Regression Results and Marginal Effects for Tennessee Milk Preferences

	Model in Paper	
Independent Variables	**Coefficient**	**Marginal Effect**
Price	−1.579***	−0.288***
	(0.198)	(0.022)
Milk_Spending	0.036**	0.007**
	(0.015)	(0.003)
Quality_Benefits	0.942***	0.172***
	(0.198)	(0.031)
Economic_Benefits	−0.020	−0.004
	(0.132)	(0.024)
Local_Premium	0.228***	0.042**
	(0.920)	(0.017)
Purchase_Organic	0.659**	0.120**
	(0.324)	(0.059)
Logo_Familiar	−0.114	−0.021
	(0.095)	(0.017)
Farmer	0.186	0.034
	(0.203)	(0.037)
Female	−0.024	−0.004
	(0.251)	(0.046)
Age	0.003	0.001
	(0.008)	(0.001)
Income	0.400	0.070
	(6.000)	(0.005)
College_Degree	−0.127	−0.023
	(0.229)	(0.042)
Household_Size	−0.084	−0.015
	(0.064)	(0.012)
%White	0.338	0.062
	(0.285)	(0.052)
Constant	−0.011	
	(0.874)	
No. of obs.	352	
Pseudo-R^2	0.465	
Wald χ^2 (10)	103.00***	
Log pseudo-likelihood	−114.30	

Notes: Standard errors in parentheses. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level.

of familiarity that a consumer had with the TN Milk logo (*Logo_Familiar*) did not have an impact on their decision to purchase TN Milk. Other variables not associated with consumers' decisions to purchase TN Milk were age, gender, income, education, household size, race, and whether someone in their household had grown up on a farm or worked on a farm at some point in their life.

WTP Estimates and Estimated TN Milk Consumption

On average, surveyed consumers in TN were willing to pay $3.02/gallon for TN Milk, with a lower bound (95% confidence level) of $2.86/gallon and an upper bound (95% confidence level) of $3.15/gallon. Considering this research assumed an average price of milk of $2.69/gallon, this represents an average WTP premium of $0.33/gallon for TN Milk, or a 12% price premium.

Consumers were also asked, "If you were to purchase TN Milk, about how much would you likely purchase per month (in gallons)?" On average, consumers stated they would be willing to purchase 3.8 gallons of TN Milk per month ($N = 176$). If we assumed that consumers would purchase TN Milk at the average premium we found of $0.33/gallon and they would purchase, on average, 3.8 gallons of milk a month, this equates to a total monthly household premium average of $1.25 per month. There are approximately 2.5 million households in TN (U.S. Census Bureau, 2020). Thus, if we assume 30% of them would be willing to consume TN Milk, which is the percentage of our sample who stated they would purchase TN Milk (Table 2), that would mean about 750,000 households would choose TN Milk. Multiplying this by the average monthly premium of $1.25 for TN Milk, this would equal an average monthly premium of $937,500 per month gained by selling TN Milk. However, if we consider only consumers who stated they would purchase TN Milk at a premium (Figure 3, price levels of $3.19/gallon and greater), then only 16% of the sample stated they would choose TN milk. This would equate to only 400,000 TN households; multiplying this by the average monthly premium of $1.25 for TN Milk would equate to an average monthly premium of $500,000. Thus, it is possible that a premium of approximately $500,000/month–$937,500/month could be gained by selling TN Milk depending on the estimated percentage of TN residents who would be willing to purchase TN Milk at a given premium of 12%. However, this is likely an overestimate since not all households consume milk and this calculation assumes all TN households are potential milk consumers. This calculation also assumes TN Milk is available readily across the state, which is also not necessarily true (as of now). For example, consumers were also asked, "What is the farthest distance out of your way you would travel by auto to purchase TN Milk?" On average, consumers were only willing to drive 3.2 miles out of their way to purchase TN Milk ($N = 203$). To attract 750,000 households to purchase TN Milk, it would have to be available in almost all retail outlets. Consumers also stated that for fluid cow's milk to be considered locally produced, the milk could travel, on average, 85 miles ($N = 352$). However, it is worth noting that the responses to this question ranged from 0 to 1,000 miles.

As the TN Milk logo is marketed over a longer period, additional research should compare the WTP estimates from this study with market pricing. However, while retail prices statewide for TN Milk that is being sold on the market were not collected in this study, anecdotally local market observations by the authors did not suggest that local retailers of TN Milk were charging consumers a premium price for this milk.

Table 2. Probit Regression Variable Definitions, Means, and Standard Deviations (*N* = 352)

Variable	Description	Hyp. Sign	Mean	Std. Dev.
Dependent variable				
TN_Milk	Percentage of respondents choosing TN Milk over generic milk		29.55	0.46
Independent variables				
Price	TN Milk price levels (dollars per gallon) of $2.69, $3.19, $3.69, $4.19, or $4.69	−	3.70	0.70
Milk_Spending	Monthly spending on milk (in dollars) (number of times purchased milk in month multiplied by price paid for container of milk)	?	14.49	6.85
Quality_Benefits	Index created by averaging the Likert scores for the following statements: "Compared with other milk, TN Milk will likely (1) be fresher, (2) be safer, (3) be better for the environment, and (4) taste better."[a]	+	3.60	0.86
Economic_Benefits	Index created by averaging the Likert scores for the following statements: "Compared with other milk, TN Milk will likely (1) help support Tennessee dairy farmers' incomes and (2) help support the state's economy."[a]	+	4.36	0.92
Local_Premium	Likert response to "I am willing to pay price premiums for locally produced food."[a]	+	2.91	1.26
Purchase_Organic	1 if regularly purchase organic cow's milk, 0 otherwise	+	0.15	0.36
Logo_Familiar	Likert response to "How familiar were you with the TN Milk logo before taking this survey?"[b]	+	1.60	1.12
Farmer	1 if anybody in your household was raised on a farm, or ever worked on a farm, 0 otherwise	+	0.44	0.50
Female	Percentage of respondents who are female	+	82.39	0.38
Age	Age in years	−	43.61	13.86
Income	Household income level ($ 100 thousands)	+	0.46	0.33
College_Degree	Percentage with a bachelor's degree or higher	+	24.72	0.43
Household_Size	Number of household members	?	3.07	1.63
%White	Percentage of sample who selected white as their race	?	86.36	0.34

Notes: Hyp = hypothesized.
[a] On a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree).
[b] On a five-point Likert scale from 1 (not at all familiar) 5 (extremely familiar).

It should also be noted that all survey participants were given the definition of TN Milk prior to indicating their preferences for TN Milk. It is possible that consumers in the supermarket may not be aware of the exact definition of TN Milk; this may mean that our estimated premiums for TN milk are higher than if we had not provided consumers with the definition of TN Milk.

Discussion and Conclusions

To support TN dairy farmers, the TDA instituted the TN Milk logo in September 2018. Milk labeled as TN Milk indicates the milk is entirely sourced, processed, and bottled in TN.

Results from this study show that TN Milk consumers would pay an average premium of $0.33/gallon for milk bearing the TN Milk logo, a 12% price premium. If TN Milk were priced the same as unlabeled milk, 85% of consumers indicated they would purchase TN Milk; however, across all price levels considered, 30% of consumers chose TN Milk over unlabeled milk.

Results from the probit regression indicated, as expected, that as the price of TN Milk increased, consumers were less likely to purchase TN Milk. Results also show that consumers who spend more on milk per month, consider TN milk to be of higher quality, would be willing to pay premiums for local products, and purchase organic milk were more likely to purchase TN Milk than unlabeled milk. These are characteristics of consumers that should be targeted in the marketing of TN milk. It is interesting to note that no specific demographics of consumers were found to be significant throughout our modeling, indicating TN Milk preferences are uniform across race, gender, income, age, education, and household size.

Given that the TN logo is fairly new and, on average, consumers disagreed that they were familiar with the TN Milk logo, increased promotion and marketing of the benefits of TN Milk will be needed to increase awareness and label recognition among consumers. This study provides valuable information on consumer's preferences for TN Milk and the characteristics of consumers who are more likely to purchase TN Milk. The results can be used by the dairy industry, retailers, and policy makers to help market TN Milk. Future research could use a choice experiment to determine which additional attributes could be complementary to the TN Milk logo.

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The Growing Market for Energy and Sports Drinks in the United States: Can Chocolate Milk Remain a Contender?

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Abstract

U.S. consumption of chocolate milk is growing as an alternative to sports and energy drinks. Using household-level demographic characteristics and purchase data for chocolate milk, energy drinks, and sports drinks, we estimate three beverage demand models. Own-price elasticities of demand for all beverages are inelastic. Household size, age, education, race, region, the presence of children, and gender are determinants of demand for chocolate milk. Chocolate milk is a substitute for energy drinks and a complement for sports drinks. These results are supportive of repositioning of chocolate milk in the sports/energy drinks market.

Keywords: chocolate milk, consumer demand, energy drinks, Nielsen data, sports drinks, Tobit model

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Introduction

Total milk production in the United States increased about 32% from 1999 to 2017 (U.S. Department of Agriculture, 2018b, p. 26), while sales have decreased since 2010 (U.S. Department of Agriculture, 2018a). However, from 2010 to 2017, sales of flavored milk have increased by 2.5%. In 2015, sales of chocolate milk reached to about $1,383 million (Statista, 2018a). The extant literature shows that the rise in sales and demand for various dairy alternative beverages might be shaping future of the dairy products in the United States (Dharmasena and Capps, 2014a,b; Copeland and Dharmasena, 2016; Yang 2018).

In contrast, the U.S. liquid refreshment beverage market (comprising carbonated soft drinks, bottled water, ready-to-drink tea and coffee, fruit beverages, energy drinks, and sports beverages, Statista, 2018b) has grown rapidly over the past decade: Sales by volume increased by about 12% in 2017 (Beverage Marketing Corporation, 2018). Currently, energy and sports drinks are two of the most popular beverages in the United Sates.[1] The U.S. market for energy drinks has become a multibillion-dollar business, accounting for 8% by value of the U.S. soft drinks market in 2017. Sales of energy drinks increased from $2.800 billion in 2015 to $2.979 billion in 2017 (Monster Beverage, 2018, p. 8). The sports drinks market is expected to reach $1,135,000,000 by the end of 2023 (Modor Intelligence, 2019). Sales of sports drinks increased about 14% from 2012 to 2015 (Beverage Digest Company, 2015, table G1). This market trend in energy and sports drinks could also be attributed to growth (or lack thereof) in other liquid refreshment beverages, such as diet soft drinks and bottled water. While flavored milk was not included in their study, Dharmasena and Capps (2012) found positive (but statistically not significant) cross-price elasticities between diet soft drinks and isotonics (both energy and sports drinks taken as one aggregated category) and bottled water and isotonics.

Several studies have shown that the consumption of chocolate milk is a viable alternative to consumption of energy and sports drinks. Compared to energy drinks, researchers have found that chocolate milk is better at reducing debilitating muscle breakdown and increasing endurance for those who are physically active (Lunn, 2012). In an experiment, when runners drank fat-free chocolate milk after a strenuous run, on average, they ran 23% longer and had a 38% increase in markers of muscle building compared to when they drank a carbohydrate-only sports beverage with the same number of calories (Lunn, 2012). Karp et al. (2006) emphasized that chocolate milk contained high carbohydrate and protein content, which were effective for recovery from strenuous exercise.

In contrast, one of the most pressing issues concerning energy drinks is the inclusion of stimulants such as caffeine and guarana. Excessive consumption of energy drinks may increase risk of caffeine overdose and result in greater potential for acute caffeine toxicity (Reissig, Strain, and Griffiths, 2009). Initially, the primary consumers of energy drinks were athletes. However, as the market for energy drinks expanded, the majority of energy drinks were targeted at teenagers and young adults 18 to 34 years old (Heckman, Sherry, and Gonzalez de Meija, 2010). According to

[1] Sports drinks provide fluids as well as other substances such as electrolytes (sodium, potassium, and magnesium) and carbohydrates. Energy drinks provide caffeine and other sources of stimulants and sugar (Collins, 2013).

Kaminer (2010), 30% of youths between the ages of 12 and 17 regularly consumed energy drinks. However, excessive caffeine is not recommended for people under the age of 18. Although many brands of energy drinks try to dispel consumer concerns about caffeine, this fact has triggered increased negative media coverage. As a consequence, consumers have looked into healthier alternative beverages.

The ingredient advantage of chocolate milk and the weakened outlook of the conventional milk market in the United States create a unique opportunity for chocolate milk to enter the fast-growing beverage market as an alternative recovery drink. This repositioning could potentially provide an additional occasion for consumers to buy chocolate milk and enhance sales (Markets and Markets report, 2016).

In fact, the dairy industry has been repositioning chocolate milk as a contender in the fast-growing market for protein bars, shakes and energy beverages. Since 2012, the Milk Processor Education Program (MilkPEP), the group responsible for the "Got Milk?" campaign, has invested $15 million a year into a marketing campaign on chocolate milk to strengthen the branding of this beverage as a new-age sports/energy drink (Yang, 2014). Also, MilkPEP has set their next 20-year campaign as "propel milk back into a position of power" (Berry, 2014). In 2012, MilkPEP launched the "My After" campaign to strengthen consumer consciousness that consuming low-fat chocolate milk was better than alternatives for athletes. According to Shoup (2019), after repositioning chocolate milk as a post workout recovery drink vis-à-vis isotonics via a MilkPEP campaign in 2012, U.S. sales of chocolate milk increased by about 8% at the end of year 2015 and were expected to continue growing over the years. This trend could be a direct result of changing consumer perceptions with regards to chocolate milk compared to isotonics.

Additionally, the marketing of chocolate milk—like sports or energy drinks—is aligning with professional athletes and celebrities, incorporating sports games and music to advertise their products. Recently, professional football and basketball players, swimmers, and running groups have been gradually taking chocolate milk as their recovery drink. Chocolate milk has become the official refuel beverage of many prominent sports organizations and teams, like the IRONMAN® triathlon series, the Rock 'N' Roll Marathon series, and the Challenged Athletes Foundation (Milk Processor Education Program, 2014).

Few past studies in the extant literature estimate U.S. demand for chocolate milk and energy drinks. For the period 1996–1998, Maynard and Liu (1999) estimated the own-price elasticity of demand for flavored milk, to be in a range of −1.4 to −1.47. Dharmasena and Capps (2011) used a Heckman sample selection procedure to estimate U.S. demand for chocolate milk for 2008 using a Nielsen Homescan panel data. They estimated the own-price elasticity of demand for chocolate milk to be −0.04.

Capps and Hanselman (2012) employed the Barten synthetic demand system to estimate own-price, cross-price, and expenditure elasticities for major energy drink brands using weekly data from October 2007 to October 2010. They estimated the own-price elasticity of demand for energy drinks to be between −0.99 and −1.69. Also, Dharmasena and Capps (2009) and Dharmasena and

Capps (2012) estimated demand for isotonics in a demand system framework. The own-price elasticities of demand for isotonics varied from −3.87 to −5.96. Although, these studies included conventional milk in the demand modeling, they did not include flavored milk (or chocolate milk) in their work. This large variation in own-price elasticity of demand estimates could be due to various reasons, including

i. product aggregation. Maynard and Liu (1999) considered all flavored milk as one aggregated category, while Dharmasena and Capps (2011) considered chocolate milk as one disaggregated category
ii. level of data used. Maynard and Liu (1999) used weekly national average retail scanner data from 1996–1998, while Dharmasena and Capps (2011) used a cross-sectional dataset of nearly 60,000 households from 2008
iii. model choice. Maynard and Liu (1999) used a linear approximated almost ideal demand system model, while Dharmasena and Capps (2011) used a Heckman two-step sample selection procedure.

While the media has linked chocolate milk to benefits based on healthy ingredients and performance as opposed to isotonics, to the best of our knowledge, economic analysis documenting U.S. demand for chocolate milk and isotonics is currently quite limited.

In this light, a thorough analysis of demand for chocolate milk, energy drinks, and sports drinks is important to uncover not only demand interrelationships among these beverages but also to explore the opportunity to reposition these beverages among consumers in the very competitive dairy marketplace. Additionally, the price sensitivity, substitutes or complements, and demographic profiling with respect to consumption of chocolate milk, energy drinks, and sports drinks are important for manufacturers, retailers, and advertisers of these beverage products for strategic positioning and marketing. Specific objectives of this study are to (i) estimate the own-price, cross-price, and income elasticities of demand for chocolate milk, energy drinks, and sports drinks and (ii) determine the socioeconomic and demographic factors affecting the purchase of chocolate milk, energy drinks, and sports drinks in the United States.

Methodology

Tobit Model

Some households may not have bought chocolate milk, energy drinks, and/or sports drinks during the sampling period. In this case, the dollar amount spent by households on these beverages was recorded as 0. If a fraction of the observations of the dependent variables take this limit value (lower limit being 0), the dependent variable is said to be *censored*. Application of ordinary least squares (OLS) to estimate this kind of situation gives rise to biased estimates, even asymptotically (Kennedy, 2003). As a result, the Tobit model is suggested as a method to explicitly model the censored dependent variables (Tobin, 1958; Heckman, 1979; Kennedy, 2003; Greene, 2003).

The Tobit model is defined as a latent variable model:

(1) $$\boldsymbol{Y} = \beta\boldsymbol{X} + \boldsymbol{\mu}\text{ , if } \beta\boldsymbol{X} + \boldsymbol{\mu} > \boldsymbol{0};\ \mu \sim Normal(0, \sigma^2)$$

and

$$\boldsymbol{Y} = 0, \text{ if } \beta\boldsymbol{X} + \boldsymbol{\mu} \leq \boldsymbol{0}$$

where Y is the censored dependent variable, $\boldsymbol{X}$ is a vector of explanatory variables, β is the vector of unknown parameters to be estimated, and $\boldsymbol{\mu}$ is the normally distributed error with variance σ^2. (Details of the Tobit model are explained in the Technical Appendix.)

Empirical Model

In the given year, some households purchased these products (chocolate milk and isotonics) and some did not. For those households that did not purchase the product, one has to estimate the price paid for the product, had the household purchased the product. This is the imputed price. In calculating the imputed price for those households that did not purchase the product, we first regressed the observed price from those households that purchased the product on three variables: household size, household income, and region where the household is located:

(2) $$P_{i,observed} = \alpha_1 + \alpha_2 HH_{i,income} + \alpha_3 HH_{i,size} + \alpha_4 HH_{i,region} + \mu_i,$$

where i = 1,2,3,…n, and n is the total number of households.

These variables and methods are used extensively in the literature to impute missing prices (Kyureghian, Capps, and Nayga, 2011; Alviola and Capps, 2010; Dharmasena and Capps, 2014a). Household income relates to the different levels of product quality as it is reflected by product price. Household region reflects spatial differences in price. Household size not only reflects the composition of the households but also relates to the amount of money households spend on the product, assuming that large households tend to buy less expensive products. The parameters estimated from this auxiliary regression are then used to forecast (impute) a price for those households that did not purchase the product. This imputation procedure addresses two things: (i) the potential endogeneity issue often questioned in the price variable through the use of predicted price as an instrument to observed price and (ii) the biases one would question for not having clustered standard errors with regards to price variables in the Tobit regression. Since we used the household region as an explanatory variable in the price imputation auxiliary regression in imputing prices, standard error results for the price variables in fact are clustered at the state or county level. Therefore, significance levels of price variables in the Tobit regression are calculated using clustered standard errors of those variables in the price imputation auxiliary regressions (Capps, Kirby, and Williams, 1994; Alviola and Capps, 2010; Kyureghian, Capps, and Nayga, 2011; Dharmasena and Capps, 2012). We find that observed price of each beverage category very closely mimics the imputed price.[2]

[2] The mean and standard deviations of imputed and observed prices for each beverage category are shown below:

	Observed Prices (USD/oz)		**Imputed Prices (USD/oz)**	
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**
Chocolate milk	0.049	0.02	0.051	0.01
Energy drinks	0.129	0.06	0.131	0.01
Sports drinks	0.052	0.15	0.053	0.003

Once the imputed price for each type of beverage is obtained, the explanatory variables to estimate the Tobit model includes prices, household income, presence of children in the household, region, race, employment status, level of education, and gender of the household head. Although economic theory suggests the use of price and income as right-side variables in quantity-dependent demand functions, theory does not suggest the choice of demographic variables to include as conditioning variables. However, considering the beverages considered in this study (chocolate milk, energy drinks, and sports drinks), we relied on such demographic variables used in similar past studies (Dharmasena and Capps, 2014a,b; Zheng et al., 2018) as well as common sense (such as the presence of children, employment status, and region). We did not undertake sequential hypothesis testing on the conditioning variables to find out the variables that should be included in the right side of the regression in this study.

The estimated demand function in general form is as follows:

$$Y_i = \alpha_i + \sum_j \beta_{ij} P_j + \gamma_i I + \theta_i D + \varepsilon_i, \tag{3}$$

where $i = 1, 2, 3\ldots 62{,}029$ (the number of households in the sample) and $j = 1, 2, 3$ (the number of products: chocolate milk, energy drinks, and sports drinks); Y_i is the quantity of chocolate milk, energy drinks, and sports drinks in ounces; P_j is the price of each beverage in dollars per ounce;[3] I is household income in dollars;[4] D are the demographic variables (see Table 1 for details), including household head age, household head employment status, household head education, household race, household ethnicity, region, age and presence of children, and gender of household head; $\alpha, \beta, \gamma, \theta$ are the estimated parameters; and ε is a random error term.

We investigated several functional forms, including linear, quadratic, and semi-log. The best functional form was decided based on model fit, significance of the variables, and the results of loss metrics like the Akaike information criterion (AIC). We found that the semi-log functional form outperformed other functional forms in the chocolate milk and sports drinks demand models (natural logarithms of beverage prices, income, and household size were used). However, for the energy drinks demand model, the price of chocolate milk in linear form outperformed price represented in its natural logarithm (which also used the natural logarithms of other price variables, income, and household size). Therefore, we used the semi-log functional form to calculate the conditional and unconditional marginal effects associated with each explanatory variable, except for linear functional form for price of chocolate milk in the energy drink demand model.

The conditional marginal effect for semi-log price variable is given by

$$\frac{\partial E(Y|Y>0)}{\partial p} = \frac{\beta}{p^c}\left(1 - z\frac{f(z)}{F(z)} - \frac{f(z)^2}{F(z)^2}\right). \tag{4}$$

[3] All prices are logged in the chocolate milk equation; energy drinks and sports drinks prices are logged in the energy drinks and sports drinks equations.
[4] Household income is logged in all three equations.

Table 1. Summary Statistics of the Variables Used in the Model

Variable	Mean	Standard Deviation
Price		
Of chocolate milk ($/ounce)	0.049	0.024
Of energy drinks ($/ounce)	0.129	0.056
Of sports drinks ($/ounce)	0.052	0.149
Household size	2.360	1.290
Household income ($thousands)	58.32	31.93
Age of household head		
25–29	0.018	0.042
30–34	0.038	0.191
35–44	0.147	0.354
45–54	0.276	0.447
55–64	0.297	0.457
65 or older	0.222	0.415
Employment status		
Part-time	0.178	0.383
Full-time	0.390	0.488
Education		
High school	0.237	0.425
Undergraduate	0.618	0.485
Post-college	0.120	0.325
Race		
Black	0.094	0.292
Asian	0.029	0.166
Other	0.040	0.196
Hispanic	0.051	0.220
Region		
New England	0.045	0.208
Middle Atlantic	0.131	0.337
East North central	0.181	0.385
West North central	0.086	0.281
South Atlantic	0.198	0.398
East South central	0.060	0.237
West South central	0.102	0.303
Mountain	0.073	0.260
Presence of children		
Children less than 6 years	0.028	0.164
Children 6–12 years	0.052	0.223
Children 13–17 years	0.067	0.249
Children under 6 and 6–12 years	0.024	0.154
Children under 6 and 13–17 years	0.004	0.064
Children 6–12 and 13–17 years	0.033	0.179
Children under 6, 6–12, and 13–17	0.005	0.070
Head of household		
Female head only	0.250	0.433
Male head only	0.096	0.295

Source: Nielsen Homescan data 2011, calculations by authors.

Notes: Base categories for categorical explanatory variables: age of household less than 25, employment status: neither full-time nor part-time, education less than high school, race white, region pacific, no children, and female and male household heads.

The unconditional marginal effect for semi-log price variable is given by equation (5) below:[5]

(5) $$\frac{\partial E(Y)}{\partial p} = \frac{\beta}{p^u} F(z),$$

where is the average price in the censored sample and is the average price of the full sample. Conditional and unconditional own-price, cross-price, and income elasticities are represented as follows:

Conditional elasticities:

(6) Own-Price: $$\varepsilon_{ii}^C = \frac{\beta}{p_i^C}\left(1 - z\frac{f(z)}{F(z)} - \frac{f(z)^2}{F(z)^2}\right)\frac{p_i^C}{Q_i^C};$$

(7) Cross-Price: $$\varepsilon_{ij}^C = \frac{\beta}{p_j^C}\left(1 - z\frac{f(z)}{F(z)} - \frac{f(z)^2}{F(z)^2}\right)\frac{p_j^C}{Q_i^C};$$

(8) Income: $$\varepsilon_I^C = \frac{\beta}{I_i^C}\left(1 - z\frac{f(z)}{F(z)} - \frac{f(z)^2}{F(z)^2}\right)\frac{I_i^C}{Q_i^C};$$

where ε_{ii}^C is the conditional own-price elasticity for the *i*th beverage; ε_{ij}^C is the conditional cross-price elasticity for beverage *i* with respect to a change in price of beverage *j*; and ε_I^C is the conditional income elasticity for the *i*th beverage.

If the price variable enters demand model as linear price (as in price of chocolate milk in the energy drinks demand model), the conditional cross-price elasticity is

(9) $$\varepsilon_{ij}^C = \beta\left(1 - z\frac{f(z)}{F(z)} - \frac{f(z)^2}{F(z)^2}\right)\frac{p_j^C}{Q_i^C}.$$

The unconditional own-price, cross-price, and income elasticities are denoted by

(10) Own-Price: $$\varepsilon_{ii}^u = \frac{\beta}{p_i^u} F(z)\frac{p_i^u}{Q_i^u};$$

(11) Cross-Price: $$\varepsilon_{ij}^u = \frac{\beta}{p_j^u} F(z)\frac{p_j^u}{Q_i^u};$$

(12) Income: $$\varepsilon_I^u = \frac{\beta}{I_i^u} F(z)\frac{I_i^u}{Q_i^u};$$

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[5] Note the presence of the p^u term in the denominator. This is just the same equation as noted in (A4) of the Technical Appendix, adjusted for the semi-log model.

where ε_{ii}^{u} is the unconditional own-price elasticity for the *i*th beverage; ε_{ij}^{u} is the unconditional cross-price of beverage *i* with respect to change in price of beverage *j*; and ε_{I}^{u} is the unconditional income elasticity for the *i*th beverage.

If the price variable enters the demand model as linear price (as in the price of chocolate milk in the energy drinks demand model), the conditional cross-price elasticity is given by

(13) $$\varepsilon_{ij}^{u} = \beta F(z) \frac{p_j^{u}}{Q_i^{u}},$$

where I^c is conditional mean income and I^u is unconditional mean income, Q_i^C is the conditional mean quantity, and Q_i^u is the unconditional mean of quantity. From equation (6), we obtain the changes in the probability of being above the limit (probability of purchase) for each beverage category in response to a change in any explanatory variable.

(14) $$\frac{\partial F(z)}{\partial X} = \frac{1}{E(Y|Y>0)}\left(\frac{\partial E(Y)}{\partial X} - F(z)\frac{\partial E(Y|Y>0)}{\partial X}\right).$$

The significance level considered in this study is at 0.05 (i.e., any *p*-value less than or equal to 0.05 results in statistical significance).

Data

The data used in this study were based on the 2011 Nielsen Homescan panel (the most recent data available at the time of this research),[6] which provides detailed beverage-purchase information from 62,029 U.S. households.[7]

Table 1 presents summary statistics for all variables included in the model. Quantity purchased is standardized as liquid ounces per household per year, and expenditures are expressed in dollars per household per year.[8] A *unit value*, which is taken as a proxy for price, is generated by dividing total expenditure by quantity for each beverage. This unit value variable is considered to be the

[6] Disclaimer: Researcher(s) own analyses calculated (or derived) based in part on data from The Nielsen Company (US), LLC and marketing databases provided through the Nielsen Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business. The conclusions drawn from the Nielsen data are those of the researchers and do not reflect the views of Nielsen. Nielsen is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.
[7] Nielsen Homescan data are a nationwide panel of households that scan their food purchases for at-home use from all retail outlets (grocery stores, department stores, convenience stores, drug stores, and club stores). The data include detailed product characteristics, quantities, and expenditures for each food item purchased by each household as well as socioeconomic and demographic characteristics of each household.
[8] The quantity of each beverage (chocolate milk, sports drinks, and energy drinks) purchased by each of the household in ounces per household per year is created by aggregating all transactions at the universal product code (UPC) level of many products of chocolate milk, sports drinks and energy drinks purchased by each household during calendar year 2011 (the latest year of data available at the time of this study). The associated expenditures with regards to purchase of these beverages are also aggregated up from each transaction to create total expenditure in dollars per household per year.

price paid for each beverage category and is expressed as dollars per ounce. The mean prices for chocolate milk, energy drinks, and sports drinks are $0.049/oz, $0.129/oz, and $0.052/oz, respectively. Note that chocolate milk is the least expensive of the three beverages.

Household size is separated into nine groups based on the number of household members. If the number of household members is more than nine, the value of household size is assigned to be nine. The mean household size is 2.36 members.

Household income is reported as a categorical variable with several income classes. In this study, household income is converted to a continuous variable by taking the mean value of the respective income class reported for each household. The mean household income is $58,320.

The reference category for the age of the household head is considered to be less than 25 years. Households aged 25–29 years (1.8% of households in the sample) and households aged 30–34 years (3.8% of households in the sample) are small proportions of the sample. Household heads aged 35–44 years constitute 14.7% of the sample; 27.6% of the household heads fall in to the 45–54 years category. Household heads who are 55–64 years make up 29.7% of the sample. Household heads over 65 years of age account for more than 20% of the sample.

Employment status is an indicator variable representing whether the household head is employed full-time (39%), part-time (17.8%), or neither. We treat household heads with neither full-time nor part-time as the reference category in this study.

We also consider the education status of households. The reference category is a household with a household head with less than a high school education. 23.7% of the household heads have a high school degree, 12% of household heads earned a post-college education, and more than 60% of household heads had undergraduate degrees.

Race is grouped as white, black, Asian, Hispanic, and other. The white category is used as the reference category for this analysis. 9.4% of the sample is black. Asian household heads account for 2.9% of the sample. 4% of the household heads belong to the "other" race category. 5.1% of household heads are Hispanic.

Regions are New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific (Table 2 summarizes the classification of regions by state). The Pacific region is treated as the reference category for this analysis. 4.5% of the household heads are from New England, 13.1% from the Middle Atlantic, 18.1% from the East North Central, 8.6% from the West North Central, 19.8% from the South Atlantic, 6% from the East South, 10.2% from the West South, and 7.3% from the Mountain region.

The variable with respect to the presence of the children in the households is classified into eight categories based on the age of children. The reference category considered in this study is households with no children. The other seven categories are households with children under the age of 6 (2.8%), children 6–12 years (5.2%), children 13–17 years (6.7%), children under 6 and

Table 2. Census Bureau Regions and States

New England	Middle Atlantic	East North Central
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont	New Jersey, New York, Pennsylvania	Indiana, Illinois, Michigan, Ohio, Wisconsin
West North Central	**South Atlantic**	**East South Central**
Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota	Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia	Alabama, Kentucky, Mississippi, Tennessee
West South Central	**Mountain**	**Pacific**
Arkansas, Louisiana, Oklahoma, Texas	Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming	Alaska, California, Hawaii, Oregon, Washington

Source: U.S. Department of Commerce Economics and Statistics Administration, U.S. Census Bureau (https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf)

6–12 years (2.4%), children under 6 and 13–17 years (0.4%), children 6–12 and 13–17 years (3.3%), and children under 6, 6–12, and 13–17 years (0.5%).

The reference category for households' gender variable is defined as a household with both female and male household heads. If the household is headed by both female and male, we considered the female's demographic characteristics. Households headed by females made up 25% of the sample. Male-only household heads composed 9.6% of the dataset.

Results and Discussion

Table 3 shows the summary statistics for price, quantity, and market penetration (number of households purchasing the beverage under consideration out of total of households sampled) for the three respective beverage categories.

Table 3. Summary Statistics for Price, Quantity and Market Penetration in 2011 in the United States

	Chocolate Milk	Energy Drinks	Sports Drinks
Market penetration (%)	26	7	36
Average price ($/ounce)	0.05	0.13	0.05
Average conditional quantity (ounces)	423	441	757
Average unconditional quantity (ounces)	110	32	271

Notes: The market penetration numbers are the number of households that purchased these beverages out of total number of households in the sample.

Table 4 presents the Tobit regression results. The price of energy drinks, the price of chocolate milk, and the price of sports drinks are statistically significant factors affecting the demand for all

Table 4. Tobit Regression Results for Chocolate Milk, Energy Drinks, and Sports Drinks

	Sports Drinks			Energy Drinks			Chocolate Milk		
Variable	***p*-Value**	**Std. Err.**	**Estimate**	***p*-Value**	**Std. Err.**	**Estimate**	***p*-Value**	**Std. Err.**	**Estimate**
Intercept	<0.0001	251.97	−7,004.03	<0.0001	288.98	−5,204.96	<0.0001	203.73	−4,813.94
Price									
Of chocolate milk	0.0118	32.92	−78.12	<0.0001	54.50	2,460.87	<0.0001	20.75	−1,008.42
Of energy drink	<0.0001	61.04	−319.24	0.0064	902.13	−1,506.67	0.0030	49.50	−146.67
Of sports drink	<0.0001	17.36	−1,639.65	<0.0001	30.47	−179.82	<0.0001	16.11	−161.25
Household size	<0.0001	10.14	163.54	<0.0001	14.79	145.63	<0.0001	8.07	75.45
Household income	0.0070	14.11	38.04	0.6707	21.14	8.99	0.0926	10.99	−18.49
Age of household head									
25–29	0.6371	177.83	−83.88	0.537	221.90	−136.99	0.8037	149.88	−37.25
30–34	0.4827	173.66	−121.92	0.3412	216.38	−205.93	0.7670	146.06	43.27
35–44	0.3384	170.89	−163.61	0.0202	212.59	−493.84	0.5875	143.86	78.05
45–54	0.1620	170.45	−238.37	0.0037	211.88	−614.89	0.4818	143.49	100.96
55–64	0.0028	170.49	−509.21	<0.0001	212.32	−962.17	0.9101	143.47	16.20
65 or older	<0.0001	171.07	−720.42	<0.0001	214.45	−1,369.22	0.1933	143.85	−187.13
Employment status									
Part-time	0.5045	22.68	−15.14	0.1739	35.59	−48.40	0.5185	17.65	−11.39
Full-time	0.0605	20.04	37.61	0.0174	30.72	73.05	0.8770	15.68	−2.43
Education									
Education high school	0.2024	53.38	68.05	0.0177	77.11	−182.90	0.5002	40.73	−27.46
Education undergraduate	0.9075	52.47	−6.10	<0.0001	75.58	−328.26	0.0056	40.11	−111.11
Education post-college	0.0114	57.49	−145.52	<0.0001	85.35	−576.51	<0.0001	44.36	−237.18
Race									
Black	0.5169	27.49	−17.81	0.4847	42.83	−29.92	<0.0001	23.84	−336.19
Asian	0.0007	47.66	−161.99	0.0004	73.46	−261.00	<0.0001	40.30	−243.60
Other	0.0493	42.07	82.72	0.0314	58.73	126.41	0.0246	34.58	−77.73
Hispanic	0.5968	37.19	19.67	0.0449	52.44	105.14	0.0156	30.84	−74.54

Continued on next page…

Table 4 (continued).

	Sports Drinks			Energy Drinks			Chocolate Milk		
Variable	***p*-Value**	**Std. Err.**	**Estimate**	***p*-Value**	**Std. Err.**	**Estimate**	***p*-Value**	**Std. Err.**	**Estimate**
Region									
New England	0.0878	45.03	76.86	<0.0001	71.06	−451.73**	0.2667	36.89	−40.97
Middle Atlantic	0.2765	33.27	36.20	<0.0001	49.02	−374.22**	<0.0001	26.78	169.63**
East North central	0.8758	32.59	5.09	<0.0001	45.99	−401.72**	<0.0001	24.81	116.35**
West North central	0.5158	37.49	−24.36	<0.0001	54.27	−349.84**	<0.0001	28.19	161.00**
South Atlantic	<0.0001	29.72	165.20**	<0.0001	42.80	−337.75**	0.0091	24.48	63.86**
East South central	<0.0001	39.71	296.76**	<0.0001	59.74	−298.10**	<0.0001	31.26	201.58**
West South central	<0.0001	33.86	252.84**	0.0071	47.62	−128.10**	<0.0001	27.67	120.92**
Mountain	0.0019	37.41	116.00**	0.1333	52.27	−78.48	0.0317	30.59	−65.70**
Presence of children									
Children less than 6 years	0.0012	50.72	−164.76**	0.0069	73.50	−198.69**	0.1028	40.23	65.63
Children 6–12 years	0.0107	37.48	95.67**	0.0659	56.54	−104.01	<0.0001	29.99	155.27**
Children 13–17 years	<0.0001	32.90	480.68**	<0.0001	46.87	265.72**	<0.0001	26.66	173.56**
Children under 6 and 6–12 years	<0.0001	56.39	−320.62**	<0.0001	85.45	−460.37**	0.0203	44.47	103.17**
Children under 6 and 13–17 years	0.8474	110.97	21.36	0.2788	159.94	−173.20	0.0893	88.59	150.50
Children 6–12 and 13–17 years	<0.0001	47.92	293.44**	0.0325	71.41	−152.66**	0.0038	38.87	112.65**
Children under 6, 6–12, 13–17	0.8988	106.02	−13.48	0.0349	152.28	−321.23**	0.2196	84.23	103.38
Head of household									
Female head only	<0.0001	23.89	−233.51**	0.1780	36.70	49.42	0.0002	18.47	−69.18**
Male head only	0.0844	31.68	−54.66	<0.0001	46.48	291.32**	<0.0001	25.34	−101.56**
Sigma	<0.0001	7.70	1,541.74**	<0.0001	17.98	1,531.57**	<0.0001	6.79	1,141.31**

Notes: Double asterisks (**) indicate statistical significance with a *p*-value of 0.05.

Table 5. χ^2 Tests for Joint Significance of Demographic Variables Considered

Chocolate Milk		**Energy Drinks**		**Sports Drinks**	
***p*-Value Associated with χ^2**	**Label**	***p*-Value Associated with χ^2**	**Label**	***p*-Value Associated with χ^2**	**Label**
<0.0001	agehh2529 = 0	<0.0001	agehh2529 = 0	<0.0001	agehh2529 = 0
	agehh3034 = 0		agehh3034 = 0		agehh3034 = 0
	agehh3544 = 0		agehh3544 = 0		agehh3544 = 0
	agehh4554 = 0		agehh4554 = 0		agehh4554 = 0
	agehh5564 = 0		agehh5564 = 0		agehh5564 = 0
	agehhgt64 = 0		agehhgt64 = 0		agehhgt64 = 0
0.8042	emphhpt = 0	0.0015	emphhpt = 0	0.0428	emphhpt = 0
	emphhft = 0		emphhft = 0		emphhft = 0
<0.0001	eduhhhs = 0	<0.0001	eduhhhs = 0	<0.0001	eduhhhs = 0
	eduhhu = 0		eduhhu = 0		eduhhu = 0
	eduhhpc = 0		eduhhpc = 0		eduhhpc = 0
<0.0001	black = 0	0.0003	black = 0	0.0009	black = 0
	oriental = 0		oriental = 0		oriental = 0
	other = 0		other = 0		other = 0
<0.0001	newengland = 0	<0.0001	newengland = 0	<0.0001	newengland = 0
	middleatlantic = 0		middleatlantic = 0		middleatlantic = 0
	eastnorthcentral = 0		eastnorthcentral = 0		eastnorthcentral = 0
	westnorthcentral = 0		westnorthcentral = 0		westnorthcentral = 0
	southatlantic = 0		southatlantic = 0		southatlantic = 0
	eastsouthcentral = 0		eastsouthcentral = 0		eastsouthcentral = 0
	westsouthcentral = 0		westsouthcentral = 0		westsouthcentral = 0
	mountain = 0		mountain = 0		mountain = 0
<0.0001	aclt6_only = 0	<0.0001	aclt6_only = 0	<0.0001	aclt6_only = 0
	ac6_12only = 0		ac6_12only = 0		ac6_12only = 0
	ac13_17only = 0		ac13_17only = 0		ac13_17only = 0
	aclt6_6_12only = 0		aclt6_6_12only = 0		aclt6_6_12only = 0
	aclt6_13_17only = 0		aclt6_13_17only = 0		aclt6_13_17only = 0
	ac6_12and13_17only = 0		ac6_12and13_17only = 0		ac6_12and13_17only = 0
	aclt6_6_12and13_17 = 0		aclt6_6_12and13_17 = 0		aclt6_6_12and13_17 = 0
<0.0001	fhonly = 0	<0.0001	fhonly = 0	<0.0001	fhonly = 0
	mhonly = 0		mhonly = 0		mhonly = 0

Notes: The χ^2 value is calculated using likelihood ratio produced for each demographic variable (presence and absence of the joint restriction).

three beverage choices. Significant demographic variables affecting demand for chocolate milk are household size, age, education, race, region, presence of children, and gender of the household head. Household income did not have a significant effect on the demand for chocolate milk. Significant demographic variables affecting demand for energy drinks are household size, age, employment status, education, race, region, presence of children, and gender of the household head. Household income did not have a significant effect on the demand for energy drinks. Significant demographic determinants affecting demand for sports drinks are household income, household size, age, education, race, region, the presence of children, and gender of the household head.

Table 5 reports the results of χ^2 test of the joint effects of categorical variables. Almost all categorical variables are significant determinants of demand for all three beverages. The employment status categorical variable was not significant in the chocolate milk demand equation.

Table 6 reports the conditional marginal effects and Table 7 reports the unconditional marginal effects. Note that conditional marginal effects are generally higher in absolute value compared to unconditional marginal effects. Table 8 reports changes in the probability of purchase associated with each explanatory variable for each beverage. Note that all of these numbers are calculated at the sample median. For brevity, we only report the conditional marginal effects and associated probabilities in this article.

There is a 2.2%, 1.7% and 4% probability of increasing the purchase of chocolate milk, energy drinks, and sports drinks with every additional member added to a given household, which is about 19, 25, and 57 additional ounces of the respective beverages per household per year.

Compared with a household head less than 25 years of age, households with a head older than 65 years had 5%, 16% and 18% less probability of purchasing chocolate milk, energy drinks, and sports drinks, respectively, which is 47, 232 and 249 fewer ounces of these respective beverages per household per year. Compared to the base age category, households with a head between 35 and 54 years of age purchased about 42 ounces per household per year more chocolate milk and about 267 and 138 ounces per household per year less energy and sports drinks. Households with a head of less than 25 years of age purchased more energy and sports drinks compared to households in other age categories.

Households with a head employed full-time showed a higher probability of purchasing energy and sports drinks, about 12 and 13 more ounces per household per year. Households with a head who has post-college education had about a 3%–7% less probability of purchasing sports drinks, energy drinks, and chocolate milk, which is about 50, 97, and 60 fewer ounces, respectively, per household per year compared to the base category of households with a head with less than a high school education.

Households with a head classified as black, Asian, or other had a 10%, 7%, and 2% less probability of purchasing of chocolate milk compared to those household with heads classified as white, equivalent to about 84, 61 and 20 fewer ounces of chocolate milk per household per year.

Table 6. Median Conditional Marginal Effect

Variable	Chocolate Milk	Energy Drinks	Sports Drinks
Household size	19.04	24.64	56.48
Age of household head			
25–29	−9.40	−23.17	−28.95
30–34	10.90	−34.83	−42.07
35–44	19.69	−83.53	−56.46
45–54	25.47	−104.01	−82.26
55–64	4.08	−162.76	−175.72
65 or older	−47.22	−231.61	−248.61
Employment status			
Part-time	−2.87	−8.19	−5.22
Full-time	−0.61	12.36	12.98
Education			
High school	−6.93	−30.94	23.48
Undergraduate	−28.04	−55.53	−2.10
Post-college	−59.85	−97.52	−50.22
Race			
Black	−84.43	−5.06	−6.15
Asian	−61.47	−44.15	−55.90
Other	−19.61	21.38	28.55
Hispanic	−18.81	17.78	6.79
Region			
New England	−10.34	−76.41	26.52
Middle Atlantic	42.81	−63.30	12.49
East North central	29.36	−67.95	1.76
West North central	40.63	−59.18	−8.41
South Atlantic	16.16	−57.13	57.01
East South central	50.87	−50.42	102.41
West South central	0.23	−21.67	87.25
Mountain	−16.58	−13.27	40.03
Presence of children			
Children less than 6 years	16.56	−33.61	−56.85
Children 6–12 years	39.18	−17.59	33.01
Children 13–17 years	43.79	44.95	165.88
Children under 6 and 6–12 years	26.04	−77.88	−110.64
Children under 6 and 13–17 years	37.98	−29.30	7.37
Children 6–12 and 13–17 years	28.43	−25.82	101.26
Children under 6,6–12,and 13–17	26.08	−54.34	−4.65
Head of household			
Female head only	−17.46	8.36	−80.58
Male head only	−25.63	49.28	−18.86

Table 7. Median Unconditional Marginal Effects

Variable	Chocolate Milk	Energy Drinks	Sports Drinks
Household size	14.92	7.71	40.50
Age of household head			
25–29	−7.37	−7.25	−20.77
30–34	8.56	−10.90	−30.19
35–44	15.44	−26.14	−40.52
45–54	19.97	−32.55	−59.03
55–64	3.20	−50.94	−126.10
65 or older	−37.03	−72.49	−178.41
Employment status			
Part-time	−2.25	−2.56	−3.75
Full-time	−0.48	3.87	9.31
Education			
High school	−5.43	−9.68	16.85
Undergraduate	−21.98	−17.38	−1.51
Post-college	−46.93	−30.52	−36.04
Race			
Black	−66.53	−1.58	−4.41
Asian	−48.21	−13.82	−40.12
Other	−15.38	6.69	20.49
Hispanic	−14.75	5.57	4.87
Region			
New England	−8.10	−23.91	19.03
Middle Atlantic	33.57	−19.81	8.97
East North central	23.02	−21.27	1.26
West North central	31.86	−18.52	−6.03
South Atlantic	12.63	−17.88	40.91
East South central	39.89	−15.78	73.49
West South central	23.93	−6.78	62.62
Mountain	−13.00	−4.15	28.73
Presence of children			
Children less than 6 years	12.99	−10.52	−40.80
Children 6–12 years	30.72	−5.51	23.69
Children 13–17 years	34.35	14.07	119.04
Children under 6 and 6–12 years	20.41	−24.37	−79.40
Children under 6 and 13–17 hears	29.78	−9.17	5.29
Children 6–12 and 13–17 years	22.29	−8.08	72.67
Children under 6, 6–12, and 13–17	20.46	−17.01	−3.34
Head of household			
Female head only	−13.69	2.61	−57.83
Male head only	−20.10	15.422	−14.47

Table 8. Median Change in Probability of Purchase Associated with each Explanatory Variable

Variable	Chocolate Milk	Energy Drinks	Sports Drinks
Household size	0.022	0.017	0.040
Age of household head			
25–29	−0.010	−0.016	−0.021
30–34	0.013	−0.024	−0.030
35–44	0.023	−0.057	−0.040
45–54	0.029	−0.071	−0.059
55–64	0.004	−0.110	−0.127
65 or older	−0.054	−0.157	−0.179
Employment status			
Part-time	−0.003	−0.006	−0.004
Full-time	−0.001	0.008	0.009
Education			
High school	−0.008	−0.021	0.017
Undergraduate	−0.032	−0.038	−0.002
Post-college	−0.069	−0.066	−0.037
Race			
Black	−0.098	−0.003	−0.004
Asian	−0.071	−0.030	−0.041
Other	−0.023	0.015	0.020
Hispanic	−0.022	0.012	0.005
Region			
New England	−0.012	−0.052	0.019
Middle Atlantic	0.049	−0.043	0.009
East North central	0.034	−0.046	0.002
West North central	0.047	−0.040	−0.005
South Atlantic	0.019	−0.039	0.042
East South central	0.059	−0.034	0.075
West South central	0.047	−0.015	0.063
Mountain	−0.019	−0.009	0.030
Presence of children			
Children less than 6 years	0.019	−0.023	−0.041
Children 6–12 years	0.045	−0.012	0.025
Children 13–17 years	0.050	0.030	0.121
Children under 6 and 6–12 years	0.030	−0.053	−0.078
Children under 6 and 13–17 hears	0.044	−0.020	0.006
Children 6–12 and 13–17 years	0.033	−0.017	0.074
Children under 6, 6–12, and 13–17	0.030	−0.037	−0.005
Head of household			
Female head only	−0.020	0.006	−0.058
Male head only	−0.029	0.033	−0.014

Considering energy and sports drinks, households with heads classified as other purchased about 21 and 29 more ounces per household per year compared to the base category, White. Household head with Hispanic origin purchased about 19 fewer ounces chocolate milk per household per year and about 18 and 7 more ounces of energy and sports drinks per household per year.

Compared to the Pacific region, households in the East South Central purchased the highest amounts of chocolate milk and sports drinks, about 51 and 102 ounces per household per year. With about 5% less probability, households in New England purchased the least amount of energy drinks, about 76 fewer ounces per household per year than the average.

Compared to households with no children, households with children 13–17 years of age purchased the highest amount of chocolate milk and sports drinks, about 44 (5% more probability) and 166 (12% more probability) more ounces per household per year, respectively. Households with children under 13 years of age purchased the lowest amount of sports drinks, about 111 fewer ounces than those with no children.

Households with male household heads purchased chocolate milk with 3% less probability (about 26 fewer ounces per household per year) and energy drinks with about 3% more probability (about 49 more ounces per household per year) compared to those with both a male and a female head.

Table 9 reports the median values of the respective conditional and unconditional elasticities for all beverages. The unconditional elasticity estimates are generally more elastic than the conditional elasticities, since the unconditional market includes consumers of these beverages who are potential buyers who might have a wide spectrum of products available to them compard to those who are more committed to purchase chocolate milk, energy drinks, and sports drinks (conditional sample of buyers). For brevity, we discuss only the conditional own- and cross-price elasticities. The conditional own-price elasticity of demand for chocolate milk is −0.62, which means that consumers are relatively insensitive to price changes. The conditional cross-price elasticities of

Table 9. Median Unconditional and Conditional Own-Price, Cross-Price, and Income Elasticities of Demand

	Chocolate Milk	Energy Drinks	Sports Drinks
Unconditional elasticities			
Chocolate milk	−2.05**	−0.30**	−0.33**
Energy drinks	0.25**	−3.08**	−0.37**
Sports drinks	−0.09**	−0.36**	−1.78**
Income	−0.04	0.02	0.03
Conditional elasticities			
Chocolate milk	−0.62**	−0.09**	−0.10**
Energy drinks	0.05**	−0.60**	−0.07**
Sports drinks	−0.04**	−0.15**	−0.75**
Income	−0.01	0.00[a]	0.02

Notes: Double asterisks (**) indicate statistical significance with a *p*-value of 0.05.
[a]The income elasticity of energy drinks is 0.004, which is rounded to 0.00 for this table.

demand of chocolate milk with energy drinks and sports drinks are −0.09 and −0.10, which implies that energy drinks and sports drinks are complementary beverages for chocolate milk in consumption. The conditional income elasticity of demand for chocolate milk is −0.01, but this estimate was not statistically significant.

The conditional own-price elasticity of demand for energy drinks is −0.60. The cross-price elasticities of demand for energy drinks with chocolate milk and sports drinks are 0.05 and −0.07, respectively. Therefore, chocolate milk is a substitute for energy drinks, but sports drinks are complementary to energy drinks. The income elasticity for energy drinks is 0.004, which was not statistically significant.

The conditional own-price elasticity of demand for sports drinks is −0.75. The cross-price elasticities of demand for sports drinks with chocolate milk and energy drinks are −0.04 and −0.15, respectively. Therefore, chocolate milk and energy drinks are complements to sports drinks. The income elasticity of demand for sports drinks is 0.02, which was not statistically significant.

Since chocolate milk, energy drinks, and sports drinks have inelastic own-price elasticities of demand, the prices of these products can be increased at the retail level (to purchasing households) to increase the retail level revenue. However, on the other hand, since the energy drinks and sports drinks are complements to chocolate milk, price increase in sports drinks and energy drinks will decrease consumption of chocolate milk. Nonetheless, this effect will be small given small (in terms of percentage changes) cross-price elasticities associated with chocolate milk. A similar argument applies for sports drinks, since both chocolate milk and energy drinks are complements for sports drinks. Since chocolate milk is a substitute for energy drinks, a price increase in chocolate milk will increase purchases of energy drinks. However, the effect will be small (in terms of percentage change) since the cross-price elasticities are small.

Having a mix of cross-price elasticities (some are complements in some equations and substitutes in other demand equations) is common in demand analysis (even with the imposed symmetry restriction for underlying parameters in complete demand models, such as almost ideal demand system). In this study, although the cross-price elasticities are small in magnitude, they are still significant. A small cross-price effect does not allude to the magnitude of the complementary and/or substitutability effect but only the percentage change. To see the change in magnitude (change in volume of one beverage to change in volume of another beverage), one has to calculate diversion ratios (Capps and Dharmasena, 2019), which is not the focus of this study.

Another school of thought in the profession shows that small cross-price elasticities support the contention that firms in an imperfectly competitive environment do not worry much about price changes among competing products since their marketing strategy is mostly about nonprice competition such as product differentiation via branding and packaging to establish a niche market. In our study, energy drinks and sports drinks are complements to chocolate milk in consumption, with very small cross price effects (elasticities). According to aforementioned line of thinking, chocolate milk manufacturers might not be interested in how energy and sports drink manufacturers price their products but rather pay attention to the price changes of their own product (own-price elasticity of demand of chocolate milk) in marketing the product. A similar argument can be applied to energy drink manufacturers not paying much attention to price changes among chocolate milk and sports drinks and sport drinks manufactures not paying much attention to chocolate milk and energy drinks in pricing their respective products. However, this argument cannot be fully supported in this research since we are not conducting the study at the brand level of each product. Nonetheless, this is an important area to investigate as we see manufactures of food and beverage products gravitate toward non-price competition via differentiating their products through branding and packaging.

Conclusions

Using household-level purchase data for chocolate milk, energy drinks, and sports drinks and selected demographic characteristics from the 2011 Nielsen Homescan data, we estimated three beverage demand models to show that chocolate milk is a substitute for energy drinks. Sports drinks are complementary to energy drinks. Chocolate milk and energy drinks are complements to sports drinks.

Household size, age, education, race, region, presence of children, and gender of the household head are significant determinants of demand for chocolate milk. Household size, age, employment status, education, race, region, presence of children, and gender of household head significantly affect demand for energy drinks. Significant demographic variables affecting the demand of sports drinks are household size, age, education, race, region, presence of children, and gender of household head.

Limitations and Implications

It is important to note that the data used in this work only capture purchases of chocolate milk, energy drinks, and sports drinks for consumption at home. As a result, this study does not capture household behavior with respect to away-from-home consumption of theses beverages. The total number of households in the 2011 Nielsen dataset was about 62,000. When constructing the data sample for those households that purchased chocolate milk, energy drinks, and sports drinks, we considered households that purchased at least one of these beverages per month in all 12 months. In that way, the market penetration of chocolate milk consumer stood at 26%. That is to say, 26% of households purchased chocolate milk (they might also have purchased isotonics). In the same light, the market penetration for energy drinks and sports drinks was 7% and 36%, respectively. These households might have purchased other beverages as well. There might be households that did not purchase any of these beverages considered in this study, which were obviously excluded from the sample (and this study). In other words, our sample of households is conditioned on purchasing at least one of the beverages considered in the study. However, if we take one of the beverages (say chocolate milk), the conditional sample of households is at 26%, while the unconditional sample of households for chocolate milk is at 74% (100% − 26%). A similar argument applies for energy drinks and sports drinks.

Based on the extant literature, it is well documented that chocolate milk has been repositioned in the U.S. market for physically active consumers as an alternative post-workout recovery drink. However, since the physical activity levels of household members is not available in the data sample we used in this study, we could not estimate demand for chocolate milk, energy drinks, and sports drinks delineated by physical activity level of households. Inclusion of such variables in the demand model would be useful future research. It should also be noted that some sports drinks are carbonated, although in this study our interest was to aggregate all sports drinks into one category. Therefore, we did not include two categories of sports drinks (carbonated and noncarbonated) in this study. This disaggregation is identified as fruitful future research. Additionally, other beverages in the market may affect demand for the three beverages identified in this study. They could be included in the mix of beverages in future studies.

Our finding that chocolate milk is a substitute for energy drinks is promising for various constituents in the chocolate milk supply chain, such as producers and advertisers. Also, since this study finds that chocolate milk acts as a complement to sports drinks, it can be stated that households that buy sports drinks also tend to buy chocolate milk. Given the complementarity of the beverage products in demand (as shown by cross-price elasticities, except for chocolate milk in the energy drinks equation), price competition does not yield any gains for the seller in terms of marketing the product as well as to gain market share. However, this study is important in terms of appropriately positioning the beverage(s) in the market (niche marketing to specific groups) uncovered by demographic factors affecting demand for chocolate milk, energy drinks, and sports drinks. The results from this study support the milk market's repositioning of chocolate milk in the isotonics complex to gain more market share while increasing consumption among those who already consume chocolate milk. Further, the somewhat elastic unconditional own-price elasticities show that consumers in the unconditional sample (the larger sample) tend to respond to price changes more than the consumers in the conditional sample where respective own-price elasticities are virtually inelastic. This also attests to the fact that consumers in the conditional sample are more loyal to their product through habit formation and less prone to switching consumption patterns.

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Technical Appendix

For Tobit model (Tobin, 1958; Heckman, 1979; Kennedy, 2003; Greene, 2003), there are two expectations of Y dependent variable: the conditional expectation, $E(Y|Y > 0, \boldsymbol{X})$, and the unconditional expectation, $E(Y)$. Equation (A1) expresses the conditional expected value of Y and equation (A2) the unconditional expected value (see McDonald and Moffitt, 1980; Tobin. 1958; Amemiya, 1973).

(A1) Conditional expectation: $E(Y|Y > 0, \boldsymbol{X}) = \boldsymbol{X}\beta + \sigma\left(\frac{f(z)}{F(z)}\right)$;

(A2) Unconditional expectation: $E(Y) = E(Y|Y > 0) * P(Y > 0|\boldsymbol{X})$;

$$= E(Y|Y > 0) * F(z);$$

$$= \boldsymbol{X}\beta F(z) + \sigma(f(z));$$

where $z = \frac{\boldsymbol{X}\beta}{\sigma}$ is the standardized linear combination of structural coefficients and explanatory variables; $\lambda = \frac{f(z)}{F(z)}$ is called the inverse Mills ratio, the ratio between the standard normal probability density function, pdf $(f(z))$ and standard normal cumulative density function, cdf $(F(z))$. In the Tobit model, the coefficients represent the effect of explanatory variables, *X*, on the latent dependent variable. Therefore, the coefficients associated with each explanatory variable must be transformed to obtain meaningful marginal effects.

There are two types of marginal effects. First, the conditional marginal effect reflects the impact of any explanatory variable on the dependent variable for those households that bought the product. Second, the unconditional marginal effect represents the impact of any explanatory variable of the dependent variable, regardless of whether the household buys the product.

Based on McDonald and Moffitt (1980) and Dharmasena and Capps (2014a), if X_i is a continuous variable, the conditional marginal effect of X_i on $E(Y|Y > 0, \boldsymbol{X})$ is represented by

(A3) $$\frac{\partial E(Y|Y>0)}{\partial \boldsymbol{X}} = \beta\left(1 - z\frac{f(z)}{F(z)} - \frac{f(z)^2}{F(z)^2}\right).$$

The unconditional marginal effect of X_i on $E(Y)$ is shown by

(A4) $$\frac{\partial E(Y)}{\partial \boldsymbol{X}} = \beta F(z).$$

From equation (A2), we know that $E(Y) = E(Y|Y > 0) \times F(z)$, therefore

(A5) $$\frac{\partial E(Y)}{\partial \boldsymbol{X}} = F(z)\frac{\partial E(Y|Y>0)}{\partial \boldsymbol{X}} + E(Y|Y > 0)\frac{\partial F(z)}{\partial \boldsymbol{X}}.$$

The marginal effect of X_i is represented by the sum of the change in the expected value of *Y* being above the limit (the conditional marginal effect) weighted by the probability of being above the limit ($[F(z)]$) and the change in the probability of being above the limit weighted by the conditional expected value of *Y* (McDonald and Moffitt, 1980).

The elasticity of *Y* with respect to x_i, conditional on $Y > 0$, is

(A6) $$\frac{\partial E(Y|Y>0)}{\partial x_i} \times \frac{x_i}{E(Y|Y>0)}.$$