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The Impacts of Foot and Mouth Disease Outbreaks on the Brazilian Meat Market

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Abstract

This paper elucidates the impacts of the September 2005 foot and mouth disease outbreak on the Brazilian meat market for different levels of the industry (export, wholesale, and farm). The associated import ban by Russia on Brazilian meat exports is also analyzed. Results suggest that the increase in domestic supply due to the import ban generated downward pressure on prices at all levels for pork and chicken. Meanwhile, export beef and wholesale beef prices underwent ambiguous and positive changes, respectively, while farm level prices only recovered after the removal of the import ban.

Keywords: animal disease outbreaks, Brazilian meat market, international trade

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Introduction

In Brazil, foot and mouth disease (FMD) outbreaks have been present in the meat industry for more than a century. In 1895, the first FMD outbreak was reported, since then, Brazilian authorities have struggled to contain the disease, which was considered endemic until the 1970's. In the mid-1980's, Brazilian livestock producers invested in both more sophisticated production methods and animal vaccination with the purpose of eradicating FMD (Lima et al. 2005). Since 1998 the Brazilian government has actively implemented efforts to eradicate FMD via the Programa Nacional de Erradicação da Febre Aftosa (PNEFA). The main purpose of this program was to eradicate the disease by the end of 2005 with the implementation of the Brazilian System of Identification and Certification of Origin for Cattle (SISBOV), which tracks and documents all animals (Haley 2005).

As the number of FMD outbreaks decreased partly due to the program mentioned above, the Brazilian government decided to follow the sanitary and phytosanitary guidelines of the World Organization for Animal Health (OIE) and World Trade Organization (WTO) by dividing its territory into five regions with the purpose of managing animal health controls more efficiently. Regionalization involves declaring one or more areas of a country FMD-free, even if other areas are responding to an outbreak. Under a regionalization policy, if one state or area is infected, the nation as a whole may not lose its FMD-free status, and trade restrictions might not be forced on all of the FMD-susceptible products. In 2000, Brazil became the fourth largest beef and pork exporter and the second largest chicken exporter. Five years later, Brazil became the largest beef and chicken exporter in the world and more than quadrupled pork exports. Currently, the Brazilian meat export industry has maintained its position as a leading meat supplier in the global market (FAS/USDA 2011).

However, Brazilian meats are still affected by FMD outbreaks. In the last ten years, two major FMD outbreaks occurred in Brazil. The most detrimental and recent outbreak occurred in September, 2005. According to the OIE (2011), the FMD outbreak took place initially in the state of Mato Grosso do Sul, which is historically the state with the third largest cattle herd in Brazil (IBGE 2014). Three months later, an outbreak was reported in the neighboring state of Paraná. The announcement of the FMD outbreak had negative impacts on Brazilian meat exports, especially for beef and pork. Several beef and pork importing countries initiated an import ban, including Russia[1], the number one importer of Brazilian meat. The Russian import ban originally was only on meat originating from the infected states of Mato Grosso do Sul and Paraná. Eventually, the Russian authorities expanded the ban to the states which were contiguous to the infected states. This expansion of the import ban covered eight meat producing states in Brazil, which from 2008 to 2012 these states accounted for more than half of the country's cattle herd (IBGE, 2014). After the destruction of 33,741 FMD-susceptible animals (32,549 cattle, 566 pigs, 626 sheep and goats) (OIE 2011) and several rounds of meetings between Brazilian and Russian authorities, the import ban was lifted in December 2007, 28 months after the FMD outbreak occurred.

[1] According to the Secretaria de Comércio Exterior (SECEX/MDIC, 2011), for the last ten years, the Russian market is a major destination of Brazilian meat exports, representing 40 percent of Brazilian total beef exports.

As a consequence, the FMD outbreaks caused immense uncertainty and economic losses to the Brazilian meat industry, particularly for exports. One to two months after the import ban by Russia and other countries, Brazilian beef exports decreased from 93,800 tons in September 2005 to 66,100 tons in December 2005, a decline of 30 percent. Furthermore, according to the SECEX/MDIC (2011) database, Brazilian beef exports to Russia decreased from 21,300 thousand tons in September 2005 to 12,500 thousand tons in December 2005 (a reduction of 41 percent).

The purpose of this study is to analyze the impacts of the FMD outbreak on the Brazilian meat prices for three different levels of the industry: export, wholesale and farm. The imposition of an import ban by Russia is also investigated. A vector error correction model (VECM) is used for this analysis. This approach quantifies the effects of the 2005 FMD outbreak in Brazil on prices of different meats at different levels of the marketing system.

This work is a contribution to the literature on the impacts of animal disease on meat markets for two reasons. First, it simultaneously investigates the effects of animal disease outbreaks on export prices, as well as domestic prices (wholesale and farm). Second, Brazil is a major player in the global meat industry. To our knowledge there is no study in the literature that has analyzed this important market at our level of detail.

This study begins with a literature review on the impacts of animal disease outbreaks on meat markets. This is followed by a presentation of a conceptual model that depicts the impacts of animal disease outbreaks followed by trade bans. The third section contains a discussion of the method of analysis. A description of the data used for analysis follows. The empirical results section presents the most important findings of the study. A conclusion completes the paper.

Literature Review

Several studies have analyzed the impacts of animal disease outbreaks and their effects on the meat prices for different countries. Burton and Young (1996) measured the impacts of bovine spongiform encephalopathy (BSE) on the British domestic beef market. Their findings indicate the BSE outbreak led to significant negative impacts for the beef industry in Great Britain. By using a food publicity index related to BSE, Lloyd et al. (2001) found that beef prices at the retail, wholesale and producer levels in the United Kingdom fell considerably. The authors argue this drop in prices was consistent with an inward shift in the demand for beef function. Sanjuán and Dawson (2003) also investigated the impacts of BSE on the UK meat sector (beef, pork, and lamb). The authors used a cointegration procedure which allowed structural breaks (BSE crisis) in the cointegrating space. Their findings indicated that the BSE crisis increased the retail-producer margin for the beef sector but no evidence of BSE-related breaks were found in the lamb or pork relationships. Lloyd et al. (2006) showed that the negative impact of the UK BSE outbreak on farm prices was more than double the impact on retail prices. They also showed that the retail-to-farm price margin became larger due to the 1996 UK BSE discovery. Piggott and Marsh (2004) estimated the impacts of publicized food safety information (media index construction) on meat demand for the United States. These authors showed that major food scares induced large demand responses, but these responses were rapidly dampened.

A stream of literature has focused on the impact of animal disease outbreaks coupled with trade bans on meat prices. Rich and Winter-Nelson (2007) developed a multimarket model with a dynamic and spatial epidemiological model to investigate FMD outbreaks in the Southern Cone region of South America. Six FMD mitigation strategies which included export restrictions were analyzed. Their results indicated that product prices and export volumes would decrease for all countries in the region. Paarlberg et al. (2008) assessed hypothetical FMD outbreaks on aggregate supply, demand, and trade in the U.S. They used an economic-epidemiological model to show that export embargoes caused by the FMD outbreaks would lead to increase in domestic supplies and lower prices. Park et al. (2008) quantified the impacts of domestic and overseas animal disease crises on the Korean meat market. One of the findings of their study is that the Korean import ban on U.S. beef meat, due to the 2003 BSE discovery, caused an overall concern in the population. This concern had negative impacts on the demand side and led to substantial decreases in prices of domestically produced beef.

More recently, Attavanich et al. (2011) estimated the impacts of media coverage related to H1N1 (swine flu) on U.S. meat and related product prices, and quantified the revenue losses across the meat and related markets. A trade ban by U.S. pork meat importing countries was also examined and was shown to negatively affect the industry by reducing lean hog prices considerably. A study by Tozer and Marsh (2012) analyzed hypothetical FMD outbreaks impacts on the second largest exporter of beef meat in the world, Australia. Scenarios with closure of export markets were evaluated. In all scenarios, domestic supply increased and domestic prices fell significantly. Furthermore, after the FMD mitigation measures, their work showed that it would take approximately one year for the Australian beef price to return to base scenario levels.

Regarding animal disease outbreaks and the impacts on the Brazilian meat industry, there are few studies in the literature. Teixeira and Maia (2008) used Box-Jenkins time series methods to estimate the impacts of the 2004 FMD outbreak on the live cattle farm price. Their findings indicate that the FMD outbreak caused a structural break in the live cattle farm price series. The authors suggest that the import ban by Russia on Brazilian meat exports (originating in the states of Amazonas and Pará) due to the outbreak possibly triggered the structural break. Otuki et al. (2009) analyzed the impacts of the FMD outbreaks in 2004 and 2005 on the price volatility of two series of farm pork prices: national price and the state of Santa Catarina price. The authors employed the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model to perform their analysis. Results from this study suggest that the FMD outbreaks caused high pork price volatility for both series.

Conceptual Model

As discussed in the literature review section, animal disease outbreaks, followed by meat trade bans, affect both exporting and importing countries. In this section a conceptual model depicts the occurrence of an import ban by a large importing country (Russia) and its impacts on the exporting country (Brazil). To illustrate this event, Figure 1 below presents the effects of a trade ban by Russia on the Brazilian beef market (this also applies for the pork and chicken). The Brazilian domestic beef supply and demand are shown in the left panel. The Russian beef market is located in the right panel. Domestic beef supplies in both countries are assumed to be perfectly inelastic (beef production is derived from the Brazilian cattle market). The panel in the middle

represents the world beef market. Excess supply is derived by measuring the horizontal distance between the supply and demand schedules in Brazil. Excess demand in the world market for simplicity is assumed to be equal to the demand schedule for Russia.

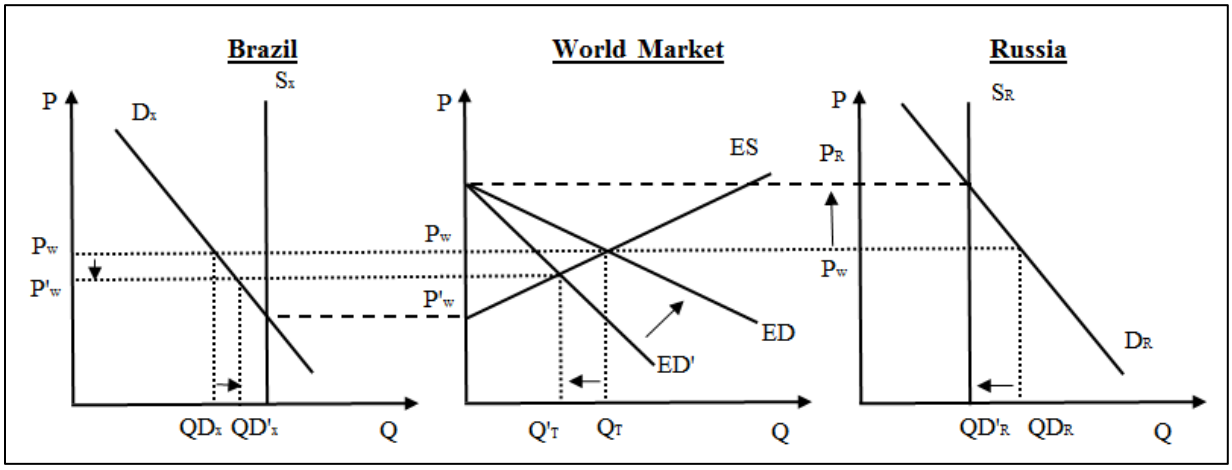

Figure 1. Effects on the Brazilian beef market of an import ban by Russia due to a foot and mouth disease outbreak

Source. Adapted from Peterson et al. (1988).

For simplicity, it is assumed that the only country exporting to Russia is Brazil[2]. Thus, the introduction of an import ban by Russia on the Brazilian beef exports means that all the domestic consumption in Russia would be supplied by the local producers. In this case, Russian imports would fall to zero and the local price would rise from P_w to P_R. In the world market, the excess demand curve would shift from ED to ED' where the excess demand in ED' is driven by other importing countries. This fall in excess demand results in a lowering of the world beef price. This can also be explained by the fact that more beef meat would be available in the Brazilian market. Consumers in Brazil are expected to benefit from the lower prices, while producers would lose. On the other hand, Russian consumers would lose due to higher beef prices while producers would gain.

In summary, the expected effects of FMD outbreaks on the Brazilian meat market coupled with an import ban from its main trade partner, Russia, are a decrease in Brazilian meat prices. These decreases in prices are expected to occur throughout the meat sector in Brazil. In other words, export, wholesale, and farm prices for beef, pork, and chicken are expected to undergo a decrease due to the import ban vis-à-vis the increase in internal meat supply.

Method of Analysis

To quantify and identify the potential impacts of FMD outbreaks followed by an import ban by Russia on the Brazilian meat industry, a time series method is employed. The Vector Error Correction Model (VECM) facilitates the comparison between the actual price that is affected by the FMD outbreak (plus the import ban) and the forecasted price that uses only information before the outbreak occurred. This approach allows the quantification of the impacts on meat prices for price levels for different types of meat and its different levels of the supply chain.

[2] This is a reasonable assumption since historically Brazil exports accounts for 40% of the Russian beef imports.

Vector Error Correction Model

A useful empirical method used to analyze a set of interrelated variables observed over time is a vector autoregression (VAR) model. An unrestricted VAR model with k lags of *M* variables is written:

$$(1)\quad X_t = \sum_{i=1}^{k} \Gamma_i X_{t-i} + \gamma + e_t \ (t = 1, \ldots, T)$$

where X is a ($M \times 1$) vector of series at time *t*, Γ_i is a ($M \times M$) matrix of coefficients relating series changes at lagged *i* period to current changes in series, γ is a ($M \times 1$) vector of constants, and e_t is a ($M \times 1$) vector of independent and identically distributed (i.i.d.) innovations (error terms). Equation (1) indicates that each of the *M* variables is a function of *k* lags of all *M* variables, including itself, a constant and a present innovation term. If some series in the set of evaluated variables are nonstationary and cointegrated, the VECM, developed by Johansen (1988), has to be utilized to study both short-run discrepancies and long-run equilibrium. A VECM model is described as follows:

$$(2)\quad \Delta X_t = \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + e_t \ (t = 1, \ldots, T)$$

where equation (2) is a VAR model in first differences with the addition of a lagged-level vector. The ($M \times M$) coefficient matrix, Π, contains the influence of lagged levels of the analyzed variables on current changes.

When the rank of Π is a positive number, *r*, and it is less than the number of series in the system, *M*, then Π = αβ', where α and β are (*M* x r) matrices. The α matrix contains the information on the speed of adjustment and β matrix includes the cointegrating parameters.

There are several approaches to specify the rank of the cointegrating vector (*r*) and the optimal lag length (*k*). One can perform the conventional approach which is a two-step procedure involving system-based likelihood ratio (LR) tests to determine *r* and *k* sequentially. In other words, optimal lag length is first estimated by the loss metric, (e.g. Schwarz-loss) and then the cointegration rank is determined (usually with a trace test, see below).

The first step is to determine the optimal lag length (*k*) of the VAR representation via loss metric criteria functions. Here we consider two different loss metrics: (i) the Schwarz-loss criterion (SIC) and (ii) the Hannan and Quinn (HQ). Both methods are asymptotically consistent (meaning as sample size grows to infinity they select the proper lag length with probability one). The second step is to identify the rank of cointegration vectors based on a trace test (Johansen 1988), with the test statistic given by

$$(3)\quad Trace = -T\Sigma_{i=r+1}^{k} \ln(1 - \lambda_i)$$

where *T* is the number of observations and λ_i's are ordered Eigenvalues of matrix Π in equation (2).

This two-step approach has its advantages and disadvantages. According to Bruggemann and Lutkepohl (2005), the main advantage of this procedure is computational simplicity. However, unfortunately, one of the main disadvantages of this procedure is that it will likely yield low

power and size distortions when the assumption of independent, identically, distributed (i.i.d.) does not hold for the error term (Wang and Bessler 2005). In addition, the two-step procedure requires an arbitrary decision with respect to which should be first determined; the cointegration rank or the optimum lag estimation. The choice of the lag order in the first step has been shown to have a non-trivial impact on the cointegration test performance (Boswijk and Franses 1992).

More recently, model selection methods based on information criteria have been proposed and implemented as an alternative to the two-step procedure (Kapetanios 2004). This method jointly estimates the cointegration rank and the optimal lag length in a VAR. There are two main advantages of the model selection compared with the two-step procedure. First, it eliminates the arbitrary choice associated with identifying the "appropriate" significance level when using the traditional system-based LR tests. Second, the model selection approach allows the researcher to jointly determine the lag order and cointegration rank by minimizing information criteria over a pool of models with various lag orders and cointegration ranks (Wang and Bessler 2005). Furthermore, simulation evidence by Chao and Phillips (1999) and Wang and Bessler (2005) suggests the information criteria approach can complement traditional parametric tests. Here HQ loss metric criterion is used to jointly determine the optimal length of the VAR representation and the cointegration rank. For comparison, both the system-based LR tests (sequential) method and the model selection (joint) procedure are used to determine the optimum lag length (k) and the rank of cointegration (r).

Data

The data used are monthly Brazilian prices of beef, pork, and chicken at the export, wholesale, and farm level from January 1996 to February 2011. All price series at the wholesale and farm levels are provided by the Instituto de Economia Agrícola (IEA 2011) and represent price quotes from farmers located within the state of São Paulo. In the original dataset, the farm level prices for beef and pork were in R$/15 kg[3]. Both beef and pork prices were transformed to Real (R$)/kgs by dividing them by 15 kg. There was no need to transform the farm chicken prices since they were in R$/kg. The wholesale price for chicken is the equivalent to the fresh chicken price and was reported in R$/kg. In Brazil, wholesale pork is commercialized in half carcass units and its price is quoted in R$/kg. The wholesale beef prices were also in R$/kg.

Export price data are from the Secretaria de Comércio Exterior (SECEX/MDIC 2011) and are in U.S. dollars. The nominal exchange rate of the R$ to the U.S. dollar was calculated using data available from ERS/USDA (2011). It is important to mention that the export price was calculated as a proxy for the unit value of the Brazilian exports (total value of exports divided by the quantity). The data were transformed to natural logarithms.

The descriptive statistics for these nine price series are presented in Table 1. The highest meat price is found in the beef market with the export price having the greatest mean (R$5.47/kg). As expected, the mean of export prices for all the analyzed meats was greater than either wholesale or farm price. The largest standard deviation was found in wholesale beef price (R$1.53/kg) and lowest in farm chicken price (R$0.39/kg).

[3] In the Brazilian meat market, there is a common unit called "arroba" to weigh live animals. This unit is equal to 15 kgs.

Table 1. Descriptive statistics on Brazilian meat prices in different levels of the industry, monthly data: January 1996–February 2011.

Variables	Mean	St.Dev.*	Minimum	Maximum
Chicken (R$/kg)				
Farm	1.21	0.39	0.58	2.07
Wholesale	1.74	0.55	0.96	3.09
Export	2.40	0.65	1.27	4.12
Pork (R$/kg)				
Farm	2.36	0.88	0.98	4.42
Wholesale	2.96	1.04	1.23	5.44
Export	3.64	1.06	2.02	7.04
Beef (R$/kg)				
Farm	3.41	1.39	1.40	7.28
Wholesale	4.05	1.53	2.07	8.80
Export	5.47	1.16	3.31	9.60

Note. *SD = Standard Deviation.

Empirical Results

In order to determine if the VECM is appropriate for these price data series, nonstationarity of each price series is tested using both Augmented Dickey-Fuller (Dickey and Fuller 1981) and Phillips-Perron (Phillips and Perron 1988) tests. The null hypothesis of both tests is that each evaluated series is nonstationary. The results in Table 2 indicate that both the Phillips–Perron and the Augmented Dickey-Fuller test fail to reject the null hypotheses of nonstationariaty at the 5 percent significance level.

Table 2. Test for nonstationarity of logarithms of Brazilian meat price series, monthly data: January 1996 – February 2011.

Meat Price Series	Augmented Dickey-Fuller	Phillips-Perron
	t-test (k)	z-test
Chicken		
Farm	-1.87 (1)	-1.62
Wholesale	-1.71 (1)	-1.41
Export	-1.98 (1)	-1.87
Pork		
Farm	-1.69 (1)	-1.70
Wholesale	-1.83 (1)	-1.85
Export	-2.30 (1)	-1.73
Beef		
Farm	-0.95 (1)	-0.90
Wholesale	-0.78 (1)	-0.23
Export	-1.77 (2)	-2.05

Note. The 5% critical value for the Augmented Dickey-Fuller and Phillips-Perron tests is -2.89 for both.

Table 3 below lists the outcome of Schwarz and Hannan and Quinn loss metrics on various lag lengths, with and without monthly (seasonal) dummy variables, associated with fit unrestricted VAR on the 9 logged price series. The measures summarize fit on 12 different models. Half the models incorporate 11 seasonal variables, with the remaining half having no seasonal variables. Both groups of models use a constant with one through 12 lags (up to 12 lags were analyzed but results are reported for 6 lags in Table 3 to save space). The model with the lowest Schwarz and Hannan and Quinn loss metrics had no seasonal variables, a constant, and prices lagged a single time period.

Table 3. Loss metrics on the order of lags (k) in a levels vector autoregression on log prices for the Brazilian livestock and meat and 11 seasonal dummy variables, monthly data: January 1996 –February 2011.

Lags = k	Schwarz-loss	Hannan and Quinn's Φ
	Constant, k lags of Prices and No Seasonals	
1	-53.61*	-54.55*
2	-52.35	-54.14
3	-50.69	-53.33
4	-48.89	-52.39
5	-47.16	-51.53
6	-45.50	-50.75
	Constant, k lags of Prices and 11 Seasonals	
1	-52.41	-54.45
2	-50.93	-53.84
3	-49.29	-53.08
4	-47.56	-52.23
5	-45.90	-51.45
6	-44.33	-50.76

Notes. The models considered are vector autoregressions of the logarithms of the nine meat prices with lags of 1 through 6 (we actually studied lags 1 – 12, but report results on the first six to save space, as all metrics on lags >6 exceed those presented here], each equation in the panel has either no, or 11 seasonal monthly variables. Metrics considered are Schwarz- loss (SL) and Hannan, and Quinn's Φ measure on lag length (k) of a levels vector autoregression: $SL=\log(|\sum|)+(9k+11+1)x(\log T)/T$, $\Phi =\log(|\sum|)+(2.00)(9k+11+1)x(\log(\log T))/T$, where $\sum$ is the error covariance matrix estimated with 9k+11+1 (the ''11'' represents the 11 seasonal dummy variables, the ''1'' represents the constant) regressors in each equation, T is the total number of observations on each series, the symbol ''| |'' denotes the determinant operator, and log is the natural logarithm. The model that minimizes the loss metric is selected. The asterisk (''*'') indicates minimum of each column.

The trace tests for both a constant within and outside the cointegrating vector(s) are presented in Table 4. Here one tests sequentially within the table starting at the top going from left to right and from top to bottom (we stop testing with the first "fail to reject" decision, indicated by a double asterisk (**) in the table). The rank of Π is less than or equal to four, with the constant within the cointegration space.

Table 4. Trace statistics on order of cointegration on logarithms of prices for Brazilian meat price series, monthly data: January 1996 –February 2011.

H_0: Rank	Trace	C(5%)	Decision	Trace *	C(5%)*	Decision
r = 0	288.21	203.34	Reject	278.79	192.30	Reject
r ≤ 1	225.32	165.73	Reject	216.12	155.75	Reject
r ≤ 2	167.51	132.00	Reject	158.81	123.04	Reject
r ≤ 3	118.63	101.84	Reject	110.09	93.92	Reject
r ≤ 4	74.19	75.74	Fail**	65.81	68.68	Fail
r ≤ 5	48.05	53.42	Fail	40.18	47.21	Fail
r ≤ 6	29.18	34.80	Fail	21.35	29.37	Fail
r ≤ 7	14.93	19.99	Fail	7.74	15.34	Fail
r ≤ 8	4.86	9.13	Fail	0.89	3.84	Fail

Note. Trace and C(5%) refer to the trace statistic and critical values at the 5 percent significance level with a constant in the cointegrating vector, respectively. Trace* and C(5%)* refer to trace statistics and critical values at the 5 percent significance level with a constant outside the cointegrating vector, respectively. The trace test considers the hypothesis that the rank of Π is less than or equal to r. Entries in the column labeled "Decision" refer to the decision to "Reject" or "Fail to Reject" the null hypothesis listed in the far column. The double asterisk (**) indicates the stopping point of testing. Critical values are taken from Hansen and Juselius (1995).

As discussed in the methods section, the model selection method is also applied. This method determines jointly the optimal lag length and cointegration rank. The Hannan and Quinn (1979) Φ statistics (HQ), a widely used information criterion, was selected in this study. Table 5 below presents the HQ value against possible lag order and cointegration rank. HQ loss statistic suggests the model with the minimal information criterion has the lag order of one (k = 1) and four cointegration vectors (r = 4).

Table 5. Hannan and Quinn statistics for different values of cointegration rank (r) and lag length (k)

Cointegration Rank (r)	Number of Lags (k)					
	1	2	3	4	5	6
1	-54.749	-54.405	-53.767	-52.911	-52.080	-51.254
2	-54.810	-54.434	-53.780	-52.906	-52.048	-51.229
3	-54.844	-54.449	-53.799	-52.851	-52.009	-51.214
4	**-54.860**	-54.477	-53.753	-52.811	-51.959	-51.206
5	-54.815	-54.439	-53.700	-52.738	-51.926	-51.183
6	-54.779	-54.397	-53.624	-52.674	-51.859	-51.109
7	-54.749	-54.366	-53.583	-52.631	-51.805	-51.058
8	-54.729	-54.349	-53.562	-52.601	-51.784	-51.022
9	-54.721	-54.339	-53.550	-52.587	-51.772	-51.009

Notes. Hannan and Quinn statistics is calculated according to the following equation: HQ=log(|∑|)+(2.00)(9k+11+1)x (log (logT))/T where ∑ is the error covariance matrix estimated with 9k+11+1 (the ''11'' represents the 11 seasonal dummy variables, the ''1'' represents the constant) regressors in each equation, T is the total number of observations on each series, the symbol ''| |'' denotes the determinant operator, and log is the natural logarithm. Bold indicates the minimum value of the HQ statistics.

The optimal lag length and the cointegration rank are found to be the same when determined via the two-step procedure (sequentially) or the model selection method (jointly), which is consistent with the results from Wang and Bessler (2005).

The Impacts of the FMD Outbreak on Brazilian Meat Prices[4]

A VECM was estimated using the data from January 1996 to August 2005, a month before the FMD outbreak in the state of Mato Grosso do Sul and two months before the beginning of the Russian import ban. Out-of-sample forecasting was done for meat prices for 29 months after the event and six months after the end of the Russian import ban on Brazilian meat (which was December, 2007). The percentage change (ΔP_{ij}) of the actual price relative to the forecasted price of each meat product was calculated for the focus of the study over August 2005 to June 2008.

Figures 2, 3, and 4 illustrate ΔP_{ij} defined over *i* meat products and *j* market levels over time for different meats following the FMD outbreak in September 2005 and, sequentially, the beginning of the Russian import ban in October 2005 through the lift of the import ban by Russia in December 2007. Following is a discussion on the impacts of the FMD outbreak on meat prices for each type of meat.

Beef Prices

In the first four months after the outbreak and three months after the Russian import ban (i.e. by January 2006), export beef prices underwent ambiguous price movements (Figure 2). One month later (February 2006), export beef prices decreased approximately 12 percent. Actual export price recovered three months later (around April 2006) and stayed above its forecast price until December 2006. After December 2006, the actual export price dropped below its forecast price and stayed in that position for 12 months, with the largest decrease in price (nearly 13 percent) in mid-2007, until the lifting of the import ban by Russia in December 2007. In January 2008, one month after the removal of the import ban by Russia, the export price rose approximately 20 percent relative to the forecasted price. By March 2008, perhaps due to potential export market uncertainties, the percentage change in the export price relative to the forecasted export price became negative (a decrease of 5 percent) but recovered one month later.

As for the wholesale beef price, the impact of the FMD outbreak was positive in the short run (up almost 18 percent in the first two months). After dropping below zero in March 2006, the actual wholesale price rebounded five months later and stayed above the forecasted price for most of the study period. Overall, the wholesale beef market appeared to have benefited from the outbreak. Different from the wholesale price, the effects of the FMD outbreak on the farm beef price were negative for most of the period. After two months with almost no variation, the actual farm beef price was below its forecasted value for the next 12 months, decreasing 20 percent by

[4] A reviewer suggested we deflate all data, offering the analysis in real (inflation adjusted) basis. We carried out such using the Índice Nacional de Preços ao Consumidor Amplo (IPCA) adjustment index calculated by the Instituto Brasileiro de Georgrafia e Estatística (IBGE) and retrieved from the Instituto de Pesquisa Econômica Aplicada (IPEA) (IPEA 2015) and found quite similar results. We provide the unadjusted nominal results here, as agents still must react to nominal prices. Readers wishing to see the real-basis results can write the senior author for our real data appendix.

June 2006 and only recovering in October 2006. After a one month recovery, the percentage change in the farm price to the forecasted farm price declined again and remained negative for the next 13 months (until November 2007), one month before the import ban removal by Russia.

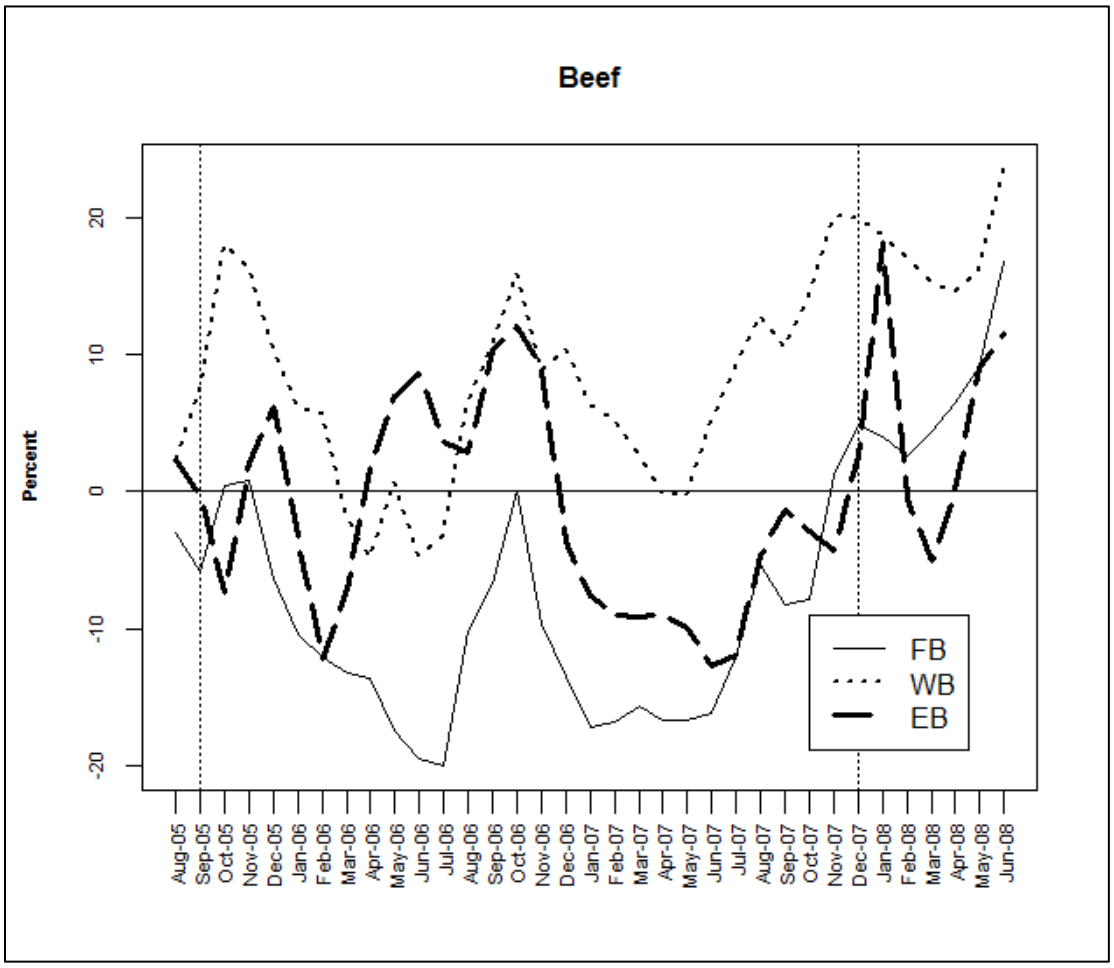

Figure 2. Percentage change in the actual beef prices relative to the forecasted beef price after the FMD outbreak, September 2005, and before the removal of the import ban by Russia, December 2007.

Note. Farm Beef Price (FB), Wholesale Beef Price (WB), Export Beef Price (EB). First vertical dotted line is the first FMD outbreak. Second vertical dotted line is the removal of Russian import ban.

Pork Prices

The graph in figure 3 represents the percentage change of the actual price relative to the forecasted price for the pork market. The export pork price reached the lowest percentage decrease six months (March 2006) after the occurrence of the FMD outbreak (down approximately 27 percent), such decrease was the largest in the short run for all the export price series. Three months later, the export pork price recovered, reaching zero percent variation in June 2006. However, one month later, the percentage change of the actual price relative to the forecasted price decreased and remained negative for the rest of the period analyzed. Overall, the

percentage change of the actual price relative to the forecast for the export pork price was negative for the entire period, with the exception of one month, and never recovered, even with the lifting of the import ban by Russia in December 2007.

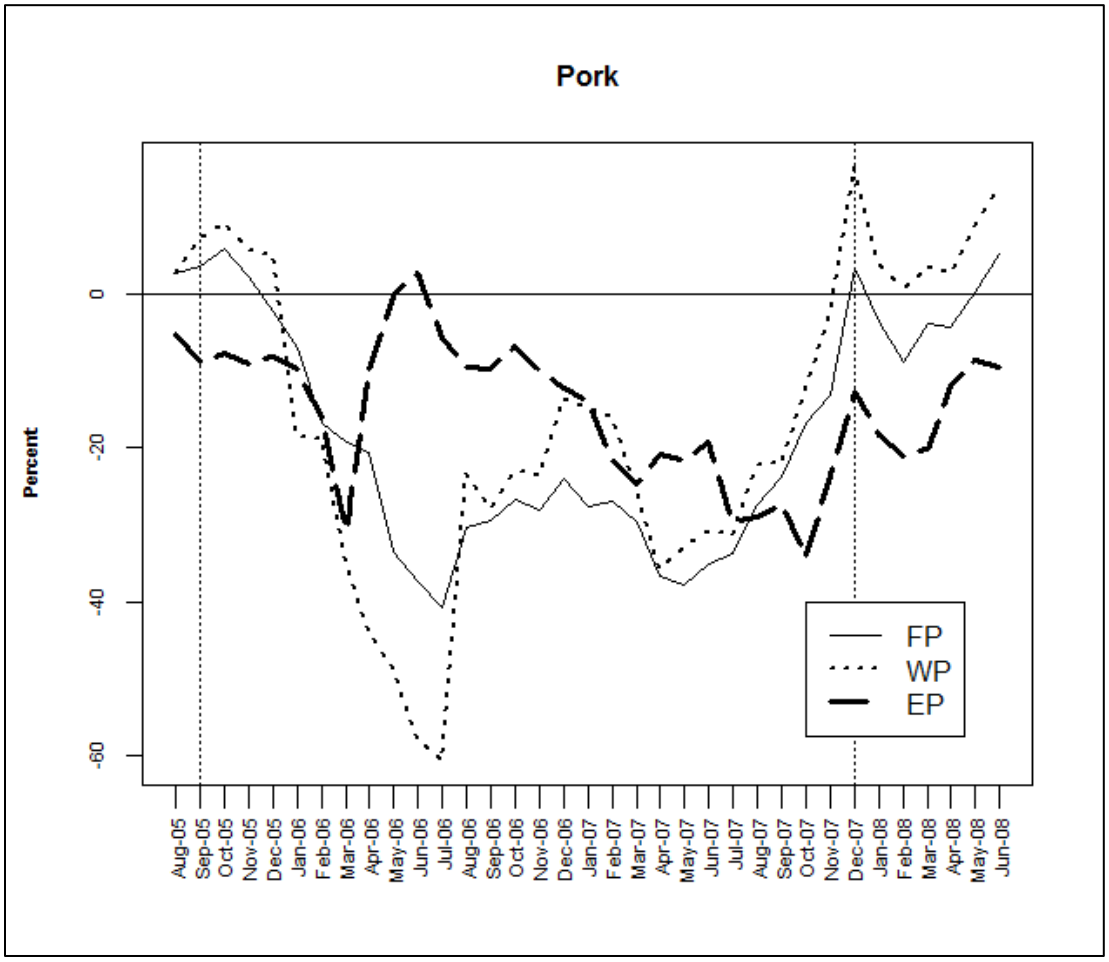

Figure 3. Percentage change in the actual pork prices relative to the forecasted pork prices after the FMD outbreak, September 2005, and before the removal of the import ban by Russia, December 2007.

Note. Farm Pork Price (FP), Wholesale Pork Price (WP), Export Pork Price (EP). First vertical dotted line is the first FMD outbreak. Second vertical dotted line is the removal of Russian import ban.

After three months with positive variation, the percentage change of the actual wholesale price relative to its forecasted price underwent a severe decrease following the FMD outbreak. In July 2006, this relationship reached nearly 60 percent, which is the lowest decrease relative to other wholesale prices. The actual price went above the forecasted price only in November 2007, one month before the lift of the import ban by Russia. Regarding the farm pork price, similar to the wholesale price, the lowest percentage change of the actual price relative to its forecasted price occurred in July 2006 (down almost 40 percent). The recovery of the farm pork price only occurred in November 2007. Of all farm price series studied, the price for pork spent the longest period below its forecasted price, totaling 24 months. The only pork prices to recover were the farm and wholesale prices. Export price never recovered during the period of our analysis.

Chicken Prices

Figure 4 presents the percentage change in the actual price to the forecasted price for the chicken market at different market levels. This market is interesting as chicken meat is considered to be a substitute for both beef and pork. In addition, since chicken cannot be infected by FMD, one would expect that the Russian government would not include chicken meat as part of the ban. Still, the Russian government included chicken meat in their import ban of Brazilian meats. As the ban on chicken meat was incorporated, the actual export chicken price declined nearly 35 percent with respect to its forecast (in April 2006). The export chicken price never recovered, not even after the removal of the import ban by the Russian authorities.

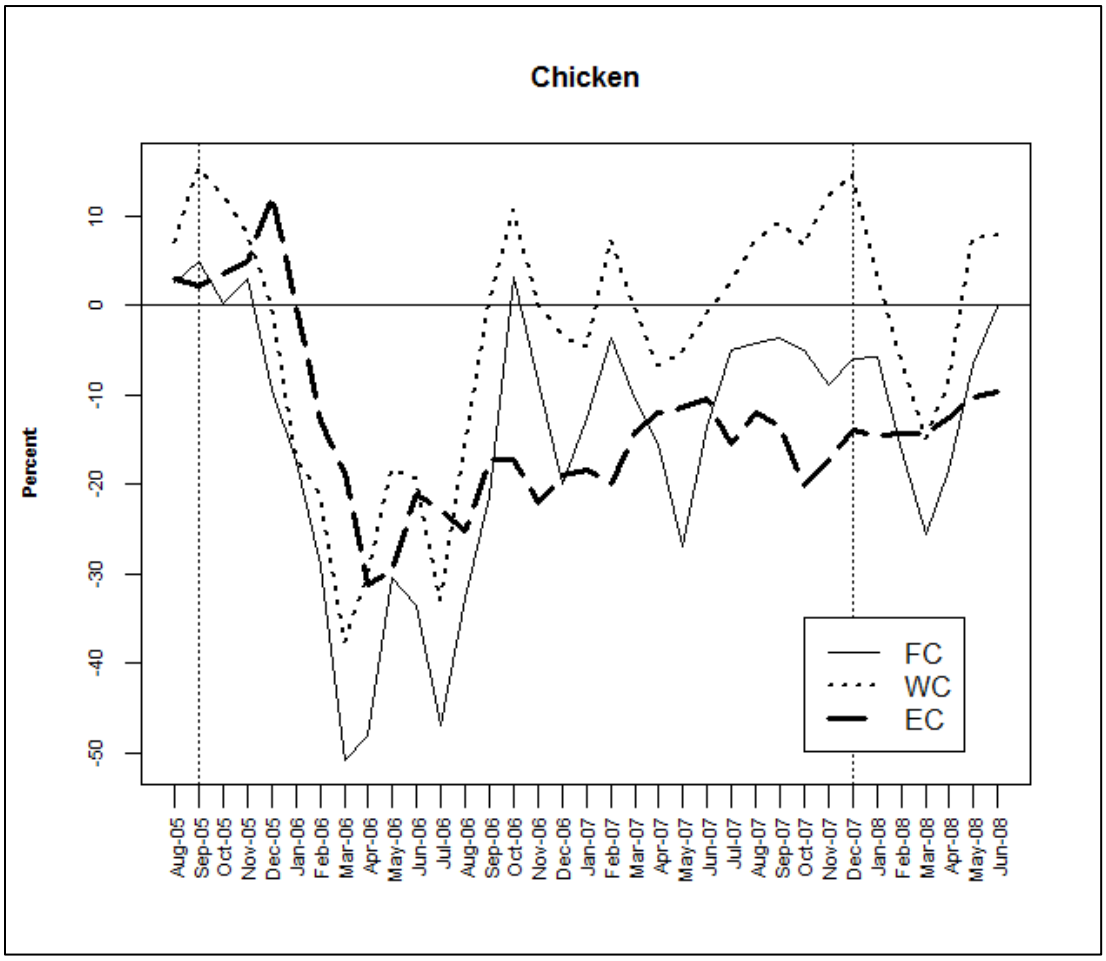

Figure 4. Percentage change in the actual chicken prices relative to the forecasted chicken prices after the FMD outbreak, September 2005, and before the removal of the import ban by Russia, December 2007.

Note. Farm Chicken Price (FC), Wholesale Chicken Price (WC), Export Chicken Price (EC). First vertical dotted line is the first FMD outbreak. Second vertical dotted line is the removal of Russian import ban.

From December 2005 to September 2006, the wholesale and farm chicken prices were affected in a similar manner to the export price. The wholesale price increased with respect to its forecast prices in the first three months then it underwent a drastic decline three months later (March

2006). By October 2006, the percentage change of the actual wholesale price relative to its forecasted price rose to nearly 10 percent but one month later this relationship declined and underwent ambiguous price movements for the remainder of the analyzed period. As for the farm chicken price, a decrease in price was observed right after the report of the FMD outbreak. Similarly to the wholesale price, this downward movement in the farm price continued and reached its lowest point in March 2006. The chicken farm price rebounded six months later (in October 2006). For most of the analyzed period, actual farm prices for chicken were below its forecasted prices. This is an interesting finding since the chicken sector was expected to benefit via cross-price effects. Yet, the opposite took place which it can be attributed to the increase in chicken supply due to the Russian import ban.

Conclusions

This study evaluates the market impacts associated with the 2005 FMD outbreak in Brazil. Included in our focus are the consequences of the meat import ban imposed by Russia in response to this FMD outbreak. By using time series methods it was discovered that the 2005 FMD outbreak did cause a price shock to the Brazilian meat market. This discovery is similar to discoveries found in other studies of animal disease outbreaks in Europe and North America (Paarlberg et al. 2008, Teixeira and Maia 2008, Attavanich et al. 2011, Tozer and Marsh 2012).

At the export level, the beef price decreased with respect to its forecasted price in the first two months after the outbreak. After three months of recovery, the beef export price declined and stayed below the forecasted price for four straight months. By April 2006, the beef export price recovered and remained above the forecasted price for seven months. In December 2006, the actual export beef price was below its forecasted price and it only recovered one year later after the removal of the import ban by Russia. On the other hand, the export pork price never fully recovered (with the exception of one month, June 2006) after the import ban was imposed by Russia. The actual export chicken price was above its forecasted price in the first four months that followed the import ban but, similarly to the export pork price, never recovered. These export price declines were expected as it was discussed in the conceptual framework section. An import ban by a large importer would cause an oversupply of the commodity in the domestic market, which would in turn put a downward pressure on the prices. As the import ban was removed by Russia, greater export demand and eventually higher prices in Brazil took place. Comparing our impacts of animal disease outbreaks at export price level results to other studies is not possible. To our knowledge, there are no studies which have investigated the effects of animal disease out breaks coupled with trade bans on export price series.

As for the wholesale prices, the beef series was positive for most of the analyzed period. The actual wholesale beef price was 18 percent greater than the forecasted price in the first month after the outbreak. By March 2006, the actual wholesale beef price declines for a few months and recovers five months later. From August 2006 to the removal of the import ban in December 2007, the wholesale beef price was above its forecasted price for fourteen of the sixteen months. This result does not correspond to our expectations discussed in the conceptual framework section. Although the wholesale beef price underwent price decreases for a few months, the extra supplies dump caused by the import ban was expected to put a downward pressure on prices. Since FMD does not have any impact on human health, the demand for beef at the wholesale

level may have put an upward pressure on the prices. As for the wholesale pork price, the results that were expected based on the conceptual framework took place. Similar to the results found in Park et al. (2008), the percentage chance in the actual wholesale pork price to the forecasted price was negative for most the analyzed period. As for the wholesale chicken price, our results were shown to differentiate from Park et al. (2008). Their results showed that the wholesale chicken price benefit from the FMD outbreak in Korea – due to cross-price effects. However, in the Brazilian case, the chicken meat was also part of the import ban by Russia which in turn increased chicken supply thus downward pressure on prices.

As for the farm prices, beef and pork prices experienced negative impacts due to the FMD outbreak and the import ban by Russia. These results correspond to the findings of several studies (Park et al. 2008, Paarlberg et al. 2008, Teixeira and Maia 2008, Tozer and Marsh 2012). As previously discussed, the FMD outbreak coupled with trade bans causes large declines in the prices due to extra supplies being dumped on the domestic market. Similarly to the study by Paarlberg et al. (2008), the recovery of the beef and pork prices begins after the end of the importing restrictions. The farm chicken price surprisingly was below its forecasted price for most of the analyzed period. As occurred in the study done by Paarlberg et al. (2008), a plausible explanation to this occurrence is that the chicken price in an initial instance has a positive correlation with the price of other meats. In other words, in the first few instances after the outbreak, the cross-price effect in the short run does not develop.

Overall, our most important findings can be summarized as follows. First, the negative price shocks caused by the FMD outbreak followed by export restrictions were most prevalent in the pork and chicken meat sectors. This result was found in all levels of the supply chain: export, wholesale, and farm. Second, the farm beef price was shown to have undergone severe negative impacts due to the outbreak. On the other hand, the export beef price underwent ambiguous changes, with prices rising and falling during our study period. An interesting result was found at the wholesale beef level where prices were shown to have benefited from the outbreak and trade restrictions. This last result calls for additional study (perhaps) on market organization and or differences in market power between farm-level suppliers, wholesalers and exporters. Such work is beyond the scope of the current study.

This work contributes to the literature in the following ways: (i) the animal disease outbreaks analyses were performed at the export level for three different types of meat; and (ii) to our knowledge, this study is the first to systematically investigate the impacts of these outbreaks on different levels of the Brazilian meat market. Still, there is additional work to be done. We did not consider the effects of animal disease outbreaks and export restrictions on Brazilian cattle producers' revenues. It is known that animal disease outbreaks cause supply disruptions (i.e. mass slaughter of cattle, hogs, etc.). We do not have precise data of slaughtered animals or data on carcass disposal. With such data an even more complete study could be made. Another interesting future research would be to analyze the impacts of the FMD outbreak on the Brazilian meat supply chain by evaluating the export-wholesale and wholesale-farm price margins.

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Competitive Behavior in the U.S. Green Skin Avocado Market

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Abstract

This study examined imperfect competition in international fruit markets. We conducted an empirical exercise to assess the intensity of competition in the US green skin avocado import market during the 2004 to 2013 period. A model using the (inverse) residual demand method as proposed by Goldberg and Knetter (1999) was specified and estimated. Findings reveal the existence of imperfect competition in the US green skin avocado market over the sample period. Estimation results show that the Dominican Republic, acting as an exporter exercises market power and maintains its marketing margin throughout the year.

Keywords: residual demand, Dominican Republic, avocado, inverse demand, imperfect competition, green skin avocado

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Introduction

Global avocado production and trade are highly concentrated, with the top five producers and exporters accounting for over 50% and 70% of the production and trade, respectively. World avocado production grew from 3.2 million metric tons (MMT) in 2003 to 4.4 MMT in 2012. In 2012, the top five producers and their share of the total production were Mexico (30.2%), Indonesia (6.8%), Dominican Republic (6.7%), U.S. (5.6%), and Colombia (5%) (FAOSTAT 2014a). Mirroring the noticeable rise in global production that occurred between 2002 and 2011, global avocado exports more than doubled during this period from 426,848 metric tons (MT) in 2002 to 951,573 MT in 2011 (last year data were available). During the 2009–2011 period, Mexico was the leading avocado exporter, accounting for 39.8% of the global trade, followed by Chile (14.8%), the Netherlands (re-exporter, 9.1%), Peru (7.5%), and Spain (6.9%) (FAOSTAT 2014b). On the import side, global avocado imports also followed an upward trend from 406,555 MT in 2002 to 951,573 MT in 2011. During the 2009–2011 period, the U.S. was the largest avocado importer, accounting for 43.3% of the total imports, followed by the Netherlands (10.9%), France (9.5%), Japan (4.1%), and Canada (3.6%). Together, these five countries accounted for 71.3% of the global avocado imports during the 2009–2011 period (FAOSTAT 2014b).

In 2013, U.S. total avocado imports exceeded 562,000 MT, with an estimated value of $1.08 billion (current prices in U.S. dollars). At 96% of volume traded in 2013, the Hass avocado cultivar represented the most popular avocado cultivar imported into the U.S., far outdistancing the green skin avocado cultivar (2.6%) and organic (1.5%) (USDA, FAS 2014).

Despite its low relative importance in U.S. domestic production and trade, the green skin avocado is an important component of the Florida agricultural economy, with an estimated wholesale value upwards of $35 million and an economic impact of close to $100 million for the year 2013 (Evans and Lozano 2014). Historically, the U.S. green skin avocado market has been supplied by Florida, the Dominican Republic, Mexico, and Chile (USDA/FAS 2014). In recent years, Mexico and Chile have turned their focus to the Hass cultivar because of its popularity in global markets and long postharvest life (Chilean Hass Avocado Committee 2015). This has resulted in a reduction in the supply of U.S. imports of green skin avocado from Mexico and Chile. This situation has allowed the Dominican Republic to increase its exports of green skin avocados to the U.S. (it now supplies 98% of the U.S. imported green skin avocados). Between 2004 and 2013, Dominican Republic green skin avocado export volume to the U.S. increased by 65.8% (USDA/FAS 2014). This has raised concerns regarding the extent to which Dominican Republic avocado exporters may exert market power when supplying the U.S. market, especially during the U.S. production off-season. There is also concern about using the perfect competition model to analyze the U.S./Dominican Republic green skin avocado trade.

Our study examined imperfect competition in international fruit markets. In particular, we conducted an empirical exercise to assess potential oligopolistic behavior in the U.S. green skin avocado market. Results provided insights regarding the competitive structure and pricing behaviour of the Dominican Republic as an exporter of green skin avocados. To our knowledge, no previous studies have focused attention on imperfect competition in the U.S. green skin avocado export market using an empirical industrial organization approach.

This paper is organized as follows: section 2 provides additional details about the U.S. green skin avocado market; section 3 describes the conceptual framework; section 4 presents the empirical model, data sources, and estimation procedures; section 5 presents the results of the empirical estimation; and section 6 contains a summary of the findings and concluding remarks.

The U.S. Avocado Market

U.S. avocado production occurs in the states of California, Florida, and Hawaii. California is the main U.S. producer of avocados, accounting for 84% of the total production during crop year 2013/14, followed by Florida (15.9%), and Hawaii (0.1%) (USDA/ERS 2014b). In terms of cultivars, California grows mainly the Hass cultivar, while Florida grows the green skin cultivars (California Avocado Commission 2015, Crane et al. 2013).

Figure 1 depicts U.S. domestic avocado production and trade from 2004 to 2013. Fluctuations in production are due to abiotic and biotic factors (i.e., avocado trees exhibit an alternate bearing cycle, with a large crop of small avocados one year, followed by a small crop of large avocados the next year). In addition, the value of U.S. avocado production at the farm gate level reached $350 million in 2013/14, a decrease of about 37% compared to the 2010/11 crop season (USDA/ERS 2014b).

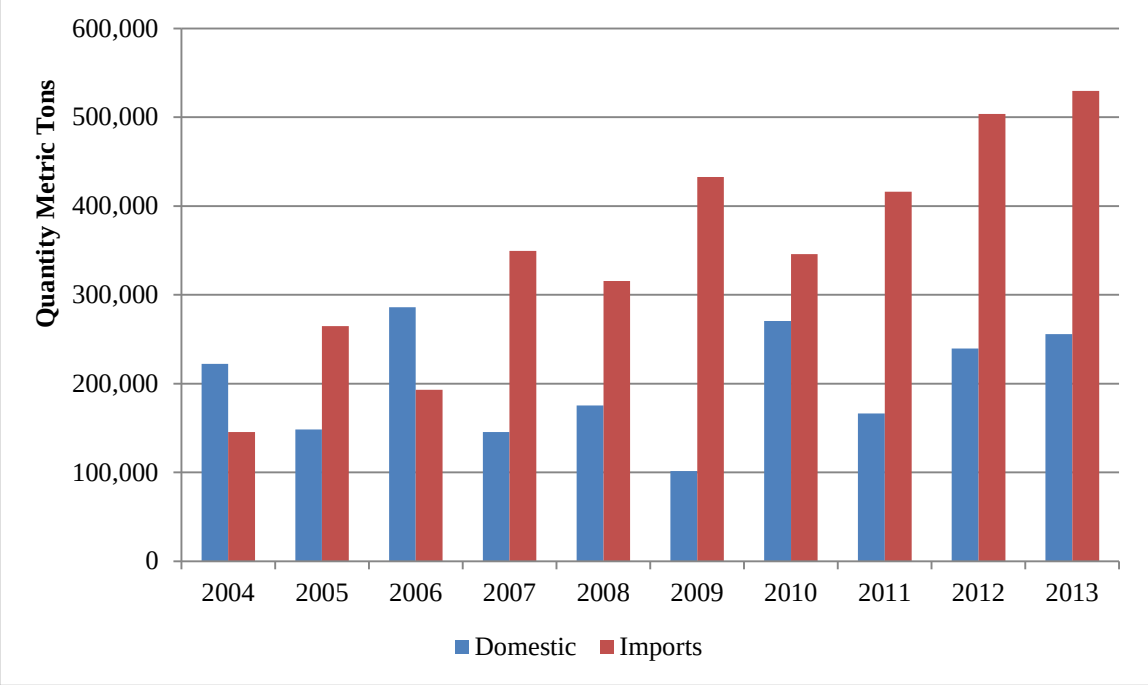

Figure 1. U.S. domestic avocado production and imports, 2004–2013
Source: USDA/FAS (2014).

Over the 2004–2013 period, Mexico emerged as the main U.S. fresh avocado overseas supplier, with a 72.4% share of the total volume of U.S. avocado imports, followed by Chile (21.9%), the Dominican Republic (4.2%), and others (1.5%) (USDA/FAS 2014). Almost all of the U.S. fresh avocado imports from Mexico and Chile are the Hass cultivar. In contrast, U.S. fresh avocado imports from the Dominican Republic are the green skin avocado cultivars, which are similar to

those produced by Florida growers. Between 2004 and 2013, U.S. imports of Dominican Republic green skin avocados increased steadily by almost 70%, from 8,477 MT in 2004 to 14,387 MT in 2013. Over the same period, the value of green skin avocado imports more than doubled, from $7.46 million in 2004 to $15.46 million in 2013 (USDA/FAS 2014).

U.S. consumption of avocados has been on the rise, with per-capita avocado consumption increasing by 87%, from 1.34 kilograms (kg) in 2004 to 2.32 kg in 2012 (USDA/ERS 2014a). While domestic production has remained relatively steady over the past decade, there has been a noticeable increase in imported avocados. Between 2004 and 2013, U.S. avocado imports grew by 394%, from 145,303 MT in 2004 to 571,827 MT in 2013 (USDA/FAS 2014).

Commercial avocado production in Florida is restricted mainly to the Miami-Dade County, with 7,000 acres. The Florida avocado industry is worth $24.4 million at the farm gate level. With 80% of the crop sold outside the state, the Florida avocado industry has a per annum economic impact of $100 million (Evans and Lozano 2014, USDA/ERS 2014b).

About 60 green skin avocado cultivars are commercially grown in Florida. These cultivars are classified into three main groups: West Indian, Guatemalan, and Mexican. Maturity season varies according to the group/race, with the fruit weighing from a few ounces to five pounds each (Crane et al. 2013). The main nutritional difference between Hass and green skin avocados is their fat content. For each golf ball-sized portion, a Hass avocado contains 4.6 grams of fat compared to 3 grams of fat for a green skin avocado (AICR 2015).

The popularity of the Hass avocados in most of the importing countries explains in part why it is the dominant cultivar grown in the major avocado producing countries (Chilean Hass Avocado Committee 2015). In addition it is known that this variety has much longer shelf life and thicker skin than green skin avocados and as such can withstand long distance shipment. These factors may help to explain why countries such as Mexico and Chile have focused their production and trade on Hass avocados.

Figure 2 depicts the monthly average for U.S. domestic production and imports of green skin avocado imports from 2004 to 2013. Because of differences in growing seasons in Florida and the Dominican Republic, green skin avocados are available year-round in the U.S. The green skin avocado marketing season runs from June to March in Florida and year-round in the Dominican Republic with the bulk occurring from October to March (Figure 2). Florida green skin avocado growers enjoy a market advantage from June to November, while Dominican Republic green skin avocado growers have the advantage from December to March. In 2012, U.S. retail sales of green skin avocados were almost $70 million, with about 75% of the retail sales occurring on the U.S. East coast, specifically in the Northeast (28%), and Southeast (47%) regions (Hass Avocado Board 2015).

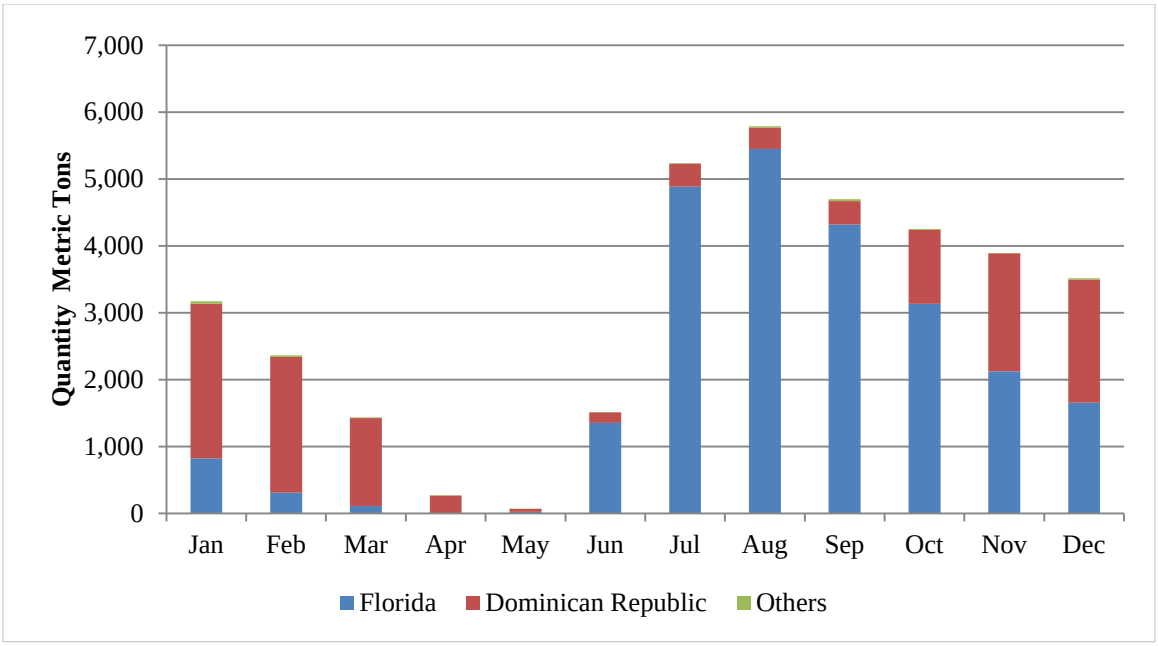

Figure 2. Monthly average for U.S. production and imports of green skin avocados, 2004–2013
Source: USDA/FAS (2014).

Conceptual Framework

A considerable amount of research has been devoted to the issue of imperfect competition in the U.S. agricultural market regarding market power (Myers et al. 2010, Reimer and Stiegert 2006, Sexton 2013). Some researchers have found that oligopolistic behavior is present in international agricultural trade (Arnade and Pick 1998, Karp and Perloff 1989, 1993).

The Lerner index, which has been the standard method to measure market power, has limited use in empirical work due to difficulties in the measurement of marginal costs. As a result, researchers in empirical industrial organization have developed several methods to estimate market power without requiring direct estimation of marginal costs. It should be noted that the data requirements to estimate a fully specified oligopoly model can be considerable and the data needed to specify an oligopoly model may not be available.

To overcome the lack of relevant data, and to make the inference of market power feasible in international markets, Goldberg and Knetter (1999) extended the residual demand model to measure market power in international markets from the seller's (exporter) side where the residual demand curve is derived as the difference between the market demand and the competitive fringe's supply curves. Therefore, with the Goldberg and Knetter (GK) method, properties of the residual demand schedule, such as elasticity, depend on properties of the market demand schedule, as well as the supply schedules of other firms in the market.

This approach is based on the identity of the Lerner index with the elasticity of the (inverse) demand faced by the firm; it does not require the estimation of all own and cross price elasticities of demand, conduct parameters, or marginal costs. The estimating equation of the inverse residual demand function using the GK method takes the following general form:

$$(1) \quad \ln P^{ex}_m = \lambda_m + \eta_m \ln Q^{ex}_m + \alpha'_m \ln Z_m + \beta'_m \ln W^N_m + \varepsilon_m$$

where ε_m is the error term, assumed to be independently and identically distributed, and subscript m indexes a specific market. P^{ex}_m is the price the export group charges expressed in the destination currency units; η_m is the residual demand elasticity; Q^{ex}_m refers to the quantity shipped by the respective exporter group; α' and β' are vectors of the parameters to be estimated. The vectors Z_m and W^N_m denote the demand shifters and the cost shifters for the n competitors the export group faces in a specific destination market, respectively. The price charged by the exporter group P^{ex}_m and the demand shifters are expressed in the destination market currency.

The coefficient of η_m, given the logarithmic specification of the model, can be interpreted directly as the residual demand elasticity. If the estimated value of η_m is not significantly different from zero, the exporter group operates in a perfectly competitive market and faces a perfectly elastic curve in the destination market. The demand shifter Z_m consists of a combination of a time trend, real income, and the price level for the destination market. The cost shifter W^N_m for the n competitors includes measures of input prices. These costs can be divided into two parts: a part expressed in the competitor's currency that is not destination-specific, and a part that varies with destination (i.e., the exchange rate of the competitor country vis-a-vis the destination market). Exchange rate movements offer ideal cost shifters in international markets because they move the relative costs of the exporting countries. The estimated parameters may be interpreted as industry averages since market data are available at the country level. Because of its convenience in terms of reduced data requirements, the GK method is sometimes used in empirical applications to test for imperfect competition in international agricultural markets (Evans and Ballen 2014, Mulik and Crespi 2011, Poosiripinyo and Reed 2005, Reed and Saghaian 2004, Song et al. 2009, and Tasdogan et al. 2005). Most study results indicate that oligopoly is the prevalent market structure in avocado markets.

Empirical Model and Data

The estimated model consists of an inverse residual demand equation, where the Dominican Republic is the exporter group, and Mexico and Chile are the fringe competitors. The empirical specification of the model is as follows:

$$lnPEXP = \beta_0 + \eta\, lnQEXP + \beta_1 lnPCDPI + \beta_2\, lnERUS\_MX + \beta_3\, lnPPI\_MX + \beta_4 lnERUS\_CH + \beta_5\, lnPPI\_CH + \sum_{i=1}^{11} \beta_6\, Di + \varepsilon$$

where *lnPEXP* is the log of real export price for U.S. imports of Dominican Republic green skin avocados (USD/MT), β_0 is the parameter intercept, η is the inverse residual demand elasticity, *lnQEXP* is the log of the quantity of U.S. imports of Dominican Republic green skin avocados (MT), *lnPCDPI* is the log of U.S. per capita disposable income (USD), *lnERUS_MX* is the log of the U.S./Mexico exchange rate (USD/Mexican peso), *lnPPI_MX* is the log of Mexican producer price index, *lnERUS_CH* is the log of U.S./Chile exchange rate (USD/Chilean peso), *lnPPI_CH* is the log of Chilean producer price index, *Di*: monthly dummy variable, where May is the base month, and ε is an iid error term.

The empirical model was estimated using monthly data from January 2004 to December 2013. Data for the (inverse) residual demand were obtained from several sources: Dominican Republic green skin avocado export prices and quantities to the U.S. market were retrieved from USDA/FAS (2014). The U.S. disposable personal income and the consumer price index used to obtain real disposable personal income came from U.S./BEA (2014). Data on the U.S./Mexico exchange rates came from USDA/ERS (2014c). Data about the Mexican producer price index for agriculture came from INEGI-Mexico (2015). Data about U.S./Chile exchange rates came from USDA/ERS (2014c). Information on the Chilean producer price index for avocado growers came from INE-Chile (2015). Monthly dummy variables were used in the model to address seasonality. May is used as the base month because this is the month when the export level is at its seasonal lowest.

To address simultaneity between export price and quantity, the equation was estimated using the instrumental variables method. As suggested by Goldberg and Knetter (1999), instrumental variables for quantity exported (QEXP) include supply shifters. The selected instruments included Dominican Republic labor costs, which consist of hourly wages for agricultural workers (Dominican Republic Central Bank 2014), the U.S./Dominican Republic exchange rate, and the one month lagged value of the U.S./Dominican Republic exchange rate (USDA/ERS 2014c). After estimating the model using Two Stage Least Squares (2SLS), diagnostic tests indicated heteroskedasticity and autocorrelation, so the final model was estimated using the Instrumental Variable Generalized Method of Moments (IV GMM) with robust and Newey-West standard errors based on a Barlett kernel with bandwidth two.

Estimation Results and Discussion

Results for the empirical model using the 2SLS and IV/GMM estimation methods are presented in Table 1. Results from the 2SLS method support employing the instrumental variable technique since the IV results indicate simultaneity bias. The Durbin-Wu-Hausman test rejects the hypothesis that export quantity is exogenous at the 5% level of significance. While the estimated parameter of the residual demand has the expected negative sign and is significant at the 5% level, results from both the Breusch-Pagan/Cook-Weisberg test (BP/CW) and the Cumby-Huizinga test found heteroskedasticity and autocorrelation issues, respectively. Using the IV/GMM estimation procedure, the Hansen J-test indicates over-identification is not a problem, and the Kleibergen-Paap under-identification test shows that the model is identified. The estimated model explains about 48% of the variation in the Dominican Republic export price.

The main parameter of interest is the (inverse) residual demand elasticity, which provides an estimate of the markup that the exporter (i.e., the Dominican Republic) charges above its marginal cost. The estimated parameter (–0.245) has the expected negative sign and is statistically significant. This suggests that the Dominican Republic exporters exercised market power in the U.S. green skin avocado market, with a markup of 25% above their marginal cost. Three explanations can be advanced in support of these findings. First, The Dominican Republic has market power because most of the U.S. imports of green skin avocado come from the Dominican Republic during the U.S. production off-season. Second, Dominican Republic avocado production costs are considerably low compared to export market prices. Third, Dominican Republic avocado exporters have flexibility in allocating their export volume to

Puerto Rico and the EU-27 (e.g., these markets account for more than 25% of the Dominican Republic exported volume) (Republica Dominicana, Ministerio de Agricultura 2015).

Table 1. Estimation results of the inverse residual demand for U.S. imports of Dominican Republic green skin avocados

	2SLS		IV/GMM	
	Coefficient	**S.E.**	**Coefficient**	**Robust S.E.**
Constant	8.421	3.816	7.343**	3.363
lnQEXP	–0.264**	0.131	–0.245**	0.124
lnPCDPI	0.026	0.065	0.011	0.076
lnERUS_MX	–0.201	0.549	–0.013	0.429
lnPPI_MX	0.402	0.305	0.399	0.296
lnERUS_CH	–0.277	0.591	–0.177	0.468
LnPPI_CH	–0.119	0.077	–0.106	0.099
June	0.252	0.199	0.221	0.163
July	0.315	0.289	0.261	0.256
August	0.064	0.278	–0.006	0.248
September	–0.098	0.276	–0.188	0.243
October	0.208	0.422	0.086	0.373
November	0.313	0.486	0.184	0.443
December	0.296	0.489	0.162	0.464
January	0.563	0.517	0.434	0.490
February	0.763	0.502	0.671	0.455
March	0.869**	0.424	0.779*	0.399
April	0.319*	0.174	0.290	0.215
BP/CW[1]	0.000			
Cumby-Huizinga[1]	0.000			
Anderson cann.LM stat[1]	0.004		Kleibergen-Paap LM stat[1]	0.028
Sargan test[1]	0.059		Hansen J stat[1]	0.190
Durbin-Wu-HaU.S.man[1]	0.018			
R-square	0.470			0.481

Note. [1] p-value
*** significant at the 1% level
**significant at the 5% level
*significant at the 10% level

Our estimate of the degree of market power falls on the low side of previous estimates of the inverse residual demand elasticity for agricultural commodities in export markets, ranging from a low of –0.02 for pork exports from Denmark (Felt et al. 2010) to a high of –0.93 for wheat exports from the U.S. (Carter et al. 1999).

Studies on fruit exporter market power are scarce. One such study is by Arnade and Pick (2000), who when evaluating seasonal oligopoly power in the U.S. pear and grape markets, found statistically significant average exporter markup estimates of 0.25 for pears in 1991–1993 and 1.03 for grapes in 1991–1993. Although a direct comparison with previous studies is inadvisable because of the different commodities, methodologies, and timeframe, the Arnade and Pick (2000) study suggests the magnitude of the exporter markup for fruit in the U.S. market.

The estimated coefficient for the U.S. per-capita disposable personal income has the expected positive sign but is not statistically significant. The coefficients of the exchange rates, and producer price indices, respectively, were not statistically significant for the cost shifters for the competing exporters (Mexico and Chile). That is, the cost variables for Mexico and Chile do not influence the export price of Dominican Republic green skin avocados to the U.S. market.

The monthly dummy variables take into consideration seasonal changes in demand based on production and import patterns. The estimated coefficients measure real price differences for the first month of the marketing year (May). The coefficient for March is the only monthly coefficient that was statistically significant, and that was at the 10% level. Therefore there is no evidence of market power seasonality during the Dominican Republic green skin avocado exporting season.

Summary and Conclusions

Imperfect competition in international agricultural markets is an issue since researchers have found evidence of oligopoly in agricultural export markets. In this paper, we assessed the intensity of competition in the U.S. green skin avocado import market during the 2004 to 2013 period. A model using the (inverse) residual demand method as proposed by Goldberg and Knetter (1999) was specified and estimated.

Findings reveal the existence of imperfect competition in the U.S. green skin avocado market over the sample period. Estimation results show that the Dominican Republic, acting as an exporter, exercises market power. This is consistent with the fact that Dominican Republic green skin avocado exporters to the U.S. market have limited competition from other overseas avocado suppliers such as Mexico and Chile. During the sample period, Dominican Republic green skin avocado exporters averaged a 25% marketing margin. We surmise that this is possible because of the low cost of Dominican Republic green skin avocado production compared to the U.S. market price and because the bulk of the Dominican Republic green skin avocado exports is shipped during the U.S. avocado production off-season.

A direct implication of the results is that consumers of green skin avocados in the U.S. are likely to be paying slightly higher prices for imported green skin avocados than would have been the case if the U.S. green skin avocado market would be served by more suppliers. It also implies that local producers benefit, as an inordinate amount of downward pressure is not placed on prices due to increased supplies coming from the Dominican Republic.

We found that the Dominican Republic green skin avocado exporters' market power is not constrained by other overseas avocado suppliers such as Mexico and Chile. The fact that the

seasonal (monthly) dummies were insignificant, except for March that was statistically significant at the 10% level, implies that the Dominican Republic maintains a marketing margin throughout the year.

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Winery Distribution Choices and the Online Wine Buyer

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Abstract

Direct to consumer (DTC) wine sales are an increasingly important distribution channel for wineries, particularly due to online wine sales growth. This research profiles the online wine buyer. Based on the responses of 918 wine consumers, the online wine buyer is an older, married man, with a high income. The online wine buyer is more likely to be a wine connoisseur. Despite access and comfort with technology, millennials are unlikely online buyers. From this research, online retailers and wineries gain positioning knowledge for appealing to individuals interested in online purchases. This research also identifies expansion opportunities through untapped consumer markets.

Keywords: online; consumer behavior, wine purchasing; online buying; Millennials

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Introduction

E-commerce represents 4% of total retail trade sales in the United States with $259 billion in value (eMarketer 2013; U.S. Census Bureau 2012). Nearly three quarters of U.S. internet users make purchases online, amounting to 191 million online purchasers in 2013 (eMarketer 2013; Statista 2014;). The demographic profile of online shoppers has broadened to include ordinary American shoppers; while at the same time significant generational differences in purchase patterns have emerged in online shopping patterns (Laudon and Traver 2007). The internet enables expansion into otherwise unreachable markets. E-commerce has emerged as one of the most important methods of doing business and holds considerable potential to increase sales (Limayem et al. 2000).

The food and beverage retail commerce category, which is one of the smaller e-commerce categories, is expected to experience a compound annual growth rate of 17% between 2012 and 2017 (eMarketer 2013). In the case of small wineries, the internet has the potential to allow them to reach a much wider audience. Wine e-commerce experienced growth of 38% in 2010 (VinterActive LLC 2011). While online wine purchasing currently represents 5% of the total wine market in developed countries and just 2% of global wine sales, select areas are significantly higher (Lockshin and Corsi 2012). Online wine sales in Britain have reached 15% of total wine sales (Pfanner 2013).

As the wine industry continues to grow, it is likely that online direct-to-consumer wine sales will grow as well. Sales of wine through the direct-to-consumer channel increased by 15% between 2013 and 2014, representing more than $1.8 billion in transactions in 2014 (Wines & Vines 2015). The direct-to-consumer channel is largely recognized as the fastest growing segment of wine sales, with the majority of those shipments going to California, Texas, New York, Florida, and Illinois (Wines & Vines 2015). There are, however, challenges associated with direct-to-consumer shipping in some states due to wine shipping laws. In 2005, there were just 27 states that allowed direct-to-consumer wine shipping, but as of 2015 that number has increased to 40 (Taylor 2014). Although state laws impede some potential direct-to-consumer sales, pressure from wineries and directly from consumers is likely to increase the number of states that allow internet wine sales and further grow this sales channel (First Research 2013). Direct-to-consumer wine sales rose 245% in 2014 as a result of changes in the Montana legislature easing the restrictions on shipments (Wines & Vines 2015). Other legislative changes in Massachusetts and North Dakota are expected to produce similar increases.

Capturing the millennial consumer is of increased interest to the wine industry. Born between 1977 and 1999, millennials are the most recent generation to come of drinking age (Olsen et al. 2007). The millennial generation currently makes up 14% of the legal drinking population, but will grow to approximately 40% of the drinking population over the next ten years (First Research 2013). The millennial generation currently makes up 28% of core wine drinkers; with core meaning that they average at least one glass of wine per week (Wine Market Council 2011).

The millennial generation grew up with the internet at their fingertips and is considered to be technologically savvy (Olsen et al. 2007). They are also heavily engaged in digital social networks and connect to them frequently (Lecat and Pelet 2011). Nielsen research shows that millennials lead online buying globally for most consumer good categories (Nielsen, 2014).

Because of this comfort with the internet, technology, and buying consumer goods online, it would seem millennials would be the prime demographic to take advantage of the increasing opportunities to purchase wine online. However, recent research suggests that the internet is the least common location for millennials to buy wine (Thach 2011).

Smaller wineries are predicted to benefit from the growth in direct-to-consumer shipments if they can market and position themselves correctly (IBISWorld 2012). Understanding who the online wine buyer is will be key to taking advantage of the growth in online direct-to-consumer wine sales. If millennials are not buying wine online as they do in other categories, who is the online wine purchaser? As such, this research aims to complete two research objectives. First, develop a profile for the online wine buyer in 2013. Second, investigate the behavioral intentions and barriers to online wine commerce for the millennial generation. The information gathered from this study will help businesses interested in using online sales as a direct-to-consumer medium understand more about the nature of online wine buyers and what will (or will not) drive them to purchase wine online, particularly in the case of millennial wine buyers.

Review of Literature

As the use of e-commerce sites have grown, so has our understanding of the behavioral inclinations of online shoppers. Online shopping venues offer convenience, selection variety, lower prices, original services, personal attention, and access to information (Zhou et al. 2007). However, online shoppers tend to be more concerned about possible losses (e.g., security of information and vendor reliability) than with perceived gains (e.g. different convenience-type attributes) (Bhatnagar and Ghose 2004).

Research on online shopping can be largely categorized as taking a consumer-oriented view or a technology-oriented view (Zhou et al. 2007). The technology-oriented view studies consumer acceptance of online shopping based on the technical specifications (user interface features, website content and design, and system usability) of an online store, while a consumer-oriented view includes consumer demographics, cognitive/psychological characteristics, perception of risks and benefits, shopping motivation, and shopping orientation. Santos and Riberio (2012) conveniently classify the variables (both technology-oriented and consumer-oriented) that influence the disposition of online wine buyers into categories that include motivation, socio-demographics, prior online shopping experiences, and barriers to online shopping. These categories serve as a useful way to organize the relevant literature on online wine buying.

Research suggests consistency in the socio-demographic characteristics of online wine buyers over time and across cultures. In contrast to other shopping experiences, men tend to have more positive sentiments toward online shopping than women (Alreck and Settle 2002). This demographic characteristic appears to hold true for online wine buyers as well. Santos and Riberio's (2012) profile of the Portuguese wine buyer, as well as Bruwer and Wood's (2005) profile of the Australian online wine buyer, suggest that men are most likely to purchase wine online. In addition, evidence suggests that online wine buyers are typically well-educated, have high incomes, and are relatively young (Santos and Riberio 2012; Bruwer and Wood 2005).

The motivations that influence online purchasing are better prices, convenience, better service, security of financial information (Limayem et al. 2000). Stening and Lockshin (2001) studied the online purchasing patterns of 700 wine customers and found that, compared to in-store retail purchases, online wine purchases consisted of higher priced wines. In addition, online wine shoppers had a larger shopping basket overall (Stening and Lockshin 2001). They speculated that online purchases tended to be for expensive and hard to find wines, versus the convenience purchases that were made in-store. Contrary to Stening and Lockshin's (2001) findings, Bruwer and Wood's (2005) research found that Australian online wine consumers were utilizing online resources to find bargains, but were also interested in the extra information provided online. Wine is both an information and price-sensitive product when it comes to online retailing (Bruwer and Wood 2005). Lynch and Ariely (2000) furthered our understanding of wine information and price sensitivities, concluding that consumers want maximally transparent wine buying environments, and that price sensitivity declines as the cost of searching for quality information declines.

The online consumer represents not only a shopper, but also a computer user (Koufaris 2002). This dual role implies the importance of the consumer's technology skills. Ease of use is continually shown to be one of the most important factors to the behavioral intention of online shoppers (Faqih 2013). Even more directly, computer skills have been used to directly predict online purchasing, further suggesting the likelihood of millennials being more comfortable than older generations with online shopping (Hoffman and Novak 1997).

Aljukhadar and Senecal (2011) used a sample of 407 participants in an online consumer panel to survey them regarding their pattern of internet use, internet experience, and psychological characteristics. Using data from this survey, the authors were able to differentiate online consumers into three global segments: basic communicators (consumers who use the internet mainly to communicate via e-mail), lurking shoppers (consumers who employ the internet to navigate and shop heavily), and social thrivers (consumers who exploit the internet's interactive features to interact socially by chatting, blogging, video streaming, and downloading). More specific to wine, online wine buyers have been classified based on their web functionality needs. Through an online survey mechanism, Bressolless and Durreiu (2008) classified visitors to 28 wine websites based on their typology after asking them to complete a precise task on the site. Six consumer groups were identified, with the majority of respondents (57%) classified as secure seekers, opportunists, or novices (Bressolless and Durreiu 2008). These categories reveal a wide array of expectations regarding the website's functionality but do little to explain the demographics and purchasing characteristics associated with those web visitors.

Security, trust, difficulty in completing the online purchase, and shipping are barriers typically cited for buying wine online. Bruwer and Wood's (2005) work on understanding the Australian wine consumer revealed that security of personal and financial information was the most important risk and respondents identified website functionality as the most important navigational issue. Trust is related to security, and to develop trust in an online environment the web retailer must recognize the online buying process, generate credence through images and reputation, and establish credibility through personal contacts (e.g. use of avatars, product knowledge of support staff) (Harridge-March and Quinton 2005; Quinton and Harridge-March 2008). Online spending can be predicted according to the level of comfort in providing

information online (Spake et al. 2011). Sheridan et al. (2009) found that first-time U.S. online wine buyers had problems trying to buy online because of the legal and technical differences across states, while Santos and Ribeiro's (2012) research identified shipping costs as the single largest barrier for online wine purchases.

Online buyers evolve as they develop more experience purchasing online (Hernandez et al. 2010). The perceptions that prompt someone to repurchase online are not the same as the perceptions of a first-time online buyer (Hernandez et al. 2010). Tracking a potential consumer's clickstream on a website can be a powerful predictor of purchasing behavior. Information related to prior purchases, consumer demographics, search terms, choice decisions, and eventual purchases can all be used by online retailers to predict a consumer's future purchases (Van den Poel and Buckinx 2005). More generally, consumers who have a preference for shopping online typically have prior experience with online purchases, and those with prior online purchases are more likely to have future online purchase intentions (Brown et al. 2003; Shim and Drake 1990).

Millennials' buying habits have become increasingly important to the wine industry as more members of this generational segment become of legal drinking age. In general, millennial wine consumers prefer cheaper wines that they believe represent a good value ($5-$9 range). Millennials perceive New World wines to be higher quality, more so than other generations (Lecat and Pelet 2011; Wolf, Carpenter, and Qenani-Petrela 2005). Millennial wine purchases are often motivated by convenience, thus the preference of supermarkets for wine purchases (Lecat and Pelet 2011). Lecat and Pelet (2011) suggest that the recall of wine websites by millennials is quite low, but that millennials are open to wine advice and new wine experiences. Millennials, in general, have been shown to lack subjective knowledge on wine and are, subsequently, more likely to be influenced by marketing activities (e.g. labels and promotions) (Chrysochou et al. 2012).

Barber, Dodd, and Ghiselli (2008) compared levels of objective and perceived subjective knowledge between Generation X and Generation Y (millennials). Millennials reported significantly lower levels of subjective knowledge than Generation X and were also significantly less likely than Generation X to consider themselves knowledgeable about wine. In addition, millennials are more likely to indicate that their peers know more than they do about wine (compared to Generation X). Although Generation X had been consuming wine for longer (average of 15 years compared to millennials' average of 3 years of wine drinking experience) each group reported purchasing approximately the same amount of wine each month (Barber, Dodd, and Ghiselli 2008). Research suggests that although millennials are new and uncertain wine consumers, they are interested in purchasing wine, and may be more open to unconventional methods of purchasing wine.

Although wine e-commerce is becoming a recognized sales channel, little research has been dedicated to developing a better understanding of the demographics and psychographics associated with these online wine purchases. With rapidly growing numbers, industry reports suggest that there are more than 2,500 websites dedicated to the sale of wine, beer, and other spirits (IBISWorld 2014). Access to the internet, as well as the number of online wine retailers, has increased since Bruwer and Wood's (2005) research as well as Stening and Lochshin's (2001) research, likewise, it is reasonable to believe that the online wine buyer has also changed.

Developing a complete picture of today's consumers who partake in wine e-commerce can have significant implications on the sales and marketing of wine.

Materials and Methods

Online Wine Buyer

A 21-question survey was developed consisting of questions related to demographics, wine consumption, wine purchase behavior, and a series of psychographic questions. Respondents were asked to indicate where they make their wine purchases by checking all that apply from a list of 13 different commonly used wine suppliers (e.g. grocery store, tasting room, wine clubs). Included in the list, were two online wine purchase venues (online from a winery and online from a non-winery controlled website). Respondents who selected either of those two online options were considered part of the target group.

Because questions pertained to consumer behavior and preference, five symmetric itemized rating scales were used to reduce leniency error (Smith and Albaum 2004). Respondents were asked to rate eighteen wine purchase features on a five-point desirability scale. These features included wine characteristics such as quality, price, and image. The survey asked participants to rate their identification with wine-related psychographic statements commonly used in wine research (Higgins et al. 2014).

The survey was available to subjects for six weeks in early 2013 through SurveyMonkey. A link to the survey and a brief explanation of the study was sent to wine purchasers from a Constant Contact email list of 3,000 wine purchasers. All respondents were pre-screened in the first three questions of the survey to ensure that they were of legal drinking age, had purchased wine in the past year, and live in a region that allows direct-to-consumer shipping. Failure to satisfy the pre-screening questions resulted in the termination of the survey. At the end of the survey, subjects had the opportunity to provide their email and be entered into a lottery for a chance to win two bottles of wine, therefore providing an incentive for completion of the survey (Sellitto 2006).

Millennial Online Wine Buying

Since millennials are online purchasers in other categories, the second objective of the research is to identify the inhibitors to milllennials' decisions to purchase wine online. A more qualitative study of millennials' hesitations to online wine buying was achieved using a second, independent survey. The survey sought to use initial findings from the first survey to further understand millennials' wine buying habits, reasons why they are not buying wine online, and ways to more effectively reach millennial consumers online. The target population for the second survey was millennial wine drinkers. The survey was distributed online and was available for three weeks, beginning approximately one month after the initial survey closed. Respondents were asked questions related to their wine purchases, demographics, experience purchasing wine online, and sentiments about making online wine purchases, modified from Limayem et al. (2000). Respondents were also surveyed regarding their use of technological devices.

Results

Profile of the Online Wine Buyer

By nature of the survey outlet (a database of wine purchasers), the demographics of the respondents tend to match the typical wine buyer in the U.S. as confirmed through MRI data (MRI+ MediaMark, 2014). Of the 918 surveys collected (a response rate of 30.6%), the majority of responders were female (62.5%). MRI data supports the female dominance of wine purchases at 60.2% as does prior wine research (Higgins and Llanos, 2015). The top four age categories were 21-24, 50-54, 25-29, and 55-59 at 19.6%, 16.6%, 13.6%, and 13.2%, respectively. A considerably high number of respondents (37.3%) had household incomes greater than $150,000, and the second largest income group was $75,000 to $149,000 at 27.4%. Though the study's income distribution differs from the income distribution in MRI data, both show a clear pattern; the majority of wine purchasers fall under the two highest household income groups (MRI reported that 17.1% of wine consumers had household incomes greater than $150,000 and 37.1% of wine consumers had household incomes in the $75,000 to $149,000 range). In considering education, the top three options represented were college graduate, postgraduate work, and some college, at 50.7%, 33.8%, and 13.8%, respectively. The majority of respondents stated they were "married/living with a partner" (65.0%). Table 1 presents a summary of the demographics associated with the complete sample.

A majority of respondents buy wine from the grocery store (84.3%). Almost half of the respondents buy wine from a wholesale store and tasting room, at 49.9% and 45.7%, respectively. Other common locations for wine purchases were restaurants, specialty wine shops, winery websites, convenience stores, and non-winery websites. Less than 3% of respondents purchase wine from gift shops, hotels, and wine apps. Friends and family were cited as the most frequent source for information about wine (73.3% regularly get information from friends and family), with winery websites being the second most frequently used resource for information about wine (45% indicated they regularly use winery websites for wine information). Premium quality, good value, and varietal were the most commonly used selection criteria for purchasing wines.

Of the 918 respondents, 20.5% respondents indicated that they had previously purchased wine online from a winery, and 5% indicated that they had purchased wine from an online site other than a winery website. The 211 respondents who purchased online were isolated into an online wine buyer target group and were compared to the remaining 707 respondents.

The split between online wine buyers and those who are not online wine buyers revealed demographic differences (see Table 1). Online wine buyers tend to be older, with 77% of the online buyers over the age of 40, compared to just 50% of non-online buyers. Only 14.7% of the online buyers were in the 21 to 29 age category (millennials), compared to 38.8% of the respondents who do not purchase online in that same age category. Consistent with prior expectations, the gender gap narrows with online buyers. In the original sample, 62.5% of the sample was female, compared to just 52.2% of the online wine buyers. Likely a function of the age difference, online wine buyers were more likely to be married (p=.000), have children living at home (p=.001), and have higher household incomes (p=.000). These findings are largely consistent with the profile of the Australian online wine buyer developed by Bruwer and Wood

(2005), suggesting that the online wine buyer is typically male, over 40 years of age, married, and has a higher than average household income.

Table 1. Comparative Demographics of Online Wine Buyers Respondents (n=918)

Variable	Category	Overall Sample	Online Buyers (n=211)	Non-online buyers (n=707)	Chi-squared value	Chi-squared p-value
Gender	Female	62.5%	52.2%	66.4%	12.668	.000
	Male	37.5%	47.8%	33.6%		
Income in USD	< $20,000	9.7%	2.7%	12.2%	30.412	.000
	$20,000 - $49,999	11.3%	6.4%	13.2%		
	$50,000 - $74,999	14.2%	13.3%	14.5%		
	$75,000 - $149,999	27.4%	29.3%	26.8%		
	> $150,000	37.3%	48.4%	33.3%		
Employment	Full-time	63.9%	66.5%	63%	1.659	.436
	Part-time	17.2%	14.3%	18.2%		
	Not-employed /Retired	18.9%	19.2%	18.8%		
Education	Some college or less	15.6%	10.8%	17.3%	6.092	.192
	College graduate	50.7%	52%	50.2%		
	Post graduate work	33.8%	37.3%	32.5%		
Children under 18 living at home	Yes	20.5%	28.8%	17.3%	12.011	.001
	No	79.5%	71.2%	82.7%		
Marital Status	Single	33.6%	19.2%	39%	27.462	.000
	Married / living with partner	65%	78.3%	60.1%		
	Widowed	1.3%	2.5%	.9%		
Age	21-29	33.2%	14.7%	38.8%	74.396	.000
	30-39	5.7%	8.1%	5%		
	40-49	13.6%	19.4%	11.9%		
	50-59	29.8%	38.9%	27%		
	60-69	10.1%	16.1%	8.3%		
	70+	3.5%	2.8%	3.7%		

Note. Some categories were aggregated from the options presented in the survey for ease of presentation in this manuscript.

Respondents were asked to indicate their level of agreement with commonly used psychographic statements related to wine using a five-point scale (Higgins et al., 2014). Testing was done through an independent samples t-test. Compared to those who don't purchase wine online, online purchasers were more likely to consider themselves wine enthusiasts (p=.005), enjoy talking about wine (p=.003), consider themselves knowledgeable about wine (p=.012), and consider themselves wine connoisseurs (p=.012). See Table 2 for full results.

Behaviorally, online wine buyers tend to differ from wine consumers who don't purchase wine online. Online wine buyers reported buying 7.7 bottles per month, compared to 5.7 for those who don't purchase online (p=.001). In addition, online wine buyers spend more on wine, having reported $134 in monthly wine spending compared to $81.6 for respondents who don't purchase wine online (p=.000). Nearly 30% of online purchasers normally spend more than $18.50 on a bottle of wine, compared to just 17% of respondents who don't purchase wine online (p=.003).

Table 2. Agreement with Wine Statements between Target Groups

Statement	Online Buyer (n=211)	Non-Online Buyer (n=707)	Independent Sample T Test	Degrees of Freedom	P-Value from an Independent Samples T-Test
I would be willing to try new and non-traditional wine varietals	3.38	3.36	.450	779	.653
I am a wine enthusiast	3.13	2.95	2.836	781	.005
I enjoy talking about wine with my friends	3.03	2.85	2.991	778	.003
I know a lot about wine	2.51	2.36	2.530	779	.012
I consider myself a wine connoisseur	2.38	2.22	2.520	775	.012

Note. (where 1 = strongly disagree and 5 = strongly agree)

Online wine buyers also seek out different characteristics in their wine purchases (see Table 3 for comparisons made using an independent samples t-test). Compared to consumers who don't purchase wine online, online buyers are more likely to be interested in wines that are considered premium quality (p=.032). Online buyers also demonstrate more interest in the wine's production characteristics, with interest in wine that is grown in an environmentally friendly way (p=.071). Online buyers are more interested in wine from a recognized growing region (p=.025), from a family owned winery (p=.005), and from a boutique winery (p=.011). Online wine buyers report more interest in both new and old world wines (p=.022 and p=.027, respectively), compared to those who don't buy wine online. In addition, online buyers are less interested in wine offered at a sale price (p=.000) and less interested in the wine's label design (p=.001).

Table 3. Wine Characteristics Important during Purchase

Characteristic	Online Buyer (n=211)	Non-Online Buyer (n=707)	Mean Difference	Independent Sample T Test	Degrees of Freedom	P-Value
From a family owned winery	3.57	3.38	.184	2.823	755	.005
From a boutique winery	2.99	2.83	.151	2.544	390	.013
Grown in an environmentally friendly way	3.40	3.26	.131	1.811	753	.071
From a recognized growing region	3.74	3.61	.130	2.247	421	.025
New world wine	3.19	3.06	.127	2.302	755	.022
Old world wine	3.04	2.91	.125	2.216	757	.027
Premium quality product	4.21	4.10	.117	2.143	755	.032
A complement to food	3.90	3.81	.092	1.644	424	.101
Sale priced	3.67	3.90	-.234	-3.809	359	.000
Label design	3.19	3.42	-.224	-3.339	751	.001

Note. (where 1 = not at all important and 5 = very important)

In the search for information about wine, online buyers tend to exhibit characteristics that are different from the typical wine buyer. Online buyers are more likely to use a smartphone application for wine information (16.1%), compared to non-online shoppers (9.9%) (p=.018). Likewise, online buyers are more likely to use a tablet application for wine information (p=.011). Other sources of information that are more likely to be used by online buyers include winery websites (p=.000), Google (p=.061), print media (p=.000), and friends/family (p=.000). There were no significant differences between the two groups in the use of Yahoo, Facebook, Twitter, and blogs for wine information. A demographic, behavioral, and psychographic profile of the online wine buyer is presented in Table 4.

Table 4. Profile of the Online Wine Buyers

	Online Buyers
Demographics	Older (77% are 40+) men
Household	Married with Children
Income	Higher household incomes
Wine knowledge	Wine enthusiasts or connoisseurs, enjoy talking about wine
Purchase habits	Each month purchase 2 bottles more and spend $50 more than traditional buyers
Wine types	Premium quality, recognized growing regions, family owned and boutique wineries
Information search	Wine apps, online sites, print media

Results from a bivariate probit model, where the dependent variable is whether or not the respondent is an online purchaser, confirm the initial findings. Table 5 presents the parameter estimates and significance levels for the estimated model. The covariates included in the model were bottles purchased per month, while factors included dummy variables to represent those who spent an average of $18.50 or more per bottle, male, over the age of 40, had incomes greater than $75,000 per year, married, and had children. The model itself is significant with a likelihood ratio chi-squared of 67.6 (p= .000). Holding everything else constant, variables with a positive sign indicate that the variable contributes to the likelihood of purchasing online. As expected, males who are over the age of 40 are more likely to purchase wine online (p values of .007 and .014, respectively), as well as those with children (p=.042). Interestingly, wine bottles per month has a negative value associated with the parameter estimate and suggests that for each additional bottle purchased, the z-score of the model decreases by .001. The meaning behind this finding could have to do with the cost of shipping large quantities of wine or that those interested in large quantities of wine are located in areas where wine access is high, negating the need to purchase wine online. These results also suggest an interest in buying premium wines online, as those who were, on average, spending more than $18.50 per bottle of wine were more likely to purchase wine online.

Table 5. Online Wine Buyer Parameter Estimates from a Bivariate Probit Model

	Parameter Estimate	Std. Error	Significance
Intercept	.371	.410	.365
Average price of a bottle purchased > $18.50	.342	.1267	.007 ***
Male	.347	.1080	.001 ***
Over the age of 40	.358	.1453	.014 **
Income greater than $75k	.112	.1494	.452
Married	.084	.1594	.599
Children	.268	.1322	.042 **
Bottles per month	-.021	.0079	.008 ***

Note. Notation of ***, **, and * refers to significance values less than .001, .05, and .1, respectively.

Millennial Online Wine Buyer

To better understand why millennial wine consumers were among the age groups least likely to purchase wine online despite being heavy purchasers of other goods online, a second independent survey was designed and distributed online (Nielson 2014). A total of 161 millennial wine drinkers completed the second survey. The majority of survey respondents were 21 to 24 years old (51%), female (68%), employed full-time (56%), and single (63%) with no children under 18 living at home (87%). Respondents were educated, with 38% completing some college and 42% with college degrees. Respondents tended to have lower incomes than the original sample with 40% reporting annual household incomes under $24,999 and the majority (63%) of incomes under $49,999. The majority of respondents own or regularly use a smartphone (96%) and a computer (94%).

The majority of millennial respondents purchase between one and five bottles of wine each month in the $10.00-$14.99 price range (85%). They purchase wine from grocery stores (85%), tasting rooms (53%), and liquor stores (53%), while 66% of respondents purchase wine most frequently from grocery stores. These findings are consistent with prior research on the millennial wine consumer (Lecat and Pelet 2011; Wolf, Carpenter, and Qenani-Petrela 2005).

Respondents were asked questions to explore their online wine purchasing history, plans for the future, and general feelings regarding online wine shopping. The majority of millennial respondents had never purchased wine online (79%) and indicated that they are unlikely (33%) or extremely unlikely (30%) to purchase wine online in the near future. Despite the lack of wine purchases online, 53% of millennial respondents are using winery websites to find information about wine, compared to just 40% using wine magazines. Table 6 showcases some of the key differences between millennial wine buyers and the general wine buyers from the first survey.

Millennial respondents were asked to indicate their level of agreement with a set of statements that explore various motivators and deterrents for online wine purchasing (see Table 7). The statements were adapted from prior research on the factors that influence online purchasing, but were modified to be appropriate for a wine purchasing environment (Limayem, Khalifa, and Frini 2000). Despite findings from prior research, the majority of millennial respondents believe their financial information is secure when purchasing wine online (64%) and don't believe privacy violations are a major problem (57%). Millennial consumers purchase wine to consume

within the next month and, therefore, believe that it is not worth waiting for a wine shipment. Millennials feel that the cost of shipping makes buying wine online too expensive, that they can get better service by purchasing wine face-to-face, and do not believe that buying wine online is more convenient. Interestingly, the most strongly agreed upon statement relates to a preference to purchase wine with an experiential connection (67% agreement). While it is possible to make online purchases for wines that you have an experiential connection with, perhaps in millennials' relatively limited tasting history, their database of wine connections is still being developed and, thus, it is more difficult to make purchases online with those experientially connected products.

Table 6. Profile of General Wine Buyers Compared to Millennial Wine Buyers

	General Wine Buyers	Millennial Buyers
Monthly wine purchases	6	4
Monthly wine spending	$95.66	$30
Wine purchase prices	$10 - $18.49	$10 - $14.99
Purchase venues	Grocery store, tasting rooms, and specialty wine shops	Grocery stores, tasting rooms, liquor stores
Purchase online	70% have never purchased online	79% never have purchased online
Wine information sources	Friends and family, Google, print media	Winey websites, print media, Facebook

Note. General wine buyers are wine buyers from the first survey, while millennial buyers are those from the second survey designed specifically for millennial respondents.

Table 7. Agreement with Online Wine Purchasing Consequences

Statement	% Who Agree or Strongly Agree	% Who Disagree or Strongly Disagree	Independent Sample T Test	P-Value
I prefer to purchase wine that I have an experiential connection with	67%	8%	11.49	.000
I believe my financial information is secure when purchasing wine online	64%	11%	13.98	.000
I typically buy wine to consume within the next month, therefore it is not worth waiting for a wine shipment	55%	30%	6.36	.000
The cost of shipping makes buying wine online too expensive	50%	9%	10.28	.000
Shopping for wine online is more convenient than regular shopping; I can do it anytime and anywhere	39%	31%	2.11	.0354
Purchasing wine online allows me to save money; I can buy the same or similar products at cheaper prices than regular stores	26%	24%	.72	.4723
I don't trust the quality of the wine I can purchase online	22%	38%	4.24	.000
Privacy violations are a major problem when purchasing wine online	17%	57%	11.49	.000
I can get better service (pre-sale, sale, and post-sale) from Internet stores	13%	36%	6.26	.000

Note. (where 1 = strongly disagree and 5 = strongly agree)

The sample was further split between millennials who had purchased online (13.5% of the sample) versus those who had not purchased online. Even within this millennial sample, respondents who have purchased wine online are significantly more likely (than respondents who have never purchased wine online) to be 25 years old or older, employed full-time, married/living with a partner, a college graduate or postgraduate, with an annual household income over $75,000. Respondents who have previously purchased wine online are significantly more likely to purchase more than ten bottles of wine a month. They are also significantly more likely to buy wine that is $15.00 a bottle or more. Respondents who have never purchased wine online are more likely to buy one to two bottles of wine a month in the $5.00-$14.99 price range.

Results from an independent sample t-test, suggest that respondents who had previously purchased wine online are more likely to agree that online purchasing saves them money (p=.011), that it is more convenient than regular shopping (p=.004), and that their financial information is secure (p=.011). They are also more likely to disagree that the quality of wine available for purchase online is untrustworthy (p=.001) and, surprisingly, they are more likely to believe that the cost of shipping makes buying wine online too expensive (p=.002). Respondents who have never purchased wine online are more likely to agree with the statement, "I typically buy wine to consume within the next month; therefore, it is not worth waiting for a wine shipment" (p=.000).

Summary and Conclusions

As the wine industry explores direct-to-consumer distribution channels through wine clubs, tasting room sales, and online sales, understanding the consumer that is most likely to use those distribution channels is increasingly important. Online wine buyers are more likely to be highly involved wine consumers who appear to know more about wine and dedicate additional resources to wine purchases. In a sample of 918 wine consumers, 211 respondents indicated that they purchase wine online. Online wine buyers purchase more wine at higher average prices, are more likely to talk about wine with friends, are more likely to consider themselves knowledgeable about wine, and are more likely to seek out information about wine. They also tended to be males over the age of 40 with higher household incomes. The male-dominated nature of online wine buying is consistent with other research on the online market space (Alreck and Settle 2002).

Despite the digital nature of the millennial generation, the 21 to 29 age group was least likely to purchase wine online and, thus, that segment of the population was the focus of a second, independent survey. Consistent with findings from the first survey, the majority of millennials surveyed in the second survey have never purchased wine online (79%). Of the respondents who have purchased wine online before, almost half (48%) aren't likely to do so again in the near future. Older millennials who have higher incomes and full-time jobs are more likely to partake in online wine purchases. Buying wine online is not thought of as a way to save money, but as an outlet to purchase nicer wines for special occasions or gifts. The top three deterrents to millennials purchasing wine online are that millennials prefer to buy wine that they have an experiential connection with, that they typically buy wine to consume within the next month (and don't think it is worth waiting for a wine shipment), and that they think the cost of shipping makes buying wine online too expensive. The majority of millennials purchase their wine from grocery stores.

Given that millennials have a tendency to purchase lower priced wines, it makes sense that shipping costs represent a greater proportion of the total purchase cost and, thus, become a barrier to online purchases. For wineries or wine shops interested in increasing online sales to millennials, it is recommended that they explore ways to decrease the cost of shipping wine. Alternatively, perhaps removing the perception of high shipping costs through education and marketing to millennials may be just as effective as actually decreasing the costs of shipping. A number of online wine retailers regularly offer free shipping deals on select wine purchases, indicating there are opportunities to reduce the shipping cost barrier of wine purchases online.

Millennials make purchases based on experiential connections. Building an experiential connection to wine through an online environment may be one of the most significant challenges to increasing millennial involvement in online wine sales. Mora and Moscarola (2010) label the wine consumer who desires an experiential connection with the wine as the "hedonistic" consumer and suggest that more than a particular feature of the wine, the emotions carried by the consumer are the driving force behind purchases for the hedonistic consumer. Mora and Moscarola (2010) further suggest tasting experiences and wine tourism as sources to encourage consumer emotions as related to wine. In the online context, an application that allows a consumer to track the wines they have tasted with links to online purchase opportunities of that wine would appear to be a viable option to promote experiential connections online, which may entice millennials to purchase wine online.

This research provides greater insight into the development of the online wine consumer; however, the research is not without its limitations. The research is based on the willing participation of more than 1,000 survey respondents (918 in the first survey and an additional 161 in the second survey). The study assumes that there is no response bias in the survey data and that the respondent's answers were not misrepresented (intentionally or inadvertently). In addition, this research opens the door to future research. Experimental research involving simulated online wine purchases may be helpful to further understand the differences between wine consumers who choose to buy online, millennial or not, and may be useful in helping to understand approaches to breaking down online purchase barriers. Another potential barrier to wine purchases online that was not fully explored in this research is the role of complicated interstate shipping regulations. Future research could focus on what role, if any, this has on online purchases. Additionally, how local access to wine impacts the decision to purchase wine would be an interesting area of study. Though this research provides much insight into the online wine buyer, there are many opportunities for additional research, especially as technologies develop for further direct to consumer wine distribution.

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Identifying Market Preferences for High Selenium Beef

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Abstract

Selenium is an element found in relatively high concentrations in crops and livestock raised on high-selenium soils. Evidence suggests that a high-selenium diet can reduce the risk of certain cancers. A choice experiment was conducted to identify preferred attributes for a high-selenium beef product and the characteristics of potential market segments. Labeling reflecting scientific support linking selenium and reduced cancer risk, and natural-source selenium was ineffective in forming the general population of respondents. Marketing opportunities identified are consistent with existing functional food market segments and include targeting consumers with higher incomes and education, 45 to 55 years of age, and with children.

Keywords: Choice Experiment, FDA approval, functional foods, health claim, labeling, selenium

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Background

Producers in regions of North and South Dakota are interested in investigating marketing opportunities for their naturally high-in-selenium products in the functional food category. Functional foods are firmly established in Japan, where the term reportedly originated (Stanton et al. 2001). European functional food markets are dominated by probiotics and prebiotic dairy foods. Vitamin- and mineral-fortified functional foods are more common in the U.S. market, which is underdeveloped compared to its counterparts in Europe and Japan.

According to Childs (1997) and Stanton et al. (2001), the typical functional food consumer in the United States was classified as female, middle-aged, well educated, of high income, and actively interested in health. Subsequent literature reports inconsistencies in identifiying the effect of socio-demographic characteristics on purchasing behavior regarding functional foods. It also identifies additional factors affecting attitudes and purchasing intentions for functional foods, including those high in Selenium (Se). For example, Cox and Bastiaans (2007) report attitudes about the importance of consuming Se-enriched foods among Australians depend on the efficacy of the product in reducing cancer risk and the respondent's fear of cancer, self-efficacy and vulnerability to cancer.

Other literature supports the idea that willingness to pay (WTP) for functional attributes depends on the specific product under consideration (Munene 2006, Cox and Bastiaans 2007, Hailu et al. 2009), with those perceived as healthy and appearing more credible in their claim as functional foods (Annunziata and Vecchio 2011, Siró et al. 2008).

Maynard and Franklin (2003) identified market segments for a specific functional food category with promise as a cancer preventative (conjugated linoleic acid dairy products), are consumers with children or health-conscious consumers in the household. Willingness to pay among some respondents was dependent on the medical community's support of the cancer-fighting evidence.

Gilbert (2000) reported that 93% of American shoppers desire foods *naturally* nutritious in key vitamins and minerals, considerably more than those who agree that supplements (62%) and fortified foods (55%) are important. This concurs with Davis and Finley (2003), Cox and Bastiaans (2007) and Sloan (2012) who report that consumers believe vitamins and minerals are more beneficial when naturally sourced from food. The 11% reported by Gilbert who strongly agreed foods could reduce drug use were labeled "food as medicine shoppers"; they are often the target of functional food products entering the market. Positive health claims had a slightly higher appeal overall to these shoppers than a claim of fear. For example, "helps to maintain healthy cholesterol" was slightly favored over "may reduce risk of heart disease." Schmidt (2000) concurred that positive statements are better received and provides additional support for the importance of the role of the medical community, dieticians, and nutritionists in marketing functional foods. Siró et al. (2008) argue that positive claims are better for some products while labeling indicating their role in reducing risk is better for others.

West et al. (2002) used stated choice experiments to estimate WTP for functional foods (e.g., anti-cancer tomato sauce) among Canadians. They found a majority were willing to pay a premium, especially if the functional property added to foods was derived from plants, although 44% were skeptical about the validity of nutrition claim information. West et al. suggested that this skepticism implies the government must employ the assistance of nutritionists and health

care professionals to disseminate information about the value of functional foods. Seventy-two percent of respondents were willing to pay for a functional attribute in a *meat product* that reduced heart disease. The authors suggested this may reflect a higher percentage of consumers willing to pay a premium for foods that are generally considered less healthy to begin with (e.g., potato chips or, as the case for the current study, steak), conflicting with findings by Annunziata and Vecchio 2011 and Siró et al. 2008.

Health claim labeling for other foods has also generally been found to be effective. For example, Roe, et al. (1999) found that consumers were more likely to consider a product healthier and have higher purchase intentions when it featured a health claim. The presence of a health claim also raised product rating on health attributes not offered in the claim (referred to as the halo effect). Length of claim can influence its effectiveness. Wansink (2003) tested three front health claim label alternatives (long, short, and no label) with a more informative back label. Consumers who saw short claims recorded more positive attribute-specific (versus general evaluative) thoughts, increasing the believability and persuasiveness of the health claim.

Garretson and Burton (2000) investigated nutrition facts label and health claim (low in fat and high in fiber) effects on Arkansas consumers' attitudes, purchase intentions, perceptions of disease risk, and diet-disease knowledge. Most consumers relied on nutrition facts information rather than claims. When compared to conditions without health claims, inclusion of a diet-disease health claim led to a marginal reduction in cancer and heart disease risk perception. Kozup et al. (2003) found that a heart-healthy logo generally indicated to primary household shoppers that the food would reduce the likelihood of heart disease or stroke. Nutrition information led to more positive attitudes towards the food product, nutrition, and reduction of disease risk, and increased purchase intentions.

Selenium

Selenium is an essential trace mineral necessary for appropriate function of the immune system, muscle function, successful reproduction, and peak brain function. It also functions at the catalytic centers of several antioxidant and thyroid hormone regulating enzymes (Rayman 2000; Combs 2007). Deficiencies in selenium have been linked to decreased thyroid function, cardiovascular disease, cancers, and other health problems (Rayman 2000)[1].

Selenium was first recognized as having some nutritional importance half a century ago (Schwarz and Foltz 1957), and, shortly thereafter Shamberger and Frost (1969) suggested a link between selenium and cancer risk (Combs 2000). They observed an inverse relationship between U.S. local cancer rates and geographical distribution of selenium in American forage crops.

Consideration of the market potential for a *naturally* high-in-selenium beef product is encouraged by evidence indicating the meat from beef cattle consuming high-selenium feeds maintains an elevated selenium level, that the selenium is well distributed throughout the

[1] The Selenium and Vitamin E Cancer Prevention Trial (SELECT), involving more than 35,000 men from North America, was conducted to investigate the effect of oral supplementation of SE, Vitamin E, and Se + Vitamin E on prostate cancer (Lippman et al. 2005). Although no preventative effect was identified, El-Bayoumy (2009) and Rayman and Combs (2009) offer compelling arguments to further examine the role of Se in various doses and forms on the cancer development processes.

animal's muscles (Hintze et al. 2002), and that selenium from natural sources is better absorbed in the meat (Lawler et al. 2004). Beef is already an important source of selenium for North Americans (Shi and Spallholz 1994). And, beef from cattle consuming plant material growing or grown in seleniferous areas has an elevated selenium level. Hintze et al. (2001) report that beef raised in a moderately seleniferous area averages 70 micrograms selenium in a 100 gram beef serving. This compares with daily selenium intakes of 96 micrograms (for women) and 120 micrograms (for men) Combs (2001) suggests would be sufficient to sustain an optimal cancer-protection target level.

Selenium was petitioned for validation of its role as an anti-carcinogenic. The Food and Drug Administration (FDA) concluded that there was not significant scientific agreement about the science underlying the statements that 'Selenium may reduce the risk of certain cancers' and that 'Selenium may produce anti-carcinogenic effects in the body.' However, the FDA did allow that existing evidence was strong enough to support qualified health claims as long as they were appropriately worded and not misleading to consumers (FDA 2003).

Currently, information about market potential for naturally high-in-selenium products, including beef, is very limited. The only known study is one considering the market potential for high-selenium wheat. SJH and Company, Inc. (2004) concluded that there was currently little industry support among wheat processors (end-users), and that marketing a high-selenium product would involve a complicated educational component and a not inconsequential level of risk. This agrees with Cox and Bastiaans (2007) who report that people don't recognize Se as an antioxidant. SJH and Company, Inc. also noted that a high-Se product would need to be a "science-based value proposition", i.e., strong support for the selenium-health link claim would be necessary. Further, for business viability, premiums received for selenium-enhanced products would have to exceed the costs of testing for selenium level and additional processing and marketing costs.

Objectives

In the current study, the key objective is assessing perceptions and effect of a health claim linking a naturally high-in-selenium beef product and cancer incidence. Assessing consumers' WTP for a high-selenium beef product is an essential step in evaluating the economic viability of producing and marketing this product and was the primary goal of this research. Cost-effective marketing usually requires identification of market segments. Therefore, the second objective is to identify potential market segments for high-selenium beef.

Methods

Survey Design

A focus group was conducted in May 2006[2]. Specific objectives were: to gain information about consumers' labeling preferences; evaluate consumers' knowledge of functional foods and selenium; determine product attributes with potential to be combined with selenium level and attribute ranges to be represented in the survey instrument; and facilitate selection of the range of price-premiums considered. The focus group was conducted according to recommendations

[2] An initial focus group was assembled with seven staff members in the Department of Agribusiness and Applied Economics at North Dakota State University consisting of three males and four females, ages 23 to 56.

specified in Krueger (1988). Focus group members did not participate in the subsequently-described choice experiments.

Eight women participated in the focus group, each indicating they were the primary household shopper and purchased beef. Half used dietary supplements and half had a history of cancer in their immediate family. Participants were only vaguely aware of selenium and had very little knowledge of its relation to cancer or the research that supports its role in cancer-prevention. Several commented that the word selenium itself "sounds bad." Most participants were aware of the availability of functional foods in the marketplace and in fact purchased them (e.g., calcium-enriched orange juice), but few were familiar with the specific term "functional food."

Different styles of labels were pictured on cuts of beef (steaks and hamburger) and displayed for participants to examine. Participants commented that short labels did not provide enough information. Their use elicited slightly negative perceptions. Medium labels with suggestions from research were most accepted and preferred, and a large label was described as containing too much information. FDA approval of selenium as a cancer preventative was generally accepted as positive and was described as likely to result in a slightly higher WTP for a beef product rich in selenium. After the moderator explained current research regarding selenium as a potential cancer-preventative, participants initially indicated they would be willing to pay a premium ranging from 0 to 10%. Individual follow-up discussions with the four participants with cancer incidences in their immediate family extended the maximum premium to 15%. Participants also indicated that a premium might be paid in order to support a locally-based product and economy given the natural soil placement of selenium in the Dakotas.

Experimental Design and Data

Because selenium-rich beef products considered in the current study are not commercially available, only stated preference methods of non-market valuation were considered. Choice experiments (CE) consider choices among products varying by attribute and follow Lancaster's theory of utility maximization (see Appendix) (Lancaster 1966). They more closely mimic a consumers' typical shopping experience than do dichotomous choice (DC) experiments, which allows cross-price elasticities to be easily determined between new and existing products, and can produce results similar to those found using revealed preference methods. Alpizar et al. (2003) also argue that it is more difficult for participants to strategically respond to queries in a CE compared to DC because of the number of unknown attributes in the CE.

A disadvantage of CE is that only discrete choices are observed, which complicates estimation of WTP and demand. There may also be inconsistencies among participants' responses across choice questions, and responses may be influenced by the complexity of the decision. Specifically, Gao and Schroeder (2009) found that WTP for product attributes depends on the number of attributes consumers consider and how they are related to one another.

Further, as is true for stated preference methods in general, CE are frequently hypothetical, and therefore WTP estimates may be biased (Silva et al. 2007, Lusk et al. 2005). Of particular note is the potential for embedding (Goldberg and Roosen 2005). Embedding occurs when respondents use their hypothetical premium to 'vote' for a product or attribute when in fact they would not

actually pay a premium for it. To overcome this problem, recent work has included the use of 'incentive compatible' contingent valuation studies where the participant has a non-zero probability of being required to purchase one or more of the goods they are evaluating.

Choice experiments have been used to test WTP for a variety of products with considerable focus on hypothetical products and those with credence attributes, such as is the case with the current study. For example, Olynk, et al. (2010) used CE to estimate WTP for credence attributes of milk and pork related to production practices. Bai et al. (2013) used a CE to calculate WTP for milk traced under different certificate issuers.

CE, a conditional logit model, was selected for the current project. The dependent variable was choice (one of the four choices in each set). Independent variables included attribute levels of the choice product and socio-demographic and behavioral variables. The experiment was approved by the NDSU Institutional Review Board; and provided to Zoomerang Market Tools, an online survey company that manages survey panelists, to administer during the fall of 2006[3]. Data were analyzed using Limdep® (Greene 1998).

Attributes and levels of each attribute were identified and grouped into choice sets. The experimental design of the survey consisted of three attributes: premium, health claim, and origin, each with three levels. Premium levels were set at 5%, 10%, and 15% of current local market price. Health claim levels were that of FDA level A (unqualified), FDA level C (qualified), and a suggestion based on recent research (research suggested). The FDA level A health claim is unqualified, reflecting significant scientific agreement about the validity of the disease-diet relationship (Federal Trade Commission 2006). A level C claim is qualified. An example of a level C health claim is "A diet high in selenium may reduce the risk of cancer but the scientific evidence is limited and inconclusive" (Federal Trade Commission 2006, p. 3). The level R health claim used in the current study is not recognized by the FDA and does not indicate FDA support.

The origin attribute referred to the label design, as well as the wording, and was represented by "naturally rich in selenium" and "selenium fortified" phrases on the labels. The "naturally rich in selenium" phrase was used within a plain rectangular border as well as a North Dakota border, thus creating the third level within this attribute.

Orthogonal reductions in the full factorial design were made using SAS® macros, resulting in 18 choice sets. Three surveys of six questions each were used for the experiment, also selected using SAS® macros. Figure 1 shows an example choice set and the verbiage instructing respondents.

[3] Although firms have added and continue to add to the market products with identified health benefits, to the best of our knowledge, there are no products that contain an FDA health claim related to the use of selenium. Furthermore, none of the high-selenium products that are on the market result from the type of extended, multi-owner marketing channel characterizing beef production. This process can result in considerable product heterogeneity, requiring that individual carcasses be tested for level of selenium and any other marketed attribute associated with its composition. Finally, the research provides insight into marketing food products with credence attributes unfamiliar to consumers.

Please read the following product description for a new product.

Selenium, an essential trace mineral to our health, has shown some recent evidence of having cancer prevention qualities. The beef product shown below is a top sirloin steak. The white-out area is where the store's label was. Participants were asked to respond as though they were going to purchase this sirloin steak. Choice "D" is the standard steak at the current market price and without any selenium labeling or known levels of selenium at the current market price.

Figure 1. Instructions and example of choice set offered to shoppers

Each of the surveys began with a series of five beef consumption questions and ended with 15 demographic and behavioral questions included to aid in identifying market segments for high selenium beef. Respondents were limited to consumers living in the United States and serving as their household's primary grocery shopper, at least of age 25, and who regularly purchased beef and meals that included beef. Numbers completed for the three surveys were 485, 484, and 507, for a total of 1,476 responses. Data were cleaned to omit incomplete entries, entries by those who were not the primary shopper, or those who did not consume beef, and those entries with extreme outliers, such as shopping for groceries 100 times per month. A total of 172 responses were omitted resulting in 1,304 completed surveys.

Survey Population

Respondents were predominately female (77%) and Caucasian (89%). Age distribution was 16% (25 to 34 years), 28% (35 to 44), 32% (45 to 54) 18% (55 to 64), and 6% (65 and older). Sixty-one percent of respondents were married and nearly half (48%) reported having children in the household.

Participants were asked to identify the highest level of education they had completed according to the following categories: high school diploma or equivalent (25%), some college (33%),

associate's degree (12%), bachelor's degree (18%), and graduate studies or more (11%). A slight majority (53%) of respondents had full-time employment status followed by homemaker (21%), retired (16%), part-time (8%), and student (2%). Figure 2 shows the distribution of income of respondents.

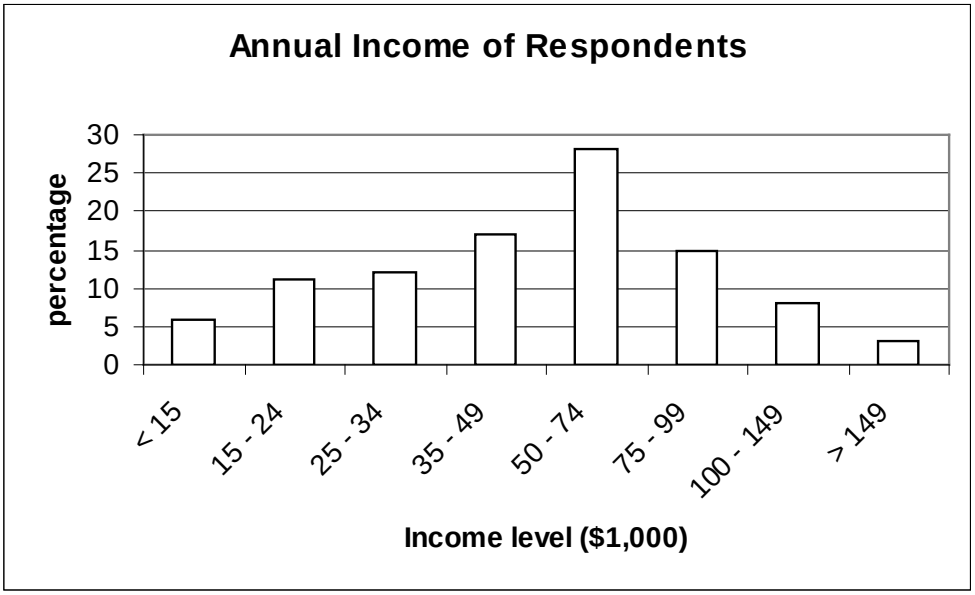

Figure 2. Income of Respondents

Two-thirds of respondents reported intentionally purchasing functional foods, one-third used tobacco products, and half reported taking dietary supplements. Fifty-six percent indicated they did not consume alcoholic drinks during an average week, and another 24% reported drinking an average of only one to three drinks weekly. Panelists were asked if they had a variety of health conditions in their immediate family. Half indicated high blood pressure, 39% arthritis, 33% diabetes, 25% cancer, 23% heart disease, and 11% osteoporosis. Twenty-eight percent reported no incidences of these health conditions among their immediate family members.

Results and Discussion

Results of the conditional logit model indicate a good fit (Table 1). Standard errors on estimated coefficients were low. The base case for this model is the "none" alternative: the standard steak labeled only 'Beef' and with market pricing (i.e., no premium).

Unexpectedly, respondents did not prefer the unqualified, qualified, or research suggested health claims. These claims included the words "cancer" and "selenium"; both words may have elicited negative thoughts about the product. As expected, the sign on the premium coefficient was negative, but it was not significant.[e] The "North Dakota Naturally Rich in Selenium" and "Selenium Fortified" labels also were not significant. Willingness-to-pay was not estimated because consumers expressed less (not more) willingness to purchase a high selenium beef product. Alternatives with a price-discount attribute were not included in the model.[4]

[4] A reviewer noted that the relatively small range of price premiums considered may have contributed to the lack of statistical significance for price.

Table 1. Health Claim Preferences

Variable (Health Claim Interaction)[a]	Coefficient and Sign	Standard Error	Level of Significance	Marginal Effect
Unqualified FDA Health Claim (U)	-1.837	0.398	0.0000	
Qualified FDA Health Claim (Q)	-1.576	0.455	0.0005	
Research Suggests Health Claim (R)	-2.190	0.437	0.0000	
Price	-0.679	0.444	0.1265	
North Dakota Label	0.269	0.040	0.4978	
Fortified Label	0.499	0.040	0.2126	
Functional Food Purchaser (U)	0.613	0.067	0.0000	13.926
Functional Food Purchaser (Q)	0.567	0.077	0.0000	2.029
Functional Food Purchaser (R)	0.833	0.076	0.0000	-0.890
Has at least a 4-year Degree (U)	-0.154	0.071	0.0317	3.124
Has at least a 4-year Degree (Q)	0.161	0.078	0.0403	3.703
Has at least a 4-year Degree (R)	0.014	0.077	0.851	2.007
≥ $50,000 household income (U)	0.171	0.065	0.0083	10.916
≥ $50,000 household income (Q)	0.412	0.076	0.0000	9.992
≥ $50,000 household income (R)	0.249	0.071	0.0005	0.451
Age 35 – 45 (U)	0.302	0.154	0.0489	-0.337
Age 35 – 45 (Q)	0.210	0.179	0.2409	3.814
Age 35 – 45 (R)	0.329	0.168	0.0506	-1.267
Age 45 – 55 (U)	0.171	0.064	0.0083	10.916
Age 45 – 55 (Q)	0.412	0.076	0.0000	9.992
Age 45 – 55 (R)	0.249	0.071	0.0005	0.451
Age 55 – 65 (U)	0.566	0.103	0.0000	-0.562
Age 55 – 65 (Q)	0.624	0.125	0.0000	-0.492
Age 55 – 65 (R)	0.697	0.111	0.0000	-1.073
Exercise 0 days / week (U)	-0.276	0.100	0.0059	10.916
Exercise 0 days / week (Q)	-0.212	0.117	0.0709	-0.416
Exercise 0 days / week (R)	-0.561	0.110	0.0000	1.734
Exercise 1-2 days / week (U)	0.232	0.086	0.0071	3.887
Exercise 1-2 days / week (Q)	-0.651	0.101	0.5186	-0.855
Exercise 1-2 days / week (R)	-0.170	0.092	0.0652	3.411
Exercise 3-4 days / week (U)	0.263	0.083	0.0015	-6.257
Exercise 3-4 days / week (Q)	0.145	0.095	0.1271	-0.855
Exercise 3-4 days / week (R)	0.649	0.088	0.4610	4.926
Exercise 5-7 days / week (U)	0.167	0.105	0.1117	-5.272
Exercise 5-7 days / week (Q)	0.300	0.121	0.0131	-0.855
Exercise 5-7 days / week (R)	0.113	0.111	0.3085	-0.850
Tobacco User (U)	0.108	0.064	0.0915	5.978
Tobacco User (Q)	-0.130	0.076	0.0879	7.255
Tobacco User (R)	0.822	0.071	0.2443	0.297

Note. Parentheses following the noted attribute indicate it is an interaction term in the model with U (unqualified FDA labeling), Q (qualified FDA labeling), or R (research supported labeling).

The "Naturally Rich in Selenium" label was excluded from the model. Presumably, respondents did not differentiate between this label and that differing only by use of a North Dakota border. The North Dakota label border was in the shape of North Dakota which is, in retrospect, very similar to the rectangle otherwise used.

Marginal effects of socio-demographic variables included in Table 1 represent the effect of a change in attribute 'm' of alternative 'j' on the probability that the individual would choose alternative 'k' (where k may or may not equal j) (Greene 1998, p. 531), mathematically shown in equation 1.

$$(1)\ \delta_{jk}(m) = \partial \Pr ob[y_i = k] / \partial x_{ji}(m) = [1(j = k) - P_j]P_k\beta_m$$

As measured by the size of the marginal effects, the most influential variables towards preference for the health claims are consistent with previously-identified attributes of functional food shoppers. Those who intentionally purchase functional foods preferred the FDA health claims, especially the unqualified claim, which is logical in that they would be more likely to understand the significance of an FDA-supported health claim. Self-identifying as using supplements did not have a significant effect on preference. Individuals with household incomes of $50,000 or greater preferred all three of the health claims at highly significant levels and the marginal effect was important for the FDA claims. Being in the 45 to 55-year-old age category increased preference for the FDA health claims. Marginal effects for the age categories of 35-45 and 55-65 years-old were negative when significant but relatively small. Those with at least a 4-year undergraduate degree preferred the FDA health claims. Those who exercise not at all or one to two times per week preferred the FDA unqualified health claim, while those exercising more did not. Those exercising up to four days per week preferred the research suggested health claim. Tobacco users preferred the stronger FDA health claims.

Men preferred the research suggested health claim, but the marginal effect was small (Table 2). Gender was insignificant for the FDA health claims. Married respondents held less preference for the qualified FDA health claim, although preference for the other health claims was insignificant. Those respondents having children exhibited positive preference for the unqualified FDA health claim. Those who purchased at least four steaks per month did not prefer the unqualified FDA or research suggested health claims, although the marginal effect for the research suggested claim was small. Preference for the qualified FDA health claim was insignificant. Those who did not consume alcohol preferred the unqualified FDA health claim and the marginal effect was relatively large. The marginal effects for the other two health claims were insignificant. Hispanic respondents' preference for all three health claims was significant, but marginal effects were small and conflicting.

Although panelists' responses about the incidence of six health issues within their immediate family were included in the model, only high blood pressure was significant for each health claim, and the effects were conflicting. Respondents with diabetes in their immediate family had a preference for the qualified FDA health claim. Surprisingly, an incidence of cancer in the family did not significantly affect preference for either FDA health claim. And, although it had a significant effect on preferences for the research suggested health claim, the marginal effect was

small. Those with incidences of heart disease and arthritis also preferred the research suggested health claim but, again, the marginal effects were small.

Table 2. Health claim preferences: Interactions with an inconclusive effect on health claim

Variable (Health Claim Interaction)[1]	Coefficient and Sign	Standard Error	Level of Significance	Marginal Effect
Male (R)	-0.227	0.083	0.0061	0.487
Married (Q)	-0.141	0.073	0.0538	-2.486
Has children (U)	0.138	0.067	0.0450	6.687
Four Steaks / Month (U)	-0.208	0.064	0.0012	-4.733
Four Steaks / Month (R)	-0.144	0.070	0.0406	-0.834
Non-drinker	0.481	0.144	0.0008	10.916
Hispanic / Latino / Spanish (U)	0.586	0.261	0.0247	-0.350
Hispanic / Latino / Spanish (Q)	0.577	0.291	0.0472	0.384
Hispanic / Latino / Spanish (R)	0.582	0.305	0.0568	1.945
High blood pressure (U)	0.162	0.066	0.0142	2.048
High blood pressure (Q)	0.216	0.076	0.0045	-2.295
High blood pressure (R)	0.123	0.072	0.0879	-1.006
Diabetes (Q)	-0.154	0.081	0.0572	5.295
Cancer in immediate family (R)	-0.214	0.082	0.0088	0.297
Heart Disease (R)	-0.181	0.087	0.0366	1.472
Arthritis in immediate family (R)	0.339	0.073	0.0000	0.670
Osteoporosis (U)	0.224	0.099	0.0231	-0.169
Osteoporosis (R)	0.167	0.107	0.1175	0.384

Note. [1]Parentheses following the noted attribute indicate it is an interaction term in the model with U (unqualified FDA labeling), Q (qualified FDA labeling), or R (research supported labeling).

Conclusions

The primary objective of this study was to identify the preferred level of beef attributes, including price, origin of selenium, and label-claim made regarding the value of selenium as a cancer preventative. As expected, consumers preferred a lower priced product although this preference was not significantly different than zero. Health claims had a negative effect on preference compared to the control steak. This may be due to the fact that the word "cancer" was used on the label. Gilbert (2000) and Schmidt (2000) argue that a positive claim has higher appeal than a claim of fear or negative claim (e.g., can reduce risk of cancer), and, food marketers often abide by the rule of thumb not to use a disease name on a label if possible (e.g., using 'supports healthy bone growth and maintenance' rather than 'prevents osteoporosis'). However, in the current work, the link between the scientific effects of Se on the body and cancer incidence would be unknown to most consumers.

It is also possible that a general lack of knowledge about selenium produced negative thoughts about the selenium-enhanced product. Focus group participants agreed that selenium "sounds

bad." The same type of perception (i.e., negative interpretation of an attribute considered value-added for marketing) was found for irradiated beef (e.g., see He et al. 2005; Nayga et al. 2006). Furthermore, even with a reported health benefit, interest in a high-selenium beef product may have been outweighed by the uncertainty of its other potential consumption effects. International Food Information Council Foundation (2006) attributed a substantial drop over time in the number of Americans who strongly agreed certain foods may have additional benefits to confusion in light of the vast amount of conflicting research they are exposed to. Hu et al. (2006) found that Japanese consumers viewed a genetically-modified attribute of bottled canola oil more negatively when they were provided with neutral or somewhat supportive information about biotechnology than when they received no such information. The authors introduced the hypothesis that this information may have caused an "alarmist effect" related to uncertainty about this credence attribute. They too offered information overflow as another possible explanation. They argued that information about the diet-disease relationship and an endorsement by a trusted entity are necessary for effective marketing of an un- or little-known credence attribute such as that considered in the current research. Their hypotheses are worth considering in investigating why consumers did not prefer high-selenium beef over the conventional beef in the current study.

Labels proclaiming the beef to be Naturally Rich in Selenium (both with and without a North Dakota border) and to be Selenium Fortified did not affect willingness to purchase. Further differentiating the labels may increase their effectiveness. For example, additional verbiage that more clearly identifies the state-origin of the beef might be included such as Bosworth et al (2014) did with their Utah's Own labeling for ice cream. Another possibility is that consumers may not care whether the product's elevated selenium level is natural or is the result of fortification, although this is contrary to existing literature for some other foods (e.g., see Sloan 2012, Cox and Bastiaans 2007, and Davis and Finley 2003).

This study further aimed to identify potential market segments for high-selenium beef. In general, functional foods are more frequently purchased by consumers with higher education and income. This held true in the current study as income levels greater than $50,000 or having at least a bachelor's degree had a positive influence on preference for the FDA health claim labeled beef. Those with children and those who did not consume alcohol preferred the unqualified FDA health claim in contrast to those consuming at least four steaks per month, who did not prefer this health claim. Based on the literature, gender was expected to affect preference but did not. Those in the 45 to 55-year-old age range preferred FDA health claims and may be a viable market segment for a high-selenium beef product. Current research supports that elevated selenium intake works short-term to prevent cancer rather than being a preventative requiring long-term consumption. This information was not provided to participants, but its inclusion may increase preference for the high-selenium products, especially among older consumers.

Not well explained is why disease incidence among an immediate family member did not consistently influence preference for the high-selenium product. Perhaps the wording of the question to include only immediate family members was too inclusive (e.g., incidence among friends, colleagues, or others may also cause individuals to consider more carefully the potential for disease). It also may be that those with a history of cancer in their family are tested at a younger age and more regularly for the disease or otherwise take action to prevent cancer and

therefore feel more secure. Our inability to create a disease-exposed market segment for this product is somewhat contrary to conventional wisdom (e.g., see Mark-Herbert 2003) and calls for further investigation.

Another interesting finding is that those with less health-oriented lifestyles, including those who do not exercise (much) and who use tobacco preferred the health claim labeled beef. This is consistent with the concept of risk compensation where a remedy reduces the perceived risk of a risky behavior (e.g., tobacco use) so individuals may "trade away" some of the reduced risk by engaging in riskier behavior. For example, Bolton et al (2006) found that a remedy message for a nicotine replacement product increased smoking intentions, and a remedy message for debt consolidation loans increased risky financial behavior intentions. In other words, remedy messages hurt those consumers most in need of help; those already engaged in risky behavior with a "high problem" status.

Further Work

Lessons can no doubt be learned through detailed investigation of successful (and unsuccessful) campaigns to introduce functional foods. Identifying a well-articulated health claim will be very important to future studies as was demonstrated by He et al. (2005) and Frenzen et al. (2000) about irradiation. Consumer resistance to irradiation was unexpected given the scientific evidence supporting its use to improve the safety of food. Due to a widespread lack of knowledge, point of purchase information about selenium may be beneficial to inform consumers about the benefits and hopefully remove the consumers' fear of including more of a little-understood element in their food. This may be the most important limitation for the industry, since promotion of a substance whose role in health is largely unknown to the public is difficult and costly. And, it was not particularly effective for irradiation, although consumer resistance may be higher regarding the process of irradiation than elevated selenium levels.

For example, like selenium, fluoride is a naturally-occurring substance absorbed by plants from the soil that builds up in animal tissues, and is toxic to humans at high levels. Fluoride was perceived negatively until consumers were educated and comfortable enough with their level of understanding to make informed purchase decisions. Local municipalities moved forward the cause of fluoride by adding it to local drinking water and it was not until later that it was commercially offered in products by enterprising firms. Perhaps selenium enhancement needs to first move to a point of public interest to facilitate inclusion in privately produced and marketed food products. As medical and other healthcare professionals remain the most believable source for health and nutrition information (International Food Information Council Foundation 2006), this group may be a good starting point.

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Appendix

The Lancaster (1966) model provides a natural setting to analyze consumer preferences in a discrete choice setting. In this model, individuals derive utility (U) from the preference of health attribute (z), which is embodied (along with economic attributes) in the product he/she consumes.

Utilities derived from preference are not directly observable. The observable variables are the product attributes (*a = label clearly-S or not label clearly-NS*) and a vector of individual characteristics (*x*). The random utility model assumes that the utility derived by individual i from the perceived health benefits can be expressed as:

$$(1)\quad U_{ai} = V_{ai} + \varepsilon_{ai}$$

where U_{ai} is the latent utility level attained by the i^{th} individual, V_{ai} is the explainable part of the latent utility that depends on the value attributes (e.g., clarity of Selenium label) and the economic outcomes, and ε_{ai} is the 'unexplainable' random component in U_{ai}.

The utility maximizing individual will choose to consume a particular food variety if and only if $V_S + \varepsilon_s > V_{NS} + \varepsilon_{NS}$ or equivalently if $\varepsilon_i = \varepsilon_{NS} - \varepsilon_S < V_S - V_{NS}$. Since ε is unobservable and stochastic in nature, the individual's choice is not deterministic and cannot be predicted exactly. Instead, the probability of any particular outcome can be derived. The probability that individual i will choose to eat a particular food variety on the basis of clearly labeled health attributes is given by:

$$(2)\quad p_i = prob(\varepsilon_{NS} - \varepsilon_S < V_s - V_{NS}) = prob(\varepsilon < V_s - V_{NS})$$

Describing the density function of ε by f (ε), the above probability is given by:

$$(3)\quad P_i = \int_{\varepsilon} Z_i (\varepsilon_i < V_S - V_{NS}) f(\varepsilon_i) d\varepsilon_i$$

where Z_i is an indicator variable, a binary term that equals 1 when the utility from selenium and proper labeling exceeds the utility from absence of selenium or poor labeling.

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An Economic Valuation on the External Cost of Alternative Milk Packaging

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Abstract

This paper investigates the degree to which glass bottled milk is an environmentally friendly alternative. A recent life cycle assessment for fluid milk packaging alternatives is utilized to quantify the environmental costs associated with each packaging type. We conduct a sensitivity analysis to identify the return and reuse rates under which the glass bottle has a lower environmental impact than the alternatives. With eight reuses and 95 percent return rate, glass bottled milk has a lower environmental cost than the alternatives. Twelve reuses and a 100 percent return rate is necessary for glass packaging to have the lowest social cost.

Keywords: milk; life cycle assessment; packaging; external costs

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Introduction

Starting in the 1970s, consumers have become more conscious about the environmental impact associated with their personal consumption choices, thus creating a demand for environmentally sound products (Byrne 1991). In recent years, firms have worked to segment markets in order to attract consumers who wish to purchase the environmentally friendly products. The primary method by which this product differentiation has occurred is eco-labeling, which has been used to identify goods as being organic, hormone free, non-GMO, Rainforest Alliance Certified, and energy efficient; as examples.

While eco-labeling is an effective method for providing information to the consumer about otherwise unobservable product attributes, product packaging may also be used to attract the environmentally conscientious consumer. Examples of such packaging are that which is more easily recycled and which is comprised of post-consumer recycled materials. Such packaging could make the difference for a consumer deciding between two relatively similar products.

In the past, dairies and creameries shipped glass bottles of milk to consumers within a 100 mile radius. Glass bottles may be reused a number of times prior to recycling the glass, resulting in the appearance of being environmentally friendly packaging. As technology advanced, especially in the production of alternative materials for packaging, plastic milk jugs became the standard as they were less expensive (Zaleski 1963). Although they have several significant advantages, disposable plastic milk containers have generated considerable controversy in the United States. According to Fischer and Hammond (1978), the disposable plastic container is a heavy user of nonrenewable hydrocarbon resources and presents greater solid waste disposal problems than reusable containers.

Given the increased demand for products which represent reduced negative environmental impact, it is not surprising that a number of dairies in the United States have either begun or expanded glass bottled milk operations. And while the glass bottle is not an option at all grocery outlets, a quick internet search returns results for glass bottled milk at some locations for nearly every major grocery chain.

It is clear that a market for locally produced milk in glass bottles exists; and that consumers perceive the product to represent a reduction in environmental impact. However, there is no guarantee to the consumer that what they are purchasing is, in fact, an environmentally friendly product. The first objective of this study is to evaluate the external environmental costs, private production costs, and total social costs associated with various packaging options of liquid milk. While the reduction of environmental impact is desirable, the benefit to society may be undone if the cost of production for the environmentally friendly alternative is sufficiently large. The second objective is to conduct a sensitivity analysis on the aforementioned costs to account for uncertainty in the reuse and return rates of glass bottles.

Theoretical Framework

Prices for goods and services traded in the market reflect the private valuation of those goods and services by the participants in the market. The market price, however, does not account for the

effects that the transaction might have on third parties. These third-party effects are called externalities, and may be either positive or negative in nature. In the case of liquid milk packaging we are interested in the negative externalities associated with the environmental impact of the packaging life cycle. A graphical representation of a negative externality is presented in Figure 1. The marginal private benefit (MPB) is the value that buyers place on the good or service and the marginal private cost (MPC) is the cost to the seller of providing the good to the market. The sum of the MPC and the external cost generated yields the marginal social cost (MSC), which is the cost to society of an additional unit of the good. If there isn't an externality associated with the transaction of the good or service, the market price of P* and market quantity of Q* occur. However, at the quantity of Q*, the MSC exceeds the MPB, which is inefficient because the external environmental cost is not being accounted for in the transaction of the good in the market.

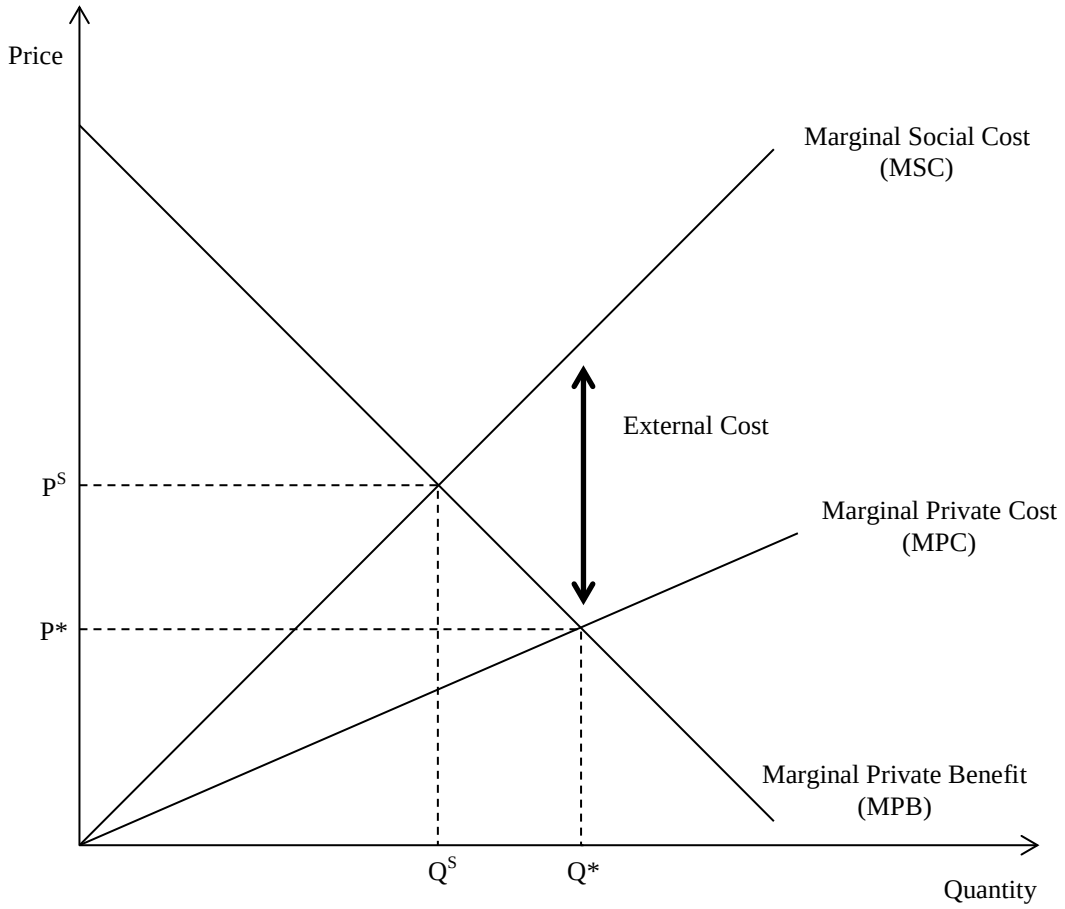

Figure 1. Graphical Representation of a Negative Externality

The assessment of negative externalities associated with the life cycle of alternative milk packaging options will be based on both direct and indirect environmental impacts. These impacts will be comprised of production and transportation energy, atmospheric emissions, and postconsumer waste. Estimated environmental costs are added to the private costs of production to obtain the social costs, which are then compared across packaging options.

Over the past 30 years, there has been a significant amount of research on the external and environmental effects of alternative types of milk packaging. Many of the previous studies focus on a life cycle assessment of each type of milk packaging; other studies focus on specific aspects of the production process. Environmental life cycle assessment (LCA) has evolved over the last three decades to become a standard method by which externalities are calculated. LCA evolved from energy analysis to a comprehensive environmental burden analysis in the 1970s (Guinee et al., 2011). Interestingly, alternative milk packaging LCAs are relatively sparse in the literature. Those that do exist discuss items such as atmospheric emissions, energy requirements, wastewater, postconsumer waste, and transportation weights, although not necessarily in a comprehensive fashion.

In a study conducted by Fischer and Hammond (1978), the LCA was conducted using an economic engineering approach, which standardizes all capital and operating costs to the current price level. Fischer and Hammond initially determined the capital cost involved in the finished fluid milk product depending on the type of packaging. They also include energy requirements, wastewater, and atmospheric emissions in their study. However, all of these environmental LCA results focused only on the external costs resulting from transportation. Due to the focus on transportation, they neglect the external cost associated with the base production of the alternative packaging. The Fischer and Hammond (1978) study is still quite useful because it reveals some of the indirect external costs associated with milk packaging alternatives. Additionally, this study exposes the private costs associated with alternative milk packaging so that both the producer and consumer decisions are presented.

O'Connor and Ford (1977) take a pure cost approach to the LCA. This study focused on plant size, as well as alternative packaging, to determine which combination would be the most effective milk processing facility. They establish an average unit expense for each type of alternative packaging by including the cost of the raw product, the cost of processing and packaging, and the general plant expense. This data provides a reference for the actual cost of each alternative packaging, upon which the other external costs, both direct and indirect, can be calculated.

Boustead (1974) used the LCA to determine the energy requirements for glass and plastic milk bottles. This study, while limited to energy requirements, includes the energy use from the mining of raw materials to delivery and return of milk bottles. The study did not include, however, any indirect energies for which data were not yet available (Boustead, 1974). Even without the indirect energies cost, the information that was presented allows for a solid starting point for calculating one facet of the overall external cost in the present work.

Keoleian and Spitzley (1999) incorporated more indirect external costs that Boustead (1974) was missing in his study by including variables such as the mass of the packaging and recycling rates, along with energy data. Keoleian and Spitzley (1999) also introduced time series analysis to determine whether there were significant changes in the data among recycling weights and recycled material value. This enhances the base of knowledge to be used in a comprehensive external cost LCA.

Recently, a comprehensive LCA has been conducted on alternative milk packaging which addresses many of the external costs associated with the entire process. The study conducted by Franklin Associates (2008) covers the amount of energy used (including fuel type), atmospheric emissions with emphasis on greenhouse gases, waterborne emissions, and postconsumer solid waste. This is the most extensive study to date and is the primary source of information for the data used in the current work. However, Franklin Associates (2008) does not place economic cost on all of the externalities, which does not allow for the determination of which milk packaging possesses the lowest external cost. A summary of the key findings from the Franklin Associates (2008) LCA is presented in Table 1.

Table 1. Summary of Franklin and Associates (2008) LCA Study

Energy Requirements	*Glass*	25% of total energy is due to transportation.
	Plastic	Net energy with recycling is significantly less from paperboard.
	Paperboard	Total energy without recycling is not significant significantly different from plastic.
Greenhouse Gas Emissions	*Glass*	Produces the most carbon dioxide equivalents.
	Plastic	Produces the least carbon dioxide equivalents.
	Paperboard	Produces the middle amount of carbon dioxide equivalents.
Postconsumer Waste	*Glass*	Weight of solid waste is 3 times higher than other other containers.
	Plastic	Weighs the least of all the containers and includes a 29% recyling rate.
	Paperboard	In the middle of the weight and volume postconsumer waste amount.

Methods and Data

The data used within this assessment of external costs is derived from a LCA of each milk packaging option. Estimates of external costs associated with energy requirements (including transportation), emissions, and post-consumer waste are included. The Franklin Associates (2008) study serves as the primary source of data because it is both the most recent and the most comprehensive. The values contained therein fall within the range of estimates presented in the other studies mentioned in the previous section. Social and economic costs are applied to the externalities that the life cycle of each milk packaging type imposes. A sensitivity analysis is performed to determine the effects of variation among consumer return rates and bottle reuse rates. The sensitivity analysis allows for determining the option with the lowest overall social cost among milk packaging alternatives under different glass bottle return and reuse rate scenarios.

The Life Cycle Assessment includes three different milk packaging methods: glass bottles, paperboard gable top containers, and high-density polyethylene (HDPE) plastic jugs. These three packaging methods are the most commonly purchased among consumers and can all be made to hold up to one-half gallon of milk. In 2005, the most recent report of packaged fluid milk sales in

federal milk order markets found that the market share for plastic was 85 percent, paper at less than 15 percent, and glass at less than 0.5 percent (AMS 2005).

Several variables were included in quantifying external cost. First, the production of container materials and the manufacturing process of the containers from the component materials require the use of energy and specific materials that may have adverse effects on the environment. Second, transportation of package to the filling destination and from the filling to the retail area is important to consider in external cost because vehicles release harmful atmospheric emissions. Finally, postconsumer disposal, as well as reuse and recycling of the container systems, are included in external cost calculations because they add to the space of a landfill or decrease the amount of trash that is being created.

It is also assumed that the ink production and printing process of any labels are the same across all production methods. Furthermore, current recycling rates were used in the calculations for the glass and HDPE plastic milk bottles but not for the gable top containers, as they are not easily recycled. In addition, the reuse rate of glass milk bottles is also based off of current market data and is incorporated into the life cycle process of the container outside of the actual recycling rate. It should be noted that by separating recycling and the reuse of the glass bottles, a better quantification of the cost of production of new glass bottles can be obtained (Franklin Associates 2008).

Throughout the analysis, some assumptions were incorporated in the original studies that must be taken into account. First, the reuse rate for the glass bottle was eight trips while the gabletop and the high density plastic containers had a single use. Second, in order to have a significant number for comparison, the data is based on a 10,000 half-gallon container production model. In other words, the total external cost of the various containers is based on producing enough containers for 10,000 uses. In this case, the 10,000 uses of the returnable glass bottle would only constitute a total production of 1,250 bottles instead of the full 10,000 containers. Finally, the returnable glass milk bottle has an assumed return rate of 100% with a 1% breakage rate.

Table 2 illustrates the range of energy used during the life cycle of each type of milk packaging. Due to the variability among the previous studies, this table represents the range of energy usage throughout the life cycles across the different studies. It is noted that the returnable glass has the lowest amount of energy usage and the paperboard gabletop container has the highest amount of usage. To clarify, energy usage consists of the production of the container, the filling process, and all transportation involved in the process. Franklin Associates (2008) reported energy use in million BTU (MM BTU), which we have converted to kilowatt hours (kWh) due to energy costs being available for that measure.

Table 2. Energy Use Total

Package Type	**Range of Reported Life Cycle Energy Use (kWh/10,000 containers)**		
	Low End	**High End**	**Franklin Associates, 2008 Study**
Returnable Glass	4,700	9,400	9,385.56
High Density Plastic	4,000	12,000	11,731.94
Paperboard Gabletop	9,700	13,200	12,553.06

Table 3 shows the level of atmospheric emissions in carbon dioxide equivalents for each container alternative. Atmospheric emissions refer to multiple particulates in which Franklin and Associates (2008) provides an itemized list. All atmospheric emissions were converted to carbon dioxide equivalents to provide an increased level of consistency across production processes. Additionally, there exists "markets" for carbon, aiding in the defense of placing a cost on the emissions.

Table 3. Greenhouse Gas Emissions

Package Type	Emissions (lbs CO2 equivalent per 10,000 containers)
Returnable Glass	5,398
High Density Plastic	3,336
Paperboard Gabletop	4,411

Source. (Franklin Associates 2008)

Table 4 presents a compilation of data on postconsumer waste, which includes disposal of all materials that are not part of recycling in the life cycle analysis and eventual disposal of all packaging. In Table 4, we provide a list of the volumes that the containers would occupy in a landfill as well as the weight of the postconsumer waste. It can be seen that glass occupies the least amount of space while plastic occupies the greatest. It is interesting to note that despite glass occupying the least amount of space in a landfill, its weight contributes significantly to the cost of disposal. Finally, Table 4 provides the private costs to the producer for each type of milk packaging, assuming that they have the appropriate equipment.

Table 4. Postconsumer Waste

Package Type	Cubic Feet per 10,000 containers	Pounds per 10,000 containers
Returnable Glass	42.2	3,733
High Density Plastic	58.0	763
Paperboard Gabletop	46.5	1,248

Source. (Franklin Associates 2008)

Table 5. Private Cost of Milk Packaging per 10,000 Containers

Package Type	Container	Handle	Cap/Overwrap	Total (1978 dollars)	Total (2012 dollars)
Returnable Glass	$918.80	$144.40	$83.40	$1,146.70	$3,382.46
High Density Plastic	$900.00	N/A	$76.00	$976.00	$2,878.94
Paperboard Gabletop	$842.50	$93.40	N/A	$935.90	$2,760.66

Source. (Fischer and Hammond 1978)

In order to obtain measures of external costs, the values presented in Tables 2-4 are multiplied by their respective costs and then summed to arrive at a total. For energy use, the 2012 average energy price provided by the U.S. Energy Information Administration of $0.11 per kWh was used. To quantify the cost of postconsumer waste, the estimation from Huhtala (1996) was used as it takes into account the process and weights associated with postconsumer waste.

The economic value used to quantify the carbon emissions in this analysis is derived from Tol (2005) as it has been cited regularly throughout the existing literature. Tol (2005) combines

social cost ranges for carbon from a multitude of other studies and creates a distribution in which a mean cost is computed. This mean cost of $25.30 per tonne of carbon is then applied to the carbon estimates of the current work to quantify the greenhouse gas emission external cost. Recent literature in carbon social cost valuation has shown a wide range of values based off of different assumptions with discount rates, risk aversion, and global temperature changes (Roe and Baker 2007; Ackerman and Stanton 2012; Anthoff and Tol 2013; Kousky et al. 2011; Howarth et al. 2014). The social value of carbon is still heavily debated due to the uncertainty of society's willingness to tolerate potentially catastrophic environmental risks (Howarth et al., 2014). The Tol (2005) estimate reflects a relatively high level of risk aversion and a mid-range time horizon of damages, which places it in the middle of the range of estimated values.

The three packaging options are then compared for their resulting external costs and social costs. Because the relative costs largely depend on the return rate and reuse rate for the glass packaging, we conduct a sensitivity analysis for those two variables. A sensitivity analysis provides the range of these rates for which glass packaging for liquid milk might be preferred from an environmental standpoint. The sensitivity analysis is conducted by calculating the external costs and social costs for the glass milk packaging under varying reuse and return rates. These resulting values are then compared to the external and social costs of the high density plastic and paperboard gabletop packaging options.

Results

The initial calculations of external cost and social cost for each milk packaging type are presented in Table 6 and Table 7, respectively. The values in these tables represent an assumed glass bottle return rate of 100% and 8 reuses, with a 1% breakage rate. Under these conditions the glass bottle represents the lowest external cost of the three options; therefore, it possesses the lowest environmental impact. However, this does not imply that the glass bottled packaging of milk is preferred.

Table 6. External Cost of Milk Packaging per 10,000 Containers

Package Type	Returnable Glass	High Density Plastic	Paperboard Gabletop
Total Energy Costs	$ 1,032.41	$ 1,290.51	$ 1,380.84
Atmospheric Emissions Cost	$ 61.99	$ 38.20	$ 50.60
Postconsumer Waste Cost	$ 186.65	$ 38.15	$ 62.40
Total External Cost (2008 Dollars)	$ 1,281.05	$ 1,366.86	$ 1,493.84
Adjusted 2012 Dollars Total	$ 1,329.96	$ 1,419.04	$ 1,550.86

The total social cost for each packaging option is calculated by summing the external cost and the private cost borne by the producer. The private cost represents the cost of all resources used in production, at a rate that purchases them away from their next highest valued use in society. This is the value that society places on the tangible aspects – traded in a market – of the packaging, whereas the external cost is an estimate of the societal value of aspects of the packaging not traded in a market. Table 7 presents the social cost comparisons of the three packaging options under the same assumptions mentioned above. While the glass bottled option represented the lowest environmental cost, it represents the highest social cost. The private cost

of production is sufficiently high so as to make it the least preferred option from a social valuation standpoint. We also find that, under this scenario, the high density plastic packaging has the lowest social cost.

Table 7. Overall Social Cost of Alternative Milk Packaging per 10,000 Containers in 2012 USD

Package Type	Returnable Glass	High Density Plastic	Paperboard Gabletop
External Cost	$ 1,329.96	$ 1,419.04	$ 1,550.86
Private Cost	$ 3,382.46	$ 2,878.94	$ 2,760.66
Total Social Cost	$ 4,712.42	$ 4,297.99	$ 4,311.52

In the above results we have assumed a 100% customer return rate for glass bottles and an average of eight uses per bottle. The results are potentially sensitive to those assumptions, so we investigate the degree to which the results hold as those parameters vary. Tables 8 and 9 (see Appendix) demonstrate the sensitivity of the above results to varying combinations of return and reuse rates.

The sensitivity analysis for our external cost results are presented in Table 8. The values in the table are the estimated external costs for various return rates and number of reuses. The shaded area of the table represents the combinations that yield a lower external cost for glass bottles as compared to the alternatives. If the typical bottle is reused eight times then a consumer return rate of 95% is necessary for the glass bottle to have the lowest external cost. However, if the number of reuses increases to 10 then the necessary return rate drops to 75%. This suggests that increasing the ability of the bottle to withstand multiple cleanings, fills, and transports ultimately increases the degree to which the glass bottle is the more environmentally friendly packaging option for milk.

In Table 9 we have provided the sensitivity analysis for the total social costs of returnable glass bottles. Again, the shaded portion of the table represents the conditions under which the glass bottle represents a lower cost than the alternative packaging options. It is worth noting that, in this case, the glass bottle must be reused 12 times – a 50% increase over today's standard – with a 100% consumer return rate in order for the glass packaging to be preferred.

Discussion

In this research we have evaluated the conditions under which glass bottles for fluid milk packaging can be considered preferred over its alternatives in terms of its environmental impact and total cost to society. Results from a comprehensive life cycle assessment were used to value the environmental costs associated with high density plastic, paperboard gabletop, and glass milk packaging options. A sensitivity analysis was conducted in order to identify the reuse and return rates necessary for glass milk packaging to be preferred.

After reviewing the results of our analysis, we find that the high density plastic milk container has the lowest social cost among the alternatives. However, the glass bottle represented the lowest external cost, which is why they may be perceived to be more environmentally friendly by some consumers. An increase in the reuse and return rates can increase the likelihood that the

glass packaging competes with the high density plastic in terms of its social cost. Efforts to educate the consumer about the importance of returning the glass packaging, as well as research aimed at increasing the number of times that a bottle may be reused, could have a significant impact on which packaging type is socially preferable. When the costs are brought to a unit by unit measurement, it was found that a consumer would need to pay an extra $0.04 to $0.19 per container use above the price of milk in a plastic container to compensate the producer for the added cost of producing milk in a returnable glass bottle. This extra cost is significant because future research should focus on consumer willingness to pay for glass bottled milk within regional areas, as well as producer willingness to switch milk packaging. This will help to determine if local dairies would be able to successfully implement a glass bottled milk operation.

This study adds to the existing literature on the environmental impacts of milk packaging alternatives. The previous literature on the subject took into account various parts of the production process but failed to create an environmental economic focused LCA that encompassed the entire production and distribution process. Also, this study accounts for the external and social cost involved with each alternative so that comparisons between the three alternatives are consistent. The results of this study can be used by producers and consumers who have a desire to make an environmentally conscious choice on milk packaging alternatives.

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Appendix

Table 8. Sensitivity Analysis of External Cost of Returnable Glass Bottles

Return Rates / Number of Reuses	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
7	3732.27	3317.57	2985.81	2714.38	2488.18	2296.78	2132.72	1990.54	1866.13	1756.36	1658.78	1571.48	1492.91
8	3265.74	2902.88	2612.59	2375.08	2177.16	2009.68	1866.13	1741.72	1632.87	1536.82	1451.44	1375.05	1306.29
9	2902.88	2580.33	2322.30	2111.18	1935.25	1786.38	1658.79	1548.20	1451.44	1366.06	1290.17	1222.26	1161.15
10	2612.59	2322.30	2090.07	1900.06	1741.73	1607.75	1492.91	1393.38	1306.29	1229.45	1161.15	1100.04	1045.03
11	2375.08	2111.18	1900.06	1727.33	1583.39	1461.59	1357.19	1266.71	1187.54	1117.68	1055.59	1000.03	950.03
12	2177.16	1935.25	1741.73	1583.39	1451.44	1339.79	1244.09	1161.15	1088.58	1024.54	967.63	916.70	870.86
13	2009.68	1786.39	1607.75	1461.59	1339.79	1236.73	1148.39	1071.83	1004.84	945.73	893.19	846.18	803.87
14	1866.14	1658.79	1492.91	1357.19	1244.09	1148.39	1066.36	995.27	933.07	878.18	829.39	785.74	746.45
15	1741.73	1548.20	1393.38	1266.71	1161.15	1071.83	995.27	928.92	870.86	819.64	774.10	733.36	696.69
16	1632.87	1451.44	1306.29	1187.54	1088.58	1004.84	933.07	870.86	816.43	768.41	725.72	687.52	653.15
17	1536.82	1366.06	1229.45	1117.69	1024.54	945.73	878.18	819.64	768.41	723.21	683.03	647.08	614.73
18	1451.44	1290.17	1161.15	1055.59	967.63	893.19	829.39	774.10	725.72	683.03	645.08	611.13	580.58
19	1375.05	1222.26	1100.04	1000.03	916.70	846.18	785.74	733.36	687.52	647.08	611.13	578.97	550.02
20	1306.29	1161.15	1045.04	950.03	870.86	803.87	746.45	696.69	653.15	614.73	580.58	550.02	522.52

Note. *Highlighted portion represents the combinations at which returnable glass has the lowest external cost.

Table 9. Sensitivity Analysis of Social Cost of Returnable Glass Bottles

Return Rates											
	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Number of Reuses											
7	6368.28	6096.84	5870.64	5679.24	5515.19	5373.00	5248.59	5138.82	5041.25	4953.94	4875.37
8	5995.05	5757.54	5559.62	5392.14	5248.60	5124.19	5015.33	4919.28	4833.90	4757.51	4688.75
9	5704.76	5493.64	5317.71	5168.85	5041.25	4930.66	4833.90	4748.52	4672.63	4604.72	4543.61
10	5472.53	5282.53	5124.19	4990.21	4875.37	4775.84	4688.76	4611.91	4543.61	4482.50	4427.50
11	5282.53	5109.79	4965.85	4844.05	4739.65	4649.17	4570.00	4500.15	4438.05	4382.50	4332.49
12	5124.19	4965.85	4833.90	4722.25	4626.55	4543.61	4471.04	4407.01	4350.09	4299.16	4253.32
13	4990.21	4844.05	4722.25	4619.19	4530.85	4454.29	4387.30	4328.19	4275.65	4228.64	4186.33
14	4875.37	4739.65	4626.55	4530.85	4448.82	4377.73	4315.53	4260.64	4211.85	4168.20	4128.92
15	4775.84	4649.17	4543.61	4454.29	4377.73	4311.38	4253.32	4202.10	4156.56	4115.82	4079.15
16	4688.76	4570.00	4471.04	4387.30	4315.53	4253.32	4198.90	4150.87	4108.18	4069.98	4035.61
17	4611.92	4500.15	4407.01	4328.20	4260.64	4202.10	4150.87	4105.67	4065.49	4029.54	3997.19
18	4543.61	4438.05	4350.09	4275.65	4211.85	4156.56	4108.18	4065.49	4027.55	3993.59	3963.04
19	4482.50	4382.50	4299.16	4228.64	4168.20	4115.82	4069.99	4029.54	3993.59	3961.43	3932.48
20	4427.50	4332.49	4253.32	4186.34	4128.92	4079.15	4035.61	3997.19	3963.04	3932.48	3904.98

Note. *Highlighted portion represents the combinations at which returnable glass has the lowest social cost.

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What Factors Do Retailers Value When Purchasing Fruits? Perceptions of Produce Industry Professionals

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Abstract

The goals of this study were to identify the retail-purchasing factors deemed most and least important by grower/packer/shippers (GPS) and retailers when purchasing fruits (melons, pears, peaches/nectarines, tomatoes, strawberries, and blueberries), and to identify factors rated significantly different by these two groups. A major survey revealed that both groups agreed that fruits being free of defects and of appropriate firmness were among the most important factors for retailers, and also that aroma was among the least important factors. Points of departure between GPS and retailer self-assessments occurred with GPS rating price and size of fruit as more important than retailers, and GPS rating essential quality characteristics as less important than retailers. Given the link between high-quality, flavorful fruits and increased consumer consumption of fruit, industry professionals will benefit from increased research as well as expanded dialogue to bridge the gap between perception and reality.

Keywords: interviews, fruit quality, retail, growers

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Introduction

Supplying consumers with high-quality, flavorful fruit they enjoy eating and want to purchase again is an important factor for increasing fruit sales (Kader 2008; Mitcham 2010). It is also a multifaceted process beginning with variety selection and ending with consumer consumption. Maintaining fruit quality from farm to table means using best management practices that help ensure a quality fruit product is properly grown, picked, packed, distributed, displayed, and then stored by shoppers until consumption. Key issues related to fruit flavor and quality include harvest timing, packaging technology, modified atmosphere packaging, and cold chain management (Brecht et al., 2003; Toivonen, 2007). Quality assurance throughout the supply chain is critical to delivering consistently high-quality fruits to supermarkets (Kader 2001). Other than the time required for ripening climacteric fruits, during which potential quality is realized, the longer the period of time between harvest and consumption, the greater the reduction in fruit quality (Kader 2008).

Assessing fruit quality is complex and takes into account factors that are both intrinsic (i.e., appearance, flavor, color, shape, size, structure) and extrinsic (i.e., price, brand name, store, nutrition) (Ophuis and Van Trijp 1995). Kader (2000) categorized the major quality components of fruits as: appearance, texture, flavor, and nutritional quality. Baldwin et al. (2000) further broke down the perception of fruit flavor to include not only how the taste receptors on the tongue perceive flavor (i.e., sweet, sour, salty, bitter), but also the effects that aroma and texture and even temperature have on flavor perception. Shewfelt (1999) asserted that typically, quality has been seen as either product oriented (i.e., based on the accuracy of measurable attributes of a fruit) or consumer oriented (i.e., based on perceptions of consumer behavior and predicting product performance).

Although there has been considerable research conducted on the purchasing factors that are important for consumers (Crisosto, Crisosto, and Bowerman 2003; Gallardo, Kupferman, and Colonna 2011; Gilbert et al. 2014; Harker, Gunson, and Jaeger 2003) very little research has been conducted on the factors *retailers* use when purchasing fruit. One of the few relevant studies, conducted in Taiwan, concluded that retailers considered "procurement price, product quality, product consistency, and food safety" to be the most important factors when selecting produce suppliers (Lin and Wu 2011:1237). Similarly, an analysis of Malaysian retailers revealed that the most important factors retailers consider when selecting produce suppliers are produce quality, produce appearance, ability to consistently supply produce, and supplier competitiveness (Nawi and Mohamed 2013). Parker et al. (2006) also concluded that price and quality are the most important retail-purchasing factors and asserted that personal relationships are especially important between produce retailers and suppliers because of the inherent complexity and volatility of this market segment. Although these studies addressed the larger purchasing factors that non-U.S. retailers use when buying fruits, they did not examine the specific quality characteristics retailers consider when buying fruits.

Given the relative scarcity of research on factors related to retail-purchasing practices and quality considerations in the produce industry, this study fills a hole in the current research literature. Using quantitative data from a major survey of industry stakeholders in the United States, this research examines how grower/packer/shippers (GPS) perceive retail-purchasing practices and

how retailers perceive their own buying practices related to fruits. This research was the result of a United States Department of Agriculture, National Institute of Food and Agriculture funded partnership between the University of California, Davis and the University of Florida: ‘‘Increasing Consumption of Specialty Crops by Enhancing their Quality and Safety.’’ The larger project focused on removing the barriers to using postharvest handling methods that ensure consistently great-tasting fruits and vegetables are marketed, and increasing consumer consumption of fruits and vegetables.

The overall objective of this study was to compare the perspectives of grower/packer/shippers and retailers on what factors shape the fruit-purchasing practices of US-based retailers. The fruits included in this study were melons, pears, peaches/nectarines, tomatoes, strawberries, and blueberries. The primary research questions were:

1. Across all fruits, what retail-purchasing factors were perceived as most and least important by GPS and retailers?
2. How did GPS and retailer assessments differ when rating the importance of retail-purchasing factors?

Methods

The project team members, including horticulturists, post-harvest technologists, agricultural economists, food and food safety scientists, and social scientists, worked in collaboration with produce industry representatives to develop two stakeholder surveys, one tailored to fruit grower/packer/shippers and the other tailored to retailers. Many of the survey questions were refined versions of open-ended interview questions administered to produce industry experts and key decision makers (See Diehl et al. 2013). The interview questions, along with the resulting analysis of responses, provided the foundation for generating closed-ended questions, which were scaled to allow for the quantitative analysis of responses. The draft surveys were created based on interview responses and team analysis, and then piloted and refined based on industry feedback. The final versions of the survey were designed to collect demographic information and company characteristics; attitudes toward delivering riper fruits to supermarkets; barriers to delivering riper fruits to supermarkets; supply chain challenges; current postharvest handling practices; consumer-buying factors; retail-purchasing factors; factors related to grower selection of varieties; importance of postharvest handling practices; and industry training needs related to fruit harvesting and handling.

The survey distribution strategy focused on industry associations as the means through which industry representatives could be contacted. An analysis was conducted to determine all of the top states of production for each of the fruits being addressed (melons, pears, peaches/nectarines, tomatoes, strawberries, and blueberries), and state, regional, and national organizations and associations were then identified based on existing industry contacts and a systematic Internet search. In sum, thirty-two organizations agreed to participate in the mixed-mode survey distribution process. The distribution protocol for the mail survey involved three contacts, the initial mailing of the survey, a reminder postcard, and a final mailing of the survey. The distribution protocol for the Internet survey also involved three contacts, an initial e-mail with a survey link, a reminder e-mail with a survey link, and a final e-mail with the survey link.

Three-thousand, six-hundred and sixty-four individuals (fruit growers, packers, shippers, and retailers) were contacted via e-mail or mail, and 557 surveys were completed for a response rate of 15.2%.

Table 1 summarizes the demographic information regarding respondents, with 534 respondents represented in this dataset, based on having answered the relevant questions for this study. Of these respondents, 175 identified themselves as growers and 298 identified themselves as grower/packer/shippers. These groups were collapsed into a single category of GPS for the purpose of these analyses (n = 473) and were compared to retailers (n = 61). For the GPS category, respondents identified growing the following fruits, with many growing more than one fruit type: melons (n = 94), pears (n = 81), peaches/nectarines (n = 87), tomatoes (n = 89), strawberries (n = 170), and blueberries (n = 170). For the data presented in this study, GPS were asked to provide ratings only for the fruits they grow.

Table 1. Demographic characteristics of sample

	N	**%**		
Gender				
Male	446	84.8		
Female	80	15.2		
Ethnicity				
Caucasian	489	92.8		
Hispanic/Latino	16	3.0		
Other	22	4.2		
Education				
HS Degree or Less	49	9.3		
Some College, No Degree	89	16.8		
Associate's Degree	47	8.9		
Bachelor's Degree	248	46.9		
Graduate or Professional Degree	96	18.1		
Industry Role				
GPS	473	88.6		
Retailer	61	11.4		
	Mean	**SD**	**Minimum**	**Maximum**
Age (years)	52.9	11.60	22	86
Industry Experience (years)	24.8	13.98	<1	63

The current study focuses on the perspectives of GPS and retailers on retail-purchasing practices for the fruits included in the study—melons, pears, peaches/nectarines, tomatoes, strawberries, and blueberries. The main variables of interest were GPS assessments of the importance of retail-purchasing factors ("When RETAILERS buy [x fruit] from suppliers, how important are the following factors?") and retailer self-assessments of the importance of retail-purchasing factors ("When YOUR COMPANY buys [x fruit] from suppliers, how important are the following factors?"). In both cases, the factors were: color, defects, firmness, size, price, shelf life, aroma, brix, supplier reputation, flavor, shrinkage, and resist damage. Both questions were rated on a 10-point Likert scale with only the endpoints labeled (with 1 being not at all important and 10 being extremely important).

For the first research question, simple mean scores were calculated for all fruit-purchasing factors for both grower/packer/shippers and for retailers. These means were arrayed from most important to least important to facilitate the identification of factors deemed to be especially important or unimportant. For the second research question, means scores were calculated for each group and for each fruit-purchasing factor. One-way between groups analysis of variance (ANOVA) was used to test whether there were statistically significant differences between grower/packer/shippers and retailers on each of the fruit-purchasing factors. While there is strong debate in the literature about whether it is appropriate to treat Likert items as continuous variables (Jamieson 2004; Norman, 2010), the use of more scale points (in this case, 10 points on the Likert scale), increases the ability to analyze the variable with statistics designed for continuous variables (Leung 2011). Further, Norman (2010), in a review and analysis of the relevant literature concludes that parametric statistics are "robust" in the face of violations of statistical assumptions (p. 625) and that "parametric statistics can be used with Likert data, with small sample sizes, with unequal variances, and with non-normal distributions, with no fear of 'coming to the wrong conclusion'" (p. 631).

Results

The first research question was: *Across all fruits, what retail-purchasing factors are perceived as most and least important by grower/packer/shippers (GPS) and most and least important by retailers?* To answer this question, mean ratings of importance were calculated for GPS and retailers on each retail-purchasing factor and each fruit; these means were then combined into an overall average across all fruits for each respondent group and this was used to determine the overall rank of each factor (See Table 2). It is important to note again that the ratings presented here compare retail self-assessments of the importance of purchasing factors with GPS perceptions of how important each of these factors is to retailers (not GPS self-assessments of how important these factors are to them).

When assessing retail-purchasing practices, GPS believe the following factors are the *most* important to retailers (in descending order): Free from defects (M = 8.98); Price (M = 8.93); Size (M = 8.43); and Firmness (M = 8.38). GPS believe that the following factors are *least* important to retailers: Shrinkage (M = 7.78); Flavor (M = 7.40); Brix (% soluble solids content) (M = 6.82); and Aroma (M = 6.35).

When self-assessing their own buying practices, retailers rated the following factors as *most* important (in descending order): Free from defects (M = 8.95); Color (M = 8.60). Supplier reputation (M = 8.53); and Firmness (M = 8.45); Retailers reported that the following were the *least* important factors: Brix (M = 7.93); Resistance to handling damage (M = 7.90); Shrinkage (M = 7.83); and Aroma (M = 7.18).

Table 2. Mean ratings, average ratings, and overall rank of retail-purchasing practices across fruits as perceived by GPS and retailers pertaining to buying-factors.

GPS / Retailer Category	Melons	Pears	Peaches	Tomatoes	Straw-berries	Blue-berries	Average	Rank
Color	8.0 / 8.2	7.4 / 7.9	8.5 / 8.7	8.9 / 9.0	8.6 / 9.1	8.2 / 8.7	8.27 / 8.60	5 / 2
Defects	8.9 / 8.9	8.7 / 8.7	8.8 / 8.9	9.1 / 8.9	9.3 / 9.3	9.1 / 9.0	8.98 / 8.95	1 / 1
Firmness	8.4 / 8.4	8.2 / 8.0	8.1 / 8.2	8.7 / 8.7	8.5 / 8.9	8.4 / 8.5	8.38 / 8.45	4 / 4
Size	8.7 / 8.3	8.1 / 8.1	8.8 / 8.3	8.7 / 8.3	8.3 / 8.1	8.0 / 8.0	8.43 / 8.18	3 / 6
Price	9.2 / 8.0	8.6 / 8.0	9.1 / 7.9	9.0 / 8.0	8.6 / 8.2	9.1 / 8.3	8.93 / 8.07	2 / 7
Shelf life	8.2 / 8.2	8.0 / 7.6	7.8 / 7.7	8.5 / 8.0	8.5 / 8.3	8.6 / 8.2	8.27 / 8.00	6 / 8
Aroma	6.3 / 7.3	5.6 / 6.9	6.0 / 7.4	6.5 / 7.0	7.4 / 7.5	6.3 / 7.0	6.35 / 7.18	12 / 12
Brix	7.8 / 8.3	6.2 / 7.9	7.1 / 8.2	6.3 / 6.7	7.0 / 8.5	6.5 / 8.0	6.82 / 7.93	11 / 9
Supplier Reputation	7.7 / 8.5	8.3 / 8.3	8.3 / 8.6	7.9 / 8.2	8.5 / 9.0	8.6 / 8.6	8.22 / 8.53	7 / 3
Flavor	7.8 / 8.6	6.9 / 8.2	7.1 / 8.5	7.2 / 8.2	7.8 / 8.6	7.6 / 8.3	7.40 / 8.40	10 / 5
Shrinkage	7.6 / 8.0	8.0 / 7.4	7.3 / 7.6	7.9 / 7.9	8.0 / 8.0	7.9 / 8.1	7.78 / 7.83	9 / 11
Resist Damage	7.9 / 7.7	7.6 / 7.5	7.5 / 8.0	8.2 / 8.0	8.3 / 7.9	8.0 / 8.0	7.92 / 7.90	8 / 10

The second research question was: *How do GPS and retailer assessments differ when rating the importance of retail-purchasing factors?* To address this question, ANOVA was used to determine significant differences between GPS and retailers on the ratings of importance for all fruits included in the study. Several patterns of findings emerged from this analysis (Table 3). GPS consistently perceived that the following factors were *less* important for retailers than retailers reported for themselves: aroma, flavor, and brix. GPS also consistently reported that price was *more* important to retailers than retailers reported for themselves. The following sections present the specific statistical tests, organized around these major areas of findings.

Table 3. Significant differences between GPS and retailer perceptions on retail-purchasing factors, based on between-groups ANOVA analysis.

Category	Melons	Pears	Peaches	Tomatoes	Strawberries	Blueberries
Color	-	-	-	-	-	-
Free of Defects	-	-	-	-	-	-
Firmness	-	-	-	-	-	-
Size	-		GPS> Retail	-	-	-
Aroma	Retail>GPS*	Retail>GPS**	Retail>GPS**	-	-	-
Brix	-	Retail>GPS*	Retail>GPS*	-	Retail>GPS*	Retail>GPS*
Flavor	Retail>GPS*	Retail>GPS***	Retail>GPS***	Retail>GPS*	Retail>GPS*	Retail>GPS*
Shrinkage	-	-	-	-	-	-
Shelf life	-	-	-	-	-	-
Resistance to handling damage	-	-	-	-	-	-
Price	Retail>GPS***	Retail>GPS*	Retail>GPS***	Retail>GPS**	-	Retail>GPS***
Supplier Reputation	Retail>GPS*	-	-	-	-	-

Note: Results are presented only for statistically significant differences for each fruit and each factor, and are arranged to show which group rated the buying factor higher.
*< .05, ** < .01, *** < .001

Aroma

Retailers consistently rated the importance of aroma as a retail-purchasing factor higher than the GPS assessments of retailers. This pattern was true for all fruits, with statistically significant differences for melons, pears, and peaches/nectarines (Table 4). This result may seem perplexing since, as seen in the first research question above, aroma was rated as the least important retail-purchasing factor by both GPS and retailers; however, the comparison of means reveals that GPS rated this factor even lower on the 1-10 scale than did retailers.

Table 4. Means, standard deviations, and statistical tests for between-groups ANOVA based on GPS and retailer assessments of the importance of the retail-purchasing factor 'aroma'.

	GPS Perception of Retailers		Retail Perception of Selves		
Fruit	**M**	**SD**	**M**	**SD**	**Statistic**
*Melons	6.3	2.54	7.3	1.76	F (1,131) = 5.24 p = .024
**Pears	5.6	2.55	6.9	2.11	F (1,116) = 8.72 p = .004
**Peaches/Nectarines	6.0	2.29	7.4	2.03	F (1,117) = 10.53 p = .002
Tomatoes	6.5	2.51	7.0	1.99	F (1,117) = .89 p = .348
Strawberries	7.4	2.13	7.5	1.89	F (1,188) = .12 p = .732
Blueberries	6.3	2.35	7.0	2.20	F (1,183) = 2.90 p = .090

Note: *< .05, ** < .01, *** < .001

Brix

As with aroma, when assessing retail-purchasing factors, retailers consistently rated brix as a more important retail-purchasing factor than GPS rated it as a factor for retail-purchasing decisions (Table 5). This difference was statistically significant for pears, peaches/nectarines, strawberries, and blueberries.

Table 5. Means, standard deviations, and statistical tests for between groups ANOVA based on GPS and retailer assessments of the importance of the retail-purchasing factor 'brix'.

	GPS Perception of Retailers		Retail Perception of Selves			
Fruit	**M**	**SD**	**M**	**SD**	**Statistic**	
Melons	7.8	1.86	8.3	1.48	F (1,132) = 2.38	p = .125
***Pears	6.2	2.58	7.9	1.73	F (1,114) = 15.09	p < .001
**Peaches/Nectarines	7.1	2.04	8.2	1.54	F (1,115) = 9.60	p = .002
Tomatoes	6.3	2.58	6.7	2.36	F (1,114) = .84	p = .360
***Strawberries	7.0	2.30	8.5	1.66	F (1,188) = 14.30	p < .001
***Blueberries	6.5	2.38	8.0	1.80	F (1,182) = 13.86	p < .001

Note: *< .05, ** < .01, *** < .001

Flavor

For all six fruit types, retailers rated the importance of flavor higher than GPS rated flavor as a retail-purchasing factor, with all differences being statistically significant (Table 6).

Table 6. Means, standard deviations, and statistical tests for between-groups ANOVA based on GPS and retailer assessments of the importance of the retail-purchasing factor 'flavor'.

	GPS Perception of Retailers		Retail Perception of Selves			
Fruit	**M**	**SD**	**M**	**SD**	**Statistic**	
*Melons	7.8	2.23	8.6	1.42	F (1,134) = 5.42	p = .021
**Pears	6.9	2.41	8.2	1.77	F (1,115) = 9.18	p = .003
***Peaches/Nectarines	7.1	2.52	8.5	1.53	F (1,117) = 10.70	p < .001
*Tomatoes	7.2	2.71	8.2	1.66	F (1,116) = 4.30	p = .040
*Strawberries	7.8	2.18	8.6	1.75	F (1,187) = 4.80	p = .030
*Blueberries	7.6	2.09	8.3	1.93	F (1,183) = 4.37	p = .038

Note: *< .05, ** < .01, *** < .001

Price

GPS rated price as a more important retail buying-factor for all fruits than retailers rated price. Statistical significance exists for five of the six fruits, the exception being strawberries (Table 7).

Table 7. Means, standard deviations, and statistical tests for between-groups ANOVA based on GPS and retailer assessments of the importance of the retail-purchasing factor 'price'.

	GPS Perception of Retailers		Retail Perception of Selves			
Fruit	**M**	**SD**	**M**	**SD**	**Statistic**	
***Melons	9.2	1.25	8.0	1.806	F (1,134) = 18.98	p < .001
*Pears	8.6	1.41	8.0	1.82	F (1,118) = 4.33	p = .040
***Peaches/Nectarines	9.1	1.23	7.9	1.88	F (1,116) = 17.78	p < .001
**Tomatoes	9.0	1.64	8.0	1.83	F (1,117) = 8.28	p = .005
Strawberries	8.6	1.82	8.2	1.80	F (1,188) = 1.57	p = .212
***Blueberries	9.1	1.08	8.3	1.81	F (1,183) = 13.51	p < .001

Note: *< .05, ** < .01, *** < .001

Discussion

For the first research question addressing which retail-purchasing factors are most and least important based on grower/packer/shipper assessments of retailers and retailer self-assessments (See Table 2), there was agreement on fruits being free of defects and having appropriate firmness as among the most important, and that aroma was the least important factor. However, there were also some interesting points of departure, with GPS rating price and size as more important retail-purchasing factors than retailers self-assessed, and GPS rating flavor, brix, and supplier reputation as less important than retailers self-assessed.

It is interesting that when GPS assess retail-purchasing practices, key measures of fruit quality and flavor components such as aroma, brix, and flavor are perceived to be of relatively low importance. Finally, the finding that shrinkage is a relatively unimportant factor for retailers is somewhat surprising at first glance given how much attention this issue receives in the produce industry. However, some large retailers charge suppliers for shrink which may account for this finding. The fact that retailers rate resistance to handling damage as relatively unimportant is also interesting, especially in light of the fact that being free from defects was rated as highly important.

For the second research question, addressing the significant differences between GPS and retailer assessments of retailer-purchasing practices, there were several interesting differences between the groups. In essence, GPS report that characteristics associated with flavor quality—aroma, brix, and flavor—are less important retail-purchasing factors than retailers themselves report. At the same time, GPS report that price is a more important retail-purchasing factor than retailers report. When viewed collectively, these findings represent an interesting disconnect between GPS and retailers, with GPS believing that essential quality characteristics are less important to retailers and that price is more important to retailers. While this study assesses the perception of retail-purchasing practices as reported by GPS and retailers, it does not address the extent to which retailers are actually considering these factors when purchasing fruits. It is not clear whether the perception of GPS or retailers is more accurate or whether the truth is somewhere in between.

This disconnect between GPS and retailers in terms of their perceptions has also been noted in a qualitative study of challenges in the fruit supply chain currently being conducted by the authors of this paper. When asked about retail-purchasing practices, for example, one grower/packer/shipper of melons said: “Very few retailers in the marketplace today are actually concerned enough about flavor that they take action to try to find it and have it in their stores . . . I think the overall trend is to not have riper, better tasting fruit, it’s to have cheaper fruit.” Other growers also noted that there had been a shift over time in the level of produce knowledge and experience of retail buyers, with a shift toward individuals who have less direct experience with farming and with produce. One grower/packer/shipper said:

> It has gotten out of the hands of the produce people and into the hands of corporate merchandisers and it’s more of the corporate thing. They try to apply some of the same principles they use in dried goods and groceries to produce and they just don’t work. So, those non-produce people are calling the shots and that’s the problem in my opinion.

In contrast, our interviews with retailers indicate a strong interest in fruit quality in addition to price when purchasing fruit. For example, one retailer commented, "If it's the right thing to do and it costs us something, but it makes a really big difference on sales and customer experience then it's something that's going to make a lot of sense for us." Another retailer pointed out that:

> [For] some retailers it's just about the price, but I believe wholeheartedly that when it comes to the produce department, it is quality first and price second. Now I don't say that and indicate that price doesn't matter, price does matter, but there's a relationship between quality and price. I believe our customer, my customer, comes into my store and if they can buy a bag of peaches and they go home a hundred percent of those peaches are edible and they are a good experience they are going to come back and buy more peaches.

Even though not all retailers share the same motivation when making fruit purchases, many retailers recognized that sales and repeat customer purchases are dependent upon offering consistently great-tasting fruit.

While this research provides useful information on what factors influence retail purchases of fruit, it also raises questions about the extent to which retailers value the importance of factors related to fruit quality, such as aroma, brix, and flavor. Given the perceptual disconnect between grower/packer/shippers and retailers, additional research and dialogue are needed to explore how much retailers truly value factors related to fruit quality. For fruit growers who are currently focused on producing high-quality, flavorful fruits, this dialogue may serve to connect them to retailers who are most interested in their products. For fruit growers who are not currently as focused on the flavor quality of fruits, this dialogue may suggest that they are missing a market opportunity. High-quality, flavorful fruit is a key to increasing consumer consumption and thereby sales of fruit (Kader 2008; Mitcham 2010; Diehl 2013), and our findings indicate that many retailers are receptive to increasing the emphasis they place on purchasing factors related to fruit flavor and quality. What remains to be seen is if actual fruit-purchasing behaviors of retailers are consistent with their self-assessments as presented in this study.

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Risk Perception and Trust Interaction in Response to Food Safety Events across Products and the Implications for Agribusiness Firms[1]

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Abstract

Food safety events can create devastating economics losses for agribusiness firms. The objective of this study is to identify the factors that influence potential purchasing decisions for fresh produce and meat products. The SPARTA model, based on the Theory of Planned Behavior, is used to determine the impact of probable factors that influence consumers' purchasing decisions. The data for this research was obtained from two surveys: fresh produce and meat products. The results suggest a food safety event in fresh produce markets affect purchasing decisions more than the same event in meat markets. Results also suggest information consumers receive about food safety events from casual conversations with family members, friends, and colleagues can influence purchasing decisions. Agribusiness firms can use these results to form strategic responses to food safety events.

Keywords: consumer behavior, theory of planned behavior, food safety, risk and trust

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Introduction

Substantial media attention given to recent food safety events has increased consumers' awareness and further complicated the marketing aspects of agricultural products. Recently, *E. coli* outbreaks in ground beef and fresh spinach, *Salmonella*-tainted fresh tomatoes and jalapeno peppers, and *Listeria* contaminated cantaloupe have captured news headlines nationwide (CDC 2015). Prior to these concerns, Avian Influenza and Bovine Spongiform Encephalopathy (BSE) dominated media coverage. Food safety events such as these have detrimental economic impacts on agribusiness firms in these markets. Brand images can be destroyed and entire industries can be affected. As an example, Kroger Co. announced in 2012 that they would no longer sell bean sprouts nor handle products processed on the same equipment because of food safety concerns (Kroger 2012). Economic losses associated with food safety events are not limited to domestic and local markets. Rather, the effects can be long-reaching and create barriers to trade with international partners. Theoretically, food safety events can open competitive opportunities for individual firms within an affected industry. Firms can differentiate their products' attributes and market safer production methods in an attempt to capture a larger market share (Bruhn and Schutz 1999). It is unclear how long the food safety event cycle takes or what signals are most effective to persuade consumers to return to their pre-scare behavior. Recent research suggests that consumers may attribute a food safety event concerning a particular product (*i.e.* spinach) to other items within the same category (*i.e.* leafy green fresh produce) (Arnade, Kuchler, and Calvin 2011). However, it is not known if consumer response is the same across product categories and geographical regions. Strategic response plans that work in one market or product area may not be as effective in others.

This study relies on contributions from the field of psychology to determine how underlying perceptions, beliefs such as trust and risk, subjective norms, and perceived behavioral control influence potential purchasing decisions following a hypothetical food safety event. The objective of this study is to identify the factors that influence potential purchasing decisions for fresh produce and meat products. It is beneficial for agribusinesses to understand how multiple determinants influence a consumer's purchasing decisions both before and after a food safety event occurs. Understanding consumers' actions in the wake of food safety events is of paramount importance, as better understanding is the cornerstone of effective strategic responses that minimize economic losses. To the best of our knowledge, no studies in the United States (US) have used the psychology-based Theory of Planned Behavior (TPB) in determining consumer response to food safety events (Ajzen 1991).

Literature Review

Extensive literature evaluating risk and how it affects human behavior exists. Some research has been dedicated to evaluating the best approach to measuring the effects of risk attitude and risk perceptions, how these differ between measurement approaches, and how they translate to actual behavior (Pennings and Smidts 2000; Pennings, Wansink, and Muelenberg 2002). Others have applied the same concepts to understanding how risk perceptions and risk attitudes affect consumer acceptance of genetically-modified foods (Lusk and Coble 2005). Further research has focused on how much trust consumers have in food-safety information sources (Ekanem, et al 2008); how risk is conveyed to the public and its impact on potential responses (Melkonyan

2011); and evaluating food safety risk perceptions on consumption. This study adds to this body of literature that uses a cross-disciplinary approach to understand consumer behavior. The method used here accounts not only for the individual components of risk and trust as studied by others, but concerns itself with the interaction of these components while including other psychological factors.

In this study we use the *SPARTA* model, which is constructed under the TPB framework in order to determine how these psychological factors influence consumers' potential purchasing decisions. Furthermore, the results from this study are compared to results from a similar study completed by Lobb, Mazzocchi, and Traill, in the European Union conducted in France, Germany, Italy, Netherlands, and the United Kingdom (2007). As agribusinesses are becoming ever more global, it is of interest to determine how consumers in the U.S. compare to those of the other countries. Agribusinesses need to tailor strategies to the consumers' perception for different products in each region as opposed to having a blanket response to food safety events.

The reliability of hypothetical studies has been examined and a growing body of literature is emerging that analyzes how accurate hypothetical scenarios are to actual consumer behavior. There is some reassuring research that indicates that hypothetical results, while imperfect, can be a good measure of actual consumer behavior (Grebitus, Colson, and Menapace 2012). Further, meta-analysis has shown that the TPB approach is effective in predicting behavior (Armitage and Conner 2001). In a recent study concerning consumers' intention concerning a food safety recall message, the TPB showed to accurately predict behavior except for one component of the model, perceived behavioral control (Freberg 2012).

Data and Methodology

The data used to conduct this research was obtained via mail survey through the United States Postal Service. The survey instruments used were comprehensive and constructed in a manner that allows consumer behavior to be traced before and after a hypothetical food safety event occurs (Lobb, Mazzocchi, and Traill 2007). This is achieved by eliciting the respondent's intended purchasing behavior concerning the target product before, and one week following, a hypothetical food safety event. This allows us to determine what factors influence consumers' decisions to purchase items in both scenarios (before and after a food safety event). *E. coli* and *Salmonella* were the hypothetical food safety events used. The decision to use these food risks was based on recent media coverage of such events and the assumption that most consumers were aware of these food borne pathogens. Most of the questions on the survey were measured with a seven-point Likert scale. For ease of explanation, most results reported have been condensed into fewer categories.

Two surveys were mailed targeting two separate products. The first survey, referred to from this point forward as the fresh produce survey targeted *"fresh produce"* in general. The second survey, referred to as the meat survey henceforth, targeted *"chicken and/or beef."* The fresh produce was mailed to 800 individuals in Kentucky in 2006 with a response rate of 5.9% (47 respondents). The target areas were the five largest cities in Kentucky based on population. The share sent to each area was weighted by the county's population that contained each of the five cities (2003 US Census Book). These cities were, in descending order of population size, as

follows: Louisville, Lexington, Covington, Owensboro, and Bowling Green. The sample size was increased to 2,000 for the meat survey with equal shares (400 each) being sent to individuals in the five largest cities in Kentucky in 2007. In an attempt to increase the response rate for the meat survey, a $2 incentive check was offered to respondents who returned a completed survey. For each survey, a reminder card was mailed 21-28 days after the initial mailing. Since the survey was an established and previously used survey in the EU, a focus group was not developed to test it before mailing it. However, changes were made to the survey to fit the population and products targeted.

An 11.2% response rate (224 respondents) was realized. Both surveys used random mailing samples obtained from the University of Kentucky Survey Research Center. In both surveys, female response rate was about 60%, indicating that in many households, female members are still the primary food purchasers. Respondents were asked to indicate their level of education from no formal education through graduate level degree. The majority of respondents, over 50%, in each survey indicated having some college education. Income levels of respondents in both surveys showed over 50% of respondents reporting income between $15,000 and $60,000. Selected demographic variables are presented in Table 1.

Table 1. Selected Demographic Variables

	FP		Meat	
	Mean	**Std Dev**	**Mean**	**Std Dev**
Number of People in Household	2.47	1.21	2.38	1.29
Age of Respondents (years)	52.8	14.1	54.24	14.36
Average Weekly Target Product Purchase (LBS)	4.5	3.27	5.32	6.53
Average Weekly Expenditure on Target Products ($)	16.8	17.3	15.45	16.75
Number of Respondents	47		224	

SPARTA Model and TPB

The survey instrument was constructed under the SPARTA model based on the TPB (Lobb, Mazzocchi, and Trail 2007; Ajzen 1991). TPB is an extension of the Theory of Reasoned Action and links attitude and beliefs to actions through intentions (Ajzen 1991). The TPB suggests that a person's intentions are determined by behavioral beliefs, normative beliefs and control beliefs. These beliefs affect intentions which is the antecedent to actual action (Ajzen 2002). This approach has been used in several studies, including the meat market in the UK (McEachern and Shroder 2004), as well as evaluating food choices of adolescents (Dennison and Shepherd 1995), predicting safe food handling by adolescents (Mullan, Wong, and Kothe 2012), evaluating how consumers' attitudes and preferences affect food-away-from-home decisions (Bhyuan 2011), as well as, evaluating farmer's acceptance to environmental measures in the EU (Schroeder 2012). Including risk and trust, which are formulated under the expectancy-value formulation consistent with the TPB, broadens the discovery of human behavior. The expectancy value model suggests that belief based measures should correlate with a direct measure of that belief based observation (Ajzen 1991). Therefore, measuring the beliefs about a certain action as well as the perceived control over acting out that behavior, gives an indication of the actual behavior that will result when the opportunity arises. This is important as this study is hypothetical and actual behavior

cannot be measured following a food safety event with prior knowledge on intended actions. Lobb, Mazzocchi, Traill added these two additional measures (risk and trust) to the traditional TPB framework, resulting in the SPARTA model. SPARTA represents subjective norms, perceived behavioral control, attitudes, risk, trust, and *alia* (all other variables) as shown in Figure 1 (Lobb, Mazzocchi, and Trail 2007).

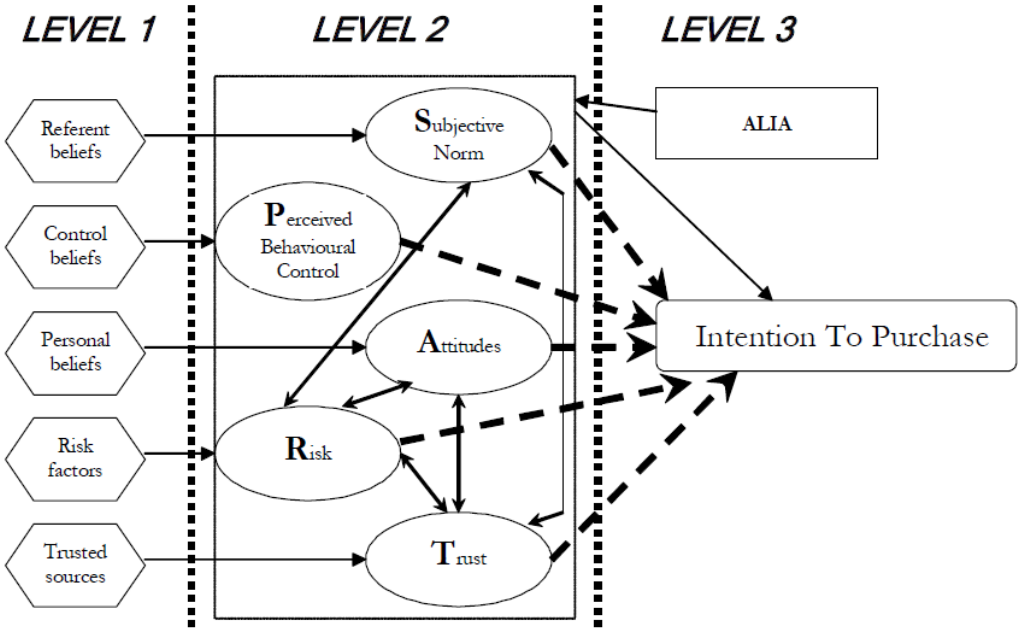

Figure 1. SPARTA Model
Source: Lobb, Mazzocchi, Traill, 2007.

Subjective norms are the peer pressures individuals feel to participate or not participate in a certain behavior. These actions are influenced by normative beliefs which are behavioral expectations a consumer may feel from referents they consider close to them such as family and friends (Ajzen 1991). These referent beliefs directly influence how individuals behave. For example, family and friends could impose opinions that purchasing organic produce will reduce food safety risks and is more ethical. Therefore, an individual may feel pressured by these referent beliefs to purchase such products for themselves. Referent beliefs differ depending on the situation (Ajzen 1991). In the workplace, referent beliefs could come from bosses or co-workers. For this study, family, friends, and colleagues are considered to be possible sources of referent beliefs. Subjective norms are hypothesized to have either a positive or negative impact on the likelihood of purchasing the target product. This is because increases in the normative belief component are consistent with consumers perceiving other opinions about the target product in their diet as being *good*. The opposite of this holds as well. Increases in motivations to comply are analogous to consumers taking others' opinions into account in their purchasing decisions to a large extent.

Perceived behavioral control is how a person sees their ability to perform a certain activity. Control beliefs are factors that make behaving in a certain manner easier or more difficult (Ajzen

1991). When considering food products there are a limited number of control beliefs to measure. For this study, two different control factors that addressed potential impediments to purchasing decisions were identified. These control factors were the consideration that a consumers' purchase decision may depend on how much of the target product the person has already consumed in the current time period or if they have a lot of the target product on hand (i.e. in the refrigerator or freezer) (Lobb, Mazzocchi, and Traill 2007). Perceived behavioral control should have a positive impact on the likelihood to purchase. An increase in this variable is consistent with consumers indicating they are "more likely" to purchase the target product if they already had some of that item on hand. Increases in the other control factor component of this variable indicate that consumers are "more likely" to purchase the target product even if the household had consumed a lot of that product during the week they completed the survey.

Attitudes are simply the perception that an individual has towards a certain activity such as it being *good* or *bad*. Attitudes are influenced by behavioral beliefs which are the expected outcomes of the behavior in question (Ajzen 1991). A person's attitude towards a certain behavior will likely be negative if the expected outcome of that behavior will have unfavorable consequences. Food safety risks may promote a negative attitude because consumers are considering the negative effects of consuming a food that is potentially risky. Attitudes are hypothesized to have a positive impact on the likelihood of purchasing the target product. If consumers have a positive attitude towards purchasing a product, their indicated purchasing decision should reflect this belief. Risk factors that are common to food safety concerns such as *Salmonella, E. coli,* etc., contribute to the risk component. Health attributes such as cholesterol and fat content are also considered risk factors because of long-term health consequences. Risk perception is hypothesized to have a negative impact on the likelihood of purchasing because increases in the risk associated with the product should deter consumption.

Trust is measured by identifying sources of information from whom consumers trust to receive food safety information. In order for agribusiness firms to effectively communicate information, it has to be conducted through trusted mediums. Increases in trust should positively affect the likelihood of purchasing the target products.

The *alia* component in this study measures demographic variables. These factors are important to analyze as they influence purchasing decisions. Poor consumers are usually concerned with maximizing caloric intake and minimizing food expenditures. When faced with a food safety event, they may not be able to substitute to other goods. Education is likely to influence a person's ability to more accurately interpret food safety information. Presence of young children may also make a household more risk averse to certain food safety concerns. All of these factors interact and influence consumers' intentions to purchase food. It is hypothesized that socio-demographic variables will have both positive and negative impacts on the likelihood of purchasing.

Model Development

The first three variables *S*, *P*, and *A* are formulated under Fishbein and Ajzens' (1976) expectancy value formulation. Following Lobb, Mazzocchi, and Traill (2007) the construction of the variables appear below:

$$(1)\quad S \propto \sum_{j=1}^{g} n_j m_j$$

where S is subjective norms and is constructed by n_j and m_j which are normative beliefs and motivations to comply, respectively. This component accounts for the "peer pressure" individuals may feel when making food purchasing decisions. Normative beliefs were obtained by asking respondents about how they perceived others' perceptions on whether or not the target product is considered "*very bad*" or "*very good*" in the diet (on a seven-point Likert scale). Motivations to comply were measured via a question that asked the respondent to indicate whether or not they take others' opinions into consideration when making food purchasing decisions about the target products.

$$(2)\quad P \propto \sum_{k=1}^{q} c_k p_k$$

P is perceived behavioral control and contains $c_{k,}$ control beliefs and p_k, power of control beliefs. Perceived behavioral control measures the individuals' perceptions concerning the amount of control they have over their decision. This element was measured by asking respondents to indicate if already having the target product in the freezer would affect their decision to purchase the product the following week. Power of control beliefs were measured by asking the respondents to indicate the likelihood of purchasing the product next week if they had already consumed a lot of that product in the week they completed the survey.

$$(3)\quad P \propto \sum_{k=1}^{q} c_k p_k$$

A is attitude and contains $b_{i,}$ behavioral beliefs and e_i, outcome evaluations of the behavioral beliefs. This component simply accounts for attitudes respondents have about certain factors that may influence their purchasing decisions. Behavioral beliefs were measured by asking the respondent to indicate how important, in general, 10 stated beliefs were about the target products to their household. These stated beliefs focused, for example, on the target product's ease of preparation, its taste in general, and whether or not they thought the target product was safe, among others. The strength of these beliefs was measured by asking the respondent to rank the three most important of the 10 beliefs when making a purchasing decision. Outcome evaluations were determined by a question later in the survey asking the respondent to indicate the importance of the 10 beliefs used to determine behavioral beliefs, in general terms, as opposed to them being tied directly to the target product. For example, "*In general, how important are each of the following to your household*." This statement was followed by a list including, "*tasty food, ease of preparation, food safety, etc*." The respondent then indicated the importance of these statements to their household on a seven-point Likert scale with (1) indicating "*extremely un-important*" and (7) indicating "*extremely important*." Attitude also had a direct measure where the respondents were asked to indicate, on a seven-point Likert scale as to whether or not purchasing the target product for their household was *good* or *bad* in general.

The risk component, R, and trust component, T, are formed similarly to the variables above *(S,P,A)* using the expectancy-value formulation (Lobb, Mazzocchi, and Traill 2007):

$$(4)\quad R \propto \sum_{l=1}^{u} r_l k_l$$

where r_l are specific risk factors and k_l are weights given by respondents stating their knowledge of each risk factor. This component accounts for how risk affects consumers purchasing decisions. Risk factors were obtained by asking the respondents to rate the risks of any one person in the household experiencing long-term health problems due to consuming the target product from a list of potential health problems, such as *E. Coli*, *Salmonella*, pesticides/antibiotics, cholesterol, etc. The weights were given by the respondents indicating their level of knowledge associated with each specific risk factor.

The trust component is as follows:

$$(5)\quad T_z = \sum_{w=1}^{s} \alpha_{zs} t_s, z = 1,..., Z$$

where t_s are the specific trust factors, α_{zs} are the loading factors, T is the principal component score, and Z is the total number of components measured across. This component of the model accounts for levels of trust consumers have towards potential information sources of hypothetical food safety events. The trust component in the meat survey was achieved by asking respondents the following question: "*Suppose that each of the following has provided information about potential risks associated with e-coli in food. Please indicate to what extent you would trust that information*." This question was followed with a table of 20 entities that hypothetically provided information about food safety risks on a seven-point Likert scale. Principal component analysis with varimax rotation was used to reduce the number of variables in this measure by accounting for correlations that may exist between these categories (Lobb, Mazzocchi, and Traill 2007). These results can be seen in Table 2. Using this statistical technique, the number of variables in this component for the meat survey was reduced into four categories: Suppliers, Government/University, Organizations, and Media; T_1, T_2, T_3, and T_4, respectively.

The Suppliers category includes shopkeepers, supermarkets, organic shops, and processors. All of these categories cover the same concept of where a consumer may obtain a food product. The Government/University category contains doctor/health authority, university scientist, USDA, state and federal government. These sub-categories are all entities that consumers would most likely consider possessing an authoritative or policy influencing voice.

Organizations contain the sub-categories of political groups, environmental groups and animal welfare organizations as well as the category of “television documentary”. On first glance, television documentary sub-category seems non-applicable. However, there is a common thread among the sub-categories in that they all have a primary focus or cause. For example, arguably, television documentaries focus on one subject or cause, allowing their inclusion into this category. Lastly, the Media category contains typical forms of communication, newspaper, internet, radio, magazines, and product labels.

Interpretation of these results is as follows. A consumer who trusts one of the sub-categories also trusts the other sub-categories within each respective group. For example, respondents who trust shopkeepers also trust supermarkets, organic shops and processors. The same is true for the case of distrust.

Principal component analysis was not conducted on the results from the fresh produce survey as the number of responses did not meet the minimal criteria for this data analysis tool. Instead a simple average of the 20 trust categories was used. Using a simple average of all trust dimensions measured puts serious limitations on this variable for the fresh produce results. The simple average does not allow for in-depth empirical analysis of how trust influences purchase decision which is one of the main focuses of this study.

(6) *Alia* = socio-demographics

Age, income, education, and gender were used as socio-demographic variables.

Following previous work by Lobb, Mazzocchi, and Traill (2007), four models were estimated for each target product; consumers' intention to purchase the target product next week in general (FP_1 and $MEAT_1$) and consumers' intention to purchase the target product next week following a hypothetical *E. coli/Salmonella* outbreak (FP_2 and $MEAT_2$). These models were also estimated using socio-demographic variables to determine if such variances have an effect on the probability of purchasing decisions (FP_{1SD}, $FP_{2SD,}$ $MEAT_{1SD}$, and $MEAT_{2SD}$, respectively). An ordered probit regression was used to estimate these models because of the ordered structure of the data and appears below (Lobb, Mazzocchi and Traill, 2007):

$$(7) \quad I_b = \beta_0 + \beta_1 S + \beta_2 P + \beta_3 A + \beta_4 R + \sum \lambda_z T_z$$

The inclusion of socio-demographic variables is as follows:

$$(8) \quad I_b = \left(\beta_0 + \sum_{i=1}^{d} \gamma_{0i} D_i\right) + \left(\beta_1 + \sum_{i=1}^{d} \gamma_{1i} D_i\right) S + \left(\beta_2 + \sum_{i=1}^{d} \gamma_{2i} D_i\right) P + \left(\beta_3 + \sum_{i=1}^{d} \gamma_{3i} D_i\right) A + \left(\beta_4 + \sum_{i=1}^{d} \gamma_{4i} D_i\right) R + \sum_{i=1}^{Z} \left(\lambda_Z + \sum_{i=1}^{d} \gamma_{gi} D_i\right) T_Z$$

Where D_i is the *i*th socio-demographic variable. Descriptive statistics for model parameters are shown in Tables 3 and 4 (see Appendix).

Table 2. Meat Survey: trust component factor loadings for respondents' trust of food safety information from 20 different potential informational sources

	Suppliers(T_1)	**Gov't/University** (T_2)	**Organizations** (T_3)	**Media** (T_4)
Shopkeepers	**0.76**	0.09	0.06	0.1
Supermarkets	**0.7**	0.23	0.1	0.06
Organic Shop	**0.74**	0.08	0.19	0.08
Farmers	**0.75**	0.11	0.16	0.09
Processors	**0.61**	0.07	0.27	0.24
Doctors/ health authority	0.18	**0.53**	-0.34	0.29
University scientists	0.22	**0.62**	0.14	0.24
USDA	0.08	**0.8**	0.18	0.05
State Government	0.17	**0.78**	0.27	0.1
Political groups	0.17	0.27	**0.63**	0.22
Environmental organizations	0.22	0.15	**0.72**	0.31
Animal welfare organizations	0.22	0.06	**0.8**	0.12
Federal Government	0.08	**0.65**	0.38	0.07
Television documentary	-0.03	0.27	**0.62**	0.21
Television news/current events[a]	0.05	-0.66	-0.05	0.21
Newspapers	0.13	0.38	0.06	**0.61**
Internet	0.12	0.19	0.2	**0.54**
Radio	0.23	0.22	0.22	**0.73**
Magazines	0.06	-0.13	0.06	**0.68**
Product label	0.04	0.12	0.2	**0.54**

Notes: [a] Television news/current events was dropped from the analysis because it loaded on more than one factor. Values in bold are greater than or equal to .40 through varimax Rotation. This statistical technique was not performed on the fresh produce survey results due to limited sample size.

Results

Regression estimates from the ordered probit model are shown in Table 5 (see Appendix). Marginal effects, shown in Table 6 (see Appendix), provide more interpretable information and are used in this section to discuss the model results.

Fresh Produce Results

The fresh produce model evaluating the likelihood of purchasing before the hypothetical food safety event with socio-demographic variables included (FP_{1SD}), resulted in the model being statistically significant at the 5% level. Marginal effects suggest that subjective norms had a negative impact on the likelihood of respondents purchasing fresh produce in general the week following the survey. This can be seen with the negative marginal effect (-0.1421) under *likely*. As subjective norms increase, the respondents' probability of purchasing the product in question shifts away from *likely* and more towards *neither* or somewhere between *neither* and *likely* (non-negative marginal effects associated with the other categories). A negative impact was also seen

with this variable when coupled with the socio-demographic variable income. Both of these results are as expected. When the level to which consumers value the opinions of others is increased, these social pressures will influence decisions made by the consumer. Higher levels of income allow consumers to be more selective in their purchasing decisions and also allow consumers to participate in purchasing trends. When the subjective norm variable was combined with socio-demographic variable, level of education, the result was positive. Intuitively, higher levels of education allow people to make more scientific decisions about food purchasing decisions and not rely on referent beliefs as much.

Perceived behavioral control coupled with socio-demographic variables, education and income had positive impacts on the likelihood to purchase. Increases in consumers' perceived behavioral control over purchasing a product should increase the likelihood of said purchase occurring. This is because this determinant is based on whether the respondent had consumed a lot of the product in the week prior to taking the survey or had a lot of the product on hand the when taking the survey. It is reasonably assumed that consumers that had recently (within seven days before taking the survey) consumed a lot of the fresh produce or had a lot on hand would not be as likely to hypothetically purchase fresh produce the following week.

Attitude with socio-demographic variable education had a negative impact. Education is likely to influence attitudes and attitudes are simply how consumers feel about consuming a product. If consuming a product is considered good, then a positive attitude will result. This result is counterintuitive as it seems rational to assume that higher education levels would positively affect attitudes. In other words, attitudes should be more scientifically influenced with increases in education. A positive increase in likelihood to purchase was realized with the attitude variable and socio-demographic variable, income. This result seems reasonable as positive increases in attitudes and income should increase the likelihood to purchase.

Average trust positively impacted the likelihood to purchase, while the inclusion of socio-demographic shifters education and income changed the impact to negative. Interestingly, education and income change the impact of trust of informational sources on potential purchasing decisions. Increases in income allow for a larger selection of substitutes and may negate the importance of trust. Further, relatively higher education levels allow for more self directed information discovery that may offset the importance of trust.

The fourth fresh produce model, FP_{2SD}, was statistically significant at the 1% level. Subjective norms with socio-demographic variable education had a negative impact. In other words, following a food safety event, consumers that are relatively more educated will likely follow further information discovery processes. More educated consumers may look further into the food safety event and determine the particulars of the event as opposed to generalizing it to all product types of the affected market. It is important to note that in the hypothetical food safety event questions, participants were asked if a food safety event would affect their purchasing decision for purchasing fresh produce the following week. The construct of the question limits the time period from which the consumer learns of the food safety event and their purchasing decision to period of seven days or less. These results show that following a food safety event, consumers with relatively higher levels of education will have a lower likelihood to purchase fresh produce.

Attitudes coupled with socio-demographic variable income, had a positive impact on the likelihood to purchase. This is consistent with what was seen in the fresh produce model that evaluated purchasing decisions in general. Risk on the other hand was positive in this model. This is of opposite effect of what was realized in FP_{1SD}. Intuitively, an increase in risk perception would result in a decreased likelihood to purchase. Risk and socio-demographic variable income in both fresh produce models had a negative impact. As risk and income increases, the likelihood to purchase decrease because higher incomes allow for more substitution. The fresh produce models of purchasing the product next week in general (FP_1) and purchasing the product following a food safety event (FP_2), were not statistically significant.

Meat Results

In the first model, $MEAT_1$, which models consumers' intentions to purchase chicken and/or beef the week following the completion of the survey, was statistically significant at the 10% level. The marginal effects indicate that subjective norms have a negative impact on the likelihood of purchasing.

In the model $MEAT_2$, which models the consumers' intentions to purchase chicken or beef the week following the completion of the survey following a hypothetical food safety event was significant at the 5% level. Trust in government/universities had a positive impact and trust in media had a negative impact. Generally, consumers trust university scientists and other authoritative entities. Trust in media is likely to be negative as media is often biased and heavily focused on sensationalized stories (Baker 1998).

The fourth model, $MEAT_{2SD}$, which includes socio-demographic variables and models consumers' intentions post a hypothetical food safety event was statistically significant at the 1% level. Subjective norms had a negative impact on the likelihood to purchase. However, when this variable was coupled with socio-demographic variables education or income or gender, the results became positive. It is likely that education, income and gender (female) over-ride the influences others have on purchasing decisions. Risk had a negative impact but coupling it with socio-demographic variables, age or income changed it to positive as well.

Trust category, suppliers, when coupled with socio-demographic variable age had a negative impact as did the trust category government/university when coupled with education. This seems counterintuitive; it seems reasonable to assume that as education increases, the trust in the educator would increase as well. Trust category media, when coupled with socio-demographic shifters age or education had a positive impact. It may be the case that relatively older consumers trust the media more than younger consumers. Further, increases in education may override the negative impacts of the media as those with higher education may be better able to decipher the bias and sensationalism. When media was coupled with the socio-demographic variable income, the impact became negative. This is most likely because higher incomes allow for more access to different media outlets and therefore can make more informed decisions. The model, $MEAT_{1SD}$, was not statistically significant.

Conclusion and Agribusiness Implications

Referent beliefs are a strong influence on consumers' purchasing decisions. Subjective norms showed a negative impact in all cases where the factor was statistically significant. The implication for agribusiness firms is that information needs to be disseminated in a timely manner. It needs to be available to the public at large. It seems as though talking over the "water cooler" is where consumers obtain information about food safety events. Since consumers are influenced by their peers, quick and uniform dissemination of information could be of benefit to affected firms/industries. In other words, it may be best for these entities to "get out ahead" with factual information and target consumers through multiple information sources. This may help solidify the message being shared amongst consumers. It could be argued that social media outlets have become the "digital water cooler," and as such, agribusinesses need to consider these information dissemination tools as well. Trust in food safety informational sources is paramount for effective restorative strategies. Further, socio-demographic variables are an influencing factor in consumer behavior as well. Higher incomes will most likely affect purchasing decisions in a negative manner as the relatively higher income allows for more substitution. Higher levels of education also seem to minimize the effects of food safety events.

Comparisons across products in the empirical sense are limited to both models that addressed intention to purchase following a food safety event with the inclusion of socio demographic factors ($Meat_{2SD}$ and FP_{1SD}). In both cases subjective norms and education were statistically significant factors but of opposite signs. Risk perception also had opposite signs when compared across products. Some of the common statistically significant factors across the two survey models offer opposite impacts on the likelihood to purchase. This may be because of the fundamental differences in the two products.

The fact that fresh produce is perishable and meat is not (can be frozen), plus the fact that meat is often cooked to high temperatures may play a role in customer perceptions/buying behavior as well. If the proper meat cooking temperatures are achieved in this process, the risk of becoming ill from a food borne pathogen is significantly reduced. Simply washing fresh produce prior to consumption does not offer the same level of risk reduction. Therefore, consumers are likely to be influenced differently by food safety events in these two different markets.

Comparison across regions is limited to the statistically significant variables and models in which both this study and the EU have in common. For the U.S., this was limited to the FP_{1SD} model. Subjective norms have a negative impact on the likelihood to purchase prior to a hypothetical food safety event in both in the EU and in the U.S. in the case of fresh produce. In both cases, as increases in subjective norms occur, the likelihood the average consumer in these studies would purchase the fresh produce decreases. Here increases in subjective norms would be the combination of how influential referents were to the average respondent and if they took this information into account before making a purchasing decision. Average trust levels from this research as well as those found by Lobb, Mazzocchi, and Traill can be seen in Table 7.

Attitude coupled with the income socio-demographic shifter was statistically significant in both the EU study and the fresh produce survey before a hypothetical food safety event. In both cases, this resulted in increased likelihood of the respondent purchasing the product the following week. This is intuitive. Increases in attitudes suggest the respondent would "feel" better about a

particular purchase. Increase in income is not as clear with its role in this variable having a positive effect on the likelihood to purchase said products.

Agribusiness firms can use these results to analyze their strategic food safety response plans. These results suggest that agribusiness firms that include strategies that relay the risk of a food safety event to consumers are likely to minimize the economic losses associated with such events. Typically, individual firms may attempt to address consumers to protect a brand image in the occurrence of a food safety event. However, it may be beneficial for entire industries to form strategic alliances amongst themselves to communicate perceived risks of food safety events to consumers to protect the entire industry that may often not be branded. Risk perception also indicates that unaffected firms could potentially tout their products as being safer in a food safety crisis in an attempt to capture more market share. Although interesting conclusions can be drawn from these results, more observations from different areas and products are needed before conclusive arguments can be made about generalizations across products and regions.

Table 7. Average trust of 20 entities that hypothetically provided information about food safety risks across products and regions

	Fresh Produce Survey	**Meat Survey**	**US Average**	**EU Average**[a]
Shopkeepers	4.57	4.41	4.49	4.69
Supermarkets	5.21	5.12	5.16	4.64
Organic Shop	4.83	4.14	4.49	5.01
Farmers	5.02	4.90	4.96	4.97
Processors	4.28	4.03	4.15	3.74
Doctors / health authority	5.96	6.08	6.02	5.99
University Scientists	5.62	5.45	5.53	5.77
USDA	5.57	5.48	5.53	5.79
State Governments	5.36	4.83	5.10	4.50
Political Groups	3.55	3.06	3.31	3.52
Environmental Organizations	4.51	3.94	4.23	4.86
Animal Welfare Organizations	3.96	3.40	3.68	4.70
Federal Government	4.96	4.48	4.72	5.21
Television documentary	5.06	4.59	4.83	4.98
Television News	5.55	5.11	5.33	5.19
Newspapers	5.66	4.99	5.32	4.94
Internet	5.15	4.44	4.80	4.54
Radio	5.30	4.54	4.92	4.97
Magazines	5.04	4.53	4.78	4.49
Product Label	5.11	4.60	4.85	5.03
Average	5.01	4.61	4.81	4.88
Elicitation	"Suppose that each of the following has provided information about potential risks associated with e-coli/salmonella in food. Please indicate to what extent you would trust that information for each category below"			
7-Point Likert Scale	Completely Distrust=1, Neither=4, Completely Trust=7			

Note. [a] Average Levels of Trust taken from taken from Lobb, Mazzocchi, and Traill 2005.

Average Trust Implications

While the sample size and limited geographical nature of the survey results may limit sweeping generalizations of the empirical results, some general observations can be made about average trust levels across products and regions. In general, consumers have clearly defined preferences for sources they trust in receiving food safety information. Based on average trust levels, university scientists and doctors/health authorities are two sources that agribusiness firms could align themselves with to provide food safety information to consumers during and after a food safety crisis. However, this is contradictory to results from the $MEAT_{SD}$ model results which showed a negative impact towards university/government sources when coupled with socio-demographic variables. Indicating that more research across a larger area in terms of geography and products is warranted to fully understand this relationship.

Typical media sources such as the internet, television and newspapers should continue to be used to provide consumers with information following a food safety event. Since consumers rely on these sources for information, it may be in the best interest of agribusiness firms to have public relations personnel who can give pertinent information to these agencies in a timely manner. Descriptive results from this study indicate that consumers expect to be informed of food safety events. Information concerning the end of food safety events or steps being taken by firms to handle the situation needs to be provided to consumers.

Subjective norms play a role in consumers' purchasing decisions. Consumers take friends and family members' opinion into consideration when making decisions. Further, consumers indicated that informing family and friends was important when hearing of a food safety event. These factors highlight the need for correct and timely information to be given to consumers. Every strategic response plan should emphasize timely dissemination of correct information to minimize the scope of events.

This research shows, in general, consumer response to food safety events is consistent. Agribusiness firms can use this information to create a base strategic response plan to food safety events. Caution should be exercised in sweeping generalization in all areas, as the results show that consumers react differently depending upon the product. Moreover, the results of this study are limited because of the small geographical area covered and the relatively low response rate. More research is needed across more products and geographical regions before adopting a blanket-type strategic response nationwide.

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Appendix

Table 3. Descriptive Statistics for Subjective Norms, Perceived Behavioral Control and Attitude

Variable		Elicitation and Scale (7-Point Likert Scale)	FP[a] Mean	FP[a] Std Dev	Meat[b] Mean	Meat[b] Std Dev
Risk (R)						
	Risk Factors (r_i)	Please rate the risk of any one person in your household suffering from the following as a result of eating (product[c]) Negligible (1)…….....Extremely High (7)	1.83	1.77	1.56	1.39
	Motivations to Comply (m_j)	I take others' opinions into account when making decisions about whether or not to buy product Completely Disagree (1).……..……. Completely Agree (7)	2.05	1.52	2.81	1.87
Perceived Behavioral Control (P)						
	Control Beliefs (c_k)	Assume that you have (product) in the refrigerator. Is it likely you would buy more next week? Extremely Unlikely (1)……...….Extremely Likely (7)	1.79	1.46	2.89	1.8
	Power of Control Beliefs (p_k)	Assume last week you ate a lot of (product). Is it likely you would not buy (product) at all next week? Extremely Unlikely (1)……...…….Extremely Likely (7)	5.00	1.99	4.05	2.36
Attitude (A)						
Belief Strengths (b_i)		My decision whether or not to buy (product) next week is based on the fact that:				
(product) tastes good		Completely Agree (1)…….Completely Disagree (7)	6.43	0.95	6.34	1.22
(product) is not easy to prepare			3.23	2.02	2.34	1.69
(product) is a safe food			5.26	1.82	5.08	1.91
Everyone in the family likes (product)			5.89	1.67	6.35	1.35
(product) works well with lots of ingredients			5.91	1.67	6.48	1.04
(product) is low in fat			6.30	1.55	4.92	1.70
(product) is low in cholesterol			5.66	2.25	4.03	2.07
(product) helps the local farmers and economy			4.64	2.34	4.65	2.40
I do not like the idea of (product) being killed for food/is grown			2.94	2.10	2.00	1.66
(product) is not produced taking into account animal/environmental welfare			2.64	2.06	5.81	2.28
Outcome Evaluations (e_i)						
Tasty food			6.13	1.42	6.34	1.13
Value for money			5.72	1.54	5.92	1.29
Ease of preparation			5.49	1.41	5.71	1.20
Food safety			6.11	1.43	6.40	1.18
Food everyone likes			5.91	1.32	6.10	1.25
Food variety			5.72	1.44	5.80	1.25
Fat content			5.51	1.57	5.63	1.37
Cholesterol content			5.36	1.61	5.48	1.40
Ethical food production methods			4.89	1.76	4.46	1.82
Local community livelihood			5.09	1.61	4.71	1.68
Animal welfare/environmental welfare			4.87	1.66	4.13	1.91

Notes: a/b "FP" and "Meat" refers to the *"fresh produce"* and *"meat"* surveys respectively. c product refers to*"fresh produce"* and "*chicken and or beef"* for the fresh produce and meat surveys, respectively.

Table 4. Descriptive Statistics for Risk and Trust

Variable		Elicitation and Scale	FP[a] Mean	FP[a] Std Dev	Meat[b] Mean	Meat[b] Std Dev
Risk (R)						
	Risk Factors (r_l)	Please rate the risk of any one person in your household suffering from the following as a result of eating (product[h]):				
	E-coli	Negligible (1)……..……Extremely High (7)	1.83	1.77	1.56	1.39
	Salmonella		1.53	1.47	1.63	1.46
	Listeria		1.17	1.27	1.14	1.23
	Cholesterol		2.09	1.89	1.47	1.48
	Health problems from pesticides		1.21	0.92	2.31	1.96
	Health problems from antibiotics		1.53	1.4	1.45	1.5
	Health problems from growth hormones		1.4	1.19	1.47	1.6
	Weights (k_l)					
	E-coli		4.23	1.66	1.56	1.39
	Salmonella		4.21	1.64	1.63	1.46
	Listeria		2.91	1.97	1.14	1.23
	Cholesterol		4.74	1.89	2.31	1.96
	Health problems from pesticides		3.65	1.9	2.94	2.06
	Health problems from growth hormones		3.65	1.75	1.45	1.67
Trust(T)		Suppose that each of the following has provided information about potential risks associated with e-coli/salmonella in food. Please indicate to what extent you would trust that information				
	Suppliers (T_1)		-[c]	-	22.6	7.51
	Gov't./University (T_2)	Completely Distrust (1)……..…….Completely Trust (7)	-	-	14.9	6.13
	Organizations (T_3)		-	-	20.23	6.02
	Media (T_4)		-	-	18.11	6.72
Intention to Purchase						
$Meat_1/FP_1$[j]		How likely or unlikely is it that you will buy fresh or frozen (product) for your household's in-home consumption at least once in the next week?	5.46	2.17	5.17	1.95
		Extremely Unlikely (1)……Extremely Likely (7)				
$Meat_2/FP_2$		Assume that you have just read an article in the newspaper that high rates of *e-coli/salmonella* in (product) have been found in your area, resulting in several people being hospitalized. How likely or unlikely is it that you will buy fresh or frozen (product) for your household's in-home consumption at least once next week?	4.63	2.15	5.23	1.99

Notes: [a/b] "FP" and "Meat" refers to the "*fresh produce"* and *"meat"* surveys respectively. [c] product refers to"*fresh produce"* and *"chicken and or beef"* for the fresh produce and meat surveys, respectively. [c] Principal Component Analysis was not possible for the Trust category for the fresh produce survey. Instead, a simple average of trust was used for each category in the probit regression. For brevity, those results are not shown here.

Table 5. SPARTA Ordered Probit Regression Estimates

Meat Survey					Fresh Produce Survey				EU[a]			
Parameter	**Demographic Shifter**	**$MEAT_1$**	**$MEAT_2$**	**$MEAT_{2SD}$**	**Parameter**	**Demographic Shifter**	**FP_{1SD}**	**FP_{2SD}**	**Parameter**	**Demographic Shifter**	**ITP1[b]**	**ITP2**
S		-0.0085***		-0.0704**	S		-0.3584**		S		-0.17***	-0.23***
S	Education			0.0082***	S	Education	0.1012**	-0.0383***	S	Education		0.07***
S	Income			0.0061***	S	Income	-0.0566**		S	Income	0.08**	
S	Gender			0.0454*	P	Education	0.4963**		A	Income	0.19**	
P		0.1388**			P	Income	1.0705*					
R				-0.0207**	A	Education	-0.0102*					
R	Age			0.0003***	A	Income		0.0053***				
R	Income			0.0017***	R			0.3893*				
Supplier	Age			-0.0019**	R	Income		-0.0506*				
Gov't/Univ			0.0384**		Avg Trust		6.124**					
Gov't/Univ	Education			-0.0247**	Avg Trust	Education	-0.5189***					
Media			-0.0254**		Avg Trust	Income	-1.3874*					
Media	Age			0.002***								
Media	Education			0.0238**								
Media	Income			-0.0249**								
Chi Squared		15.37***	17.06**	66.51*			48.45**	55.65*				
Log Likelihood		-385.11	-372.65	-347.92			-68.17	-87.25				
Number of Observations		224	224	224			47	47				
Degrees of Freedom		40	40	40			25	25				

Notes: Level of significance: ***** 1% ,** 5%,*** 10%. Only models that were at least 10% significant and only variables in those models that were at least 10% significant are reported in table above. [a] Parameter estimates taken from Lobb, Mazzocchi, and Traill 2007. [b] ITP1 = the intention to purchase in general. ITP2= the intention to purchase following a food safety event. In both cases, these models included socio-demographic shifters.

Table 6. SPARTA Intention to Purchase Marginal Effects

	Unlikely			Neither			Likely[a]
$Meat_1$							
S	0.0022	0.0006	0.0001	0.0002	0.0002	-0.0004	-0.003
P	-0.0139	-0.001	-0.0002	-0.004	-0.004	0.0007	0.0049
$Meat_2$							
Gov't/Univ	-0.004	-0.0046	-0.003	-0.0019	-0.0015	0.0001	0.0148
Media	0.0026	0.003	0.002	0.0013	0.001	-0.0001	-0.0098
$Meat_{2SD}$[b]							
S	0.0049	0.0079	0.0062	0.0044	0.0037	-0.0001	-0.0271
S * Education	-0.0006	-0.0009	-0.0007	-0.0005	-0.0004	0	0.0032
S * Income	-0.0004	-0.0007	-0.0005	-0.0004	-0.0003	0	0.0024
S * Gender	-0.0032	-0.0051	-0.004	-0.0028	-0.0024	0	0.0175
R	0.0014	0.0023	0.0018	0.0013	0.0011	0	-0.008
R * Age	0	0	0	0	0	0	0.001
R * Income	-0.0001	-0.0002	-0.0002	-0.0001	-0.0001	0	0.0007
Suppliers * Age	0.0001	0.0002	0.0002	0.0001	0.0001	0	-0.0007
Gov't/Univ * Education	0.0017	0.0028	0.0022	0.0015	0.0013	0	-0.0095
Media * Age	-0.0001	-0.0002	-0.0002	-0.0001	-0.0001	0	0.0008
Media * Education	-0.0017	-0.0027	-0.0021	-0.0015	-0.0013	0	0.0091
Media * Income	0.0017	0.0028	0.0022	0.0015	0.0013	0	-0.0096
FP_{1SD}							
S	0.0076	0.0129	0.0085	0.0101	0.0743	0.0287	-0.1421
S * Education	-0.0021	-0.0036	-0.0024	-0.0029	-0.021	-0.0081	0.0401
S * Income	0.0012	0.002	0.0013	0.0016	0.0117	0.0045	-0.0224
P * Education	-0.0105	-0.0179	-0.0118	-0.014	-0.1028	-0.0398	0.1968
P * Income	-0.0226	-0.0386	-0.0253	-0.0302	-0.2218	-0.0858	0.4244
A * Education	0.0002	0.0004	0.0002	0.0003	0.0021	0.0008	-0.004
A * Income	-0.0001	-0.0002	-0.0001	-0.0001	-0.0011	-0.0004	0.0021
R	0.0016	0.0028	0.0018	0.0022	0.0161	0.0062	-0.0308
R * Income	0.0001	0.0002	0.0002	0.0002	0.0013	0.0005	-0.0026
AT	-0.1295	-0.2206	-0.145	-0.1727	-1.269	-0.4911	2.428
AT * Education	0.011	0.0187	0.0123	0.0146	0.1075	0.0416	-0.2057
AT * Income	0.0293	0.05	0.0328	0.0391	0.2875	0.1113	-0.5501
FP_{2SD}							
S * Education	0.0001	0.0006	0.001	0.0035	0.0058	0.0034	-0.0145
A * Income	0	-0.0001	-0.0001	-0.0005	-0.0008	-0.0005	0.002
R	-0.001	-0.0065	-0.0105	-0.0354	-0.0595	-0.0347	0.1475
R * Income	0.0001	0.0008	0.0014	0.0046	0.0077	0.0045	-0.0192

Notes: [a] A 7-point Likert scale was used to measure intention to purchase anchored with *unlikely* and *likely* at values of 1 and 7, respectively. [b] SD indicates inclusion of socio-demographic variables.

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Are Grocery Shoppers of Households with Weight-Concerned Members Willing to Pay More for Nutritional Information on Food?

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Abstract

This study used eye-tracking technology and an experimental auction to unveil shoppers' visual usage of nutrition information and willingness to pay (WTP) for food. Particular attention was given to primary grocery shoppers of households having weight-concerned members (shoppers included). The results showed that shoppers of household with weight-concerned members were more attentive to nutritional label information. Furthermore, their WTP for roasted peanuts decreased as their visual attention to the fat and sugar content increased. In addition, they were willing to pay more for salad mix compared to other shoppers. Health claims did not have an effect on shoppers' WTP.

Keywords: Experimental auction; eye-tracking technology; nutrition information; WTP

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Introduction

Americans are increasingly concerned about weight gain. According to the National Health and Nutrition Examination Survey, at least two-thirds of U.S. adults are overweight or obese (Flegal et al. 2012)**.** Major contributors to being overweight or obesity are improper dietary intake and physical inactivity (Bonsmann, Storcksdieck, and Wills 2012). Therefore, health professionals have been taking steps to aid consumers in making healthier diet choices.

Nutritional information on food packages assists consumers in making healthier food choices (Drichoutis, Lazaridis and Nayga 2009). Evidence has shown that increased use of food labels is associated with improved nutrient intake and healthier dietary patterns (Kreuter et al. 1997, Neuhouser, Kristal, and Patterson 1999, Satia, Galanko, and Neuhouser 2005, Lin, Lee, and Yen 2004, Kim, Nayga, and Capps 2001). Additionally, most consumers, especially overweight ones, use nutrition panels when purchasing food items (Sliverglade 1997; Bredbenner, Wong, and Cottee 2000; Blitstein and Evans 2006; Drichoutis et al. 2008; Chen et al. 2012). However, conflicting research (Higginson et al. 2002a, 2002b; Mhurchu and Gorton 2007; Bonsmann, Storcksdieck, and Wills 2012) implies that consumers do not view nutritional labels as frequently as reported. Consequently, more studies are needed to assess consumers' actual nutrition information viewing patterns.

In recent years, eye tracking technology has been adopted by researchers to detect consumers' visual usage of nutritional information on food packages. According to Russo (2011), eye tracking technology measures consumers' behavior that other more overt techniques cannot obtain (Karn, Ellis, and Juliano 2000). In their "eye-mind" hypothesis, Just and Carpenter (1976) argue that the cognitive processing in an individual's mind is related to the location where his/her eyes are gazing. One measure of visual attention is eye fixations. Piqueras-Fiszman et al. (2013) define eye fixations as when eyes are relatively immobile. Generally, eye fixations have been characterized by frequency (fixation counts) and duration (time spent on fixation points as well as saccades-when eyes are moving between fixation points). However, research has shown that information acquisition and processing occur primarily during fixations (Pieters, Warlop, and Wedel 2002; Reutskaja et al. 2011), but not during saccades (Rayner 1998). Therefore, fixation counts are often used in eye tracking research to indicate visual attention and processing. It is argued that greater fixation counts occur when consumers are processing information (Velichkovsky et al. 2002; Jacob and Karn 2003) and/or if the information is more important to them (Pieters and Warlop 1999; Wedel and Pieters 2000; Wedel and Pieters 2008; Seiler, Madhavan, and Liechty 2011). Using eye tracking software, Reutskaja, Camerer and Rangel (2011) have found that visual attention plays an important role in choice. Studies using eye tracking technology for food choices include Visschers, Hess and Siegrist (2010), Graham and Jeffery (2011), and Piqueras-Fiszman et al. (2013), among others.

In terms of WTP, studies have shown that consumers are willing to pay more for nutritional information on food products. Loureiro, Gracis, and Nayga (2006) determined shoppers were willing to pay almost 11 percent more to get cookies with nutritional information. Drichoutis, Lazaridis and Nayga (2009) found individuals were willing to pay 5.9 percent more for cookies with nutrition labels. In Ginon et al. (2009) consumers were willing to pay 12% more for a baguette with the label "source of fiber". Hellyer, Fraser, and Haddock-Fraser (2012) also stated

that health claims along with nutritional information positively influence individuals' WTP. Additionally, U.S. consumers were willing to pay more for bison meat after being informed of its nutritional contents (Yang and Woods 2013). In spite of the previous findings, many studies base their arguments on consumers' stated preferences. Furthermore, few studies provided evidence on the effects of specific nutritional information on consumers' WTP.

Recently, experimental auctions have been used to create incentives for people to reveal their "true" preferences (Vickery 1961). In a typical incentive compatible experimental auction, subjects bid to obtain one or more goods. The highest bidder(s) win the auction and pay a price that is determined exogenously from the individual(s)' bid(s). Preferences for a product can then be determined by comparing bids for that specific good to bids for a pre-existing substitute or by directly eliciting bids to exchange a pre-existing substitute for that good (Lusk, Alexander, and Rousu 2007). Recent studies that use experimental auctions to unveil consumers' willingness to pay for food items include: Poole and Martinez-Carrasco (2007) for citrus, Yue, Alfnes and Jensen (2009) for apples, Colson, Huffman and Rousu (2011) for genetically modified foods, and Wang and McCluskey (2010) for wine.

This study used eye tracking technology and an experimental auction[1] to reveal grocery shoppers' actual viewing of health claims and the nutritional label information as well as their true WTP for food items. Participants consisted of primary grocery shoppers from households in Minnesota. Particular attention was given to those from households with weight-concerned members (shoppers included). Salad mix and roasted peanuts were the food items included in the experiment. Research questions include: (1) Does primary grocery shoppers' visual attention to nutrition information have any effect on their WTP for different food items? And, (2) do primary grocery shoppers from households with weight-concerned members (shoppers included) have different viewing patterns and WTP values for nutritional information when compared to others?

Experiment Design

Experiment Set-Up

A three-step experiment was conducted to collect the data. In the first step, participants were familiarized with the eye tracking device and experimental auction procedure. Next, participants completed the eye tracking and experimental auction simultaneously. Lastly, participants were asked to complete a survey.

Salad mix (5 oz.) and roasted peanuts[2] (12 oz.) were used in the experiment. These two products represented commonly available food items with different levels of processing and nutritional

[1] A Becker-DeGroot Marschak (BDM) experimental auction was utilized in this study because participants completed the auctions individually instead of participating as a group (Noussair Kristal, and Patterson 2004; Lusk and Shogren 2007). Individual participation was required to capture participants' eye movements. In a BDM experimental auction, the subject submits a bid. The bid is compared to a price (termed 'binding price') determined by a random number with uniform distribution. If the bid is greater than the binding price, the subject pays the binding price and receives the auctioned item. If the bid is lower than the binding price, the subject pays nothing and receives nothing.

[2] The product name was "Peanuts", but shoppers were able to see in the product image that they were roasted peanuts.

components. For example, salad mix is minimally processed and includes raw chopped up lettuce; while roasted peanuts are moderately processed. Moreover, salad mix is considered healthy and low in fat and calories, while roasted peanuts are considered less healthy due to their higher fat and sugar content. As illustrated in Table 1, each food item had similar categories for production method and origin attributes, but different health claims[3].

Table 1. Products and attribute combinations

Product	Production Method	Origin	Health Claim
Salad mix	All natural	Product of the U.S.A.	High in fiber
	Organic	Product of Mexico*	No label
	No label	Minnesota Grown	
Roasted peanuts	All natural	Product of the U.S.A.	Low in sodium
	Organic	Product of Canada*	No label
	No label	Minnesota Grown	

Note. * The countries used for products with import country of origin labels were based on USDA import statistics indicating where the majority of that product was imported from at the time of the study, including: lettuce from Mexico, and roasted peanuts from Canada (USDA 2012).

Primary grocery shoppers in different households were recruited from Minneapolis-St. Paul and the surrounding area as participants. Primary shoppers were selected because they would take the experiment seriously. Moreover, it ensured that the experiment mimicked real shopping experience, where the primary grocery shoppers would shop for their household members. Hence, primary grocery shoppers' label usage was assumed to influence the food intake of their household members. Additionally, their usage of labels and shopping decisions were assumed to be influenced by their household members' preferences and health conditions (Chang and Nayga Jr. 2011;Vinoles, You, and Nayga 2013).

For the experiment, participants were scheduled every 30 minutes between 9am and 5pm from April 9, 2012, through April 12, 2012. The study took place in a university office where two eye tracking computers were stationed (portable Tobii X1 Light Eye Trackers were used to collect gaze data). Each participant was given a unique ID number and a bid sheet upon arrival. Then they sat in front of the eye tracking computer and were read the consent form and experimental auction instructions. The eye tracker was then calibrated to each participant using a five point system[4]. Afterwards, each participant was reimbursed $30 for their time. Eighty-nine of the 101 participants provided complete, usable information.

Data Collection

To collect fixation information for this study, areas of interest (AOI) were defined in the nutrition panel for each item. Based on the categories of nutrition information defined by the Food and Agriculture Organization, the AOI for salad were determined as: calories, serving size, fat (including total fat, saturated fat and trans fat), vitamins and minerals (including vitamin A

[3] Examples of front-of-pack images for salad mix and roasted peanuts are in Appendix A.

[4] Before an eye tracking recording was started, the user was taken through a calibration procedure. During the procedure, the eye tracking camera measured characteristics of the user's eyes which were used with an internal, physiological 3D eye model to calculate the gaze data. The five point system refers to the method used in calibration, with five points appearing on the computer screen to facilitate the calibration process.

and C, calcium and iron), sodium, protein, sugar, carbohydrate, fiber, and ingredients. The AOI for roasted peanuts were similar, plus allergy information (see Figure 1).

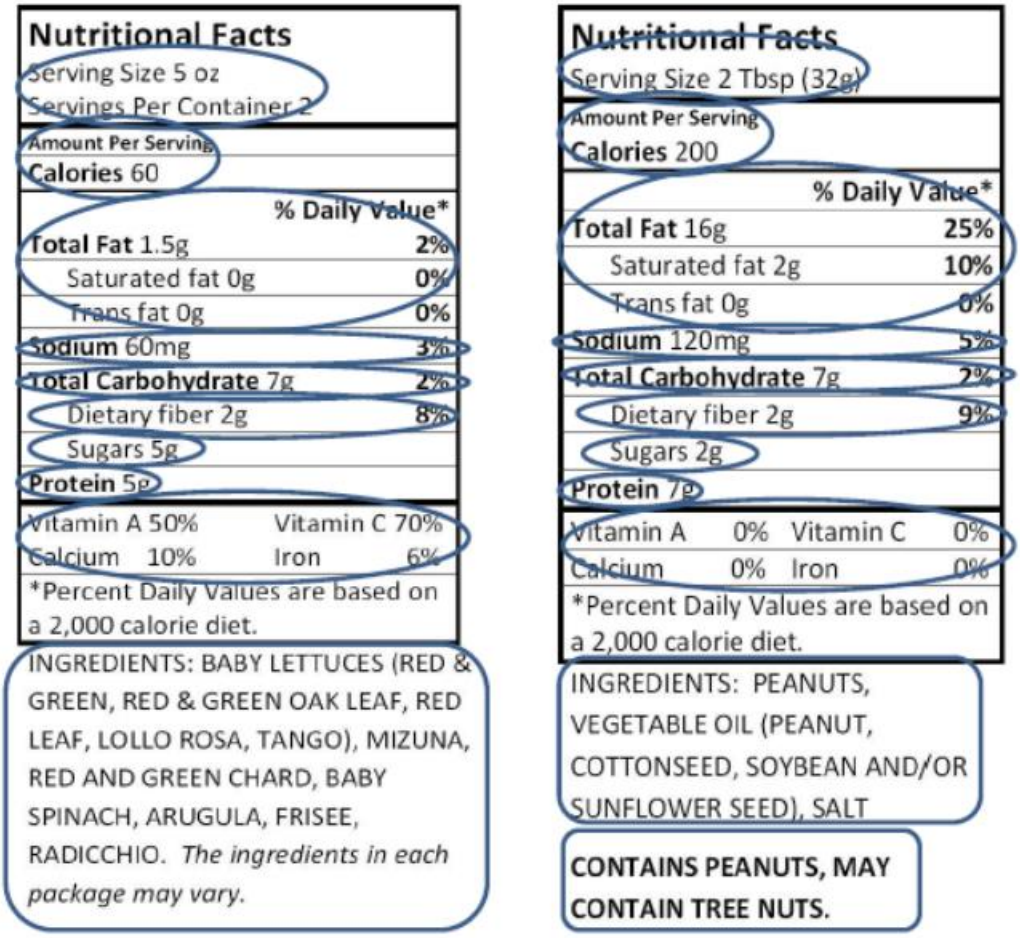

Figure 1. Examples of salad and peanut nutrition labels with areas of interest defined[5]

A mouse click moved the images forward and participants clicked through the images, which gave them adequate time to determine their WTP bids. Four random versions of the 18 images were used to prevent order effect. In addition, all versions began with an introductory slide using an image of a candy bar (as a trial version), followed by a slide asking if they wanted more information (yes or no), then a slide of the candy bar's nutrition information if the participant indicated 'yes' in the previous question, and finally a slide indicating it was time for them to write down their bid[6]. This order was repeated for each product attributes combination – front

[5]The images of the nutrition labels were enlarged on the computer screen to ensure the accuracy in capturing the eye fixations in each AOI.

[6] The purpose of the candy bar in the introduction was to familiarize participants with the technique/technology and give them ample opportunities to ask questions. Additionally, the introduction slides gave the monitor the opportunity to remind participants to wait for the prompt slide to submit their bids. As a result, the data was easier to analyze due to the participants focusing on the image instead of looking down at their bid sheets.

image, the more information question, nutrition information, and the bid prompt[7]. After the participant completed the eye tracking/auction, s/he was asked to complete the survey. While s/he completed the survey, the moderator determined if s/he won the auction by drawing the auctioned item and binding price out of a hat. The binding prices were determined in relation to prices from different stores in the study area.

Then the participants were asked to complete a survey. The survey was administered through Qualtrics Survey Software and consisted of 36 questions including background information on grocery shopping, their attitudes on product origin, production practices, nutrient content claims, and socio-demographics. One important question related to this study was whether the primary grocery shopper or anyone in his/her family had concerns about weight gain. Upon completion of the eye tracking/auction and survey, participants were given their compensation ($30 if they did not win the auction, $30 minus the binding price if they did win the auction plus the item they won) and departed.

Summary Statistics

Table 2 lists the means and standard deviations of the product attributes and socio-economic status variables. On average, all participants were willing to pay around $2.52 for a 5 oz. container of salad mix and $2.61 for a 12 oz[8]. container of roasted peanuts. Most of the households' primary grocery shoppers were approximately 50 years old with at least some college education. In addition, three-fourths of them were female and approximately half of them were married. On average, participants' households had more than two members with an average income of approximately $46,000. Seventy-five percent of them (67 participants) had weight-concerned household members (shoppers included). It is important to note that the socio-economic characteristics of the above-mentioned 67 participants were similar to those of the remaining participants.

Table 2.a Summary statistics of the product attributes

Observations	Salad Mix (5 oz.)				Roasted Peanuts (12 oz.)			
	All (651)		Weight-concerned[a] (497)		All (642)		Weight-concerned (488)	
	Mean	S.d.	Mean	S.d	Mean	S.d.	Mean	S.d.
Price bid ($)	2.52	1.27	2.6	1.28	2.61	1.48	2.7	1.58
Import	0.36	0.48	0.35	0.48	0.35	0.48	0.36	0.48
Minnesota Grown	0.29	0.45	0.29	0.45	0.36	0.48	0.35	0.48
All natural	0.36	0.48	0.35	0.48	0.35	0.48	0.36	0.48
Organic	0.29	0.45	0.29	0.45	0.29	0.45	0.29	0.45

Note. a "Weight-concerned" represents the shoppers who were concerned about their own weight or whose household member(s) had weight concerns.

[7] The eye tracker recorded raw eye movement data points every 16.7 or 8.3 millisecond (depending on whether the sampling data rate was 60Hz or 120Hz respectively). Then the raw data were processed into fixations through a fixation filter by Tobii Studio (the following link provides more details about the software: http://www.tobii.com/ Global/ Analysis/ Downloads/User_Manuals_and_Guides/Tobii_Studio2.2_UserManual.pdf).

[8] The WTP is comparable to what is found in the stores, and the number is calculated with 0 bids.

Table 2.b Summary statistics of participants' demographics

Participants	Salad mix (5 oz.)				Roasted peanuts (12 oz.)			
	All (89)		Weight-concerned (67)		All (89)		Weight-concerned (67)	
	Mean	S.d.	Mean	S.d	Mean	S.d.	Mean	S.d.
Price bid ($)	2.52	1.27	2.6	1.28	2.61	1.48	2.7	1.58
Import	0.36	0.48	0.35	0.48	0.35	0.48	0.36	0.48
Minnesota Grown	0.29	0.45	0.29	0.45	0.36	0.48	0.35	0.48
All natural	0.36	0.48	0.35	0.48	0.35	0.48	0.36	0.48
Organic	0.29	0.45	0.29	0.45	0.29	0.45	0.29	0.45
Age	49.83	14.13	49.65	13.89	49.84	13.9	49.65	13.89
Education	3.72	1.44	3.7	1.42	3.72	1.44	3.7	1.42
Gender	0.24	0.43	0.24	0.43	0.24	0.43	0.24	0.43
Marital status	0.53	0.5	0.49	0.5	0.53	0.5	0.49	0.5
Family members	2.6	1.45	2.51	1.36	2.6	1.45	2.51	1.36
Income ($10,000)	4.59	2.25	4.58	2.3	4.59	2.25	4.58	2.3

Note. a "Weight-concerned" represents the shoppers who were concerned about their own weight or whose household member(s) had weight concerns.

Shoppers from households with weight-concerned members (shoppers included) had different nutrition information viewing patterns. Table 3 lists the means and standard deviations of fixation counts for each AOI.

Table 3. Summary statistics of the fixation count variables

	Salad mix (5 oz.)					Roasted peanuts(12 oz.)				
	Weight-concerned[a] (WC) (497 obs.)		Non-WC (154 obs.)		T-test	Weight-concerned (WC) (488 obs.)		Non-WC (154 obs.)		T-test
	Mean	S.d	Mean	S.d.	P-value	Mean	S.d.	Mean	S.d.	P-value
Health claim[b]	0.63	1.42	0.65	1.14	0.42	0.74	1.74	0.81	1.25	0.31
Serving size	2.74	6.39	0.88	1.46	0.00	1.74	3.3	0.64	1.36	0.00
Calories	1.39	2.26	0.64	0.98	0.00	2.19	3.18	1.1	2.01	0.00
Fat	5.21	6.78	4.01	7.65	0.04	7.26	9.18	4.6	6	0.00
Vitamin+mineral	3.47	4.91	2.29	3.49	0.00	3.12	3.93	2.4	2.91	0.01
Sodium	1.28	1.79	1.12	1.73	0.16	1.63	2.38	1.31	1.96	0.05
Protein	1.48	2.42	0.97	1.61	0.00	1.34	2.14	0.86	1.08	0.00
Sugar	1.45	2.34	1.02	2.17	0.02	1.41	2.13	1.06	1.89	0.03
Carbohydrate	1.61	2.48	1.1	2.25	0.01	2.21	3.24	1.56	2.54	0.01
Fiber	1.62	2.47	0.81	1.4	0.00	1.99	2.74	1.32	2.16	0.00
Ingredients	14.46	19.11	13.44	13.75	0.23	7.63	9.59	6.99	6.44	0.17
Allergen						3.65	4.92	2.93	3.23	0.02

Note. a "Weight-concerned" represents the shoppers who were concerned about their own weight or whose household member(s) had weight concerns.
b Health claims included "high in fiber" for salad, "low in sodium" for roasted peanuts.

On average, shoppers from households with weight-concerned members (shoppers included) had more fixations for most of the AOI. One-tail t-tests comparing average fixation counts of shoppers of households with weight-concerned members (shoppers included) and the remaining shoppers also confirms this finding. Specifically, at a 5% significance level, shoppers from households with weight-concerned members (shoppers included) had more fixations on serving size, calories, fat content, vitamins and minerals, protein content, sugar content, carbohydrates, and fiber information for both salad mix and roasted peanuts. However, compared to other shoppers, they did not pay more visual attention to health claims.

Willingness-to-Pay Model

To analyze the influence of shoppers' viewing patterns on their WTP, a linear regression model was constructed as follows:

$$(1)\ y_t = \boldsymbol{\beta X}_{it} + \boldsymbol{\gamma Z}_{jt} + \boldsymbol{\alpha K}_{ijt} + \varepsilon_t$$

where $\boldsymbol{X}_{it}$ represents a vector with the consumer characteristics of income, gender and age; $\boldsymbol{Z}_{jt}$ indicates a vector with the product attributes of origin and production method; and $\boldsymbol{K}_{ijt}$ signifies a vector with individual and attribute-specific information such as the eye fixation counts of each shopper in each AOI. $\boldsymbol{\beta}$, $\boldsymbol{\gamma}$, and $\boldsymbol{\alpha}$ were parameter vectors related to the above-mentioned variables.

Of note, in our study, the dependent variable was the shopper's bid price for the food items. Since the dependent variable might take a zero value, a Tobit[9] model was used for the analysis. To answer research question two, a dummy variable was created, taking value one if grocery shopper indicated that s/he or any household member had weight concern, and zero otherwise. To compare the WTP of shoppers from households with weight-concerned members (shoppers included) to those without, interaction terms of fixation-counts with the dummy variable were created. Marginal effects for the explanatory variables are listed in Table 4 (See Appendix B). Interpretations are presented below based on these results.

Results

Salad Mix

A likelihood ratio test with the null hypothesis that shoppers' WTP was not influenced by their nutrition information viewing pattern was rejected with a P-value less than 0.0001. Therefore, specific nutritional information did have an effect on shoppers' WTP. A second likelihood ratio test with the null hypothesis that there was no distinction between WTP of shoppers from households with weight-concerned members (shoppers included) and others was rejected with a

[9] The assumptions of homoscedasticity and normality were tested to ensure consistency of the estimates. The assumptions only held for the salad mix model. Therefore, CLAD (censored least absolute deviations estimator) method was used to obtain the estimates for the roasted peanuts. The replication for bootstrapping in CLAD method was 5000 times. Ordinary least square (OLS) estimation could also be used for the salad mix. However, the goodness-of-fit of the Tobit model was similar to that of the OLS. Therefore, a Tobit model was chosen for the salad mix data in order to be comparable with the CLAD method for roasted peanuts.

P-value less than 0.0001. Therefore, compared to others, shoppers of households with weight-concerned members (shoppers included) did have different WTP values for specific product information.

As for the influence of their socio-economic status, generally, if the shopper's income increased, s/he was willing to pay more for salad mix. Furthermore, as the shopper's family size increased, s/he was willing to pay less for salad. One possible explanation was that salad was a common food consumed by many individuals regularly. Therefore, having a larger household implies greater consumption of salad. Given grocery shoppers' budget constraints, they preferred the unit price to be lower so that enough quantity could be purchased for the household, *ceteris paribus*. The same explanation could be applied to married individuals, since they typically have more family members (such as a spouse or children) than single individuals. Consequently, married individuals tended to buy more salad. Interestingly, if the participant was older, s/he was willing to pay less for salad. This result was consistent with findings from an earlier study (Dettmann and Dimitri 2009) on organic salad purchasing, which showed that older people (age over 50) were willing to pay less for salad.

As for product specification, shoppers in general were willing to pay 40 cents more for locally grown salad mix when compared to that from other places in the U.S., or from Mexico. This is probably due to perceptions of improved freshness, nutritional value, and the production methods' effects on the environment for local food (Martinez 2010). In addition, if salad mix was organic, participants were willing to pay approximately 64 cents more when compared to regular or all natural[10] salad mix, since organic salad is often perceived as better quality (Worthington 2001; Lairon 2010).

Shoppers from households with weight-concerned members (shoppers included) were willing to pay approximately 42 cents more than others for salad mix (5 oz.), *ceteris paribus*. Furthermore, if a shopper of the household with weight-concerned members (shoppers included) had an additional fixation on the fat content information, s/he was willing to pay approximately two cents more (14 cents less for non-weight-concerned participants), probably due to her/his awareness that salad mix is naturally low in fat. In addition, a shopper of the household with weight-concerned members (shoppers included) was willing to pay two cents less for salad mix if s/he had one additional fixation on serving size information (while other shoppers were willing to pay 32 cents more). Finally, a shopper of the household with weight-concerned members (shoppers included) was willing to pay one cent less if s/he had an additional fixation on the ingredient information (while others were willing to pay three cents more).

Surprisingly, the estimates of the remaining AOIs were not significant. This might be because salad mix was a familiar food item so that shoppers did not rely much on detailed nutrition information to make purchasing decisions, unless it was their first time reading it (Kreuter et al. 1996). Furthermore, since salad mix was minimally processed and healthy, being locally and organically grown provided sufficient incentives to shoppers to pay more.

[10]Interestingly, for both products, shoppers in general gave more credit to organic food. This indicates that although they were not informed of the difference between organic and all natural production methods during the experiment, they themselves did have prior knowledge or perceptions of distinct differences between the two.

Roasted Peanuts

Pseudo R^2 was used to compare the full model and reduced models since the CLAD model was adopted to analyze the effects for roasted peanuts. When comparing the Pseudo R^2 values of the full and reduced models, results indicate that nutrition information did influence consumers' WTP. Specifically, shoppers from households with weight-concerned members (shoppers included) were different from others in their WTP values, similar to what was found in the salad mix model.

As for socio-economic factors, in general, shoppers from households with more members were willing to pay seven cents more for roasted peanuts; while older, more educated, or married individuals were willing to pay less. This may be due to roasted peanuts being relatively less healthy than other food options and older, better educated individuals are more health conscious (Girois et al. 2001). Similar to salad mix, shoppers generally were willing to pay 17 cents more for locally grown roasted peanuts than for non-local options, and they were willing to pay 29 cents more for organic peanuts than for regular or all natural ones.

Compared to salad mix, detailed nutrition information had more influence on shoppers' WTP for roasted peanuts. Not surprisingly, both shoppers of households with weight-concerned members (shoppers included) and others were willing to pay six cents less after having an additional fixation on the product's fat content information. In addition, both types of consumers were willing to pay seven cents less after viewing vitamin and mineral information, probably because the vitamin and mineral levels were all zero for roasted peanuts. However, all shoppers were willing to pay 24 cents more if they fixated on the sodium content information. This result might be because sodium level reflects salt content (which drastically influences flavor) and many individuals preferred savory roasted peanuts.

Shoppers of households with weight-concerned members (shoppers included) were different from others in their WTP for sugar, fiber and protein content information. First of all, they were willing to pay 12 cents less if they had an additional fixation on sugar content information (18 cents more for others), likely due to concerns about excessive sugar intake. Further, they were willing to pay 12 cents more if they had an additional fixation on fiber content information (16 cents less for others). Interestingly, shoppers of households with weight-concerned members (shoppers included) were willing to pay one cent less if they fixated on the protein information (50 cents less for others). A possible explanation is that better protein sources exist when compared to roasted peanuts. Lastly, shoppers of households with weight-concerned members (shoppers included) were willing to pay 12 cents more if they had an additional fixation on the allergy information.

Summary and Discussion

The research results of this study contributed to a better understanding of households' primary grocery shoppers' nutrition information viewing patterns and the effects of nutrition information on their WTP. Particular attention was given to shoppers of households with weight-concerned members (shoppers included). The results showed that for both salad mix and roasted peanuts, shoppers of households with weight-concerned members (shoppers included) gave more visual

attention to most of the nutritional contents information than other shoppers. Furthermore, detailed nutritional information influenced the WTP of shoppers of households with weight-concerned members (shoppers included) differently compared to other shoppers.

In general, shoppers were willing to pay more for organically produced or locally grown/processed products, including minimally processed salad mix and moderately processed roasted peanuts. Additionally, their WTP for salad mix was not greatly influenced by detailed nutrition information or health claims. This might be because of the healthy nature of salad mix or consumers' general familiarity with salad mix. In comparison, detailed nutrition information had more influence on shoppers' WTP for roasted peanuts. Besides production method and product origin, information such as fat, vitamin and mineral content, and sodium all contributed to their WTP. This may be because roasted peanuts are considered less healthy and more processed than salad mix. Consequently, more information (with regards to nutritional details) is needed for shoppers to make their purchasing decisions. Interestingly, neither health claim (i.e. 'high in fiber' for salad mix and 'low in sodium' for roasted peanuts) had any effect on shoppers' WTP. This might be because of the ineffective design/wording of the health claims, or the ineffectiveness of health claims in tackling risk factors of chronic diseases (Drichoutis, Nayga and Lazaridis 2009).

Shoppers from households with weight-concerned members (shoppers included) were different from others in several aspects. First, they were willing to pay more for salad mix, regardless of the product characteristics. This may be due to the healthy nature of salad mix. Furthermore, they were more responsive to detailed nutritional information of roasted peanuts. For instance, their WTP was positively related to their visual attention to the fiber content, but negatively related to viewing sugar content information. To some extent, this reflects that Shoppers from households with weight-concerned members (shoppers included) appreciated healthy food attributes more than others. On the other hand, they gave less credit to food components contributing to weight gain.

The research results from this study can contribute to more effective marketing of food products. First, detailed nutrition information influences shoppers' purchasing decisions, especially when buying more processed food items (such as roasted peanuts). Therefore, detailed nutritional information (particularly on more processed food) should be easily accessible to shoppers[11]. As health concerns related to weight continue to rise, providing easy to grasp information is likely to become increasingly important. Second, a healthy food section can be set up in grocery stores and supermarkets to assist grocery shoppers with weight concerns or having weight-concerned household members in making easier purchasing decisions. For instance, products in this section could have labels that are easy to visually recognize which communicate weight-related information such as fat content, sugar content, serving size, etc. Similar ideas are being explored in other countries (i.e. the stoplight system in the UK (Sacks, Rayner and Swinburn 2009). Third, since shoppers are not necessarily willing to pay more for all natural food when compared to regular food items, it might be wise not to label a food item as 'all natural' and charge higher prices. Lastly, it is important to note that this study used a sample from the Minneapolis - St.

[11]Recently, the Food and Drug Administration proposed a new nutrition label, emphasizing serving size, calories, as well as fat, cholesterol, sodium, carbohydrates and protein content information; and simplifying the label to make it more user-friendly. This may help in effectively presenting the nutrition information on various food packages.

Paul area. Since the sample demographics were comparable to the demographics of the two cities, the results of this study can be generalized to these two cities and other similar areas. Future studies could explore the impact of visual attention to nutritional information on grocery shoppers' WTP in other regions to test the robustness of the results.

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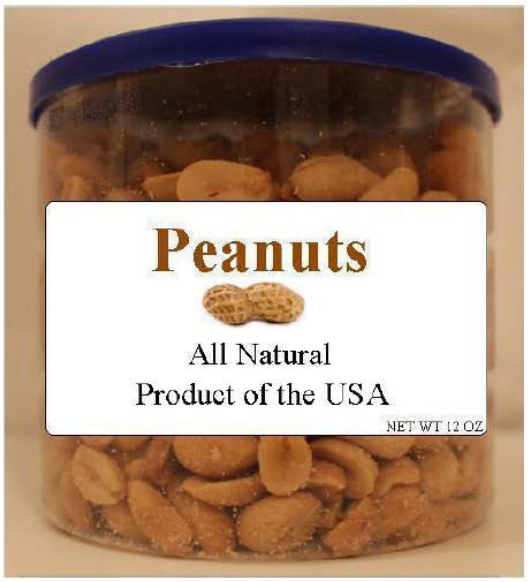
Appendix A

Examples of front-of-pack images



Appendix B

Table 4. Marginal effects of salad mix and roasted peanuts (Tobit model)

	Salad Mix	**Roasted Peanuts**
Age	-0.029***	-0.017*
Education level	-0.023***	-0.176*
Gender	-0.118	-0.180
Marital status	-0.359***	-0.301*
Household member	-0.109***	0.044
Income	0.098***	0.073
Non-weight-concerned	**Salad Mix**	**Roasted Peanuts**
Import	-0.202	-0.062
Minnesota Grown	0.403*	0.175*
Naturally produced	0.319	0.211
Organically produced	0.640***	0.286*
Fixation count (health claim[a])	0.011	0.057
Fixation count (serving size)	0.317***	0.064
Fixation count (calories)	0.076	0.038
Fixation count (fat)	-0.140***	-0.060*
Fixation count (vitamins and minerals)	-0.006	-0.076*
Fixation count (sodium)	-0.022	0.238*
Fixation count (protein)	0.148	-0.498*
Fixation count (sugar)	-0.021	0.186*
Fixation count (carbohydrate)	0.031	0.014
Fixation count (fiber)	0.167	0.162*
Fixation count (ingredients)	0.032***	0.021
Fixation count (allergen)		-0.044
Weight-concerned[b]	**Salad Mix**	**Roasted Peanuts**
Weight conscious shopper indicator	0.417*	-0.054
Import	-0.134	-0.030
Minnesota Grown	0.403*	0.175*
Naturally produced	0.071	0.000
Organically produced	0.640***	0.286*
Fixation count (health claim[a])	0.019	0.000
Fixation count (serving size)	-0.019***	0.027
Fixation count (calories)	-0.007	-0.061
Fixation count (fat)	0.015***	-0.060*

Table 4. *Continued*

Weight-concerned[b]	**Salad Mix**	**Roasted Peanuts**
Fixation count (vitamins and minerals)	-0.019	-0.076*
Fixation count (sodium)	-0.041	0.238*
Fixation count (protein)	-0.025	-0.012*
Fixation count (sugar)	0.029	-0.120*
Fixation count (carbohydrate)	0.107	0.019
Fixation count (fiber)	-0.018	0.118*
Fixation count (ingredients)	0.013*	0.004
Fixation count (allergen)		0.121*
Censored	12	20
Likelihood	-960.02	
Sigma	1.069	

Note. [a] Health claim for salad is "High in Fiber", and that for roasted peanuts is "Low in Sodium".
[b] "Weight-concerned" represents the shoppers who were concerned about their own weight or whose household member(s) had weight concerns.
*, **, *** indicate significance level of 10%, 5% and 1%, respectively.

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Fruit and Vegetable Consumption of College Students: What is the Role of Food Culture?

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Abstract

Our primary objective is to assess the role of culture by linking college students' current consumption of fruits and vegetables with their produce consumption levels while with family. Using a Tobit model, we analyzed data from an online survey with college students. Family consumption of fruits was highly predictive of the individual's consumption of fruits. For each unit increase in the reported consumption of fruits (vegetables) with the family, the respondents' fruit (vegetable) consumption at school increased by 0.65 (0.30) units compared to the base consumption level of 1.95 (1.82) times of fruit intake per day.

Keywords: fruit and vegetable consumption, college students, food culture, health knowledge

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Introduction

Food culture encompasses measurable factors that describe taste preferences, food choices and familiarity with foods (Schroeter, Anders, and Carlson 2013). Given that food culture is still a relative new construct, it is rarely considered in agribusiness literature. Often, the only proxy used for culture is ethnicity, which may be underrepresented in survey research. A recent study found that diet quality is strongly interrelated with food culture. Food culture includes factors over which the individual has complete control, such as type of activity performed while eating food or intake of vitamin supplements. Other elements of food culture over which the individual has no control include immigration or citizen status, heritage and ethnicity. The latter are indicators of the types of foods and/or traditional consumption patterns the individual has been exposed to over a long period of time (Schroeter, Anders, and Carlson 2013).

Eating habits formed during childhood have been shown to have a lasting impact on adult food habits (Becker 1992; Dietary Guidelines Advisory Committee 2010; Schroeter, Anders, and Carlson 2013). Previous research suggested that family customs such as meals influence the food culture of adolescents by establishing healthful habits (Gillman et al. 2000, Neumark-Sztainer et al. 2003, Rockett 2007). Thus, the impact of culture on food consumption should not be understated, given that it may provide the opportunity to prevent obesity in adolescents and young adults.

Physical activity, eating habits, socioeconomic status, and living environment define a person's lifestyle. More specifically, these characteristics can mold the eating habits and establish a certain food culture during adolescent years, which ultimately may lead to a strong or a poor diet in adulthood (Daniels 2006). [1]

Recently, increased policy attention has been placed on increasing efforts to change dietary habits. In particular, the World Health Organization, the U.S. Surgeon General, and the 2010 Dietary Guidelines for Americans (DGAs) associated the consumption of fruits and vegetables with the prevention of overweight, high blood pressure, heart disease, diabetes, and stroke (USDHHS-NCHS 2000; World Health Organization 2003; Centers for Disease Control and Prevention (CDC) 2007a). One of the national initiatives to increase the consumption of fruits and vegetables is the Half-Your-Plate Concept by the Fruits & Veggies- More Matters Initiative, which recommends that Americans make half their plate fruits and vegetables for meals and snacks (Fruits &Veggies More Matters 2014).

In 1995, the National College Health Risk Behavior Survey (NCHRBS) determined that 74% of U.S. college students ate less than five servings of fruits and vegetables daily and 22% consumed three or more high-fat foods per day (CDC 1997). About a decade later, Sparling (2007) found that produce consumption has further declined and 9 of 10 college students consumed fewer than five servings of fruits and vegetables per day. Recent data from the National College Health Assessment (NCHA) showed that 94.4% of its respondents consumed less than the recommended 5 or more servings of fruit and vegetables per day (American College Health

[1] Whether an individual is overweight or obese is determined by the Body Mass Index (BMI), which is determined by the formula: weight (in kilograms)/height^2 (in meters). Among adults, overweight is classified by a BMI between 25.0 and 29.9, while a BMI greater than or equal to 30.0 defines obesity (CDC 2006).

Association (ACHA) 2013). These declining trends in produce consumption patterns are commonly attributed to a changing food culture, such as rising demand for convenience foods and declining food preparation skills (e.g. Mancino et al. 2009, Stewart and Blisard 2008).

In order to address the missing link between food culture, fruit and vegetable consumption, and young adult obesity, a deeper investigation is needed. Our primary objective is to assess the role of culture by linking college students' current consumption of fruits and vegetables with their produce consumption levels while with family. Providing a deeper understanding of the relationship between food culture and food consumption directly benefits policymakers and industry with information about the role that at-home consumption may play in forming young adult food choices.

Background

Previous research (e.g. CDC 2007a) has given us insight into what variables are expected to be related to fruit and vegetable consumption. Demographics may impact the consumption of fruits and vegetables, such as age and gender. A study by the Centers for Disease Control and Prevention (CDC) determined that adults between 18 to 24 years ate the fewest vegetables, with almost 80% reporting they regularly do not consume any vegetables (CDC 2007a). In addition, research has shown differences in consumption of fruits and vegetables by gender, with consumption typically lower among men in comparison to women (CDC 2007a). Economic variables, such as individual income may influence the intake of fruits and vegetables, as high income could indicate a better access to nutrition information compared to lower income households (Drenowski 2003). In general, placing a higher value on labor market time leads to decrease in the time spent in the household, and thus, less time can be devoted to preparing meals. Working college students might buy more take-out foods or use ready-to-prepare entrees (Capps, Tedford, and Havlicek 1985, Chou, Grossman, and Saffer 2004).

In order to include variables that represent food culture, we researched the origins of this term in cultural anthropology, which is rooted in identifying cultural variations among humans. Douglas (1997) noted that food acts as a code, where the culture of food consumption is encoded in messages found in the patterns of social relationships. Behaviors such as work, sports, leisure, and celebration, are expressed through food consumption. However, while cultural anthropologists have been the pioneer in the definition and measurement of food culture, they have not used it to predict behavior, such as food consumption.

Counihan (1992) studied food rules among U.S. college students. He found that food culture focuses on the students' emotional associations. Though certain foods were related to specific meanings (i.e. turkey and Thanksgiving), the overall interest in food came from the students' relationship to it, rather than from the food's intrinsic qualities, such as the nutritional content of it. Eating was seen as a way to express power, with individuals feeling some sense of control from selecting their own diet. Many students were only vaguely aware about healthy eating and they had trouble being explicit about specific nutritional recommendations. They simply categorized fruits and vegetables as foods that were "good for you." Thus, there is a need to assess dietary and health knowledge when investigating students' fruit and vegetable intake.

Another variable that relates to food culture relates to the intake of vitamin supplements. Consumers have more favorable attitudes towards nutritional supplements as a perceived alternative healthy way to improve diet quality (Pole 2007). Many physicians advise the intake of multivitamin supplements because their patients might have difficulties consuming a balanced diet including a variety of fruits and vegetables (Wang 2011, Dooren 2011). Consumers may choose to take nutritional supplements to *complement* and improve their diet with specific micronutrients. As such, vitamins might serve as a disease-preventative input. The U.S. Council for Responsible Nutrition suggests that up to $8.4 billion annually could be saved if people consumed at least 100 International Units (IU) of vitamin E on a regular long-term basis to reduce the risk of heart disease (Bendich et al. 1997, Dickinson 2002). Other consumers may choose to consume vitamin supplements to *substitute* for the lack of consuming vitamins from fruits and vegetables. However, there might be insufficient evidence that the same protective effect of fruit and vitamins could be derived from dietary supplements (USDA/USHHS 2010; Schroeter, Anders, and Carlson 2013).

Model

We use a Tobit regression (Tobin 1958) to model food consumption because it is expected that not all students will report consuming fruits and vegetables. Censoring and truncation of the dependent variable (i.e. consumption of fruits or vegetables) is common in survey data and food consumption studies. For example, previous research on fruits and vegetable consumption found significant numbers of individuals with zero consumption (e.g. Crowley 2007, Newman 2013, Meng et al. 2014). The Tobit model accommodates dependent variables with only non-negative values (Woolridge 2006).

The Tobit model can be expressed by:

$$(1)\quad yi^* = \beta' xi + \varepsilon i, \qquad \varepsilon i \sim N(0, \sigma^2)$$
$$(2)\quad yi = 0 \text{ if } yi^* \leq 0,$$
$$(3)\quad yi = yi^* \text{ if } yi^* > 0$$

where yi^* is the latent variable; yi is the dependent variable; xi is a vector of determinants; β is a vector of parameters to be estimated; and ε is the error term followed using a normal distribution with zero mean and variance of σ^2. The model implies that yi will only be positive given a value of yi^* greater than zero.

In this study, two models are estimated. The first dependent variable is the frequency of consuming fruits and fruit juices per day. In the second model, the dependent variable is the frequency of consuming green salad, potatoes (not fried), carrots, and other vegetables per day. While controlling for demographics, and lifestyle characteristics, the relationship between fruit and vegetable consumption, food culture, and dietary and health knowledge, is considered.

Data and Methods

Data for this study were collected at a large (>15,000 students) public university -California Polytechnic State University, San Luis Obispo (Cal Poly), via an online survey of undergraduate

and graduate students. Once granted Institutional Review Board (IRB) approval, the electronic survey was transmitted via e-mail to multiple academic departments at Cal Poly in order to gather a wide array of responses from students in various disciplines. E-mails were distributed using departmental aliases to collect a random, non-discriminated sample of Cal Poly students. The e-mail contained a link to the online survey, which was hosted at a non-University website to reduce bias from respondents. About 2,000 students received this email via class listservs given their enrollment in various classes in the College of Agriculture, Food, and Environmental Sciences (CAFES). A total of 223 students responded and completed the survey, for an overall response rate of approximately 11%.

In the survey, data were collected on five basic categories: 1) frequency of fruit and vegetable consumption; 2) demographics; 3) food culture; 4) dietary and health knowledge; and 5) lifestyle variables. Descriptive statistics of variables are shown in Table 1 (please see Appendix).

Frequency of Fruit and Vegetable Consumption

Respondents were asked to indicate how frequently they consumed various fruits and vegetables within a time frame of their choosing (question shown in Figure 1). We calculated daily fruit and vegetable consumption by multiplying the student's reported consumption frequency by 365, 52, 12, or 1 for daily, weekly, monthly or less than monthly, respectively. As ChooseMyPlate.gov states, 1 cup of fruit or 100% fruit juice can be considered as 1 cup from the fruit group (USDA 2015); thus, we aggregated the fruit and fruit juice consumption into one variable. As respondents were asked to identify consumption of multiple types of fruits (fruit and fruit juice) and vegetables (green salad, potatoes (not fried), carrots, and other vegetables), we then summed the calculated daily consumption amounts for each food that belonged in the category. On average, respondents consumed fruits and 100% fruit juices 1.88 times per day and vegetables 2.03 times per day. The average frequency of fruit and vegetable consumption was 3.91 times per day, with 76.6% of the respondents consuming fruit and vegetables less than 5 times per day. These findings correspond to previous research. Schroeter, House, and Lorence (2007) found college students consumed fruit and fruit juice 1.64 times per day. Walker, Wolf, and Schroeter (2009) found California college students indicated an intake of 4.4 produce servings (both fruit and vegetable) per day. Finally, the analysis of the NCHRBS data determined 74% of U.S. college students eat less than the recommended five servings of fruits and vegetables (CDC 1997).

Demographics

Given the focus on college students, our sample contained a majority (58.9%) of respondents in the 18-21 year age range. Our sample was representative of the overall Cal Poly student body with respect to the age distribution, which is 20.2 years (Cal Poly News 2014). This represented a younger sample compared to Schroeter, House, and Lorence (2007), where 45.6% of the respondents were part of the 18-21 year age range and the ACHA (2013), which showed a mean age of 21.4 years. Our sample contained 44.8% male respondents.

The BMI of the individual respondent was calculated by asking respondents to identify their height and weight. On average, the respondents were slightly overweight, with an average BMI of 23.4. The average BMI for males (females) was 24.5 (22.6). In our sample, 35% (10%) of males (females) were overweight, while 6% (3%) of males (females) were obese. Our findings

are similar to another U.S. college-level health study (Lynn 2012), which took place at the University of Nebraska during about the same time period. In Lynn's (2012) study, the average BMI for male college students (females) was 24.96 (23.1) and the total average BMI 23.1. About 35% (15%) of the males (females) were overweight, with 6% (5%) being obese. Thus, while the BMIs of male college students in California and the Midwest were identical, female Californian college students were on average of healthier weight, given the lower rates of overweight and obesity at Cal Poly compared to the University of Nebraska. The NCHA showed an average BMI of 24.33, with lower rates of overweight among male students (27.4%) and a higher percentage of overweight female students (18.7%) compared to our sample (ACHA 2013).

In the case of college students, income is difficult to judge as it could be the student or the parent (or some combination thereof) providing funds for food. To assess the impact, we collected data on two variables. The first was self-reported individual income (on a monthly basis). Over half (54.0%) indicated they have incomes of less than $500 per month, while 19% indicated incomes of equal to or over $1,000 per month. In addition to monthly income, respondents were asked if they work while attending school. In our study, about 56% of all respondents state they work while attending school.

Please answer the following questions based on your behavior while you are ***living at school***:					
Please indicate how frequently you regularly consume these products:	Daily	Weekly	Monthly	Less Frequent or Never	Based on the frequency you just answered, how many times per day, week, or month do you typically consume these products?
Fruit juices such as orange, grapefruit, or tomato					
Fruit (not counting juice)					
Green salad					
Potatoes (not including French fries, fried potatoes, or potato chips)					
Carrots					
Raw or cooked vegetables (not counting potatoes, carrots, green salad)					
French fries or potato chips					

Figure 1. Survey Question to Collect Frequency of Consumption Data

Note. * A second question was asked with the same format, but substituting "living at home with your family" for "living at school"

Food Culture

Food consumption has a strong cultural element, as it is not just influenced by food availability, but also by the traditions that extend across large numbers of people. Thus, we aimed at capturing taste preferences, food choices and familiarity with fruits and vegetables in our survey. Using a method similar to Gittelsohn et al. (2000), we measured food culture by having respondents identify an ideal set of goods, in this case, by identifying the expected behavior of food consumption in their family home. This represented their knowledge of the set of cultural foods typically eaten by their family. In this case, students were asked to identify the typical consumption of fruits and vegetables in the family home. It was expected that a higher frequency in the consumption of a certain food product with the family may lead to a higher frequency of the food product's consumption by the individual college student.

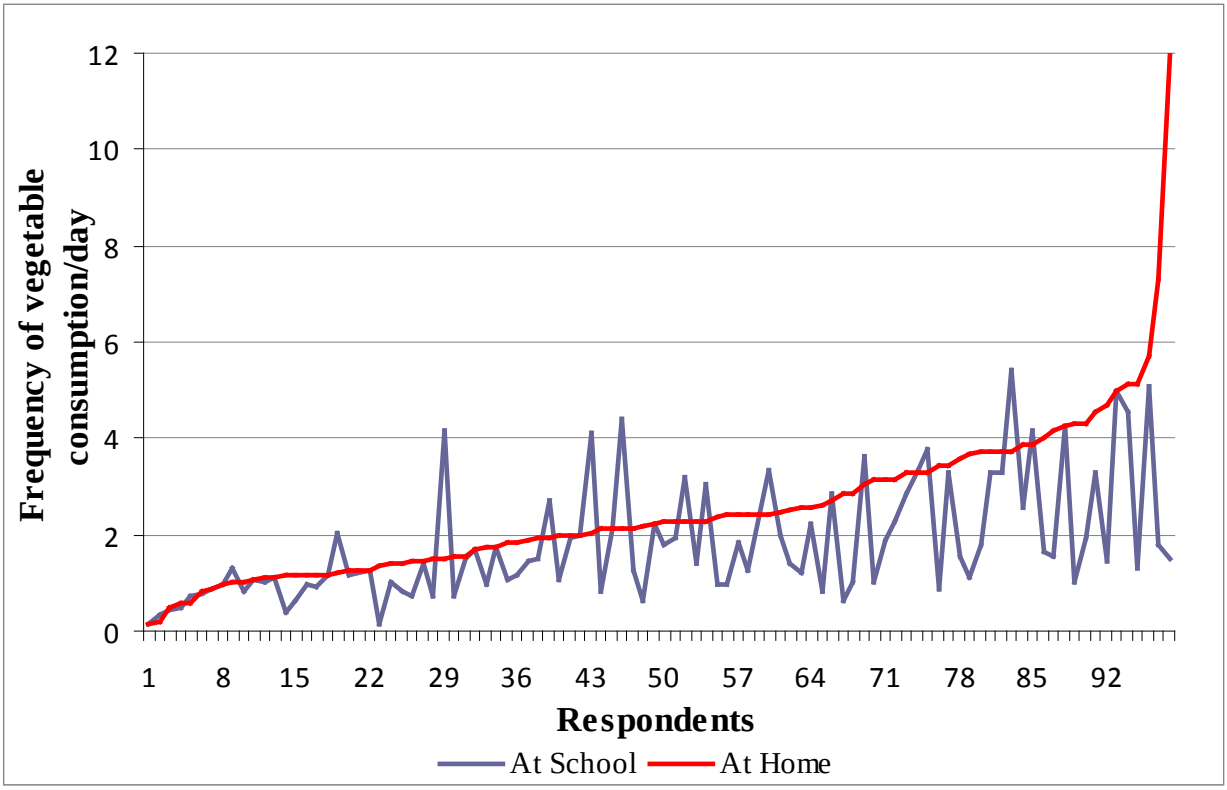

Figure 2. Individual Daily Frequency of Vegetable Consumption at School and with Family

Note. * When the at-school line is above the at-home line, this implies the respondent indicated they ate more vegetables at school than at home.

A comparison of respondents' fruit and vegetable consumption at school and at home is shown in Figures 2 and 3. From observation of these graphs, it can be seen that some students reported consuming more fruits or vegetables at school than at home, while the majority of levels of reported consumption at school fell below the line of consumption at home, particularly for vegetables. Reported frequency consumption of fruits at home averaged 2.27 times per day (0.39 times per day more than at school) and vegetables at home averaged 2.46 times per day (0.43 times per day more than at school).

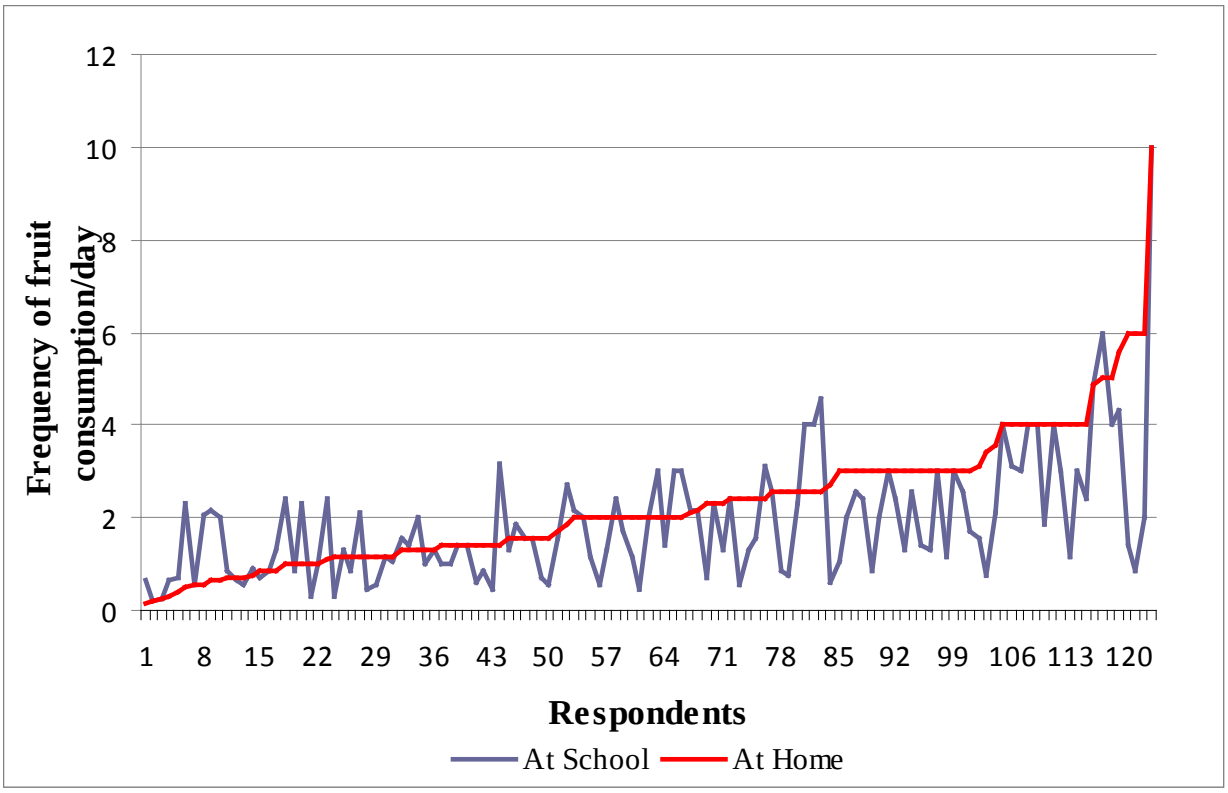

Figure 3. Individual Daily Frequency of Fruit Consumption at School and with Family

Note. * When the at-school line is above the at-home line, this implies the respondent indicated they ate more fruits at school than at home.

In addition to including food culture as measured by the family's food consumption pattern, previous studies showed that ethnic origin determines food culture. In our study, the majority of respondents described themselves as non-Hispanic Caucasian (85.9%), followed by Hispanic or Latino (5.5%). In general, Cal Poly's College of Agriculture, Food, and Environmental Sciences has a smaller percentage of Hispanics compared to the average representation at rest of the University (14%) (CSU Mentor 2014). In order to assure the representativeness of our study, we compared our data to another large-scale data collection with a different sample at the same university and the averages for the ethnicity variables were comparable between the two studies (Schroeter and Wolf 2012). In our current sample, we found that Hispanics consumed fruits 2.29 times per day and vegetables 1.98 times per day at school. Non-Hispanic Caucasians reported consuming fruits 1.92 times per day and vegetables at a frequency of 2.07 per day. For family consumption, the results are different, with Hispanics reporting a consumption frequency of 1.99 per day of fruit and only 1.00 times per day of vegetables while non-Hispanic Caucasians report family consumption of 2.36 and 2.61 times per day for fruits and vegetables, respectively. If each intake would amount to about one serving size, this amount would come close to the recommended daily allowance of at least five servings per day.

Another measure of food culture is related to rituals (Barthes 1997). One way to measure rituals involved in food culture is to consider the locations of meal consumption or activity during consumption. The variables meal activity and home meal activity measure whether the meal is typically eaten while sitting at a table without the TV on (see Table 1) at college and in the

family home, respectively. At school, 22% of respondents indicated they eat meals sitting at a table without the television on, while 50% watch TV while eating. At home, 95% of the respondents typically ate at least one meal together as a family. Of all respondents, 69% indicated they ate more than one meal together. For those that ate meals together as a family at home, 76% indicated they eat the meal at a table without television, while 21% indicated they watched television during the meal.

Food culture also encompasses the intake of vitamin supplements. In our sample, 71% of respondents indicated they take vitamins at least sometimes, with 34% indicating they take them regularly. Vitamin-supplement takers (either regularly or irregularly), consumed vegetables 0.25 times less frequently per day than those who did not report being on vitamins. Though this result may at first seem counterintuitive, it may be the result of students either acting on the knowledge they are not consuming enough healthy foods and supplementing with vitamins; or, they may see vitamins as substitutes for eating fruits and vegetables. Thus, if supplements do replace a healthy diet in the student population, an additional intervention might be needed to encourage the intake of nutrients from food instead of supplements (Schroeter, Anders, and Carlson 2013).

Dietary and Health Knowledge

We assessed the student's dietary and health knowledge by asking the respondents to self-rate their knowledge about nutrition and health. The majority of respondents rate their own nutrition (health) knowledge as 'above average.'

Lifestyle Variables

Several lifestyle variables such as physical activity, physical health, the amount of time spent watching TV, self-rating of the nutritional quality of their diet, and importance of various factors on food choice were included in the survey. Given that exercising goes along with a healthier lifestyle, respondents that engage in physical activity regularly may consume healthier food choices such as fruits and vegetables. To judge this relationship, students were asked to rate their level of physical activity. Nearly half (44.4%) of the respondents rated their physical activity level as high, with nearly one-quarter (22.7%) rating their activity level low. While rating the nutritional quality of their diet, nearly half of the students rated their diet quality as high (47.8%) while 15% rated it low. Related, respondents were asked to identify their current physical health. In this case, over half (57.7%) rated their health as high, while 11% rated their health low. Respondents reported watching an average of two hours of television per day.

Finally, empirical evidence from consumer marketing studies suggests that food purchases are mainly influenced by taste, cost, and convenience, with health assuming a subsidiary role (Drenowski and Levine 2003). In our study, respondents rated the importance of taste, price, convenience, health, ecology/animal rights, pleasure, packaging, newness, organic, seasonality, and perishability in their food choice. These results are shown in Figure 4.

Taste, pleasure, price and health were most frequently cited to be important. Convenience is another important decision factor for the food purchasing decision, which is consistent with previous research that showed that the individual cost of nutritional and leisure time choices have increased over the past two decades (e.g. Chou, Grossman, and Saffer 2004). Moreover, a loss of proper cooking skills increases the need to eat convenience food or food away from home (Hall 1992).

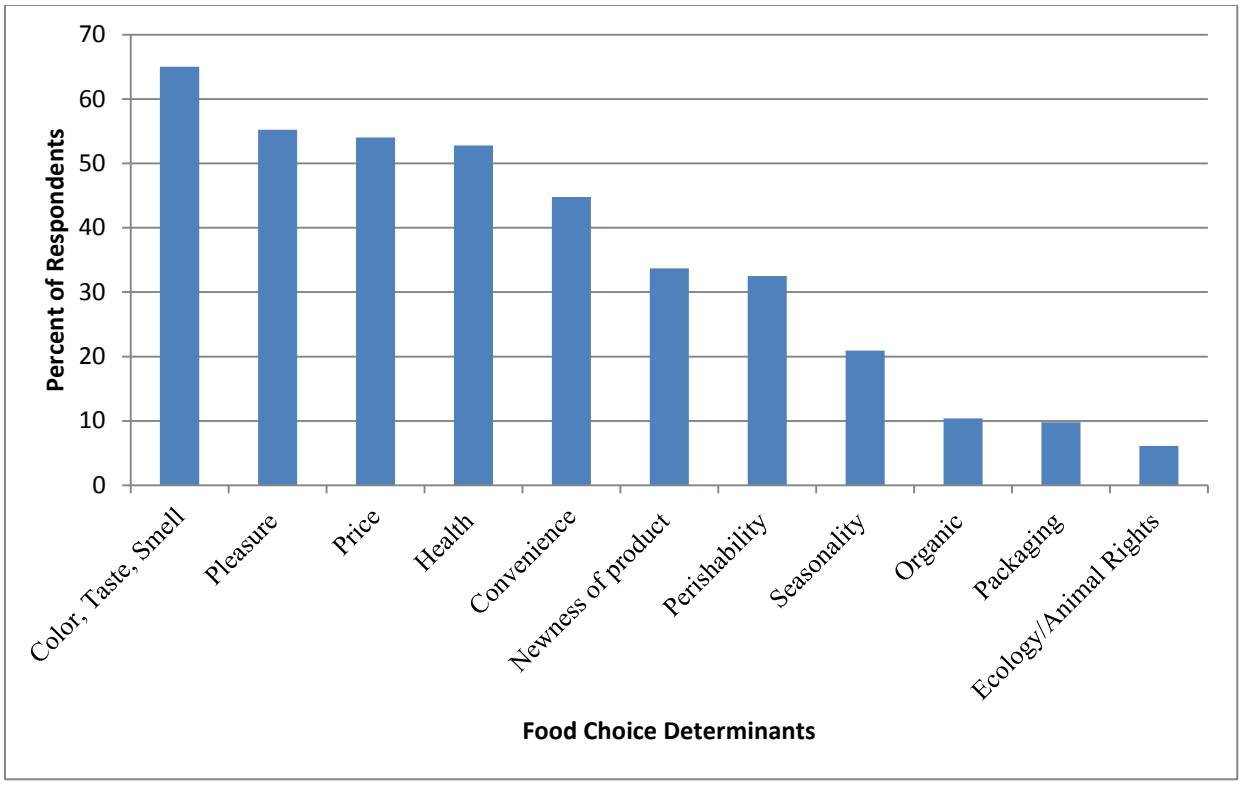

Figure 4. Ranking of Importance of Food Choice Determinants as Important

Note. * Respondents rated attribute on a 5 point scale from not at all important to extremely important. Percent shown in graph answered attribute was a 3 (important), 4 (very important) or 5 (extremely important).

Methods

Two Tobit regression models are estimated for this study (Equation 1). The dependent variables are fruits (the sum of fruit and fruit juice consumption) and vegetables (the sum of green salad, potato, carrot, and other vegetable consumption), as defined earlier.

(4) Frequency of fruit (vegetable) consumption = f(demographics, food culture, dietary and health knowledge, lifestyle)

where demographics include age, gender, BMI, whether the student has a job while in school, income, and whether they live in a city or rural area; food culture includes family fruit and vegetable consumption, race, ethnicity, whether television is watched while eating at school and home, if they take vitamins and if they are a vegetarian; dietary and health knowledge is represented by two self-rated variables; and lifestyle includes self-ratings of physical health, activity levels, and quality of the diet, time spent exercising, number of hours spent watching television, the importance of convenience, ecology/animal rights, price, color/taste/smell, and organic production in food choices.

Results

Results from the analysis are presented in Table 2. Marginal effects are calculated and shown in Table 3.

Table 2. Results from the Regression Analysis of Fruit and Vegetable Consumption by College-Aged Students

	Fruits		**Vegetables**	
	Coefficient	p-value.	Coefficient	p-value
Demographics				
Age	-0.32	0.125	-0.42*	0.074
Male	0.15	0.448	-0.38*	0.071
BMI	0.01	0.601	0.01	0.668
Work	0.05	0.827	-0.46**	0.048
Low Income	0.53**	0.028	0.19	0.465
Medium Income	0.16	0.573	-0.17	0.565
City	0.15	0.486	0.02	0.932
Food Culture				
Family Fruit and Fruit Juice	0.65**	0.000	-0.11	0.151
Family Vegetables	-0.20**	0.003	0.30**	0.000
Caucasian	0.60	0.108	1.73**	0.000
Hispanic/Latino	0.78	0.126	1.14*	0.072
Meal Activity	-0.09	0.711	0.23	0.357
Home Meal Activity	-0.20	0.335	-0.14	0.539
Vegetarian	0.87*	0.061	1.54*	0.005
Vitamins	-0.03	0.803	-0.25*	0.058
Dietary and Health Knowledge				
High Nutrition Knowledge	0.25	0.319	0.54	0.124
High Health Knowledge	-0.08	0.351	-0.26	0.492
Lifestyle				
Low Overall Physical Health	-0.11	0.774	0.26	0.564
High Overall Physical Health	0.02	0.925	0.01	0.972
Low Level of Physical Activity	-0.53*	0.092	-0.33	0.317
High Level of Physical Activity	-0.05	0.852	0.40	0.180
Time Exercise	-0.23	0.453	-0.12	0.712
TV	-0.02	0.818	-0.17**	0.039
Importance of Convenience	-0.19	0.357	-0.37	0.118
Importance of Ecology/Animal Rights	0.25	0.561	-0.82	0.143
Importance of Health	0.35	0.117	0.73**	0.002
Importance of Price	-0.06	0.756	0.32	0.140
Importance of Color, Taste, Smell	0.28		0.49**	0.030
Importance of Organic	-0.67**	0.032	-0.47	0..269
Low Nutritional Quality	-0.18	0.553	-0.67**	0.048
High Nutritional Quality	0.00	0.818	-0.18	0.512
Log-Likelihood	-125.73		-109.81	

Demographics

Demographics impacted the frequency of vegetable consumption more than fruit consumption. Respondents aged 21 and under were significantly likely to eat vegetables less frequently (-0.42 times per day), as were males (-0.38 times per day). Respondents who indicated they worked while attending school were significantly less likely to eat vegetables. This finding may relate to the time it takes to prepare vegetables; even though the importance of convenience of food was not significantly related to vegetable consumption. For fruits, those with reported lower incomes actually consumed a significantly higher frequency of fruits per day (+0.53 times per day).

Food Culture

Family consumption of fruits was highly predictive of the individual's consumption of fruits. For each unit increase in the reported consumption of fruits with the family, the respondents' fruit consumption at school increased significantly (+0.65 units) compared to the base consumption level of 1.95 times of fruit intake per day (Table 3). The same is true for the vegetable model, with a significant increase in family vegetable consumption of one more time per day leading to an increase (+0.30 times per day) in consumption of vegetables at school compared to the base consumption level (1.82 times per day).

Race and ethnicity were significantly related to the frequency of vegetable consumption, but not to the fruit consumption frequency. Non-Hispanic Caucasians were likely to consume vegetables more frequently (+1.73 times per day) compared to non-Caucasians. Hispanic/Latino respondents were likely to consume vegetables more often (+1.14 times per day) than non-Hispanics.

Whether the television was on and the respondent sat at the table during dinner (both at school and at home) were not related to either fruit or vegetable consumption frequency. Though whether a person ate meals at a table with the television off was surprisingly not significant, we captured the expected effect through the variable "hours spent watching television." With each increase in hours spent watching TV, respondents would decrease the frequency of their vegetable consumption (-0.16 times per day) (Table 3).

Those who reported to be Vegetarian were significantly more likely to eat fruits and vegetables more often; with an increased fruit consumption (+0.87 times per day), and a higher vegetable intake (+1.54 times per day). We found that a student who reported to be Vegetarian would consume fruits and vegetables 6.15 times per day, which was a 53% increase compared to non-Vegetarians. Respondents who reported taking vitamin supplements were significantly would consume fewer vegetables (-0.25 times per day), but there was no relationship between supplement takers and fruit consumption.

Dietary and Health Knowledge

Self-rated health and nutrition knowledge were not significantly related to fruit or vegetable consumption frequency. Table 2 shows that neither of the variables, high nutrition knowledge and high health knowledge, had any influence on fruit and vegetable intake.

Lifestyle

As shown in Table 2, many lifestyle variables had a significant impact on fruit and vegetable consumption, but interestingly, none of the variables impacted the frequency of both fruit and vegetable consumption. Fruit consumption frequency was significantly lower for respondents who indicated a relatively low level of physical activity. This would be expected, as they may not be dedicated to a "healthy" lifestyle. Self-rated health and nutrition knowledge had no impact on respondent's frequency of consuming fruits and vegetables (see Table 2). Respondents who self-reported to have a diet with low nutritional quality ate vegetables less frequently (-0.67 times per day), indicating the students are aware their behavior may have impacts.

Table 3 shows that respondents who indicated health and flavor were very important in their purchasing decision did consume vegetables more often, with health having a stronger impact (+0.72 times per day) compared to flavor (+ 0.49 times per day). Students who rated "organic" as being an important attribute in their purchasing decision, showed a lower frequency of fruit consumption.

Table 3. Marginal Effects for Significant Variables

	Fruits	**Vegetables**
	Marginal Effect	Marginal Effect
Demographics		
Age		-0.413
Male		-0.379
Work		-0.457
Low Income	0.527	
Lifestyle		
Low Level of Physical Activity	-0.527	
TV		-0.164
Importance of Health		0.723
Importance of Color, Taste, Smell		0.488
Importance of Organic	-0.660	
Low Nutritional Quality		-0.661
Food Culture		
Family Fruit and Fruit Juice	0.646	
Family Vegetables	-0.201	0.298
Caucasian		1.708
Hispanic/Latino		1.129
Vegetarian	0.861	1.521
Vitamins		-0.245

Discussion and Conclusions

Our study assessed food culture by examining family food consumption and individual student behavior. In anthropology, a field where culture is the focus of the study, family behavior is likened to an ideal set of goods. Aggregating this ideal set across people allows patterns to emerge that would be considered culture, or similarities among different groups of people. Additionally, family behavior impacts food choice, as well as food consumption behavior. Thus, one key component of our survey measured the frequency of fruit and vegetable consumption at the family and individual college student level.

Our results suggest that family consumption of fruits is highly predictive of the individual college-student's consumption of fruits. For each unit increase in the reported consumption of fruits with the family, the respondents' fruit consumption at school increased. This finding is consistent with previous research, which determined that with a higher frequency of family dinners, the intake of fruits and vegetables increased among adolescents/young adults (Gillman et al. 2000, Neumark-Sztainer et al. 2003, Schroeter, House, and Lorence 2007). Gillman et al. (2000) found that children ate nearly one full additional serving of fruit and vegetables when they had daily dinners with their families.

An important result is to note the combined effect of family vegetable consumption. We found that family consumption of vegetables significantly decreased the consumption of fruits. Our findings suggest that if the family culture emphasizes the consumption of vegetables, such as salad, it might not stress fruit consumption jointly with it. We find that for each increase in the frequency of vegetable consumption per day with the family, the individual's consumption of fruits at school decreases. As such, a student at school consumes fruits and vegetables about four times per day at the base consumption level. The more vegetables students would consume in the family home, the higher would their individual vegetable consumption increase (+0.30 times), while fruit consumption would decrease (-0.20 times). Thus, the combined effect of fruit and vegetable consumption was only slightly above (+0.1 times per day) the base level.

Our demographic variables showed interesting findings. We found that college students with reported lower incomes consumed a higher frequency of fruits per day. This is not the expected relationship, as fruits are often perceived as more expensive. One possibility is that students reporting lower incomes are on meal plans, and have increased access to fruits through schools. A second possibility is related to the limitations of using an income variable for students, as they may not consider parental financial support that increases their spending money. With regard to lifestyle, college students who stated organic food was an important factor in their choice of fruits and vegetables also showed lower frequency of fruit consumption. This is somewhat unexpected as fruits and vegetables represent 39.7% of 2010's total organic food value and 11.8% of all U.S. produce sales (Organic Trade Association (OTA) 2011). The results suggest that given a preference for organic fruits/fruit juices, students might rather buy a smaller quantity at a higher price, which is likely associated with organic fruits. Thus, they might just purchase less, because they may prefer high-priced organics compared to conventional fruits, yet, they are constrained by a certain budget constraint. Our result could also be an indication that organic fruits are not easily accessible on college campuses and suggest further investigations into the food environment on campus.

Variables used to represent food culture included ethnicity, race, and activity during meals, and taking vitamins. With regard to ethnicity, we found that Hispanics consumed lower amounts of fruits and vegetables compared to Caucasians. A study by the CDC (2007a) indicates that Hispanics had the highest fruit and lowest vegetable intake, and Caucasians had the lowest (CDC 2007b). Other research determined that even though immigrants are in better health upon arrival to the U.S compared to their U.S.-born counterparts, this health advantage erodes over time (Antecol and Bedard 2006), which is confirmed by our study.

Regarding the meal activity, our analysis determined that college students decreased the frequency of their vegetable consumption with each increase in hours spent watching TV, which is consistent with previous studies (Boynton-Jarrett et al. 2003). It is alarming that television shows targeted at adolescents and young adults feature mostly commercials for high-calorie and high-sugar foods (Strauss and Knight 1999). There is need for more research that assesses the impact of TV-viewing on food choice behavior.

Given the lack of relationship between self-reported knowledge and fruit and vegetable consumption, our findings suggest that future research may need to consider assessing objective knowledge when measuring dietary and health knowledge. While our online data collection was associated with minimal cost, self-reported variables such as weight and diet habits are typically more reliable in intervention studies that collect this data directly. However, all typical food diary studies, such as the national representative Behavioral Risk Factor Surveillance System (BRFSS) collected by the CDC, rely on the 24-hour recall method – "what foods have you eaten in the last 24 hours" – because of the inability of people to accurately recall what they ate over a longer period of time (CDC-BRFSS 2005). Intervention studies that observe eating behaviors are more accurate, but also form a more costly method of data collection.

If attempting to influence fruit and vegetable consumption, we suggest that the emphasis should be placed on food culture and lifestyle. This suggestion is reinforced by the finding that self-rated nutrition and health knowledge were not related. Traditionally, nutrition policies have focused on consumer education. This approach may be a less effective intervention versus focusing on the importance of family traditions, which could have a greater impact than increasing information on the number of servings of fruits and vegetables people should consume. Understanding drivers of college students' food choices are important, not only to potentially improving students' health through increased fruit and vegetable consumption, but those increases in demand would be beneficial for agribusiness companies. To meet the DGA recommendations, Americans on a 2,000-calorie diet would need to significantly increase daily fruit and vegetable consumption (Buzby, Wells, and Vocke 2006). These increases would not only improve the nation's health, but also provide opportunities for U.S. fruit and vegetable growers. Previous studies have shown that if Americans changed their current fruit consumption patterns to meet the DGAs, U.S. production of fruit and vegetable production would need to rise. Substantial increases in U.S. fruit and vegetable production would also increase demand for farm labor, land, and transportation, which would increase labor and land costs. In some cases, the higher costs would likely be passed on to the consumer in form of higher fruit and vegetable prices. Furthermore, imports and exports would be affected; particularly the largest markets for U.S. vegetable exports, Mexico and Canada (Buzby, Wells, and Vocke 2006). Overall, firms along the supply chain in fruit and vegetable production would benefit from these increases in consumption (Jetter, Chalfant, and Sumner 2004).

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Appendix

Table 1. Definitions, Means and Standard Deviations of Variables used in the Regression

Variable	Definition	Mean (Std. Dev.) or Percent
Fruit and Vegetable Consumption		
Fruits	Frequency of consuming fruits /100% fruit juices per day	1.88 (1.34)
Vegetables	Frequency of consuming green salad, potatoes (not fried), carrots, and other vegetables per day	2.03 (1.50)
Demographics		
Age	Percent of respondents between 18 and 21 yrs	58.9%
Male	Male percent of respondents	44.8%
Body Mass Index (BMI)	Weight (kg)/ (Height (m))^2	23.4 (3.43)
Work	Percent of respondents working while attending school	55.8%
Low Income	Percent of respondents with individual income of less than $499 per month	54.0%
Medium Income	Percent of respondents with individual income of $500-$999 per month	25.2%
High income	Percent of respondents with individual income of ≥$1,000 per month	19.0%
Food Culture		
Family Fruit and Fruit Juice	Frequency of fruit and fruit juice intake in family home per day	2.27 (1.44)
Family Vegetables	Frequency of consumption of green salad, potatoes (not fried), carrots, and other vegetables in family home per day	2.46 (1.54)
Caucasian, non-Hispanic	Percent of respondents who identify as Caucasian, non-Hispanic	85.9%
Hispanic/Latino	Percent of respondents who identify as Hispanic	5.5%
Other race/ethnicity	Percent of respondents who identify as Black, non-Hispanic, Asian or Pacific Islander, or other	8.6%
Meal Activity	Percent of respondents who typically consume meals while sitting at a table without TV while living at school	22.1%
Home Meal Activity	Percent of respondents who typically consume meals while sitting at a table without TV while living at home	72.4%
Vegetarian	Percent of respondents who are vegetarian	4.5%
Vitamins Daily	Percent of respondents who took vitamins daily	34.4%
Vitamins	Percent of respondents who took vitamins occasionally	36.8%
No Vitamins	Percent of respondents who did not take vitamins	28.8%
City	Percent of respondents who raised in an area with more than 50,000 people	44.8%

Table 1- *Continued*

Variable	Definition	Mean (Std. Dev.) or Percent
Dietary and Health Knowledge		
Low Nutrition Knowledge	Self - rating of nutrition knowledge is poor, fair, or average	42.3%
High Nutrition Knowledge	Self - rating of nutrition knowledge is above average or excellent	57.9%
Low Health Knowledge	Self - rating of health knowledge is poor, fair, or average	30.7%
High Health Knowledge	Self - rating of health knowledge is above average or excellent	69.3%
Lifestyle		
Low Overall Physical Health	Self-rating of overall physical health is poor or fair	11.0%
Medium Overall Physical Health	Self-rating of overall physical health is average	31.2%
High Overall Physical Health	Self-rating of overall physical health is above average or excellent	57.7%
Low Level of Physical Activity	Self-rating of physical activity is poor or fair	22.7%
Medium Level of Physical Activity	Self-rating of physical activity is average	33.1%
High Level of Physical Activity	Self-rating of physical activity is above average or excellent	44.2%
Exercise Lifestyle	Percent who indicate exercise is a part of their lifestyle	76.7%
TV	Number of hours the respondent watches TV per day	1.96 (1.76)
Importance of Convenience	Rated importance of convenience on food choice as important or higher	44.8%
Importance of Ecology/Animal Rights	Rated importance of ecology/ animal rights on food choice as important or higher	6.1%
Importance of Health	Rated importance of health on food choice as important or higher	52.8%
Importance of Price	Rated importance of price on food choice as important or higher	54.0%
Importance of Color, Taste, Smell	Rated importance of color/taste/smell on food choice as important or higher	65.0%
Importance of Pleasure	Rated importance of pleasure on food choice as important or higher	55.2%
Importance of Packaging	Rated importance of packaging on food choice as important or higher	9.8%
Importance of Newness of Product	Rated importance of newness on food choice as important or higher	33.7%
Importance of Organic	Rated importance of organic on food choice as important or higher	10.4%
Importance of Seasonality	Rated importance of seasonality on food choice as important or higher	20.9%
Importance of Perishability	Rated importance of perishability on food choice as important or higher	32.5%
Low Nutritional Quality	Self - rating of nutritional quality of diet is poor or fair	14.7%
Medium Nutritional Quality	Self - rating of nutritional quality of diet is average	37.4%
High Nutritional Quality	Self - rating of nutritional quality of diet is above average or excellent	47.8%

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A Multi-Store Auction to Measure Willingness-to-Pay for Organic and Local Blueberries[1]

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Abstract

There are various types of marketing outlets that feature food with different attributes and quality. We conduct a series of BDM auctions at multiple marketing outlets (price-conscious grocery stores, quality-focused grocery stores and farmers' markets), to elicit consumers' willingness-to-pay for organic and local blueberries. The results show that consumers' attitudes and their reported valuation of organic and local production of blueberries vary across different types of marketing outlets. Specifically, auction participants at the quality-focused stores and farmers' markets have higher WTPs for local blueberries while participants at the quality-focused store have higher WTPs for organic blueberries than price-conscious stores. Additionally, in the multivariate regression, we find the impact of the two store types (quality-focused store and farmers' market) on the price premium of organic/local to be equal.

Keywords: BDM auction, Multi-store auction, willingness-to-pay

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Introduction

The Becker-DeGroot-Marschak auction (BDM) (Becker, Degroot, and Marschak, 1964) is an auction format used at point-of-purchase locations, such as grocery stores. It is widely applied to elicit consumers' perception of food (Wertenbroch and Skiera 2002, Carrigan and Rousu 2008, Silva et al. 2007, Rozan, Stenger, and Willinger 2004, Rousu et al. 2005 and Lusk et al. 2001, etc.). The experimental auctions conducted at shopping locations provide participants with a more realistic choice situation (Carson et al. 1994).

In the literature, most of the auction locations at grocery stores or a marketing outlet were randomly picked by the researchers. For example, in Lusk et al. (2001) and Corrigan and Rousu (2008), the auction locations were at urban retail grocery stores. Lusk and Fox (2003) conducted the auction at the convenience store and bakery on a university campus. However, most researchers provided little to no explanation about how they chose their locations for BDM auctions. Another relevant issue is that the auction location was usually limited to only one type of marketing outlets in the literature, whereas many types of marketing outlets are available.

Among different types of marketing outlets, consumers' expectation varies significantly regarding food quality, availability, store atmosphere, and price ranges. For example, Wolf (1997) concluded that consumers perceived farmers' market produce as fresher looking, fresher tasting, of higher quality and better money value than supermarket produce. Wolf, Spittler, and Ahern (2005) found that consumers attended farmers' markets primarily for high-quality products. Zhu, Singh, and Dukes (2006) concluded that discount stores tended to attract more price sensitive consumers. On the other hand, consumers' selection of different types of store might be an indicator of their preferences and attitudes. Specifically, consumers who like organic food may be more likely to go to a quality-focused grocery store that features organic food, or to marketing outlets like farmers' markets. Consumers who like locally produced food might be frequent shoppers at a farmers' market. Thus, aggregating data of different retail formats might lead to incorrect demand analysis results due to customer self-selection (Hansen and Singh, 2009).

Therefore, one question of interest in this study would be the impact of BDM auction locations on willingness-to-pay (WTP) estimates. To be more specific, using a case of organic and local blueberries, we are interested in whether consumers shopping at farmers' markets are willing to pay more for local food than traditional supermarket shoppers, and whether organic grocer consumers are willing to pay more for organic food than the other consumers. Additionally, do consumers shopping at farmers' markets consider local production of food as a more valuable attribute than organic production of food? Or, would the bids for organic food exceed the bids for locally produced food at a quality-focused grocery store?

The objective of this study is to estimate and compare consumers' valuation of organic and local blueberries from different types of retail stores. To achieve the objective, we conducted a series of BDM auctions at three different types of marketing outlets: price-conscious grocery stores that focus on delivering products at the lowest price, quality-focused grocery stores that focus on high quality food, and farmers' markets that feature locally produced food. Since to our knowledge, no studies have yet conducted auctions at different types of retail stores to compare

the results, our study would contribute to the literature by filling the gap and provide useful information for future auction studies.

Our results confirmed that the difference of store selection exists and could be driven by consumer characteristics. Such results indicate that the store types can be used to capture un-measurable attitude differences among consumers or as a criterion to classify different consumer groups. Moreover, our study brings attention to the issue of how WTP estimates are impacted by researchers' choice of auction locations.

Literature Review

While auctions in labs have been conducted widely to elicit consumers' perception on non-market goods (e.g., food safety or environment conservation), auctions in real contexts have been gaining popularity in empirical studies of consumer behavior and the elicitation of market goods. Field auctions have numerous advantages over lab auctions. For example, the target population can be easily captured and the point-of-purchase locations provide auction participants more realistic circumstances. Additionally, the compensation and recruiting fees are usually considerably less than a lab auction (Lust and Fox 2003, Lusk et al. 2001). Corrigan and Rousu (2008) suggested that participants understood the mechanism of BDM auctions, which supported the possibility of the unbiasedness of bids. Wertenbroch and Skiera (2002) also found no overbidding in BDM auctions.

The BDM auctions have been widely applied in literature. Lusk et al. (2001) examined consumer WTP values for a higher level of tenderness in beef steaks, and they conducted auction at three urban retail grocery stores that were owned by large regional chain in the Midwestern area. Corrigan and Rousu (2008) tested whether field auction provide an unbiased WTP estimate at two grocery stores owned by Weis Markets chain in Pennsylvania. Lusk and Fox (2003) conducted the auction for new cookies at the convenience store and bakery on a university campus. In Silva et al. (2007), the auction for grapefruit took place at selected grocery stores in College Station, Texas. However, most studies picked auction locations by researchers with little information about how the auction locations were chosen. Moreover, even though some studies explained the location choices (e.g., Rousu et al. 2005), the experiments were usually conducted at only one type of marketing outlet.

Previous studies have provided some insights. Darden and Schwinghammer (1985) found that quality perception depended on store format. Wolf (1997) compared produce at farmers' markets versus supermarkets, and he concluded that consumers perceived farmers' market produce as fresher looking and tasting, of higher quality and better money value. Wolf, Spittler, and Ahern (2005) found that the primary reason to shop at farmers' markets was for high-quality products. On the other hand, different store selection would be related to different consumer characteristics. For example, Wolf (1997) found demographic differences between consumers shopping at farmers' market and general produce purchasers. Wolf, Spittler, and Ahern (2005) found that farmers' market consumers were more likely to be married, female, and have postgraduate degree. Zhu, Singh, and Dukes (2006) found that price sensitive consumers were more likely shop at discount stores.

Our study would contribute the auction literature by conducting field experiments using a multi-store auction approach, and the results will reveal the importance of store selection in auction experiments.

Auction Procedure

This study used four types of blueberries in auction: organic and locally produced blueberries, organic blueberries produced in the U.S., conventional blueberries produced in the U.S., and conventional and locally produced blueberries. Before the auction, each auction participant received an instruction sheet with detailed auction procedure. After they read the instructions, the auctioneer explained the auction procedure and answered any auction-related questions from the participants.

The auction procedure involved four steps:

1. The auctioneer endowed each participant with $7 cash and told the participants that the cash could be used to pay for the blueberries if they won the auction or was theirs to keep if they did not win. Then each participant was asked to write down his/her bids for the four types of blueberries simultaneously, which were in one-pint clamshell packages. The auctioneer told the participants that their bids should be exactly equal to their willingness-to-pay for the blueberry packages.

2. After the participants placed the bids, they were asked to randomly draw a letter, which indicated the blueberry type, to determine which blueberry package was actually auctioned. Therefore, the participants only had the opportunity to "win" one type of blueberries.

3. After the auctioned blueberry type was determined, participants drew a random price.

4. If a participant's bid for the selected blueberries was higher than the randomly drawn price, the participant "won" the auction and purchased the blueberries at the price he/she drew. If a participant's bid for the selected blueberries was lower than the randomly drawn price, the participant did not "win" the auction and therefore did not purchase the blueberries.

Data and Model

Data were collected in July and August 2011 in Pittsburgh, Pennsylvania and Orlando, Florida. In each city, a price-conscious grocery store, a quality-focused grocery store and a farmers' market were selected. There were approximately 70 observations collected in each location and the total number of qualified observations was 356. The auctions were conducted at the entrances to the grocery stores and at the front of the farmers' markets. Shoppers approaching the stores/markets were randomly stopped and invited to participate in an experiment about blueberry consumption. Qualified shoppers (adult, main grocery shoppers in the households, blueberry consumers without food allergies) were given a questionnaire about purchase intention, demographics etc. to complete, and the auction was conducted afterwards.

The partial bids, which are derived from the full bids, are calculated as the estimates of WTP for organic and local blueberries (Alfnes and Rickertsen, 2003; Huffman et al., 2003). The partial bids for organic blueberries are calculated as (OLbid+ONbid-CLbid-CNbid)/2, where OLbid, ONbid, CLbid, and CNbid indicate bids for organic local blueberries, organic U.S. produced blueberries, conventional local blueberries, and conventional U.S. produced blueberries, respectively. Similarly, the partial bids for local blueberries are calculated as (OLbid+CLbid-ONbid-CNbid)/2.

To further explore the impacts of auction locations as well as demographics on the partial bids, a multivariate regression is used, and can be specified as follows:

$$(1)\ WTP_{iorg} = \beta_0 + \beta_1 X_i + \beta_2 FM_i + \beta_3 Qualityfocused_i + \beta_4 Florida_i + \varepsilon_i$$

$$(2)\ WTP_{ilocal} = \gamma_0 + \gamma_1 X_i + \gamma_2 FM_i + \gamma_3 Qualityfocused_i + \gamma_4 Florida_i + \tau_i$$

X_i is the vector of independent variables including demographics and attitude information.

The demographics describe age, gender, income, education level and the number of children in the household. The attitude independent variables include how well the participants like fresh blueberries and whether they agree to the statement "Organic blueberries are healthier than other blueberries". FM_i and $Qualityfocused_i$ are dummy variables indicating store types and $Florida_i$ indicates Florida auction participants. For identification purpose, price-conscious store and Pennsylvania are omitted. ε_i and τ_i are error terms. Correlation between WTPs for organic and local is allowed.

Results

The summary of participant demographics at each marketing outlet is shown in Table 1. Demographics differ by location, with the price-conscious marketing outlet featuring consumers who tended to be younger, had lower income, had a lower education level, and were more likely to be Black or African American. They also tended to have more children than consumers at the other two marketing outlets. The participants at the farmers' markets had the highest average income and education level. The variation in demographics at different marketing outlets indicates that the different bids may occur at different locations.

Summary statistics of the bids for the four types of blueberries at each marketing outlet are shown in Table 2. Significant differences are listed in the last row. Farmers' markets have higher bids for conventional local blueberries (CLbid) than price-conscious stores. Both farmers' markets and quality-focused stores have higher bids for organic U.S. produced (ONbid) and organic local blueberries (OLbid) than price-conscious stores. The reason why consumers at farmers' markets also have higher bids for organic fruit might be that those who shop at farmers' markets generally have higher quality demand for food and some of them are trying to buy organic food at farmers' markets. No significant differences are found between store types in the bids for conventional U.S. produced blueberries (CNbid). This result indicates that the differences between store types in the bids for the other types of blueberries are due to attitude difference toward those value-added attributes.

Table 1. Demographics of Participants at Each Marketing Outlet

Independent Variables	Price-Conscious	Farmers' Market	Quality-Focused
Female	79.41%	69.05%	78.13%
Age	40	45	50
Caucasian	38.24%	80.16%	82.81%
Hispanic	3.92%	2.38%	4.69%
Asian	1.96%	3.17%	2.34%
Black or African American	49.02%	5.56%	7.81%
Other races	6.86%	8.73%	2.34%
Income($34,999 or below)	46.08%	23.02%	18.75%
Income($35,000-$99,999)	44.12%	43.65%	47.66%
Income($100,000 or above)	6.86%	30.95%	28.91%
Income(don't know)	2.94%	2.38%	4.69%
College 4-year degree + post-graduate	20.59%	58.73%	53.13%
Some college-including 2-year degree	39.21%	30.95%	33.59%
High school degree or less	40.20%	10.32%	13.28%
No child at home	43.14%	69.84%	69.53%
One or two children	42.16%	25.40%	25.00%
More than two children	14.71%	4.76%	5.47%

Note: The median of age is used.

Table 2. Summary Statistics of Bids for Blueberries

Store Types	Organic Local ($)	Conventional Local ($)	Organic U.S. Produced ($)	Conventional U.S. produced ($)
Price-conscious stores (1)	2.93 (1.71)	2.64 (1.25)	2.85 (1.67)	2.59 (1.27)
Farmers' market (2)	4.13 (1.73)	3.39 (1.35)	3.43 (1.54)	2.79 (1.30)
Quality-focused stores (3)	3.89 (1.51)	3.04 (1.26)	3.63 (1.50)	2.61 (1.29)
Significant difference (5% level) Bonferroni test)	(2)>(1) (3)>(1)	(2)>(1)	(2)>(1) (3)>(1)	

Note: The numbers in the parenthesis are standard errors.

In the survey before the auction, information on attitudes toward organic and local fruits was collected. Significant differences are found among the answers from shoppers at different locations. Specifically, shoppers at the quality-focused grocery stores demonstrate more trust in organic fruits than shoppers at the price-conscious grocery stores. They are more likely to agree to a statement that they will pay more for fruits with an organic label than shoppers at the price-

conscious grocery stores (on a 5-point Likert scale). Shoppers from the farmers' markets are generally more likely to indicate that they will purchase local blueberries than consumers from the other two store types (on a 5-point Likert scale).

The means and standard deviations of partial bids for organic and local blueberries at different marketing outlets are shown in Table 3. According to the Bonferroni multiple comparison test, shoppers at the quality-focused stores, which are known for selling organic food, have higher partial bids for organic blueberries than shoppers at the price-conscious grocery stores. There is no significant difference between the partial bids for organic from shoppers at the quality-focused stores and those at the farmers' markets. For local blueberries, participants at the farmers' markets have the highest partial bids among the three marketing outlets and the price-conscious stores have the lowest partial bids. The results are consistent with our expectation that the experiments will yield higher WTP estimates for organic blueberries at quality-focused grocery stores than price-conscious grocery stores and higher WTP estimates for local blueberries at farmers' market than the other marketing outlets. Additionally, the partial bids for organic blueberries are larger than the partial bids for local blueberries, no matter where the auction was conducted. This indicates that consumers generally consider the organic production of blueberries a more important attribute than production location (when comparing local to imported blueberries). The partial bids for organic blueberries have smaller coefficients of variation (COV) than those for local blueberries at price-conscious stores and quality-focused stores. However, the relationship reverses at farmers' markets. This indicates that at farmers' markets, consumers' attitudes toward the local production of blueberries are more consistent than their attitudes toward organic blueberries while the attitudes toward local are more diversified at the other two types of stores.

Table 3. Partial Bids at Different Locations

Store Type	Partial Bids for Organic			Partial Bids for Local		
	Mean($)	Std. Dev	COV	Mean($)	Std. Dev	COV
Price-conscious (1)	0.28	1.21	4.32	0.07	0.74	23.53
Farmers' market (2)	0.69	1.15	1.67	0.65	0.98	1.50
Quality-focused (3)	0.94	1.53	1.62	0.34	0.77	2.25
Significant difference (5% level) (Bonferroni test)	(3)>(1)			(2)>(3)>(1)		

Multivariate Regression for WTP Estimates

The multivariate regression is used because the partial bids have both positive and negative signs and there is correlation between WTPs for organic and WTPs for local (The Pearson correlation is 0.113 with significance level=0.035). The estimation results are shown in Table 4. Results show that older consumers were willing to pay less for both local and organic blueberries than younger consumers. For local blueberries, the dummy variables representing the locations of the auction are significant, indicating that after demographics are controlled, the partial bids for local at farmers' markets and quality-focused stores are still higher than those at price-conscious stores (All the independent variables have a VIF < 2.5, so we exclude potential collinearity between auction location and demographics as a problem in the regression). Therefore, quality-focused store shoppers also have a preference for locally produced fruit though the WTP estimates for local at farmers' markets are the highest among the three locations. As expected, the participants

who believe that organic blueberries are healthier than conventional blueberries are willing to pay more for organic than the other participants. Females generally place more emphasis on organic production than males. Surprisingly, college education or above has a negative impact on the price premium consumers are willing to pay for organic production. As for store types, both quality-focused stores and farmers' markets (significant at 10% level) shoppers give significantly higher WTPs than the price-conscious stores shoppers. This indicates that consumers shopping at farmers' markets, which feature in selling locally produced food, are also willing to pay more for organic fruit.

We further test the attitude difference toward organic and local in each of the specialized market outlets. The null hypothesis (H_0) is specified as: *[wlocal]fmarket =[worg]fmarket* and *[wlocal]highend =[worg]highend*. The F test result shows that there is no significant difference found between the attitudes toward organic and local in each of the two marketing outlets.

Table 4. Multivariate Regression for Partial Bids

Independent Variables	Local			Organic		
	Coef.	Std. Err.	P>t	Coef.	Std. Err.	P>t
Age	-0.014**	0.003	0.000	-0.011**	0.005	0.019
Female	-0.017	0.107	0.874	0.282*	0.161	0.081
Income	0.000	0.001	0.642	0.001	0.001	0.483
College or above	0.101	0.135	0.456	-0.358*	0.202	0.077
Some college	0.195	0.129	0.133	-0.210	0.194	0.280
child	-0.054	0.046	0.239	0.054	0.068	0.428
Florida	-0.051	0.093	0.583	-0.018	0.139	0.896
Like	-0.010	0.066	0.883	0.032	0.099	0.749
Farmers' market	0.580**	0.135	0.000	0.345*	0.202	0.088
Quality-focused	0.390**	0.133	0.004	0.619**	0.198	0.002
Health	0.043	0.093	0.639	0.827**	0.139	0.000
Intercept	0.632*	0.346	0.069	0.181	0.518	0.727
Model Fitting Statistics						
Number of Observation	328			328		
R-squared	0.137			0.174		
Prob > F	0.000			0.000		
Test of Equality of Attitudes						
H_0	F (1,316)			P-Value		
[wlocal]fmarket =[worg]fmarket	1			0.318		
[wlocal]highend =[worg]highend	0.99			0.320		

Note. Dummies for male, Pennsylvania, education level high school or below college and price-conscious store type are omitted for identification; Like: How well the participant likes fresh blueberries (1=dislike very much; 5=like very much); Child: Number of children at home. Health: =1 if the participant agrees to the statement "Organic blueberries are healthier than other blueberries"; =0 if otherwise. ** indicates significance at 5% level. * indicates significance at 10% level.

Conclusions

We conducted a series of BDM auctions at three different types of marketing outlets to elicit consumers' preference for organic and locally produced blueberries. The auctions were conducted at price-conscious grocery stores, farmers' markets and quality-focused grocery stores to determine the differences in bids at different marketing outlets.

Our data show that there are differences in demographics of consumers, as well as their attitudes toward organic and local production of fruits across different marketing outlets. Partial bids for "organic" and "local" are significantly different across different marketing outlets. Specifically, consumers at the farmers' markets and the quality-focused stores had higher partial bids for local blueberries while consumers at the quality-focused stores had higher partial bids for organic blueberries than consumers at the price-conscious stores. In the multivariate regression, we find that consumer attitudes toward these two value-added food attributes do not demonstrate significant differences between farmers' markets and quality-focused stores.

The results indicate that if the auction was conducted at only one type of marketing outlet, the WTPs might be underestimated or overestimated. Specifically, if the research topic is to measure how consumers value organic food, the choice of a relatively low-end grocery store might give the researchers lower-than-average WTP estimates. Similarly, if a BDM auction is conducted at a farmers' market, the WTP estimates for local might be above average. Considering the relatively low explanatory power of demographic information in our regression results, we argue that store type might be an alternative market segmentation tool than demographic information and can provide researchers with valuable attitude indicators. People's valuation is difficult to measure. However, by observing how they behave (e.g., which type of store they go), we can easily tell the difference in valuation since behavior is driven by attitudes and perception. Therefore, for studies focusing on value-added food attributes, although BDM auctions in grocery stores provide the auction participants point-of-purchase situations, researchers might have segmented the consumers unintentionally by choosing a single type of grocery store. Our studies put forward the importance of location choices, which might be another interesting topic for future studies on value elicitation with BDM auctions.

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The Impact of Neighborhood Income on the Cost of Energy-Dense and Nutrient-Dense Foods in Supermarkets

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Abstract

Prices of 14 nutrient-dense and energy-dense food items were collected at full-service grocery stores in 2009. Using econometric models that included both supply and demand factors, analysis was conducted to determine whether income and demographic variables had differential impacts on the pricing of energy-dense versus nutrient-dense foods. Results showed that the store's being part of a supercenter was the most important pricing determinant for both food types. All other independent variables were significant for only one to three food items. Very limited statistical evidence was found to support neighborhood per-household income having differential impacts on nutrient-dense versus energy-dense food pricing.

Keywords: food deserts, poverty, nutrition

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Introduction

Poor diet quality of low-income consumers has historically been a worldwide policy concern (Garcia and Pinstrup-Anderson 1987; von Braun et al. 1992). A number of U.S. government programs such as the Supplemental Nutrition Assistance Program (SNAP) child nutrition programs, of which the National School Lunch Program and the School Breakfast Program are a part, have sought to alleviate the impacts of this problem on children. Some posit that low diet quality among the poor has resulted in large part because increased diet quality often results in higher food costs: energy-dense, nutrient-poor foods are generally lower-cost per kilocalorie (kcal) than nutrient-dense, energy-poor foods (Monsivais and Drewnowski 2009). The results of higher costs for healthy foods on a per kcal basis have recently been verified, but have also been found to be dependent on the metric utilized to measure the costs of foods. Specifically, on an average portion size measure, many healthy foods such as fruit, vegetables and dairy cost less than more energy-dense, less healthy food items, such as soft drinks and chips, that are high in saturated fatty acids, sodium, or added sugars (Carlson and Frazão 2012).

A number of studies have sought to determine patterns in grocery store pricing by neighborhood, focusing almost exclusively on affordability of food items that could be used to meet the Dietary Guidelines for Americans (e.g., Hatzenbuehler, Gillespie, and O'Neil 2012; subsequently referenced as HGO 2012). These studies have generally investigated whether grocery stores in low-income areas charged higher or lower prices for foods than grocery stores in higher-income areas. Results have been mixed (Chung and Myers 1999; Hayes 2000). The authors are unaware, however, of studies that have analyzed the differential impacts of neighborhood income and other demographic variables on individual items within a subset of energy-dense and nutrient-dense foods. The objective of this study is to determine whether household income, other household demographic variables, and store characteristics explain the variation in prices of 14 selected commonly consumed foods, nine of which are considered "healthy" nutrient-dense foods, and five of which are considered less healthy energy-dense foods.

The question this study addresses is whether nutrient-dense foods are relatively less expensive in higher-income than in lower-income neighborhood grocery stores, and whether energy-dense foods are relatively less expensive in lower-income than in higher-income neighborhood grocery stores. This study differs significantly from HGO (2012), which used the same dataset but did not address differences in the pricing of nutrient-dense versus energy-dense foods by store neighborhood income levels. We are interested primarily in whether low-income people can purchase nutrient-dense and energy-dense foods for the same prices in the supermarkets located in their neighborhoods as in supermarkets in higher-income areas.

This question stems from observations made by the authors, as well as consideration of economic theory. During surveys of grocery stores in lower-income areas, reduced-price specials were often observed for energy-dense foods, with displays prominently placed in easily accessible locations toward the front of the store. Cameron et al. (2012) showed that, in Melbourne, Australia, shelf space devoted to selected energy-dense snack foods relative to fruits and vegetables was greater in socioeconomically disadvantaged areas. If demand for energy-dense foods were higher in low-income neighborhoods due to exogenous, non-price or demographic related factors such as tastes and preferences, then stores in those neighborhoods should be able to charge more for those foods. On the other hand, this situation may result in

stores running specials or generally charging lower prices on these foods, a marketing strategy to attract people into the store. The models we develop allow us to examine, for a limited set of items, whether energy-dense and nutrient-dense foods are priced differently based on neighborhood demographics, notably household income.

Background

Nutritional guidance has advocated the regular, sufficient consumption of foods such as whole grains, fruit, vegetables, lean meats, and low fat dairy, while limiting energy-dense, nutrient-poor foods (Dietary Guidelines for Americans, 2010). Energy-dense, nutrient-poor foods generally "provide excess energy relative to their nutrient value" (Briefel, Wilson, and Gleason 2009) and may be considered "competitive foods" – those that compete with nutrient-dense foods with regard to grocery consumer choices. Energy-dense foods are typically relatively high in energy, lipids, cholesterol, or added sugars; yet low in essential nutrients such as (i) vitamins A, B-6, B-12, C, D, E, and K; folate, choline, pantothenic acid, niacin, riboflavin, and thiamin; and (ii) minerals such as calcium, iron, magnesium, phosphorus, zinc, copper, manganese, and selenium. Nutrient-dense foods are relatively higher in vitamins and minerals and lower in energy, lipids, cholesterol, and sugars.

Literature Review

Previous studies have examined whether grocery stores in low-income areas charge higher prices for foods that could be used to meet dietary recommendations than stores in higher-income areas. The results have been mixed (Alcaly and Klevorick 1971; Kunreuther 1973; Hayes 2000). Studies finding lower food prices in low-income areas include Hayes (2000) and Andreyeva et al. (2008). Bell and Burlin (1993) and Chung and Meyers (1999) found higher grocery prices in low-income areas, but also differences in store type. Food prices have been lowest in chain stores and supercenters, with those stores being less available in lower-income urban areas (Bell and Burlin 1993; Chung and Meyers 1999; HGO 2012). HGO (2012) found that higher income areas have stores with both the lowest and highest prices, but mean prices in high and low income areas were not significantly different.

Studies have shown lower grocery store accessibility in rural areas (Kaufman 1999), which are often lower-income on average than urban and suburban areas, and there are also fewer chain stores in rural areas (Powell et al. 2007). MacDonald and Nelson (1991) found that urban grocery stores charged higher prices for food than suburban food stores, where there was more competition by warehouse stores. King, Leibtag, and Behl (2004) showed that, if grocery stores in lower-income neighborhoods charged more for food, the higher prices would not be the result of higher operating costs. In sum, a consistent finding has been that smaller stores charge higher prices for food (Goodman 1968; Kunreuther 1973; MacDonald and Nelson 1991; Bell and Burlin 1993; Kaufman et al. 1997; Chung and Meyers 1999; Woo et al. 2001) and chain and supercenter stores charge lower prices (Bell and Burlin 1993; Kaufman et al. 1997; Chung and Meyers 1999; Woo et al. 2001; HGO 2012). The aforementioned studies have focused primarily on the prices of either a subset of commonly purchased "healthy" foods or an aggregate market basket of "healthy" foods, unlike the present study, which addresses differences in pricing patterns among energy-dense, nutrient-poor and nutrient-dense, energy-poor foods. Though this study uses the

same data as HGO (2012), it addresses a different topic, specifically whether there are differential impacts of store neighborhood income on pricing of energy-dense versus nutrient-dense foods.

Data and Methods

Grocery Store Data Collection

Pricing data for 208 food items in 60 full-service grocery stores in the Baton Rouge, Louisiana, nine-parish metropolitan statistical area were collected in an on-site survey over a three-week period in January, 2009. The price data were collected by two faculty members, two graduate students and two staff members of the Louisiana State University Agricultural Center after a training session on data gathering methods. A variety of foods were included for pricing: (1) foods that were included in a two-week menu developed by Stewart (2006) to meet the 2005 Dietary Guidelines for Americans and that would appeal to Southern Louisiana consumers, (2) foods that were included in the "Recipes and Tips for Healthy, Thrifty Meals" (Thrifty Food Plan) menu developed by Pennsylvania State University with the USDA Center for Nutrition Policy and Promotion, and (3) foods that were reported to have been consumed during 24-hour dietary recalls with low-income women in Southern Louisiana (Smith 2002). Thus, included in the pricing survey were a variety of nutrient-dense food items such as fresh, canned, and frozen vegetables; fresh, canned, and frozen fruit; fresh and canned meats; whole-grain items; dairy products; and energy-dense items such as chips, snack cakes, ice cream, and others. A complete list of foods included in the survey is found in Hatzenbuehler (2010).

We limited our survey to full-service grocery stores (supermarkets) because it would be difficult if not impossible to purchase a market basket of foods to meet the Dietary Guidelines for Americans at most convenience stores. These stores rarely have extensive selections of the nutrient-dense foods such as the fresh fruit and vegetables that we are analyzing, so they do not apply to our analysis. Cameron et al. (2012) and Thornton et al. (2012) selected 35 supermarkets for their examinations of the availability of snack foods in Melbourne, Australia.

All six individuals who collected food price data were trained on how to record price data and conducted the first survey together. The survey form specified size and form of all food items for which a price was to be recorded. The lowest priced item was recorded, irrespective of brand, assuming all items of the same type and size to be of equal quality regardless of brand. This assumption would hold for most cases, though in cases of highly processed items, some variation might be found. We chose the lowest-priced items regardless of brand because they would be the most affordable for economizing consumers. For our purposes of nutritional equivalence, for instance, Store A's having a higher brand-name cola price than Store B would mean little if Store A had a lower-priced alternative cola brand of similar quality while Store B did not. For purposes of this study, where most of the nutrient-dense food items were in raw form (bananas, navel oranges, broccoli, carrots, red potatoes) or minimally processed (skim milk, chicken fryer) or a specific brand was priced (snack cakes), this should not pose major concerns for differential product quality. For the remaining items, whole-wheat bread, oatmeal, cola, fruit drink, potato chips, and vanilla ice cream, we argue that their nutritional contents are unlikely to vary greatly and low-income consumers, who generally have relatively higher own-price elasticities of

demand (Jones 1997), will choose the lower priced items. If a sale price was the lowest price, the sale price was recorded. In cases where the specified item size was unavailable in the store, the closest-sized item to the specified size was included and indicated on the survey form. Bulk items were not priced.

In addition to food prices, the following were also collected for each store: retail space of the store, measured by the surveyor (square feet); and additional services offered by the store, such as a salad bar, prepared hot meals, prepared salads, sliced meats, prepared baked goods, and an olive bar. United States census data were used to determine demographics of the neighborhoods in which the stores resided (2010 Census: Atlas: The Louisiana Statewide GIS). For these variables, the census tract value was used.

Selecting Food Items for Inclusion in the Analysis

Of the 208 items included in the in-store pricing survey, 14 were chosen for this analysis: nine nutrient-dense and five energy-dense foods. The foods included: fresh bananas (1-lb), loose navel oranges, fresh broccoli (head), whole carrots (1-lb bag), red potatoes (5-lb bag), whole wheat bread (loaf), oatmeal (18-oz box), 1-gallon fat-free milk, whole chicken fryer, snack cakes (box), 2-liter cola, 1-gallon fruit drink, regular potato chips (12-oz bag), and vanilla ice cream (1/2 gallon). These items were chosen as representative of foods that could be used not only as meal components, but also as snacks, i.e., bananas, broccoli, and carrots for "healthy" snacks and snack cakes, cola, and potato chips as energy-dense snacks. Furthermore, they are not strong complements with other food items such that another item would need to be purchased and they were available at most of the supermarkets. Our choices of energy-dense foods to analyze are consistent with Briefel, Wilson, and Gleason's (2009) listed examples of energy-dense foods: "sugar-sweetened beverages, salty/high-fat chips, high-fat baked goods, and desserts." The nutrient-dense foods are represented by fresh fruit, green vegetables, orange vegetables, starchy vegetables, grains, dairy, and meat. The energy-dense foods are represented by sodas, sweets, and salty snacks.

To compare and contrast the energy-dense and nutrient-dense foods, nutrient analyses of each of the selected food items are shown in Appendix B, Tables 1A-3A. Examining minerals and vitamins per 100g edible portion and per 100kcal, the nutrient-dense items are generally higher except for sodium. In terms of energy per 100g edible portion, the lowest of the nutrient-dense items is raw broccoli, at 28kcal, while the highest is whole wheat bread, at 247kcal. In comparison, the lowest of the energy-dense items is cola, at 37kcal, and the highest is potato chips, at 536kcal. Total lipids are generally higher for the energy-dense foods, with the exceptions of cola and fruit drinks. Sugars are generally higher for the energy-dense foods, with the exception of potato chips. Sodium is generally higher per 100g for the energy-dense foods, with the exceptions of cola and fruit drink (relatively low) and whole wheat bread (relatively high).

Table 1 presents estimates of nutrient density and energy density scores for each of the selected food items. Nutrient density scores are estimated according to Drewnowski's (2005) Naturally Nutrient Rich Score, which measures the average of the percentage daily values of the following 14 nutrients in 2000 kcal of food: protein, calcium, iron, vitamin A, vitamin C, thiamine,

riboflavin, vitamin B-12, folate, vitamin D, vitamin E, monounsaturated fat, potassium, and zinc. Limitations of nutrient density calculations are that there is no standard method; not all formulas include all healthful nutrients. For example, Drewnowski's (2005) formula does not include fiber and some formulas do not subtract nutrients that may be unhealthy if over-consumed, such as sodium and saturated fatty acids. Foods categorized as "nutrient-dense" generally have higher nutrient density scores, particularly navel oranges, raw broccoli, cooked broccoli, raw carrots, and cooked carrots. It is noted, however, that snack cakes also has a relatively "good" nutrient density score because the flour is enriched, which provides iron, folate, and other B vitamins. The potato chips also have among the highest nutrient density scores since they are high in monounsaturated fatty acids, potassium, and vitamin C. Both, however, also have among the highest energy-density scores in the group and are high in saturated fat as well as added sugar and/or sodium.

Table 1. Nutrient Density and Energy Density Scores, Selected Foods

Food Item	Nutrient Density Score	Energy Density Score
Nutrient-Dense Foods		
Banana	2.99	89
Naval Orange	12.79	49
Raw Broccoli	11.99	28
Cooked Broccoli	22.37	35
Raw Carrots	14.00	41
Cooked Carrots	13.43	35
Red Potatoes Cooked	5.43	78
Whole Wheat Bread	9.00	247
Oatmeal	2.09	71
Chicken Fryer	8.40	190
Fluid Fat Free Milk	4.59	34
Energy-Dense Foods		
Snack Cakes	9.25	247
Cola	0.08	37
Fruit Drink	0.09	64
Potato Chips	17.50	536
Vanilla Ice Cream	5.73	207

Energy density refers to the amount of energy in a given weight of food or beverages. It depends on the fat, fiber, and water content of the food. Energy density was defined as kcals per 100 grams of food / beverage consumed (2005 DGA Advisory Committee Report). Foods with the highest energy density scores include snack cakes, potato chips, and vanilla ice cream. Whole wheat bread also has a relatively high energy density score, though we categorize it as a nutrient-dense food because it is also relatively nutrient-dense and has relatively high fiber content, low added sugar, and low saturated fat. The nutrient density and energy density scores as shown illustrate some of the challenges in attempting to classify foods into these two categories,

particularly since existent nutrient density scores do not account for all healthful nutrients and it is possible for a food item to score relatively high for both nutrient density and energy density. Given the challenges, however, of classifying foods based upon imperfect scoring systems, our selection of energy-dense foods is consistent with Briefel, Wilson, and Gleason's (2009) definition of energy-dense foods and the 2010 Dietary Guidelines for Americans food components that are recommended to be reduced. The 2010 Dietary Guidelines for Americans recommends the reduction of items containing sodium, solid fats, added sugars, and refined grains, some or all of which our "energy-dense" foods include; these are listed as "foods and food items to reduce" in the guidelines. Furthermore, our categorization of "nutrient-dense" foods is consistent with the 2010 Dietary Guidelines categorization of "foods and food items to increase."

Examination of the selected energy-dense relative to nutrient-dense foods shows that they are relatively inexpensive on per-kcal bases (Table 2). Price/100g and price/kcal were calculated using average prices collected in the survey. Comparing the mean of the prices per 100g of the nine nutrient-dense items with the mean of the prices of the five energy-dense items, both were 32.8¢/100g. However, comparing the mean of the average prices per kcal, nutrient-dense foods cost more than energy-dense foods: 0.5¢/kcal versus 0.1¢/kcal, a finding that is consistent with Monsivais, Maclain, and Drewnowski (2010) and Carlson and Frazão (2012), which helps to explain why cash-constrained low-income people may opt for energy-dense, nutrient-poor foods as less expensive energy sources.

Table 2. Average Price per 100 Grams and Price per Kilocalorie, Selected Foods, 60 Surveyed Baton Rouge Grocery Stores

Item	Average Price of Edible Food (Cents / 100 Grams)	Average Price (Cents / Kilocalorie)
Nutrient-Dense Foods		
Bananas, Fresh	25.63	0.29
Naval Oranges, Fresh	49.95	1.02
Broccoli, Fresh	39.37	1.41
Carrots, Fresh	24.43	0.60
Red Potatoes, Fresh	16.01	0.21
Whole Wheat Bread	34.33	0.14
Oatmeal	31.17	0.44
Skim Milk	11.19	0.33
Chicken Fryer	62.76	0.33
Energy-Dense Foods		
Snack Cakes	48.64	0.12
Cola	5.50	0.15
Fruit Drink	4.85	0.08
Potato Chips	88.35	0.16
Vanilla Ice Cream	16.51	0.08

A Model to Estimate Food Price Drivers

To determine the impact of supply and demand factors on food prices, Equation (1) is estimated, where $Price_i$ is the price per unit of a food item in store *i,* for $i = 1...n$:

$$(1) \quad Price_i = f(MargCost_i, Competition_i, Demand_i),$$

where $MargCost_i$ represents store *i*'s marginal costs, which are supply factors such as store size and scope of services, $Competition_i$ is a measure of the extent of spatial market competition experienced by the store, and $Demand_i$ measures the impact of demand factors such as income and demographic characteristics on pricing. This equation is estimated using ordinary least squares regression. Since *Price* and *Competition* may be simultaneously determined, this raises the concern of endogeneity of *Competition* in the *Price* equation, and thus the likelihood of *Competition* being correlated with the error term in (1). Therefore, we used the Hausman (1978) test to determine whether endogeneity was present, including measures for population density and average household size as instruments. In no case was endogeneity found, suggesting that we can include our estimated measure for *Competition* directly in the model. In our models, heteroskedasticity-consistent robust standard errors are estimated. In addition to separate models for each food item, we sum the costs for each of the items within a group (nine nutrient-dense foods and five energy-dense foods) and estimate the impacts of *MargCost, Competition,* and *Demand* on the costs of the market baskets of both groups.

Independent Variables

Demand variables included in the model are *Income* ($\bar{X} = 45{,}392$), the median household income, divided by 1,000 for computational purposes, and *Black* ($\bar{X} = 0.39$), the portion of individuals self-identified as African American. These demand variables are included to explore the impacts of income and tastes and preferences of the population around the grocery store on food pricing. Marginal cost or supply variables included in the model are *High Real Estate Value* and *Low Real Estate Value* dummy variables, which are dummy variables that indicate whether average home values in the census tract where the grocery store is located are >$170,000 and <$124,000, respectively. The base includes home values between those two values, with the three categories divided as approximate tertiles of home values. These variables are used as proxies for fixed property costs of the grocery store. *Urban* ($\bar{X} = 0.88$) is included to control for transportation costs, as in Stewart and Davis (2005).

Other independent variables for supply are *Chain* ($\bar{X} = 0.38$), a discrete variable defined as the store being part of a firm owning and operating ≥11 stores (Marion et al. 1979); *Supercenter* ($\bar{X} = 0.18$), a discrete variable defined as "a very large discount department store that also sells a complete line of grocery merchandise"; *Services* ($\bar{X} = 3.08$), defined as the total number of the following included in the grocery store: salad bar, olive bar, prepared hot meals, prepared salads, full-service deli, and full-service bakery; and *Store Size* ($\bar{X} = 12{,}291$), defined as the number of square feet of retail space in the grocery store, divided by 1,000 for computational purposes. Supercenter and chain stores were expected to charge lower prices for food items (Kaufman et al. 1997; Woo et al. 2001; HGO 2012). Stores with more services have been found to charge higher food prices (MacDonald and Nelson 1991; Anderson 1993; and, King, Leibtag, and Behl 2004),

although HGO (2012) found lower costs for market baskets meeting the 2005 Dietary Guidelines for Americans and Thrifty Food Plan in stores with more services. Larger stores were also generally expected to charge lower food prices (MacDonald and Nelson 1991; Binkley and Connor 1998; Hayes 2000), though Anderson (1993) suggested that longer hours and higher utility costs increased the costs of larger stores, driving up food costs, and HGO (2012) found larger stores charged higher fruit prices.

Competition is a spatial competition gravity index variable, calculated as follows for each of the 60 surveyed stores:

$$(2) \quad Competition_{ij} = \sum_{j=1}^{n} \frac{Distance_{ij}}{(Distance_{ij})^2}$$

where *i* refers to the store of interest, *j* refers to other stores within a 10-mile radius of store *i*, and *n* is the number of stores within a 10-mile radius of store *i*. $Distance_{ij}$ is the distance in miles between stores *i* and *j*. Several full-service grocery stores in the Baton Rouge metropolitan statistical area were not surveyed; they were, however, included in calculations for $Competition_i$ if they were within a 10-mile radius of store *i*. Given this gravity model as calculated via equation (2), stores closer to store *i* become more heavily weighted than those further away, as they are considered to be more direct competitors. Blanchard and Matthews (2007) described areas outside a 10-mile radius of a store as having "low access;" thus stores outside a 10-mile radius were not considered competitors. Distances were measured using MapQuest to determine actual driving distances between stores. It is expected that competition reduces food prices in grocery stores.

The natural logs of continuous variables *Income, Black, Services, Store Size,* and *Competition* are used in the model, as are the natural logs of the prices of each of the food items, so the interpretation of the results is akin to an elasticity – percentage change in price with respect to a percentage change in the independent variable. *Chain, Supercenter, High Real Estate Value, Low Real Estate Value,* and *Urban* are dummy variables, so we do not use natural logs of these variables.

Examining the Relationship between Income and Ratios of Nutrient-Dense / Energy-Dense Food Prices

To further examine whether nutrient-dense and energy-dense foods were priced differently in neighborhoods with higher versus lower median household incomes, regression analysis was used in similar manner to that in Equation (1) except that the ratios of the prices of each of the nutrient-dense foods to the prices of each of the energy-dense foods served as the dependent variables, for a total of 9 nutrient-dense × 5 energy-dense = 45 regressions. The same independent variables were included in these models as were included in the individual pricing models. This allowed us to determine whether supply and demand factors including income influenced the relative pricing of nutrient-dense versus energy-dense foods.

One of the stores was a significant pricing outlier, specializing in higher-end and organic foods, so for all statistical analyses, 59 of the 60 stores were included (unless there were missing values

for a price, where fewer were analyzed). The pricing outlier store's inclusion in the analyses resulted in non-normal distributions of errors (HGO 2012).

Results

Table 3 (see Appendix A) shows individual food pricing model results for nutrient-dense and energy-dense foods. Multicollinearity did not appear to be influencing the data, as variance inflation factors were all <5 and no correlation coefficients for any of the independent variables were >0.75. Several of the models (carrots, potatoes, chicken fryer, snack cakes, and fruit drink) either had regression F values that were not significant at the $P \leq 0.10$ level or had no estimates that were significant at the $P \leq 0.10$ level; these results are not included in Table 3 and are not discussed, despite some of the ones with non-significant F values having one or two significant coefficients that were generally consistent in sign with those of the discussed analyses.

Results show limited impact of demand factors influencing the pricing of energy-dense foods, with grocery stores in higher-income neighborhoods charging more for potato chips and the market basket of energy-dense foods than grocery stores in lower-income neighborhoods. Results suggest that a 10% increase in income around the store increases the price of potato chips by 5.4% and the market basket of energy-dense foods by 2.4%. These results are generally consistent with studies that have found higher prices in higher-income areas (i.e., Hayes 2000) and inconsistent with those finding lower prices in higher-income areas (i.e., Chung and Myers, 1999). Grocery stores with higher percentages of African Americans residing in their neighborhoods charged more for oranges and ice cream.

Supply factors other than *Supercenter* generally had limited impact on pricing of either nutrient-dense or energy-dense foods. Stores in areas with high-valued real estate charged less for potato chips than stores in areas with medium-valued real estate. Furthermore, stores in areas with low-valued real estate charged more for the market basket of energy-dense foods than those located in areas with medium-valued real estate. Both results are inconsistent with expectations, given that assumed higher real estate values would lead to greater fixed costs for the stores. When we did not include real estate values in the models, the *Income* results did not change in sign or significance, so we cannot conclude that these values are serving as additional proxies for income level. Stores in urban areas charged less for skim milk and whole wheat bread than stores in rural areas, consistent with lower transportation costs for these stores to obtain goods, but more for oranges. Chain stores charged less for oranges, cola, and the market basket of energy-dense foods than non-chain, non-supercenter stores, consistent with results by HGO (2012), who found lower market basket costs in chain stores. Stores that provided more services charged less for whole-wheat bread, a result that would be consistent with economies of scope in grocery stores and consistent with HGO (2012), but inconsistent with the argument that greater services lead to greater costs to be spread over the full line of grocery items. Larger stores charged more for oranges, a result that is counter to expectations if economies of size lead to lower prices, but consistent with HGO (2012) results for fruit and Anderson's (1993) argument that these stores might be higher cost due to longer hours and higher utility costs.

Supercenter was the most important determinant of pricing, with supercenters charging less than non-supercenter stores for seven of the individual items: broccoli, whole wheat bread, oatmeal,

skim milk, cola, potato chips, and ice cream. Furthermore, supercenter stores charged less for the market baskets of both energy-dense and nutrient-dense foods. *Competition* was significant with the expected sign for bananas and for the market basket of energy-dense foods. Overall, with the exception of *Supercenter*, it would be ill-advised to draw final conclusions that any of the variables have significant impacts on grocery store pricing on the basis of our analysis since at most any of the other variables showed significant impacts on the pricing in three of the 11 regressions. Thus, the possibility of a making a type 1 error in concluding general impact is quite high in these cases. Noteworthy, however, is that *Income, Low Real Estate Value, Chain,* and *Competition* were significant in the energy-dense market basket analysis, with results that provide preliminary evidence of lower prices for energy-dense foods in lower income areas.

Of the regression analyses for the 45 nutrient-dense / energy-dense pricing ratios, only 27 were significant at the $P \leq 0.10$ level. These are the only regressions we include in our discussion of the following results. Though in a few cases some of the independent variables were significant in regressions that were not significant, they are not included in the percentages of positive and negative impacts we found, which are provided in Table 4. *Income* was significant for 26% of the regressions at $P \leq 0.10$, with 15 percent indicating that higher income resulted in relatively higher prices for nutrient-dense foods relative to energy-dense foods and 11 percent indicating the opposite. The positive results for income were for whole-wheat bread, potatoes, and oatmeal, all relative to snack cakes, and oatmeal relative to cola. The negative results were for skim milk and bananas relative to cola and bananas relative to potato chips. When the nutrient-dense market basket / energy-dense market basket cost ratio was analyzed, *Income* was non-significant. Considering that snack cakes, oatmeal, and cola are common to multiple cases and that there is no consistency in signs by income, we cannot infer a general relationship between income and differential pricing of nutrient-dense versus energy-dense foods.

Table 4. Summary of Results of Nutrient Dense / Energy-Dense Pricing Ratio Regression Models

	Percentage of β Estimates of the 27 Regressions Indicating Positive and Negative Influences at P≥0.10 on Price Ratios	
Independent Variable	Positive	Negative
Income	14.8	11.1
Black	0	18.5
High Real Estate Value	29.6	3.7
Low Real Estate Value	37.0	14.8
Urban	0	7.4
Chain	0	0
Supercenter	14.8	14.8
Services	3.7	0
Store Size	25.9	11.1
Competition	11.1	3.7

A summary of other results suggests that, for 19 percent of the cases, higher percentages of African Americans residing in a neighborhood resulted in relatively higher prices of energy-dense foods. Real estate values had significant impacts on price ratios, with mixed results. For 7 percent of the combinations, stores located in urban areas charged relatively higher prices for energy-dense foods relative to nutrient-dense foods. No relationship was found between chain

stores and nutrient-dense / energy-dense price ratios and for equal numbers of price ratios, supercenters charged higher or lower prices for nutrient-dense relative to energy-dense foods. Furthermore, for the nutrient-dense market basket cost relative to the energy-dense market basket cost, supercenters charged relatively higher prices for nutrient-dense foods relative to energy-dense foods when comparing to non-supercenter stores. For 26 percent of the cases, larger stores charged relatively more for nutrient-dense than energy-dense foods, while for 11 percent of the cases, the opposite was found. For 11 percent of the cases, stores with more competition charged relatively more for nutrient dense relative to energy-dense foods. Overall, no clear patterns of influence on pricing of nutrient-dense relative to energy-dense foods were found.

Conclusions and Observations

Previous research showing diet quality to be lower for low-income individuals coupled with observations of prominently-displayed specials of energy-dense foods in grocery stores in low-income Baton Rouge, Louisiana, neighborhoods led us to question whether there were differences in relative prices of energy-dense and nutrient-dense foods in grocery stores by neighborhood income. Furthermore, while a number of studies had examined nutrient-dense food pricing, none were found examining impacts of neighborhood demographics on energy-dense food pricing. Our results do not provide statistical evidence for consistent patterns of differential pricing of energy-dense and nutrient-dense foods by neighborhood income level. Of the 14 items tested, one energy-dense food and the market basket for energy-dense foods showed higher prices in higher-income neighborhoods than in lower-income neighborhoods. However, regression analysis of the ratios of nutrient-dense to energy-dense food prices with median neighborhood income level did not suggest a consistent pattern of differential pricing of these food types by neighborhood income level. Therefore, we cannot conclude that differential supermarket pricing exists for these food types by neighborhood income. From an industry perspective, inconclusive evidence of differential pricing of these food types by neighborhood income is not too surprising. This is because stores could either (1) use the generally lower-priced energy-dense foods to pull in more customers in low-income areas or (2) charge higher prices for the energy-dense foods that are in greater demand.

Consistent with HGO (2012) findings with market baskets that met the 2005 Dietary Guidelines for Americans and USDA's Thrifty Food Plan, the store's being a part of a supercenter appears to have the greatest influence on individual food item pricing, regardless of whether the food item is an energy-dense or nutrient-dense product. In seven of the 14 cases and for both energy-dense and nutrient-dense market baskets, supercenter stores charged lower prices than non-chain, non-supercenter stores. Thus, location near these stores appears to be the most important factor in having access to lower food prices regardless of nutrient or energy density. It appears that in cases where cities are attempting to attract grocery stores into low-income food desert areas, the high-volume supercenter stores will provide residents with the lowest-cost food, regardless of whether the foods are energy-dense or nutrient-dense.

Our results should not be interpreted as suggesting lower and upper-income individuals have equal access to competitively-priced nutrient-dense foods. This study did not address that issue, as the issue has already been addressed by others, such as HGO (2012), who showed fewer supermarkets in lower-income areas. In lower-income areas with fewer grocery stores, shoppers

may be more likely to frequent convenience stores, which are generally higher priced and unlikely to carry full selections of nutrient-dense foods such as those analyzed in this study. We must be clear, however, that our results hold only for full-service grocery stores. For fresh fruits and vegetables and some others, this is not a major limiting assumption since full-service grocery stores are the major places where these items are purchased. However, for foods that are more heavily processed, the assumption is a greater limitation, particularly given the recent expansion of "dollar" stores that carry food items.

In conducting this study, identifying foods we could agree upon as being categorized under "energy-dense" and "nutrient-dense" labels was generally not difficult. However, within-category nutrient density and energy density scores for those foods varied widely, such that some nutrient-dense (energy-dense) foods had higher energy density (nutrient-density) scores than some of the energy-dense (nutrient-dense) foods. Thus, examining only one of these scores without the other, and without further examining more specific nutrients of the foods could be misleading. Furthermore, for the subsets of nutrient-dense and energy-dense foods we studied, energy-dense foods had lower prices on per kcal bases, but not on per 100 g bases, than nutrient-dense foods. This supports recent studies showing that differences in food pricing between nutrient-dense and energy-dense foods depends upon the units by which the food is measured.

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Appendix A

Table 3. Regression Models for Pricing of Nutrient-Dense and Energy-Dense Foods

Variable	Banana 1 Pound	Orange 1 Pound	Oatmeal 18 Ounces	Skim Milk 1 Gallon	Brocolli 1 Pound	Whole Wheat Bread 20 Ounces
Intercept	1.771	-3.139	-3.898	-1.820*	-1.630	-0.800
	(2.590)	(2.199)	(3.395)	(0.969)	(2.013)	(2.842)
Income	-0.212	0.225	0.401	0.117	0.207	0.167
	(0.237)	(0.204)	(0.307)	(0.087)	(0.185)	(0.257)
Black	0.001	0.139***	-0.002	0.010	0.004	-0.013
	(0.034)	(0.041)	(0.063)	(0.022)	(0.032)	(0.052)
High Real Estate Value	0.125	0.056	-0.155	-0.053	-0.079	-0.139
	(0.099)	(0.145)	(0.146)	(0.042)	(0.102)	(0.151)
Low Real Estate Value	-0.046	0.066	0.159	0.032	0.011	0.041
	(0.053)	(0.122)	(0.128)	(0.043)	(0.071)	(0.147)
Urban	0.071	0.305**	-0.043	-0.142*	-0.088	-0.245*
	(0.072)	(0.134)	(0.119)	(0.071)	(0.091)	(0.140)
Chain	-0.014	-0.448***	-0.117	0.062	-0.048	-0.031
	(0.098)	(0.145)	(0.127)	(0.045)	(0.091)	(0.180)
Supercenter	-0.031	-0.104	-0.297**	-0.086**	-0.430***	-0.228*
	(0.069)	(0.129)	(0.114)	(0.037)	(0.079)	(0.130)
Services	0.017	-0.002	-0.001	-0.005	-0.003	-0.052*
	(0.024)	(0.018)	(0.025)	(0.010)	(0.018)	(0.031)
Store Size	0.014	0.212**	0.010	-0.019	0.012	-0.019
	(0.072)	(0.091)	(0.089)	(0.033)	(0.055)	(0.109)
Competition	-0.021*	-0.016	-0.014	0.008	-0.002	-2.20E-4
	(0.011)	(0.026)	(0.022)	(0.009)	(0.012)	(0.022)
Prob > F	0.008	0.000	0.006	0.001	0.000	0.036
R^2	0.128	0.358	0.206	0.326	0.424	0.220
Observations	59	58	58	59	59	58

Note. Food items, Income, Black, Services, Store Size, and Competition are specified as natural logs.

Table 3. *Continued.* Regression Models for Pricing of Nutrient-Dense and Energy-Dense Foods

Variable	Potato Chips 12 Ounces	Cola 2 Liter Bottle	Ice Cream Half Gallon	Energy-Dense Foods	Nutrient Dense Foods
Intercept	-4.120*	-2.057	-1.821	-0.429	0.712
	(2.386)	(2.457)	(2.055)	(1.466)	(1.501)
Income	0.543**	0.082	0.121	0.237*	0.143
	(0.215)	(0.225)	(0.186)	(0.131)	(0.138)
Black	0.193	0.045	0.050*	-0.033	0.010
	(0.047)	(0.034)	(0.026)	(0.024)	(0.028)
High Real Estate Value	-0.359***	-0.122	0.075	-0.080	-0.028
	(0.123)	(0.128)	(0.094)	(0.074)	(0.080)
Low Real Estate Value	0.045	-0.026	0.021	0.166**	0.046
	(0.097)	(0.096)	(0.068)	(0.068)	(0.057)
Urban	0.025	-0.066	-0.059	0.100	0.020
	(0.105)	(0.091)	(0.047)	(0.073)	(0.044)
Chain	-0.105	-0.365***	-0.089	-0.187*	-0.079
	(0.112)	(0.096)	(0.098)	(0.097)	(0.076)
Supercenter	-0.480***	-0.520***	-0.257***	-0.402***	-0.166**
	(0.105)	(0.120)	(0.080)	(0.083)	(0.062)
Services	-0.010	-0.027	-0.023	-0.024	0.007
	(0.028)	(0.021)	(0.021)	(0.025)	(0.016)
Store Size	-0.069	-0.019	0.075	0.028	0.039
	(0.073)	(0.085)	(0.050)	(0.054)	(0.047)
Competition	-0.025	-0.015	-0.015	-0.027**	-0.004
	(0.021)	(0.014)	(0.019)	(0.012)	(0.009)
Prob > F	0.000	0.000	0.018	0.000	0.070
Adjusted R^2	0.486	0.488	0.217	0.596	0.184
Observations	57	58	59	40	50

Note. Food items, Income, Black, Services, Store Size, and Competition are specified as natural logs.

Appendix B

Table A1. Nutrient Analyses of Fruit and Vegetables Used in the Analysis

	Raw Banana, 36% ref		**Raw Navel Oranges, 32% ref**		**Raw Broccoli[1]**		**Cooked Broccoli[2]**	
Nutrient	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal
Water (g)	74.91	84.17	85.97	175	90.69	323.89	89.25	255
Energy (kcal)	89	----	49	----	28	----	35	----
Protein (g)	1.09	1.22	0.91	1.84	2.98	10.64	2.38	6.8
Total lipid (g)	0.33	0.37	0.15	0.31	0.35	1.25	0.41	1.17
SFA (g)	0.11	0.12	0.1	0.2	0.05	0.18	0.08	0.23
MUFA (g)	0.03	0.03	0.03	0.06	0.02	0.07	0.04	0.11
PUFA (g)	0.07	0.08	0.03	0.06	0.17	0.61	0.17	0.49
Cholesterol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ash g	0.82	0.92	0.43	0.88	0.92	3.29	0.77	2.2
Carbohydrate (g)	22.84	25.66	12.54	25.59	5.24	18.71	7.18	20.51
Fiber (g)[4]	2.6	2.92	2.2	4.49	N/A	N/A	3.3	9.43
Sugars, Total (g)	12.23	13.74	8.50	17.35	N/A	N/A	1.39	3.97
Starch	5.38	6.55	0.00	0.00	N/A	N/A	0.00	0.00
Calcium (mg)	5	5.62	43	87.76	48	171.43	40	114.29
Iron (mg)	0.26	0.29	0.13	0.27	0.88	3.14	0.67	1.91
Magnesium (mg)	27	30.33	11	22.45	25	89.29	21	60
Phosphorus (mg)	22	24.72	23	46.94	66	235.71	67	191.43
Potassium (mg)	358	402.25	166	338.78	325.24	1160.71	293	837.14
Sodium (mg)	1.0	1.12	1	2.04	27	96.43	41	117.14
Zinc (mg)	0.15	0.17	0.08	0.16	0.40	1.43	0.45	1.29
Copper (mg)	0.08	0.09	0.04	0.08	0.05	0.18	0.06	0.17
Manganese (mg)	0.27	0.30	0.03	0.06	0.23	0.82	0.19	0.54
Selenium (mcg)	1.0	1.12	0.0	0.00	3.0	10.71	1.6	4.57
Vitamin C (mg)	8.7	9.78	59.1	0.01	93.2	332.86	64.9	185.43
Thiamin (mg)	0.03	0.03	0.07	0.14	0.07	0.25	0.06	0.17
Riboflavin (mg)	0.07	0.08	0.51	1.04	0.12	0.43	0.12	0.34
Niacin (mg)	0.67	0.75	0.43	0.88	0.64	2.29	0.55	1.57
Pantothenic acid (mg)	0.33	0.37	0.26	0.53	0.54	1.93	0.62	1.77
Vitamin B-6 (mg)	0.37	0.42	0.08	0.16	0.16	0.57	0.20	0.57
Folate (mcg_DFE)	20	22.47	34	69.39	71	253.57	108	308.57
Choline (mg)	9.8	11.01	8.4	17.14	N/A	N/A	40.1	114.57
Vitamin B-12 (mcg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vitamin A (mcg_RAE)	3	3.37	12	24.49	150	535.71	77	220
Vitamin E (mg)	0.10	0.11	0.15	0.31	N/A	N/A	1.45	4.14
Vitamin D (mcg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vitamin K (mcg)	0.5	0.56	0.00	0.00	N/A	N/A	141.1	403.14

Appendix Table A1 *Continued.* Nutrient Analyses of Fruit and Vegetables Used in the Analysis

	Raw Carrots, 11% refuse		**Cooked Carrots[2]**		**Cooked Red Potatoes[3]**	
Nutrient	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal
Water (g)	88.29	215.34	90.17	257.63	77.80	99.74
Energy (kcal)	41	----	35	----	78	----
Protein (g)	0.93	2.27	0.76	2.17	2.86	3.67
Total lipid (g)	0.24	0.59	0.18	0.51	0.10	0.13
SFA (g)	0.04	0.10	0.03	0.09	0.03	0.04
MUFA (g)	0.01	0.02	0.01	0.29	0.00	0.00
PUFA (g)	0.12	0.29	0.09	0.26	0.04	0.05
Cholesterol	0.00	0.00	0.00	0.00	0.00	0.00
Ash g	0.97	2.37	0.67	1.91	2.04	2.62
Carbohydrate (g)	9.58	23.37	8.22	23.49	17.21	22.06
Fiber (g)[4]	2.8	6.83	3.0	8.57	3.3	4.23
Sugars, Total (g)	4.74	11.56	3.45	9.86	N/A	N/A
Starch	1.43	3.49	0.17	0.49	N/A	N/A
Calcium (mg)	33	80.49	30	85.71	45	57.69
Iron (mg)	0.30	0.73	0.34	0.97	6.07	7.78
Magnesium (mg)	12	29.27	10	28.57	30	38.46
Phosphorus (mg)	35	85.37	30	85.71	54	69.23
Potassium (mg)	320	780.49	235	674.43	407	521.79
Sodium (mg)	69	168.29	58	165.71	14	17.95
Zinc (mg)	0.24	0.59	0.20	0.57	0.44	0.56
Copper (mg)	0.05	0.12	0.02	0.06	0.88	1.13
Manganese (mg)	0.14	0.34	0.16	0.46	1.34	1.72
Selenium (mcg)	0.1	0.24	0.7	2	0.3	0.38
Vitamin C (mg)	5.9	14.39	3.6	10.29	5.2	6.67
Thiamin (mg)	0.07	0.17	0.07	0.2	0.03	0.04
Riboflavin (mg)	0.06	0.15	0.04	0.11	0.04	0.05
Niacin (mg)	0.98	2.39	0.65	1.86	1.22	1.56
Pantothenic acid (mg)	0.27	0.66	0.23	0.66	0.36	0.46
Vitamin B-6 (mg)	0.14	0.34	0.15	0.43	0.24	0.31
Folate (mcg_DFE)	19	46.34	14	40	10	12.82
Choline (mg)	8.8	21.46	808	2308.57	N/A	N/A
Vitamin B-12 (mcg)	0.00	0.00	0.00	0.00	0.00	0.00
Vitamin A (mcg_RAE)	835	2036.59	852	2434.29	0.00	0.00
Vitamin E (mg)	0.66	1.61	1.03	2.94	N/A	N/A
Vitamin D (mcg)	0.00	0.00	0.00	0.00	0.00	0.00
Vitamin K (mcg)	13.2	32.20	13.7	39.14	N/A	N/A

Appendix Table 2A. Nutrient Analyses of Other Nutrient Dense Foods Used in the Analysis

	Bread, Whole Wheat[1]		**Oatmeal[2]**		**Chicken Fryer[3] 46% refuse[4]**		**Milk, Fluid, Skim[5]**	
Nutrient	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal
Water (g)	38.58	15.62	83.61	117.76	63.79	33.57	90.84	267.18
Energy (kcal)	247	----	71	----	190	----	34	----
Protein (g)	12.95	5.24	2.54	3.58	28.93	15.23	3.37	9.91
Total lipid (g)	3.35	1.36	1.52	2.14	7.41	3.9	0.08	0.24
SFA (g)	0.75	0.30	0.31	0.44	2.04	1.26	0.06	0.18
MUFA (g)	1.60	0.65	0.44	0.62	2.66	1.4	0.03	0.09
PUFA (g)	0.60	0.24	0.56	0.79	1.69	0.89	0.03	0.09
Cholesterol	0.00	0.00	0.00	0.00	89	46.84	2	5.88
Ash g	3.82	1.55	0.34	0.48	1.02	0.54	0.75	2.21
Carbohydrate (g)	41.29	16.72	12	16.90	0.00	0.00	4.96	13.79
Fiber (g)[4]	6.8	2.75	1.7	2.39	0.00	0.00	0.00	0.00
Sugars, Total (g)	5.57	2.26	0.27	0.38	0.00	0.00	5.09	14.97
Starch	N/A	N/A	11.60	16.34	0.00	0.00	N/A	N/A
Calcium (mg)	107	43.32	9.0	12.68	15	7.89	122	358.83
Iron (mg)	2.43	0.98	0.90	1.27	1.21	63.68	0.03	0.09
Magnesium (mg)	82	33.20	27	38.03	25	13.16	11	32.35
Phosphorus (mg)	202	81.78	77	108.45	195	1.03	101	297.06
Potassium (mg)	248	100.40	70	98.59	243	127.89	156	458.83
Sodium (mg)	472	191.09	4.0	5.63	86	45.26	42	123.53
Zinc (mg)	1.80	0.73	1.0	1.41	2.10	1.11	0.42	1.24
Copper (mg)	0.38	0.15	0.07	0.10	0.07	0.04	0.01	0.03
Manganese (mg)	2.14	0.87	0.58	0.82	0.02	0.01	0.00	0.00
Selenium (mcg)	40.3	16.32	5.4	7.61	22.0	11.58	3.1	9.12
Vitamin C (mg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thiamin (mg)	0.35	0.14	0.08	0.11	0.07	0.04	0.05	0.15
Riboflavin (mg)	0.22	0.09	0.02	0.03	0.18	0.09	0.18	0.53
Niacin (mg)	4.71	1.92	0.23	0.32	9.17	4.83	0.09	0.26
Pantothenic acid (mg)	0.69	0.03	0.31	0.44	1.10	0.58	0.36	1.06
Vitamin B-6 (mg)	0.21	0.09	0.01	0.01	0.47	0.25	0.37	1.09
Folate (mcg_DFE)	50	20.24	6	8.45	6	3.16	5	14.71
Choline (mg)	26.5	10.73	7.4	10.42	78.8	78.8	15.6	45.88
Vitamin B-12 (mcg)	0.00	0.00	0.00	0.00	0.33	0.17	0.50	1.47
Vitamin A (mcg_RAE)	0.00	0.00	0.00	0.00	16	8.42	61	179.41
Vitamin E (mg)	0.55	0.22	0.08	0.11	0.27	0.14	0.01	0.03
Vitamin D (mcg)	0.00	0.00	0.00	0.00	0.1	0.05	1.2	3.53
Vitamin K (mcg)	7.8	3.16	0.03	0.04	2.4	1.26	0.00	0.00

Appendix Table 3A. Nutrient Analyses of Energy-dense Food Items Used in the Analysis.

Nutrient	Chocolate[1] Chip Cookies		Snack Cakes		Cola[3]		Fruit Drink[4]		Chips, Potato[5]		Ice Cream, Vanilla	
	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal
Water (g)	6.48	1.37	13.61	3.36	90.31	244.08	83.87	131.05	1.9	0.35	61.00	29.47
Energy (kcal)	474	---	405	---	37	---	64	---	536	---	207	---
Protein (g)	5.12	1.08	4.80	1.19	0.07	0.19	0.00	0.00	7.0	1.31	3.50	1.69
Total lipid (g)	23.31	4.92	16.30	4.02	0.02	0.05	0.00	0.00	34.60	6.46	11.00	5.31
SFA (g)	9.95	2.10	4.23	1.04	0.00	0.00	0.00	0.00	5.43	1.01	6.79	3.28
MUFA (g)	7.28	1.54	8.97	2.21	0.00	0.00	0.00	0.00	18	3.36	2.97	1.43
PUFA (g)	2.68	0.57	2.26	0.56	0.00	0.00	0.00	0.00	9.16	1.71	0.45	0.22
Cholesterol	0.00	0.00	16.39	4.05	0.00	0.00	0.00	0.00	0.00	0.00	44	21.26
Ash g	1.23	0.26	1.30	0.32	0.04	0.11	0.10	0.16	3.6	0.67	0.90	0.43
Carbohydrate (g)	63.86	13.47	63.90	15.78	9.56	25.84	16.03	25.05	52.90	9.87	23.60	11.40
Fiber (g)[6]	2.4	0.51	2.13	0.53	0.00	0.00	0.00	0.00	4.8	0.90	0.7	0.34
Sugars, Total (g)	35.14	7.41	36.61	9.04	8.97	23.16	15.85	24.77	N/A	N/A	21.22	10.25
Starch	26.91	5.68	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calcium (mg)	26	5.49	29.51	7.29	2	5.41	3	4.69	24	4.48	128	61.84
Iron (mg)	3.2	0.68	2.25	0.56	0.11	0.00	0.00	0.00	1.63	0.30	0.09	0.04
Magnesium (mg)	39	8.23	31.15	7.69	0.00	0.00	1	1.56	67	12.5	14	6.76
Phosphorus (mg)	84	17.72	101.64	25.10	10	0.00	0.00	0.00	165	30.78	105	50.72
Potassium (mg)	147	31.01	149.18	36.83	2	5.41	31	48.44	1275	237.87	199	96.14
Sodium (mg)	344	72.57	249.18	61.53	4	10.81	36	56.25	594	110.82	80	38.65
Zinc (mg)	0.65	0.14	0.72	0.18	0.02	0.05	0.00	0.00	1.09	0.20	0.69	0.33
Copper (mg)	0.27	0.06	0.23	0.06	0.00	0.00	0.01	0.02	0.31	0.06	0.23	0.11
Manganese (mg)	0.37	0.08	0.13	0.03	0.00	0.00	N/A	N/A	0.44	0.08	0.01	0.00
Selenium (mcg)	4.0	0.84	6.23	1.54	0.1	0.27	0.00	0.00	8.1	1.51	1.8	0.87
Vitamin C (mg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.1	5.8	0.6	0.29
Thiamin (mg)	0.17	0.04	0.26	0.06	0.00	0.00	0.00	0.00	0.17	0.03	0.04	0.02
Riboflavin (mg)	0.15	0.03	0.21	0.05	0.00	0.00	0.00	0.00	0.20	0.04	0.24	0.12

Appendix Table 3A *Continued.* Nutrient Analyses of Energy-dense Food Items Used in the Analysis.

Nutrient	Chocolate[1] Chip Cookies		Snack Cakes		Cola[3]		Fruit Drink[4]		Chips, Potato[5]		Ice Cream, Vanilla	
	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal	Per 100 g edible portion	Per 100 kcal
Niacin (mg)	1.92	0.41	1.72	0.42	0.00	0.00	0.00	0.00	3.83	0.71	0.12	0.06
Pantothenic acid (mg)	0.25	0.05	0.54	0.13	0.00	0.00	N/A	N/A	0.40	0.07	0.58	0.28
Vitamin B-6 (mg)	0.03	0.01	0.34	0.08	0.00	0.00	0.00	0.00	0.66	0.12	0.05	0.02
Folate, (mcg_DFE)	69	14.56	72.13	17.81	0.00	0.00	0.00	0.00	45	8.40	5	2.42
Choline (mg)	17.1	3.61	10	2.47	0.3	0.81	0.00	0.00	N/A	N/A	26	12.56
Vitamin B-12 (mcg)	0.06	0.01	0.07	0.02	0.00	0.00	0.00	0.00	N/A	N/A	0.39	0.19
Vitamin A (mcg_RAE)	0.00	0.00	19.67	4.86	0.00	0.00	0.00	0.00	0.00	0.00	118	57.00
Vitamin E (mg)	2.24	0.47	0.15	0.04	0.00	0.00	0.00	0.00	N/A	N/A	0.30	0.14
Vitamin D (mcg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	N/A	0.20	0.10
Vitamin K (mcg)	5.2	1.10	6.56	1.62	0.00	0.00	0.00	0.00	N/A	N/A	0.3	0.14

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Comparing Consumer's Willingness to Pay for Conventional, Non-Certified Organic and Organic Milk from Small and Large Farms

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Abstract

Considering local milk, data from auction experiments was used to determine whether farm size affects consumer willingness to pay (WTP) for conventional, non-certified organic, and organic versions. Tobit models including socio-demographics and variables from the theory of planned behavior were used to examine WTP for each. While farm size was insignificant for each type, WTP for large farm non-certified organic was not higher than small farm conventional. Further, WTP for small farm non-certified organic was not significantly less than large farm organic. Small farms could potentially use these differences in attempts to compete with large farms.

Keywords: small farm, organic, conventional, non-certified organic, willingness to pay, milk

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Introduction

The U.S. Department of Agriculture (USDA) classifies 91% of farms as small, meaning having gross sales under $250,000 (Hoppe et al. 2010). Within this group, those with gross revenues under $50,000 constitute the vast majority, with the EPA reporting that less than 1 in 4 produce higher gross revenues (EPA 2013). For dairy, smaller operations also represent the majority with 67.7% owning less than 100 cows, 18.1% owning 100-199 cows, 7.8% having between 200 and 499 cows, and only 6.6% owning 500 or more cows (Hoard's Dairyman 2012). Actual dairy production though is dominated by large farms, accounting for approximately 86.4% of milk in the U.S., leaving small dairy operations with little market share despite their numbers (Progressive Dairyman 2012). This has created a difficult competitive position for small licensed dairy operations and their numbers have fallen from 131,509 in 1992 to 51,481 in 2011 (Hoard's Dairyman 2012). Dairy is thus following the typical farm trend of fewer, larger operations with the number of dairies overall declining 39% from 1998 to 2007 (Mosheim and Lovell 2009), and the average median for milking herds increasing from 140 cows in 1997 to 570 cows in 2007 (Hoppe et al. 2010, MacDonald et al. 2009).

The competition issues for small dairy farms are fueled by issues such as their typical lower efficiency and declining milk consumption. MacDonald et al. (2007) suggested significant economies of scale in dairy operations and noted that as herd size increases, average costs of production fall. This advantage for large farms helps them be more profitable than their smaller competitors, especially during adverse market conditions. As Barrett (2012) noted, profit margins on beverage milk are often low and sometimes negative profits are unavoidable. While these margins impact all dairy farms, larger ones are often better equipped to remain viable in such periods than small operations.

All dairy operations have needed to adjust for the decline in average per capita milk consumption. Consumption has fallen from 0.96 cup-equivalents per day in the 1970s to 0.61 and is expected to continue to decline as a new generation with a reduced demand enters the market (Stewart et al. 2013). Much of this change stems from consumers' increased desire for healthier and environmentally friendly foods, non-dairy options, and animal welfare considerations (Mosheim and Lovell 2009). A slow response to these changing consumer demands has begun lowering profit margins and endangering many dairy farms.

The rise in local and organic foods are two consumer demand trends that dairy farmers could take advantage of. The former has quickly risen from a small niche market to one that now may rival the latter in consumer interest. Local should be an especially inviting avenue for small operations in that consumers mostly view foods from outlets such as farmers markets' as being from smaller scale farms. Many consumers further view local as a way to help smaller farms, making it an area where their size may benefit them in competing with large dairies.

Organic is an option already pursued by several dairy farmers. In 2014 organic dairy sales reached $5.46 billion (McNeil 2015). However, the move to organic entails a certification cost that could be too high for many small operations. A related option would be to follow the organic standards and note they are being followed without becoming certified. While this would prevent

the use of the term organic[1], it still may be possible to achieve a premium for such milk, especially if sold locally or at a farmers market. If an extra premium for small farms existed for either of these types it could open a new avenue for them to be more competitive in the market.

The goal of this research was therefore to identify and compare willingness to pay (WTP) for local milk from a small dairy farm and a large dairy farm marketed as conventional, non-certified organic, and organic. Given their large numbers noted above and the risks they are under, small farms are here considered under $50,000 gross sales with large ones those over $250,000. This study will allow small milk producers to see if a "from a small farm" marketing focus could help them increase demand and profit margins, and large operations to better understand different possible premiums and how a small farm campaign could impact them on the local level. An accompanying goal was to determine for both farm sizes the premiums possible when moving either to non-certified organic from conventional, or from either of those to certified organic. If the non-certified organic claim is enough to increase consumer WTP, it could drastically cut certification costs, which may or may not benefit small farmers more.

Literature Review

Large vs. Small Farms

Consumers have very different perceptions of small and large farms. Large scale farms, including dairy, are generally viewed as having negative impacts on water, soil and air quality (Center for Food Safety 2013). In contrast Lohr (2012) noted consumers view small farms as the main drivers behind the growing "Buy Fresh-Buy Local" movement that they see as advantageous and as providers of fresher foods with more nutrients.

There is little known about consumer demand and premiums for milk produced on small versus large farms. Wolf et al. (2011) conducted a choice experiment to evaluate consumers' value for milk produced on a "family farm" with and without enhanced food safety labels. The results suggested a premium for a half gallon of milk produced on a family farm of $0.39 for milk with enhanced food safety claims, and a premium of $0.46 for milk without enhanced food safety claims, compared to that of no claims about the farm. Though they did not directly examine WTP for "small" versus "large" farms, 75% of the respondents stated that in their opinion the typical "family farm" was a smaller than average size operation (although most large farms are also family operated). This finding suggests that a similar premium may be found for milk produced on a farm specifically noted as small.

While approximately one in four small commercial farms show good financial returns (MacDonald et al. 2009), they still may be unable to fully compensate operators for the time they devote to the farm (Hoppe et al. 2010). MacDonald et al. (2007) stated that in 2005 dairy farms with at least 999 cows had average net profits of nearly $3 per cwt. of milk, those with 500-999 cows showed average net profits of $0.50 per cwt. of milk, but smaller dairy farms had negative net returns on average. Small dairy operations are clearly at a disadvantage and could benefit greatly from any potential premiums they can obtain by promoting their size.

Organic

[1] Dairy operations small enough to be exempt from requiring certification could still use the term organic.

Dairy products and beverages occupy the second largest segment in the organic foods market, following fruits and vegetables. While organic milk only represented approximately 4% of total milk sales in 2011, the amount has been growing rapidly (Huntrods and Schultz 2013). For example in 2005, when conventional milk sales were flat, organic dairy products had sales of $2.1 billion – a 23% increase from the previous year (USDA 2012a). The USDA National Organic Program (NOP) standards with respect to milk state that organic milk is (a) made from the milk of animals raised under organic management where cows are raised in a herd separate from conventional dairy cows, (b) animals are not given growth hormones or antibiotics, but can be given preventive medical care including vaccines and dietary, and (c) organic dairy cows must have access to pasture (NOP 2011).

There are many motivations for consumers to buy organic. Organic products are thought to have a better taste and be of higher quality and freshness (Fotopoulos and Krystallis 2002, O'Donovan and McCarthy 2002, Kalogeras et al. 2009). Organic products are regarded as being healthier and more nutritious for the consumer (Akaichi et. al. 2012, Fotopoulos and Krystallis 2002, O'Donovan and McCarty 2002, Roitner-Schobesberger et al. 2008). Consumers who are also concerned about animal welfare and environmental health prefer organic over conventional (O'Donovan and McCarthy 2002, Chen 2007, Roitner-Schobesberger et al. 2008, Whole Foods Market 2005).

Organic certification though comes at a high cost for farmers and can influence negatively small farmers' ability and willingness to participate in the certification program (Constance et al. 2008). CCOF, one of the certifiers for USDA organic, stated that for a small farm, the average certification for the first year is $700, and each additional year would cost between $300 and $500 (CCOF 2013). The National Organic Cost Share Program supplied producers who obtained USDA organic certification with a reimbursement of up to 75% of costs, not to exceed $750 per year (CFSA 2013). However, this funding ran out in 2013 leaving dairies with few options to aid with the costs of certification.

Non-Certified Organic

Due to the high cost of certification, the idea of producing and marketing foods as "non-certified organic" has gown. Constance et al. (2008) noted that both certified and non-certified organic farmers have claimed that the organic certification process has been complicated by the NOP standards. They state that each group agrees there is a better price premium when it comes to certified organic products, but disagree on the necessity of certification. Also, they found that certification seems unnecessary for non-certified organic producers (often small farmers or those selling at farmer's markets) who believe there is a level of trust between them and their customers. Campbell and Liepens (2001) noted that in New Zealand, some farmers dropped their certification due to rising fees and instead relied on the 'trust' system to market their non-certified organic products in local markets.

Constance et al. (2008) studied certified and non-certified organic farmers in Texas and found approximately half of certified producers brought in gross organic sales of $50,000 or more annually, whereas 55% of non-certified organic producers brought in less than $5,000. However, non-certified organic sales may continue to grow due to the increase in the development of farmers markets and local food avenues which reduce the need for certification due to the direct

connection between farmers and consumers (Lockie et al. 2004). Determining if non-certified organic would work well for small dairy farms selling in local markets was in part what this research was designed to examine.

Experimental Design and Data

A series of experimental auctions was conducted using consumers from the general population. Experimental auctions were chosen to elicit subjects' WTP since auctions use real products and real money to create a setting where participants have the greatest incentive to reveal their true values. The auctions were accompanied by surveys to obtain information on the subjects to be used in modeling their WTP.

Specifically, eleven sessions of economic experiments were conducted between July 28th and August 19th, 2010, with a total of 128 subjects. Subjects were recruited by handing out flyers at area supermarkets and during Ag Day, which is an annual University of Delaware event designed for the surrounding community, as well as through local classified ads and Craig's List. During recruiting, the experiment was described as a "food marketing study" to avoid mentioning phrases like local or organic that could influence people prior to their participation and the only requirement was that participants be over 18. Most subjects were from Northern Delaware with a few from nearby Maryland and Pennsylvania.

Each session lasted about one and a half hours and consisted of eight to nineteen subjects. Sessions were held in the Experimental Economics Laboratory for Policy and Behavioral Research at the University of Delaware. Each person received $45 for participation, minus the expense for purchasing food in the auctions if applicable. Within each session there were multiple rounds of questionnaires and food auctions. The entire experiment was conducted on computers using Qualtrics. To begin, subjects were asked to complete a questionnaire on their shopping habits and demographic information.

In the second part, the commonly employed incentive-compatible Vickrey fourth-price auction was used to collect WTP for each version of the food products from the subjects.[2] To be sure subjects grasped the principles and workings of the auction, there was a brief presentation explaining the optimal strategy of bidding your value and examples of potential problems if that strategy was not used. This was followed by a real money practice auction using induced values where each subject went against computer bidders. After making sure everyone understood the mechanism, the series of food auctions were conducted. For the milk products, three different local versions were auctioned (conventional, non-certified organic, and organic) for both large and small farms for a total of six auctions. The order of the products to bid on was randomized on people's screens to control for order effects.

As many studies have shown that information can influence WTP significantly (see for example Gifford and Bernard 2004, 2006) factual and neutral definitions for all the terms were provided to the subjects. Organic food was defined according to the USDA standards. Non-certified organic was explained as farmers having followed the requirements of organic but not having been certified. Farm size was defined as discussed earlier. For local food, no definition was provided, but the products were noted to have been purchased that day from relatively close by.

[2] Complete details of the experiment are available from the authors on request.

Subjects were informed that only one auction would be binding, and that the binding auction had been pre-determined and sealed in an envelope visible to all, following Bernard and Bernard (2009). The envelope was opened by a volunteer after the end of a session.

After the auctions, subjects were given another questionnaire that contained questions designed using the theory of planned behavior (TPB). As developed by Ajzen (1987, 1991), the TPB is a commonly used behavioral model for investigating the determinants of an individual's decisions. Components of it have been used on studies of the food industry, including purchasing fair trade grocery products, GM foods, and consumer choices of organic and local food (Sparks et al. 1995, Shaw et al. 2000; Michaelidou and Hassan 2008, Nurse et al. 2010). Elements here included purchasing behavior and perceptions, outcome beliefs and evaluations, and self-identity and norms.

To begin the TPB components, consumers' future purchase intentions were asked as these could be a good indicator of behavior and, correspondingly, a subjects' WTP. This was addressed alongside a question regarding past purchasing habits. To determine the role price may play in purchasing behavior, subjects were asked if they viewed organic foods as too expensive. These were accompanied by general perception questions regarding conventional and organic farming practices.

Two outcome belief questions were designed to examine whether consumers pay much attention to supporting small farms and sustainable practices, with the latter geared towards capturing some of the motivation for organic food purchases. These were paired with two outcome evaluation questions to determine if subjects believed their purchases could actually support these elements. Three self-identity items asked subjects to judge how they viewed themselves and their purchasing habits. Personal norm was also measured by three items. The first regarded a subject's own ethical feelings towards purchasing organic food. The second was regarding how buying organic makes the subject feel. To these, a newly proposed norm was added asking each subject if they felt an obligation to pay more for organic food.

The specific definitions and mean and standard deviations for these questions and all the other variables can be found in Table 1 (see Appendix). The average age of the participants was 39 years old with an income of $61,874.57. Caucasians were 77.3 percent of the sample while 6.3 percent were vegetarians, 37.3 percent had farming experience, 71.9 percent were the primary grocery shoppers for their household and 28.1 percent had children living in the household. Females and college educated consumers were slightly overrepresented at 57 percent for each category. The latter might be because the experiment was conducted in a college town.

Model and Hypotheses

Consumer bids were modeled using the variables described above. Given the restricted bid range from 0 to 10, a censored regression approach was needed for this analysis. The Tobit model was selected as it is commonly used in the literature and yields parameter estimates that are very easy to understand (see Lusk and Shogren (2007) for more details). Three Tobit models, one each for the bids on conventional, non-certified organic, and organic local milk. Modeling each separately allows for the clearest understanding of the factors influencing each, especially those from the

theory of planned behavior. All three were run using Stata (StataCorp. 2011) with the consistent form:

$$\begin{aligned} Bid_{ij} = {} & \beta_0 + \beta_1 \text{Small} + \beta_2 \text{Collegedeg} + \beta_3 \text{Caucasian} + \beta_4 \text{Children} + \beta_5 \text{Age} + \beta_6 \text{Income} \\ & + \beta_7 \text{Female} + \beta_8 \text{Vegetarian} + \beta_9 \text{Farmexp} + \beta_{10} \text{Primshopper} + \beta_{11} \text{Shopfarmmkt} \\ & + \beta_{12} \text{Pastpur} + \beta_{13} \text{Futpur} + \beta_{14} \text{Orgexp} + \beta_{15} \text{Confarmnw} + \beta_{16} \text{Confarmeff} \\ & + \beta_{17} \text{Importanceorg} + \beta_{18} \text{Confidenceorg} + \beta_{19} \text{Ifbuysupfam} + \beta_{20} \text{Ifbuysupsus} \\ & + \beta_{21} \text{Imsupfamfarm} + \beta_{22} \text{Imsupsusfarm} + \beta_{23} \text{Green} + \beta_{24} \text{Typorgbuy} \\ & + \beta_{25} \text{Healthconscious} + \beta_{26} \text{Healthydiet} + \beta_{27} \text{Ethical} + \beta_{28} \text{Betterpers} \\ & + \beta_{29} \text{Bidmore} + \beta_{30} \text{Small} + u \end{aligned}$$

Where:
i = small farm, large farm
j = organic, non-certified organic, conventional

The key variable for this study was the size of farm producing the milk, where it was expected that a premium would exist for milk labeled as being from a small farm for all three types. Demographic variables were also expected to influence consumer WTP for the different types of milk. For instance, it was hypothesized that females would have a higher WTP for organic milk following studies such as He and Bernard (2011). Caucasians were expected to have lower WTP for organic and non-certified organic products as Onozaka and Mcfadden (2011) found such shoppers valued organic products less than other ethnicities. Income level was hypothesized to have a positive relation on WTP for organic and non-certified organic milk following Loureiro and Hine (2001) and Angulo et al. (2003).

Past findings regarding other demographic characteristics have been mixed. Age has been shown to have a positive impact on WTP for organic products, as found by Gil and Soler (2007) for Spanish consumers, while Loureiro and Hine (2002) and Govindasamy and Italia (1999) found the reverse. Education was found to be positively correlated with WTP for organic foods in Cranfield and Magnusson (2003), Rodriguez et al. (2006), Lin et al. (2009), and Loureiro and Hine (2002) while Govindasamy and Italia (1999) and Krystallis and Chryssohoidis (2005) found the impact to be insignificant. Presence of children was expected to have a positive influence on consumers' WTP for organic and non-certified organic milk. Consumers have become increasingly concerned with what their children eat, and studies have connected this trend with an increase in organic purchases (Cranfield and Magnusson 2003, Krystallis et al. 2006, Laroche et al. 2001). Magnusson et al. (2001) provided conflicting results though, suggesting no difference between households with and without children.

Farming experience was predicted to have a positive influence on consumers' WTP a premium for organic as they may understand the effort and expense required, although it could also be that conventional farmers harbor negative feelings toward organic production. Vegetarians were expected to be willing to pay higher premiums for organic and non-certified organic foods while primary shoppers may bid differently simply due to a better knowledge of market prices.

Purchasing behavior and perceptions were hypothesized to have a substantial impact on consumer WTP. Those who purchase organic products routinely, or plan to purchase such products in the future were believed to have a higher WTP for organic. Based on Botonaki et al. (2006), consumers with greater confidence in organic production methods were also expected to have a significantly greater WTP for organic while those who placed a high importance on

organic standards, or shop routinely at farmers markets were expected to have a higher WTP for organic and non-certified organic products.

Those who believed organic milk was too expensive were expected to have a lower WTP for it. Similarly, if the subject believed that conventional farming was the most efficient, or that there was nothing wrong with conventional farming, it was expected that his or her WTP for organic milk would be negatively impacted.

Consumers' beliefs and evaluations about outcomes from their purchases were also examined. If it was important to them that they support family farms or sustainable farming practices or if they are confident that buying organic allows them to do so, it was expected that they would pay significantly more for organic and non-certified organic products. Finally, self-identity and social norms were expected to influence WTP. Consumers who believed they have a healthy diet, are health conscious, to be a typical buyer of organics, or green consumer may be more willing to devote additional money to buying organic and non-certified organic milk. Those who felt they ought to bid more for organic, felt they had an ethical obligation to purchase organics, or that doing so made them a better person were further expected to have higher WTP for organic and non-certified organic milk.

Results and Discussion

Mean Bids Comparison

First, comparisons were made of the bids for each different type of milk for each farm size. In terms of the former it was hypothesized, based on past studies and market observations, that organic milk would receive the highest bids, followed by non-certified milk, with the lowest bids for conventional milk. For the latter question, it was expected that small farms could gain an additional premium for each milk production practice, with the possibility that it may become more pronounced at the non-certified organic and organic levels. As the bids were not normally distributed, the relationships between them were tested using the nonparametric Wilcoxon test to see if any were significantly different from each other.

The mean bids for each different local milk type and test results can be found in Table 2. Note that milk types that are not significantly different from each other have the same group letter. Two results were quickly evident. First, as expected, there is a premium for switching from conventional to non-certified organic and then again for switching from non-certified organic to organic. Between conventional and non-certified organic for small dairy farms there was a 12.6 percent premium, and between non-certified organic and organic there was a 10.2 percent premium. There was a slightly smaller premium between conventional and non-certified organic milk (9.4 percent) from large dairy farms compared to that for small farms. However, the premium between non-certified organic and organic milk for large dairy operations (12.2 percent) was higher than for small dairy operations. For both large and small farms, these premiums for switching between production practices could be highly beneficial. Small dairy farms in particular would obtain a significant premium if they followed organic standards even if they were not certified. This could be their best option considering the costs required to become USDA certified organic. Each small dairy would have to determine whether the extra 10.2

percent premium between non-certified organic and organic milk would be worth the USDA certification costs.

Table 2. Mean Bid Prices per Milk Type and Significant Relations

Milk Type	Mean Bid ($)	S.D.	Group
Small Farm – Organic	$3.25	1.452	A
Large Farm – Organic	$3.12	1.338	A, B
Small Farm – Non Certified Organic	$2.95	1.251	B, C
Large Farm – Non Certified Organic	$2.78	1.241	C, D
Small Farm – Conventional	$2.62	1.205	D, E
Large Farm – Conventional	$2.54	1.146	E

Note. Milk types with the same group letter are not significantly different from each other.

The second result was that bids between corresponding milk types for small and large farms were not significantly different, suggesting there may not be extra value for small dairies in promoting themselves as such. However, it was found that farm size did make a difference when comparing bids across production practices. The bids small farms received for non-certified organic milk were not significantly less than the bids for large farm organic milk. This implied that small farms could be competitive with large organic dairy farms by following the less expensive non-certified organic route. Additionally, bids for small farm conventional milk were not significantly different than those for large farm non-certified organic milk. Perhaps consumers expect larger farms to be able to complete the certification process, given their likely extra resources. It is therefore questionable if large farms should choose a non-certified organic path, despite the significant premium over conventional milk, especially if they face competition from milk marketed as being from small farms.

Model Results

Table 3 contains results from the heteroskedasticity-robust tobit models for conventional, non-certified organic, and organic milk. Results for the main variable of interest, small farm, followed the findings above by not being significant for any of the three production types. It was noteworthy however that the small farm premium only narrowly missed a 10% significance level for non-certified organic milk (p-value 0.1085). Such a finding corresponds to what appears to be a greater overall benefit for small farms in following this practice relative to large farms and may warrant further consideration.

Table 3. Tobit Model Results

Variable	Conventional		Non-Certified Organic		Certified Organic	
Intercept	0.4116		0.0739		-0.1096	
Small Farm Premium						
Small	0.0848		0.1822		0.1292	
Socio-Demographics						
Collegedeg	0.1353		0.3533	**	0.5263	***
Caucasian	0.4928	**	0.6606	***	0.8151	***
Children	0.1427		0.2390	*	0.1524	
Age	-0.0105	**	-0.0121	**	-0.0166	**
Income	0.0044	***	0.0039	***	0.0026	*
Female	-0.6231	***	-0.3840	**	-0.4994	**
Vegetarian	-1.0193	*	-0.3431		-0.4280	
Farmexp	0.1125	*	0.0775		-0.1611	
Primshopper	-0.0352		-0.3583	**	-0.4187	**
Purchasing Behavior and Perceptions						
Shopfarmmkt	0.3489	***	0.3636	***	0.3743	***
Pastpur	0.1435	*	0.1032		0.1872	**
Futpur	0.2642	***	0.3265	***	0.3167	***
Orgexp	0.2486	***	0.2183	***	0.2502	***
Confarmnw	0.1198	**	0.0675		0.1036	*
Confarmeff	-0.0201		0.0461		-0.0617	
Importanceorg	0.0135	*	0.0063		0.0182	**
Confidenceorg	-0.0321	***	-0.0227	***	-0.0185	**
Outcome Beliefs and Evaluation						
Ifbuysupfam	0.0568		0.1085		0.0958	
Ifbuysupsus	-0.1306		-0.1379		-0.0901	
Imsupfamfarm	0.1080		0.0471		0.1125	
Imsupsusfarm	-0.0790		-0.0176		-0.0881	
Self-Identy and Norms						
Green	0.1375	*	0.1956	**	0.2007	**
Typorgbuy	-0.2901	***	-0.2167	***	-0.2814	***
Healthconscious	-0.0434		-0.0851		-0.0753	
Healthydiet	-0.0398		-0.0646		-0.0753	
Ethical	0.0431		-0.0037		-0.0017	
Betterpers	-0.0979	*	-0.0590		-0.0905	
Bidmore	0.0421		0.0561		0.1129	*

Note. *indicates significant at 10% level, **significant at 5%, and *** significant at 1%

Socio-Demographics

Several socio-demographic variables were found to have a significant impact on WTP for the milk types. Having a college degree and being Caucasian had a positive relationship on WTP at the 5% level in both the non-certified organic and organic models, but between the two only Caucasian was significant for conventional milk. Specifically, those with a college degree were

willing to pay $0.35 more for non-certified organic, and $0.53 more for organic than those without college degrees. Caucasians were willing to pay $0.49, $0.66, and $0.82 more, for conventional, non-certified organic, and organic milk respectively. This was different than expected and may reflect a growing interest in organic products among this group. Having children under 18 in the household was only significant at the 10% level for non-certified organic milk, with such consumers willing to pay $0.24 more.

Age had a negative relationship with WTP for all three models. This conflicted with the hypothesis; however, it seems plausible that a younger generation may be more concerned with environmental stewardship, health and animal welfare as this is a more recent trend. Income was significant in all models, but had little overall impact on WTP, as was also seen in Thompson and Kidwell (1998). Gender had a significant negative effect for females for all three models, with women willing to pay less than men by: -$0.62 for conventional, -$0.38 for non-certified organic and -$0.50 for organic. This conflicts with studies stating that gender either doesn't have a significant impact on WTP for organic foods or that being female has a positive effect.

Those who stated they were the primary shoppers for their household showed a significant negative effect for WTP for non-certified organic (-$0.36) and organic (-$0.42). Vegetarians displayed a significant negative impact on WTP for conventional milk (-$1.02), but this was not significant in the other two models. Having farming experience was not significant in any model.

Purchasing Behavior and Perceptions

Variables relating to purchasing behavior and perceptions had a significant impact on consumer's WTP. How often a consumer shops at farmer's markets or purchases organic milk products had a significant positive impact on consumers WTP for all milk types. As the frequency of shopping at a farmer's market increases, a consumer's WTP increases by $0.35 for conventional, $0.36 for non-certified organic and $0.37 for organic. The similar numbers likely follow directly from all three milk types being local. As the level of past organic dairy purchases increases for the consumer, his or her WTP also increased. Similarly, as the frequency of likely future purchases of organic dairy products increases, so does the consumer's WTP for all three models. This conforms to the TPB concept that behavioral intentions are important in assessing actual behavior.

Consumers who believed that organic milk was too expensive exhibited a significant positive relationship with WTP for all three models. This was unexpected in the organic model, and may show that many consumers are uncertain of how much organic milk does cost. Consumers who believed there was nothing wrong with conventional farming showed a significantly positive WTP for conventional (5 percent level) as well as organic (10 percent level) at $0.12 and $0.10 respectively. This indicates that they were willing to pay similar premiums for both conventional and organic, even though they do not believe anything is wrong with conventional farming. The related variable regarding consumers' view of the efficiency of conventional farming was not significant in any model.

The variable pertaining to the importance of the organic standards showed a significant positive impact on WTP for organic milk; however the variable pertaining to the consumer's confidence in such standards showed a significant negative impact on WTP for organics. The latter was an

unexpected relationship with no clear interpretation. The role of consumers' confidence in standards as it relates to their WTP is an area in need of further examination.

Outcome Beliefs and Evaluations

None of the four variables included measuring the influence of consumers' outcome beliefs and evaluations were significant. It may be worth noting still that in several instances, they only narrowly missed being significant at the 10 percent level. This was particularly evident for the "if I purchase" questions in the non-certified organic model and the corresponding importance questions in the conventional model. Given this, it is recommended that these aspects continue to be investigated in future efforts.

Self-Identity and Norms

How consumers view themselves and their opinions of societal norms played a role in WTP. The level at which consumers considered themselves a green consumer had a significant (5 percent for non-certified organic and organic, and 10 percent for conventional) positive relationship on consumer's WTP in all models. With a coefficient of $0.14 for conventional, and $0.20 for non-certified organic and organic, it is suggested that green consumers value non-certified organic and organic milk higher than conventional milk, as expected. Typical buyers of organic showed a significant negative effect on WTP for all three models, meaning they would pay less than those who do not typically buy organic products. It was again interesting to note the similar values for conventional and organic (-$0.28 and -$0.29). The negative finding for organic may again reflect better price knowledge of organic relative to other consumers in the study. Consumers' views on their diet and shopping with regards to health, however, did not influence WTP in any model.

For norms, those who feel as if purchasing organic milk makes them feel like a better person had a significant (at 10 percent) negative relationship to WTP for conventional. Feeling you had an ethical obligation to purchase organic however did not influence WTP in any model. Lastly, those who felt they should bid more for organic milk did express a significant (10 percent) positive relationship to WTP for organic milk. This norm, which had not been explored previously to the best of the authors' knowledge, suggests that how people think they should bid may be an important factor in understanding bids in auction experiments. More research on this is suggested since if people are following their view of norms in an auction experiment, it may detract from the ability to gain true WTP values with their bids.

Conclusion

This study examined the difference between consumers' WTP for local milk products produced on small and large dairy farms. The three local milk types were conventional, non-certified organic (but follow organic standards) and USDA certified organic. The U.S. dairy industry typically exhibits a very small profit margin, which could be detrimental in the long-run for small dairy farms that are less efficient than larger operations and in return less competitive. Due to this the dairy sector has followed the common farm trend of decreasing numbers and increasing size. The goal here was thus to determine if consumers may be willing to pay a premium for local milk produced on small farms if that fact was promoted while also comparing WTP for the three different production practices.

It was found that for both large and small dairy operations there is a premium to be obtained from switching from conventional to non-certified organic production methods and from non-certified organic to organic production methods. However, it was determined that the size of the farm the milk was produced at did not significantly impact consumer's WTP for any milk type. This contradicted the hypothesis, and may suggest that consumers do not feel as if small dairy farms contain benefits over that of large dairy farms that are worth paying an extra premium. Given the design it could be that the local attribute for all versions may have reduced the influence of both farm size and organic. This likely has bearing on the results and, obviously, the findings cannot be used to make general statements about these label conditions beyond the local market segment. The increasing strength of the local food market though, arguably, could make it an easier outlet for small farms to compete in and aid in small farm survivability. Additionally, Connolly and Klaiber (2014) presented evidence that organic can have extra value over local to consumers, and small farms here were close to having a benefit in the non-certified organic category.

Notably though, when WTP for small versus large farm was compared across milk production practices some potential benefits from promoting an operation as a small farm were discovered. Most relevant was the lack of significant difference between WTP for large farm organic and small farm non-certified organic. Thus, small dairies could avoid the cost of obtaining USDA organic certification and receive a comparable premium to that of organic milk from their large farm counterparts. This could allow small farms to be more competitive and potentially profitable. Similarly, WTP for small farm conventional milk was not different from large farm non-certified organic milk. Non-certified milk from large competitors would therefore not seem to be any threat to small dairies and indeed, despite a real premium, do not appear to be a promising avenue for large dairies.

There are several limitations and possible extensions to this research. One issue could be the small geographical area of the study, and, while a number of recruiting methods were used, having a portion of the sample from Ag Day could influence results. Expanding the geographical area with a larger, more random sample would be an obvious extension. Another area limiting the scope of this work, and offering extension opportunities, was in the definitions for local and farm size. Where participants used their own impression of local, other specific definitions could be used (e.g. within state). Also, as discussed, the definition for a small farm was smaller than official classifications. Arguably more important though is the actual distribution of sales within categories, with the vast majority of small farms in the under $50,000 sales group. This group is also the one with the most losses and thus with the greatest potential to gain from these findings. Consumer perceptions of the size of a small farm, relative to official classifications, is also worthy of future research.

For other extensions, it would be interesting to analyze what consumers view as the potential benefits of small farm production, especially in terms of environmental, animal welfare and economic benefits and how more precisely these impact their WTP. Finally, does the distance from the farm (small or large) impact consumer's WTP for milk produced from small farms or does it remain the same as that for milk produced on large farms? While this study sheds light on this topic, follow-ups with specific mileage or other measures of local could add to these findings.

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Appendix

Table 1. Variable Definitions and Descriptive Statistics

Variable	Description	Mean	Std. dev.
Small Farm Premium			
Small	1 if milk came from a small farm, 0 otherwise	0.5000	0.5003
Socio-Demographics			
Collegedeg	1 if subject has college degree, 0 otherwise	0.5703	0.4954
Caucasian	1 if subject is Caucasian, 0 otherwise	0.7734	0.4189
Children	1 if children in the household, 0 otherwise	0.2813	0.4499
Age	Subject age, in years	38.9531	14.8441
Income	Income level, in thousands	61.8746	55.6569
Female	1 if subject is female, 0 otherwise	0.5703	0.4954
Vegetarian	1 if subject is vegetarian, 0 otherwise	0.0625	0.2422
Farmexp	1 if subject has farming experience, 0 otherwise	0.2734	0.4460
Primshopper	1 if subject is the primary shopper, 0 otherwise	0.7188	0.4499
Purchasing Behavior and Perceptions			
Shopfarmmkt	Shop at Farmers markets, 1= Not at all to 5= Very often	2.9531	1.0894
Pastpur	Past Purchase-Organic dairy products, 1= Not at all to 5= Very often	2.1484	1.2883
Futpur	How likely to purchase organic dairy products in the future, 1= Not at all to 5= Very often	2.3906	1.2397
Orgexp	1 if subject views organic milk as too expensive, 0 otherwise	5.5859	1.2788
Confarmnw	There is nothing wrong with conventional farming, 1= Strongly Disagree to 7= Strongly Agree	3.5234	1.6162
Confarmeff	Conventional farming practices are the most efficient, 1= Strongly Disagree to 7= Strongly Agree	3.9063	1.4610
Importanceorg	Summation for subjects' ratings (likert scale) for several questions on the importance of the key organic standards.	37.7266	9.8288
Confidenceorg	Summation for subjects' ratings (likert scale) for several questions on their confidence of the key organic standards.	31.7734	9.6420

Table 1. *Continued*

Variable	Description	Mean	Std. dev.
Outcome Beliefs and Evaluations			
Ifbuysupfam	If I purchase organic food, I'll be Supporting small family farms, 1= Strongly Disagree to 7= Strongly Agree	4.6016	1.6035
Ifbuysupsus	If I purchase organic food, I'll be Supporting sustainable farming, 1= Strongly Disagree to 7= Strongly Agree	4.9766	1.4122
Imsupfamfarm	Supporting small family farms, 1= Very Unimportant to 7= Very Important	5.1641	1.3224
Imsupsusfarm	Supporting sustainable farming practices, 1= Very Unimportant to 7= Very Important	5.1953	1.3762
Self-Identity and Norms (Seven point scale: 1= Strongly Disagree to 7=Strongly Agree)			
Green	I consider myself a green consumer	4.4063	1.4285
Typorgbuy	I consider myself a typical buyer of organic food	3.3438	1.6040
Healthconscious	I think of myself as a health conscious consumer	5.4219	1.2037
Healthydiet	I think I have a very healthy diet	4.8359	1.4521
Ethical	I feel that I have an ethical obligation to purchase organic food	3.4688	1.7950
Betterpers	Buying organic makes me feel like a better person	3.9844	1.8039
Bidmore	I felt I ought to bid more for organic food	4.8750	1.7953