JOURNAL of FOOD DISTRIBUTION RESEARCH

Volume 54 / Issue 2 / July 2023

Published by

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Journal of Food Distribution Research
Volume 54, Issue 2
July 2023

ISSN 0047-245X

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Understanding the Household's Food Insecurity and Poverty Status in Gert Sibande District of Mpumalanga Province of South Africa

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Abstract

This study evaluated households' food insecurity and poverty status in Gert Sibande District of Mpumalanga Province in South Africa. Using electricity as the cooking energy, growing cereals, being employed, and employment income were negatively associated with food insecurity, whereas housing ownership and access to government child support were positively associated with food insecurity. While household size was positively associated with being poor, employment income, access to social grants, and receipt of remittance were negatively associated with households' poverty status. To address food insecurity and poverty issues, multiple measures are needed, including population planning, employment training programs, and social welfare programs.

Keywords: COVID-19; food security; poverty; social grant; remittance

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Background

The world is no longer a stranger to different forms of disproportional challenges and tragedies. Regardless of the varying magnitude of devastation caused by local and global issues, the SARS-CoV-2/COVID-19 virus has caused enormous suffering around the world. The pandemic and its ripple effects have spread to virtually all parts of the world, causing adverse outcomes such as increased mortality and exacerbation of poverty and food insecurity within the already marginalized populations of the world (Dabone et al., 2021). These marginalized populations include African, Caribbean, and Black (ACB) populations where food insecurity has become disproportionately high since the COVID-19 pandemic started, as there have been reports of lack of access to healthy food, food unaffordability, and food unavailability (Dabone et al., 2021; Feeding America, 2020; Omotayo and Aremu, 2020). This is no exception to a nation like the Republic of South Africa, as about half of the population in South Africa lives in poverty (World Bank, 2020). The prevalence of food insecurity (or percentage being moderately or severely food insecure) increased from 42.9% of the population in 2014–2016 to 44.9% in 2018–2020 in South Africa (FAO, ECA, and AUC, 2021).

The model of food security is a comprehensive assessment that is somewhat complex to understand. Many definitions of food security emerged in the late 1990s, but the concept of food security originated in 1970 during a time of global food shortage (Daniel G. Maxwell, 1996). Food security was mainly defined and instituted on food availability and food supply both at local and international levels. In 1974, food security was described at the World Food Summit as the process that can sustain food consumption, expansion, reduced fluctuation in price, and production of basic world foodstuff through a constant supply of food to the people (United Nations, 1974).

At the 1996 World Food Summit, food security was defined as when "all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." (World Bank, n.d.) This definition incorporated four pillars of food security, including physical availability of food, economic and physical access to food, food utilization, and stability of the other three dimensions over time (FAO, 2008). Availability deals with the supply side and mainly concerns food production and inventory; access involves financial resources (e.g., incomes, expenditures, food prices) to obtain food and physical access to food markets; utilization refers to a nutritious diet and the biological processing of food intake; food security requires the stability in the availability, access, and utilization of food over time (FAO, 2008; Devereux, Bene, and Hoddinott, 2020).

COVID-19 did not disrupt food production significantly, as the agriculture sector was largely exempted from lockdown restrictions (Devereux, Bene, and Hoddinott, 2020). However, COVID-19-related illness, absence, and quarantine-caused labor shortages led to temporary supply chain disruptions, resulting in higher prices and occasional stockouts of meat products on grocery shelves (Balagtas and Cooper, 2021).

COVID-19 posed significant risks to food accessibility, due to falling incomes, rising prices, and transportation restrictions. Job losses and unemployment have led to reduced income and deepened

poverty in South Africa during the pandemic (Arndt et al., 2020; Jain et al., 2020). In April 2020, South Africa's president announced a budget of R500 billion rand or $26 billion U.S. dollars to help combat the devastating effects of COVID-19 on the economy (Anna and Magome, 2020). The competition commission of South Africa received many complaints alleging that retailers raised prices substantially for essential food items and other pandemic-related products (Competition Commission of South Africa, 2020). Meanwhile, many people in South Africa were frustrated about the strenuous process of getting transportation permits to move from one community to another (Iwara et al., 2020).

This study aims to investigate the socioeconomic characteristics of the sampled farming households and analyze the factors that contribute to food insecurity and poverty in the Gert Sibande district of Mpumalanga Province, South Africa. Mpumalanga Province is one of the most prominent provinces in South Africa. It has been characterized as one of the stable economic resource provinces in the country, with most of the population living in rural areas (Mngqawa, Mangena-Netshikweta, and Katerere, 2016; Simpson et al., 2019). This study thereby leverages the momentum to inform, influence, and catalyze key agricultural actors to sustainably reduce food insecurity and poverty in the district, province, and South Africa at large. To our knowledge, this is the latest study investigating the food security and poverty status of residents in Mpumalanga Province during the COVID-19 pandemic. This study is guided by the following three research questions: (i) What is the socioeconomic, food security, and poverty status of the residents in the study area? (ii) What are the factors associated with the households' food insecurity status? and (iii) What are the factors relating to the households' poverty status?

Review of Recent Literature on Food Security and Poverty in South Africa

Impact of the COVID-19 Pandemic on Poverty and Food Security

During the COVID-19 pandemic, active employment in South Africa declined by 21 percentage points, attributed to nonemployment paid leave and temporary layoff (Jain et al., 2020). As a result, wage earnings were down about 30% for all workers in South Africa, with a 40% reduction for the lower-educated workers in particular (Arndt et al., 2020). Low-income households depended heavily on low-education labor incomes and received little capital income. Thus, they were more severely impacted by the wage reduction and threatened by food insecurity during the pandemic (Arndt et al., 2020). Ningi et al. (2022) studied the food security status of a sample of 283 households from Hamburg and Melani communities in Eastern Cape, one of the poorest provinces in South Arica. They found that more than 20% of the households from these two communities were moderately or severely food insecure during the pandemic. Another study (Hamadani et al., 2020) compared the income level and food security status of 2,424 mothers in rural Bangladesh before the pandemic and during the lockdown. Ninety-six percent of the mothers experienced reduced income, and the number of families experiencing moderate or severe food insecurity increased by 51.7%. A case study from the Vhembe district of South Africa revealed that many people had to rely on savings, social grants, and donated food parcels for survival during the pandemic (Iwara et al., 2020). Omotayo and Aremu (2020) analyzed a sample of 133 rural

households from North West Province in South Africa and found that 40.6% of them were food insecure.

Drivers of Poverty and Food Insecurity in South Africa

Poverty was the most-cited factor underlying food insecurity in South Africa. According to a systemic review of 169 food insecurity studies in South Africa between 1995 and 2014, 86 (or 51%) of the studies considered poverty or lack of income as an important factor associated with food insecurity (Misselhorn and Hendriks, 2017). Sixty (or 70%) of the 86 studies evaluated the impact of individual or household income on food security. Recent studies also found that income was positively associated with food security in South Africa (Cheteni, Khamfula, and Mah, 2020; Dunga, 2020; Ijatuyi, Omotayo, and Nkonki-Mandleni, 2018; Megbowon and Mushunje, 2018).

Both public income transfers (social grants) and private income transfers (remittances) are expected to increase income and food expenditures, thus alleviating poverty and food insecurity (Misselhorn and Hendriks, 2017; Waidler and Devereux, 2019). Based on a nationally representative survey (National Income Dynamic Survey) of 28,000 individuals in South Africa, Waidler and Devereux (2019) found that Older Person's Grant had a positive relationship with dietary diversity. In contrast, Dunga (2020) did not find a significant association between social grants and food security among female-headed households in South Africa. Chakona and Shackleton (2019) found that households who received social grants had lower monthly food expenditures, had lower dietary diversity, and were more likely to be food insecure, compared with those who did not receive social grants. Previous evidence indicated that social grants might discourage people from engaging in subsistence farming or homestead food gardening, as the grants might have provided enough funds to purchase food (Minkley, 2012; Trefry, Parkins, and Cundill, 2014). Therefore, grants might also be viewed as hurdles to long-term food security (Misselhorn and Hendriks, 2017). Musakwa and Odhiambo (2021) confirmed a causal relationship between remittance and poverty in South Africa using time series data from 1980 to 2017. They recommended that South Africa should continue adopting policies to encourage emigration and increase remittance inflows to reduce poverty.

Women play an essential role in household food security. They are often the drivers of homestead food production, but are also hampered by limited access to and control over farm and non-farm assets (Misselhorn and Hendriks, 2017). Many studies found that female-headed households were more food secure than male-headed households in South Africa (Cheteni et al., 2020; Ningi et al., 2022). Female-headed households were also found to have a more diverse diet than their male-headed counterparts, since women had the capability of selecting, purchasing, and preparing a diverse diet for their families (Megbowon and Mushunje, 2018). However, another argument is that men tend to engage in various income-generating activities and have better access to land and credit than women. A study of rural households in the North West Province of South Africa found that male-headed households were more likely to be food secure than their female-headed counterparts (Omotayo and Aremu, 2020).

Methods

Study Area

The study was carried out in the Gert Sibande District Municipality of the Mpumalanga province in South Africa (see Figure 1). The district was named after Richard Gert Sibande, an African National Congress (ANC) political activist. The district was chosen for the survey because it is the largest of the three districts in the province, making up almost half of the geographical area of Mpumalanga province. It is comprised of seven local municipalities: Govan Mbeki, Chief Albert Luthuli, Msukaligwa, Dipaleseng, Mkhondo, Lekwa, and Pixley ka Isaka Seme. The district is primarily rural, with more than half the population living in rural areas. The main economic activities of the Gert Sibande District Municipalities are manufacturing, mining, and agriculture, although service-related sectors, such as transport, trade, community services, tourism, and finance, are dominant economic drivers in some parts of the district.

Sampling Methods and Sample Size

Two of the seven municipal areas were selected for data collection (see Figure 2). The Govan Mbeki municipality consists of a population of 294,538 (99.68 per km^2) and 83,874 households (28.39 per km^2), while Albert Luthuli comprises a population of 186,010 (33.46 per km^2) and 47,705 households (8.58 per km^2) (Frith, 2011). The research was conducted in 20 villages dispersed throughout the two municipal areas: Bethel, Embalenhle, Trichardt, Secunda, Leslie, eMzinoni, Kinross, Lebogang, Charl Cilliers, Leandra, Bhevula, Eerstehoek, Embhuleni, Enikakuyengwa, Mpisikazi, Tshabalala, Lukwatini, Mpuluzi, Silobela, and Emjindini (see Figure 2)

Multistage sampling was used in the collection of the data. In the first stage, purposive sampling was used to select two municipalities based on their relative sizes in terms of population in the district. Both selected municipalities have the largest population in the province, while the residents principally engage in agricultural and farming operations. In the second stage, 20 rural farming communities for data collection were selected by simple random sampling. The rural farming communities belonged to the two selected municipalities. In the third stage, simple random sampling was used to select 20 households in each of the 20 rural farming communities, which totaled 400 administered questionnaires. Overall, 383 questionnaires were filled out properly by the household heads. Socioeconomic characteristics of the households and their perception of food security were collected from all respondents. The chart below shows the sequence of local municipalities and how the sample survey took place (see Figure 2). The sample survey was obtained from the November 23, 2020, to January 25, 2021.

Mbeki municipality consists of a population of 294,538 (99.68 per km^2). The sample size was determined using sampling formula (Krejcie and Morgan, 1970):

$$S = \frac{X^2 NP(1-P)}{d^2(N-1)+X^2 P(1-P)} \quad (1)$$

Where: S = Required Sample size

X = Z value (e.g., 1.96 for 95% confidence level)

N = Population Size

P = Population proportion (expressed as decimal) (assumed to be 0.5 or 50%)

d = Degree of accuracy (5%), expressed as a proportion (.05)

N = 131,579, which is the total number of households in the two municipal areas

$X^2 = 3.841$

P = 0.5

$d^2 = 0.05$

$$S = \frac{3.841 * 131{,}579 * 0.5 * 0.5}{((0.05)^2 * (131{,}579 - 1)) + (3.841 * 0.5 * 0.5)}$$

$$S = \frac{126348.73}{329.905}$$

$$S = \mathbf{383}$$

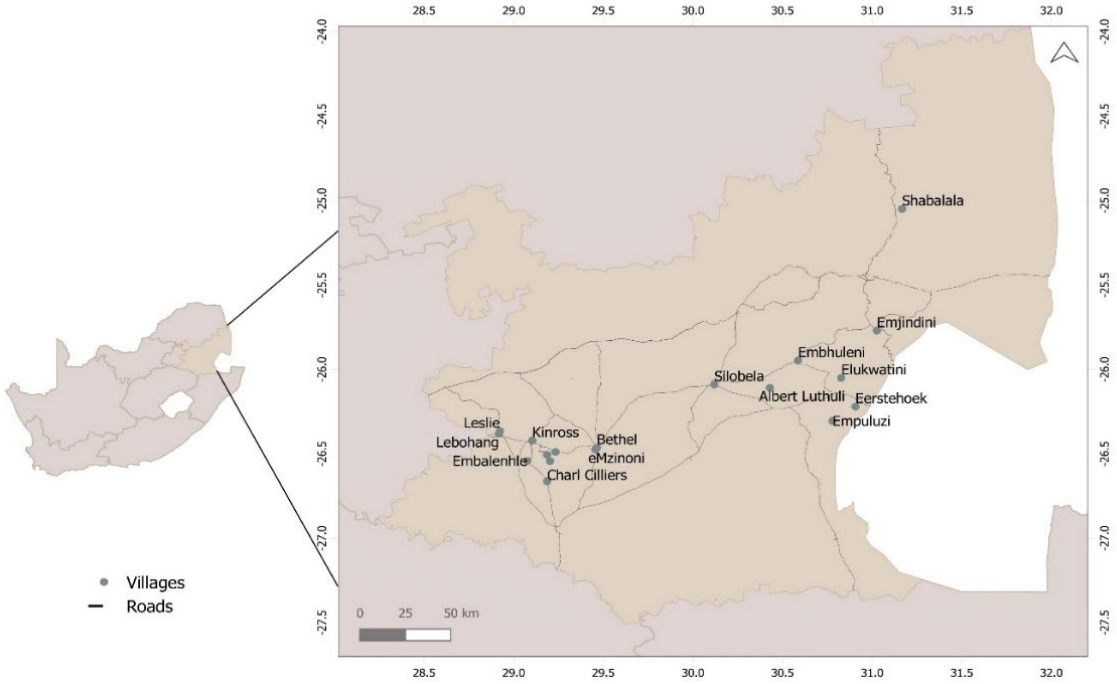

Figure 1. Gert Sibande Municipality of Mpumalanga Province, South Africa

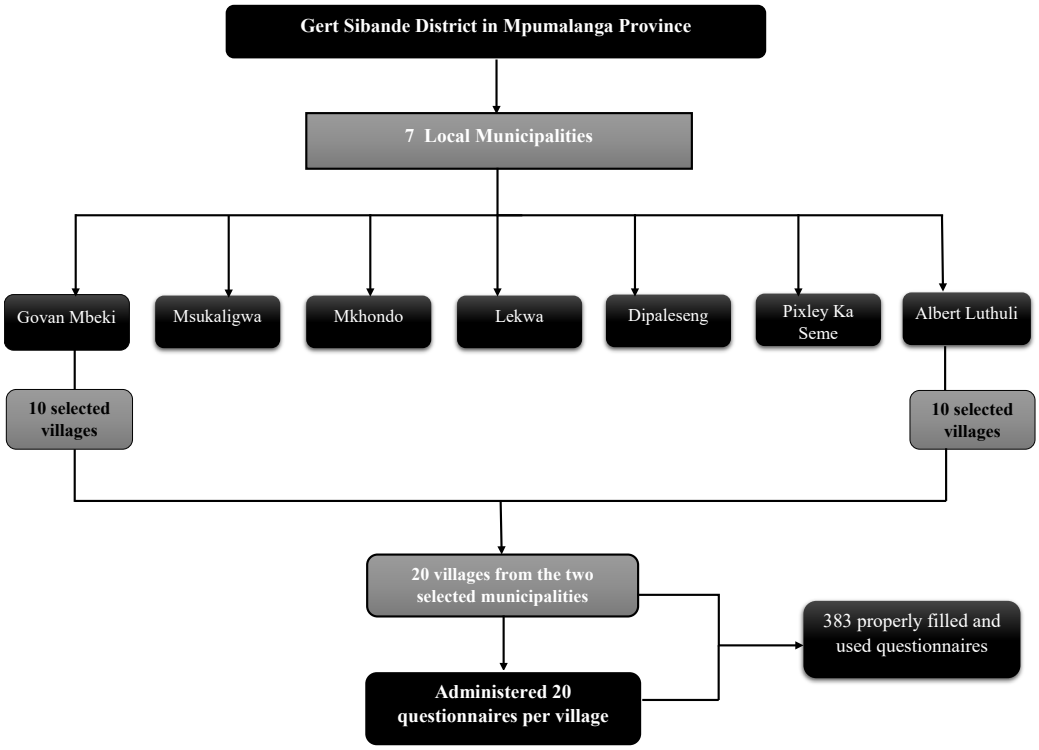

Figure 2. Schematic Flow for the Sampling Method and Sample Size for the Study

Statistical and Analytical Structure

The study's data were analyzed with Microsoft Excel, IBM SPSS Statistics (Version 25) predictive analytical software and STATA Statistical Software (Version 16) for descriptive and inferential statistics.

Household Food Insecurity Assessment Scale (HFIAS)

The information gathered from this study was used to categorize households based on their level of food security. The Household Food Insecurity Assessment Scale (HFIAS) has been used for many years by several researchers to assess the food security status of households. The instrument was developed by the Food and Nutrition Technical Assistance (FANTA) project (Copeland, Frankenberger, and Kennedy, 2002; Coates, Webb, and Houser, 2003; Faber, Schwabe, and Drimie, 2009; Deitchler et al., 2010). It has been used globally to measure the rate of food insecurity in rural households and to check the level of food shortages and poor dietary intake in rural communities. The HFIAS is a composite index calculated for each household and consists of nine key questions designed to measure the severity of household food insecurity for the past 30 days. If a respondent answers "yes" to a question, a frequency question is asked to assess whether the event happened rarely (once or twice), sometimes (three to 10 times), or often (more than 10 times) in the past 4 weeks. "Rarely," "sometimes," and "often" are assigned scores of 1, 2, and 3, respectively. The HFIAS score is the sum of the numbers for each frequency question. It ranges

from 0 to 27. The higher the score, the more severe the food insecurity the households have experienced (Adams, Grummer-Strawn, and Chavez, 2003; Pardilla et al., 2014). We included the detailed HFIAS questions in the appendix. Secondly, the households were classified into four food insecurity categories: food secure, mildly food insecure, moderately food insecure, and severely food insecure, according to the Household Food Insecurity Assessment (HFIA) categorization scheme shown in the appendix.

Foster-Greer-Thorbecke (FGT) Indices

The Foster-Greer-Thorbecke (FGT) poverty index was used to categorize the poverty status of the sample. As a generalized measure of poverty, the FGT index is an inferential statistic and has been widely used to measure households' poverty status (Foster, Greer, and Thorbecke, 2010). It combines information on the extent of poverty (as measured by the head count ratio), the intensity of poverty (as measured by the total poverty gap), and the severity of poverty (Alkire and Santos, 2013). The formula for the FGT is given by:

$$FGT_\alpha = \frac{1}{N}\sum_{i=1}^{H}\left(\frac{z-y_i}{z}\right)^\alpha \quad (2)$$

where Z represents the poverty line, measured as per capita monthly income in this study. N is the total number of members of the population under consideration. H is the number of those with incomes at or below z. y_i is the per capita monthly income of the i-th person. α is a parameter characterized by the degree of poverty aversion (i.e., the parameter α determines the precise measure of poverty). When α equals zero, the head count ratio (H) is generated, indicating the proportion of the population below the poverty line; when α equals 1, the poverty gap ratio (PG) is generated (often considered to represent the depth of poverty); and when α equals 2, the poverty severity (PS) is generated.

Regression Models of Factors Associated with Household Food Insecurity and Poverty Status

An OLS model was used to evaluate the factors relating to the household's food insecurity status.

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots . + \beta_n X_n + \varepsilon_i \quad (3)$$

where Y_i is a continuous variable denoting the severity of food insecurity, X_1 to X_n are the independent variables described in Table 3. ε_i is the error term.

A binary logistic regression model was employed to determine the factors influencing the farming households' poverty status. The binary logistic regression model is stated as:

$$\text{Logit(p)} = \text{Log}\left(\frac{\text{p}}{1-\text{p}}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots . + \beta_n X_n \quad (4)$$

where $p = prob(Y_i = 1)$.

Y_i is the binary variable with a value of 1 if respondents are in poverty and 0 otherwise. β_0 is the intercept (constant), and β_1, β_2, to β_n are the regression coefficients of the predictor variables, X_1, X_2, and Xn. The logistic regression model is widely used to analyze data with dichotomous dependent variables. Hence, it was considered a suitable model for this research because the dependent variable was dichotomous. The model will be estimated by the Maximum Likelihood method. All the dependent and independent variables are described in Table 1.

The dependent variable of the OLS model was the HFIAS score, a continuous variable measuring the severity of food insecurity. This variable was explained in the section Household Food Insecurity Assessment Scale (HFIAS). A binary logistic regression model was employed to determine the factors associated with the households' poverty status. The dependent variable, poverty status, was a binary variable, with 1 being at or below the poverty line (in this case, R1,268 per capita per month) and 0 otherwise. The poverty line was derived by Statistics South Africa in 2020 (Statistics SA, 2020). The poverty status in the regression indicates whether a household is at or below the poverty line, whereas the H index indicates the percentage of all the households in the sample at or below the poverty line. The independent variables in these two models included the age, gender, educational level, employment status of the household head, housing ownership, cooking energy, access to farming land, crop grown, employment income, access to social grant, receipt of remittance, and access to government child support and/or pension grant.

Table 1. Factors Influencing Household Food Insecurity and Poverty Status in Mpumalanga Province of South Africa

Variable	Description
Dependent variable	
HFIAS score	Continuous
Poverty status	1= below poverty line; 0 = above poverty line
Independent variable	
Gender	1 = male; 0 = female
Age of household head	Continuous
Education level	1 = primary education or above; 0 = no formal education
Household size	Number of members
Housing ownership	1 = own; 0 = rent
Cooking energy	1 = electricity; 0 = other
Access to farming land	1 = yes; 0 = no
Crop grown	1 = cereal; 0 = other
Employment status of household head	1 = employed; 0 = unemployed
Employment income in rands	Continuous
Access to social grant	1 = yes; 0 = no
Receipt of remittance	1 = yes; 0 = no
Access to government child support	1 = yes; 0 = no
Access to government pension grant	1 = yes; 0 = no

Results and Discussion

Demographic Characteristics of Households in the Study Area

Table 2 illustrates the socioeconomic characteristics of 383 households in the study area. The age distribution of the respondents reveals that most respondents fell into the age intervals of 46–55 years (42.30%), with an average age of 52 years in the pooled dataset. According to a previous study (Aldrich and Cliff, 2003), the age of the household head is highly important because it reveals whether the households benefit from the experience of the household head or whether the households have to base their decisions on the risk of taking advice from other households. Most households (56.14%) have between 1 and 5 family members. The average household size was 5. Large household sizes may result in insufficient food intake and poor health, thereby exacerbating poverty (Omotayo, 2017).

Furthermore, 40.73% of the participants have completed secondary education. A higher number of years of education could have a positive influence on the ability of households to know their diet, food composition, and the need for diversity. Seventy-seven percent of the household heads were employed, with an average employment income of R11,336 per month. The majority of households owned their homes (84%). More than 90% of households used electricity as their cooking energy. About 90% of them had access to farming land. Many of them received remittance (42%), had access to social grants (24%), government child support (12%), or pension grants (23%).

Table 2. Demographic Characteristics of Household Heads

Households' Characteristics	Frequency	Percentage (%)	Mean
Gender			
Male	238	62.14	
Female	145	37.86	
Age			
18–35	13	3.39	
36–45	80	20.89	51.95
46–55	162	42.30	
56–65	109	28.46	
> 65	19	4.96	
Household size			
1–5	215	56.14	
6-10	164	42.82	5.39
11-15	4	1.04	
Marital status			
Married	225	58.75	
Never married	83	21.67	
Widowed	37	9.66	
Divorced	38	9.92	

Table 2. Continued

Households' Characteristics	Frequency	Percentage (%)	Mean
Education level			
No formal education	76	19.84	
Primary education	72	18.80	
Secondary education	156	40.73	
Tertiary education	79	20.63	
Employment status			
Permanent employment	82	21.41	
Seasonal employment	28	7.31	
Self-employed	185	48.30	
Not employed	88	22.98	
Total	383	100	

Descriptive Statistics of the Sample

Table 3 presents the descriptive analysis of household demographics for the study. The HFIAS score in the sample ranged from 0 to 24, with a mean score of 6.51. Roughly 33% of the sampled households were living below the poverty line. About 62% of the households were male headed, with the remaining 38% being female headed. This finding is in line with the traditional belief and prior findings that households in Africa are predominantly male oriented in nature (Omotayo, 2016; Wahaga, 2018).

Table 3. Descriptive Statistics of Dependent and Independent Variables

Variable	Mean	Std. Dev.	Min	Max
HFIAS score	6.51	6.18	0	24
Poverty status (1 = below poverty line; 0 = above poverty line)	0.33	0.47	0	1
Gender (1 = male; 0 = female)	0.62	0.49	0	1
Age of household head	51.95	8.84	27	80
Education level (1 = no formal education; 2 = primary education; 3 = secondary education; 4 = tertiary education)	2.62	1.02	1	4
Household size	5.39	1.58	1	13
Housing ownership (1 = own; 0 = rent)	0.84	0.37	0	1
Cooking energy (1 = electricity; 0 = other)	0.95	0.23	0	1
Access to farming land (1 = yes; 0 = no)	0.90	0.31	0	1
Crop grown (1 = cereal; 0 = other)	0.39	0.49	0	1
Employment status of household head (1 = employed; 0 = unemployed)	0.77	0.42	0	1
Employment income in thousand rands	11.34	10.21	0	71

Table 3. Continued

	Mean	Std. Dev.	Min	Max
Access to social grant (1 = yes; 0 = no)	0.24	0.43	0	1
Receipt of remittance (1 = yes; 0 = no)	0.42	0.49	0	1
Access to government child support (1 = yes; 0 = no)	0.12	0.32	0	1
Access to government pension grant (1 = yes; 0 = no)	0.23	0.42	0	1

Note: The mean of dummy variables indicates the proportion of responses with a value of 1.

To avoid inconsistency and bias from the estimated parameters, the study subjected the variables to a multicollinearity test using the Collin command in STATA 16. The multicollinearity test was carried out with Variance Inflation Factor (VIF), and the mean VIF was 1.41 (see Table 11). All the VIF values were below 5, and the tolerance values were above 0.2. A high level of tolerance computed for the variables indicates an absence of serious multicollinearity in the analysis.

Table 4. Multicollinearity Test of Variables

Variable	VIF	Tolerance
Gender	1.02	0.9851
Age of household head	1.75	0.5729
Education level	2.11	0.4742
Household size	1.12	0.892
Housing ownership	1.1	0.9058
Cooking energy	1.04	0.9604
Access to farming land	1.26	0.7959
Crop grown	1.25	0.8004
Employment status of household head	1.78	0.5618
Employment income	1.94	0.5159
Access to social grant	1.61	0.6226
Receipt of remittance	1.21	0.8249
Access to government child support	1.19	0.8392
Mean VIF	1.41	

Respondents' Food Security Profile

Table 5 summarizes the responses to the HFIAS questions. The results indicate that about 51% of the households were worried about running out of food. Half (50%) of the households were unable to eat their preferred meal due to a lack of resources. Additionally, half (50%) of the households reported eating undesirable food because of a lack of resources. About 1 in 8 households (13%) complained about not having food at all in their households; another 8 (12%) of the households went to sleep hungry; and 2% of the households indicated that they had no food to eat all day. Based on the HFIA categorization scheme outlined in the Appendix, it was found that just over a third (34.46%) of the households were food secure in the sample, whereas 40.47% and 20.89%, respectively, of the households were moderately and severely food insecure. The prevalence of food insecurity in the study area was 61.36%, significantly higher than the average of 44.9% in

2018–2020 in South Africa (FAO, ECA, and AUC, 2021). This finding might indicate a severe food insecurity problem of farming households during the pandemic.

Table 5. Responses to the HFIAS Questions and HFIA Categories

Questions	Percentage of Yes Responses
1. Worried about food	51
2. Unable to eat preferred meal due to lack of resources	50
3. Eat just a few kinds of food	46
4. Ate undesirable meal due to lack of resources	50
5. Ate smaller meal due to not having enough food	43
6. Ate fewer meals or skipped some meals in a day	35
7. No food at all in the household	13
8. Went to sleep hungry	12
9. Did not eat at all for a whole day	2
Categories	**Percentage**
Food secure	34.46
Mildly food insecure	4.18
Moderately food insecure	40.47
Severely food insecure	20.89

Poverty Status of Respondents

Table 6 demonstrates the FGT poverty indices of the sample. The incidence of poverty (H) in this study was 0.3264, indicating that 32.64% of the households were considered poor, while the remainder (67.36%) were categorized as non-poor households. Moreover, poverty depth (PG) among the sampled rural households was 0.1300, meaning that, on average, each household member (both poor and non-poor) would need to increase their monthly income by 13% of the poverty line (R1,268 per capita) to eliminate poverty in the sample. The poverty severity (PS) among the sampled households was 0.0727. Among the poor households in the sample, the average poverty gap per person was R504.94, which is the minimum cost per person of eliminating poverty using transfer payments to the poor households. In other words, this amount will be the average cost per person of filling up each poverty gap. From the findings, it could be inferred that the existence of poverty abounds among the rural households in the study area.

Table 6. Poverty Status of Participating Households

FGT Poverty Indices	Abbreviation	Number
FGT incidence	H	0.3264
FGT depth	PG	0.1300
FGT severity	PS	0.0727
	Poverty Line (z)	**R1268**
Poverty Status	**Frequency**	**Percentage**
Above poverty line	258	67.36%
Below poverty line	125	32.64%
Total	383	100%

OLS Results for Factors Associated with Household Food Insecurity

The OLS results for the factors associated with households' food insecurity status are presented in Table 7. Small VIF values indicate a low level of multicollinearity. Out of the 13 independent variables considered in the model, 6 were statistically significant. These were housing ownership ($p < 0.05$), cooking energy ($p < 0.05$), crops grown ($p < 0.05$), employment status of the household head ($p < 0.01$), employment income ($p < 0.001$), and access to government child support ($p < 0.001$). Owning a house was positively correlated with food insecurity, whereas using electricity as a cooking energy source and growing cereals were negatively correlated with food insecurity.

The coefficient of the employment status of the household head was found to be negatively associated with food insecurity (-2.10) at a significance level of 0.01. Being employed reduced the HFIAS score by 2.10, with other factors held constant. This finding corroborates existing studies (Muche, Endalew, and Koricho, 2014; Aragie and Genanu, 2017) showing that the household head's employment and income status are significant determinants of how food-secured a household will be.

Furthermore, the coefficient for employment income was negative (-0.29) and significant ($p < 0.001$). For each 1,000 Rand growth in income, the HFIAS score would be reduced by 0.29, indicating that the household head's income has the probability of enhancing the food security status of the family. It corroborates the findings from previous studies (Ahmed et al., 2017; Ijatuyi et al., 2018; Megbowon and Mushunje, 2018; Cheteni et al., 2020; Dunga, 2020). Poverty, or lack of income, has been established as a top contributor to food insecurity in South Africa (Misselhorn and Hendriks, 2017). It is imperative for the government to boost employment and create opportunities for households to earn various sources of incomes. However, access to social grant did not have a significant relationship with food insecurity in this study. Similar to previous findings (Patel, 2012), access to government child support was positively associated with food insecurity in this study. Perhaps food-insecure households were more likely to receive government child support.

Table 7. Factors Associated with Households' Food Insecurity and Poverty Status

Independent Variable ↓	Coefficient (Std. Error)	VIF	Coefficient (Std. Error)	Odds Ratio (Std. Error)
Gender	-0.06 (0.45)	1.02	-0.01 (0.69)	0.99 (0.68)
Age of household head	0.004 (0.03)	1.75	0.04 (0.06)	1.04 (1.04)
Education level	-0.30 (0.31)	2.11	0.02 (0.43)	1.02 (0.44)
Household size	0.09 (0.15)	1.12	2.77 (0.56)***	15.88 (8.89) ***
Housing ownership	1.42 (0.62)*	1.10	1.77 (1.27)	5.89 (7.50)
Cooking energy	-2.07 (0.98)*	1.04	-1.39 (1.01)	0.25 (0.25)
Access to farmland	-0.83 (0.80)	1.26	-1.25 (1.24)	0.29 (0.35)
Crop grown	-1.17 (0.50)*	1.25	-1.14 (0.79)	0.32 (0.25)
Employment status	-2.10 (0.69)**	1.78	2.09 (1.13)	8.05 (9.13)
Employment income	-0.29 (0.03)***	1.94	-1.87 (0.36)***	0.15 (0.06)***
Access to social grant	0.65 (0.64)	1.61	-2.27 (0.86)**	0.10 (0.09)**
Receipt of remittance	-0.38 (0.49)	1.21	-2.79 (0.94)**	0.06 (0.06)**
Access to government child support	2.97 (0.74)***	1.19	1.25 (1.15)	3.50 (4.01)
Intercept	13.58 (2.48)		-6.19 (3.95)	0.002 (0.01)

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

Logit Results for the Factors Relating to Households' Poverty Status

Table 7 also includes the Logit results for the factors relating to households' poverty status. Four factors were statistically significant, including household size ($p < 0.001$), employment income ($p < 0.001$), access to social grants ($p < 0.01$), and receipts of remittance ($p < 0.01$). Table 4 shows that the coefficient for household size was 2.77, with an odds ratio of 15.88. This result implies that a larger household size was significantly associated with a higher probability of being poor. For each additional member in the household, the odds of living below the poverty line increased by a factor of 15.88. This is in line with prior findings that a larger household size could worsen the poverty status of the household (Damisa, 2011; Sarti, Terraneo, and Tognetti Bordogna, 2017).

Moreover, the coefficient of the respondent's monthly employment income captured in 1,000 South African Rands was negative (-1.87) at a significance level of 0.001, indicating that an increase in the household head's income would decrease the probability of living below the poverty line. An odds ratio of 0.15 indicates that for each additional 1,000 Rands of monthly income, the odds of being poor decreased by 85%, holding other variables constant. This is in line with the existing literature as an increase in income could reduce the poverty level of households (Bigsten, Kebede, and Taddesse, 2003). Meanwhile, access to social grants and receipts of remittances were both negatively associated with households' poverty status, suggesting that providing social grants and remittances might help alleviate poverty. Indeed, many residents in South Africa relied on social grants for survival during the pandemic (Iwara et al., 2020). It was found that social grants were positively correlated with food security in South Africa (Waidler and Devereux, 2019). Our study provided additional evidence supporting the role of social grants in reducing poverty. A previous study established a causal relationship between remittance and poverty (Musakwa and Odhiambo, 2021). Therefore, policy makers in South Africa should

continue encouraging emigration and remittance inflows by removing regulatory obstacles to migration and international monetary transfers.

Limitations

This was not a causal study and only correlations may be implied from the results of the models. We only sampled two of the seven municipalities in the Gert Sibande District of Mpumalanga Province of South Africa. As the two municipalities were not randomly chosen, the sample may not be representative of either the district or the entire province. Another limitation is that no specific questions were asked about how the household was affected by the pandemic.

Conclusions

Food insecurity and poverty are major problems for many households in developing nations. In South Africa, these dual threats constitute physical and economic problems decreasing the nutritional and health base of the households. This study, therefore, evaluated the factors contributing to households' food insecurity and poverty in the Gert Sibande Municipality of Mpumalanga Province of South Africa. It was designed to recognize the knowledge gaps, encourage new thinking, and stimulate concrete actions on leveraging agriculture to improve households' food security and poverty status. A large household size was reported in the research, which could result in a lower income per capita, leading to poverty in the study area. The logit model results indicated that a larger household size was associated with a significantly higher probability of living under the poverty line. Perhaps population planning programs may be initiated to promote fewer births through eugenic procreation.

The results of the two models highlighted the importance of employment income in alleviating food security and poverty. Households' employment income came from three major sources: seasonal, permanent, and self-employment. The average monthly incomes of households relying on farming and off-farm activities as their primary livelihood activities were R12,430 and R10,865, respectively. For households relying on both on-farm and off-farm livelihood activities, their average monthly income (R21,008) was almost two times that of those depending on just one source of livelihood. Therefore, involvement in both on-farm and off-farm livelihood activities might prevent food insecurity and poverty. Engaging in agricultural production constitutes an important source of income for the residents in the sampled area. Training programs may be used to enhance the farming ability and employability of the adult residents, generating multiple sources of income for the household.

Additionally, we found evidence showing that access to social grants may help reduce poverty. As such, social welfare programs such as governmental transfer payment programs and non-governmental charitable donations could go a long way toward addressing food insecurity and poverty issues in the sampled area. Households' ability to endure difficulties such as food insecurity and poverty is greatly determined by their respective asset portfolios, such as financial, physical, and intangible human assets. To strengthen their asset portfolios, multiple measures are

needed, including population planning, employment training programs, and social welfare programs.

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Appendix

Table A1. Household Food Insecurity Access Scale (HFIAS) Questions

No.	Questions
1	In the past four weeks, did you worry that your household would not have enough food? 0 = No (skip to Q2) 1 = Yes
1a	How often did this happen? 1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)
2	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources? 0 = No (skip to Q3) 1 = Yes
2a	How often did this happen? 1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)
3	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources? 0 = No (skip to Q4) 1 = Yes
3a	How often did this happen? 1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)
4	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food? 0 = No (skip to Q5) 1 = Yes
4a	How often did this happen? 1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)
5	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food? 0 = No (skip to Q6) 1 = Yes
5a	How often did this happen? 1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)

Table A1. Continued

No.	Questions
6	In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food? 0 = No (skip to Q7) 1 = Yes
6a	How often did this happen? 1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)
7	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food? 0 = No (skip to Q8) 1 = Yes
7a	How often did this happen? 1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)
8	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food? 0 = No (skip to Q9) 1 = Yes
8a	How often did this happen? 1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)
9	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food? 0 = No 1 = Yes
9a	How often did this happen? 1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to 10 times in the past four weeks) 3 = Often (more than 10 times in the past four weeks)

Source: Coates, Swindale, and Bilinsky (2007). Household Food Insecurity Access Scale (HFIAS) for measurement of food access: indicator guide: version 3.

Table A2. Calculation of Household Food Insecurity Access (HFIA) Categorical Variable

HFIA Categories	Calculation
Food secure	HFIA category = 1 IF (Q1a = 0 or Q1a = 1) and Q2 = 0 and Q3 = 0 and Q4 = 0 and Q5 = 0 and Q6 = 0 and Q7 = 0 and Q8 = 0 and Q9 = 0
Mildly food insecure	HFIA category = 2 IF (Q1a = 2 or Q1a = 3 or Q2a = 1 or Q2a = 2 or Q2a = 3 or Q3a = 1 or Q4a =1) and Q5 = 0 and Q6 = 0 and Q7 = 0 and Q8 = 0 and Q9 = 0
Moderately food insecure	HFIA category = 3 IF (Q3a = 2 or Q3a = 3 or Q4a = 2 or Q4a = 3 or Q5a = 1 or Q5a = 2 or Q6a = 1 or Q6a = 2) and Q7 = 0 and Q8 = 0 and Q9 = 0
Severely food insecure	HFIA category = 4 IF Q5a = 3 or Q6a = 3 or Q7a = 1 or Q7a = 2 or Q7a = 3 or Q8a = 1 or Q8a = 2 or Q8a = 3 or Q9a = 1 or Q9a = 2 or Q9a = 3

Source: Coates, Swindale, and Bilinsky (2007). Household Food Insecurity Access Scale (HFIAS) for measurement of food access: indicator guide: version 3.

Food Distribution Research Society

Journal of Food Distribution Research
Volume 54, Issue 2, pp. 25–46

A Comparative Analysis of Changes in Consumers' Perceptions and Attitudes toward Local Wines in an Emerging Wine Region

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Abstract

By comparing consumer data from two surveys (2006 and 2021), the current study analyzes factors contributing to changes in consumer attitudes toward local wines in an emerging region. Results of two regression models indicate that over a 15-year period Texas wines have improved in quality and earned a higher reputation among local consumers. Three factors—visiting local wine festivals, higher incomes, and recommending local wines to others—played a particularly significant role in paying higher prices for local wines. Three attributes—wines are well-known, good quality, and better than expected—significantly contributed to changes in attitudes over time.

Keywords: consumer attitudes, emerging wine production region, Texas wine

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Introduction

Wine is one of the oldest commodities on the market, and yet the global wine industry continues to dynamically develop, grow, and expand. Recent consumer trends indicate that while older consumers still show attachments to Old World wines, younger generations are more open to wines from new regions, as well as nontraditional varieties and unique production technologies (Thach and Chang, 2016). Historically, Europe, North Africa, and the Middle East were considered the Old World wine-producing regions, whereas wines made in Argentina, Chile, South Africa, New Zealand, Canada, and the United States are considered the New World. The list of New World regions is expanding, with more unconventional wine-producing countries, like Mexico, Japan, and China, making and exporting their wine.

Currently, the United States is considered one of the most dynamic and important wine markets in the world. Globally, the United States is the top wine-consuming country and the fourth largest wine producer (International Organization of Vine and Wine, 2022). While California accounts for the largest share of the total U.S. wine market (85%), several other states became notable players. Cumulatively, Washington, New York, Oregon, and Texas account for 12% of the total U.S. wine production (America Wines Paper, 2019; Wines Vines Analytics, 2021). These emerging wine regions experience considerable economic growth and importantly, play a critical role not only for the local economies but also for the growth of wine consumption worldwide. While wine consumption has fallen within the last decade globally, particularly in European countries, the number of wine consumers is on the rise, and the growth in the wine category comes from new consumers located in emerging markets (Huyghe, 2014). Therefore, what drives emerging markets' consumer choices is worth researching.

The current research focuses on one such emerging market—the state of Texas. Texas was selected as a site for the study for a variety of reasons, including a long history of grape growing and wine production (much longer than in California). The first vineyard in North America was established in Texas by Spanish missionaries in the late 1600s. At the turn of the 20th century, there were 1.3 million grapevines of bearing age (the equivalent of 2,900 acres today) and two dozen commercial wineries that collectively produced more than 100,000 gallons of wine (Marshall, 2007). Unfortunately, when the Eighteenth Amendment instituted Prohibition in 1919, the flourishing growth of the Texas wine industry had ended.

It was not until 50 years later when the state started seeing a rebirth of its wine and grape industry. Texas has come a long way since the emergence of only a handful of wineries in the early 1980s to 487 wineries today producing 2 million cases (Wines Vines Analytics, 2021). Throughout the last four decades, the Texas wine industry propelled itself to great heights, growing into a $13.1 billion industry (Danze, 2022).

This study aims to investigate the factors behind the successful growth and development of the Texas wine industry. The evaluation of economic growth can be approached through a myriad of methods. The current study focuses on the *consumer perspective* to identify factors that guide local consumers in their selections of Texas wine.

There are five general categories of factors that influence consumer behavior: *cultural, social, personal, economic,* and *psychological* (Bakkah, 2023). The current study approaches wine consumer behavior through a mix of constructs reflecting these categories. Personal and economic factors are combined into a demographic category in this study. This category was evaluated by using age, gender, education, and income variables. The role of gender has been widely examined in the literature to determine if male and female consumers have different perspectives on evaluating products (Palan, 2001) and how gender stereotypes influence consumers' choices (Thach, 2012).

Researchers recognize that age is an important factor in driving consumer behavior (Gregoire, 2003; Thach and Olsen, 2006; Koksal, 2019; Tait et al., 2020; Thach, Riewe, and Camillo, 2021; Wolf, Wolf, and Lecat, 2022). For example, a study of four generational groups of wine consumers in Lebanon identified differences in wine attributes, information sources, purchasing and consumption, and sociodemographic characteristics (Koksal, 2019). It is also well-established in the literature that tastes and preferences change as people go through different stages of their life cycles. The share of wine consumption by Baby Boomers and Gen-X'ers has fallen; therefore, some recent research is focusing on millennials and Generation Z (e.g., Thach, Riewe, and Camillo, 2021). Consumers' age also impacts sources of information, how information is gathered and processed, decision making, purchasing behavior, and brand choices (Thach and Olsen, 2006; Evanschitzky and Woisetschläger, 2008; Thach, Riewe, and Camillo, 2021; Wolf, Wolf, and Lecat, 2022).

Other demographic factors, such as income, education, and occupation, not only represent the demographic characteristics of consumers, but also show how they influence consumer behavior. For example, income affects buying behavior in terms of the amount, types, and prices of products purchased, and education influences consumers' evaluation criteria in the decision process (Williams, 2002).

It has been observed that wine consumer choices are influenced by culture and other beliefs (Banks and Overton, 2010). *Cultural factors* can be reflected in loyalty developed to place, local products, and brands, while living in a specific surrounding, state, or country. The current study uses *the number of years lived in the state* as a cultural factor. In addition, price patterns for red and white wine are different and known to correlate with consumer opinions (Cacchiarelli et al., 2014). Batra (2008) found that red wine was most popular among consumers at the time of his study. However, consumer trends change, and today sparkling wine has gained popularity, especially among younger consumers and during special festive occasions (Castellini and Samoggia, 2018). Another example is the popularity of still rose wine, the sales volume of which in the U.S. market alone had grown by 118% from 2015 to 2020 (Dupuy, 2021). The *type of wine* as consumer preference will also be considered as a factor in the current research.

One recent study examined how wine preferences are related to wine attributes and to tasters' experiences (Wang and Prešern, 2018). Researchers found that wine preferences are positively correlated with the following wine characteristics: age, acidity, sweetness, and color. Another finding is related to the assessment of how the experience of wine tasting changes with the

acquisition of training and expertise. Researchers found that training improves the accuracy of guesses of grape variety, country, region, and wine acidity estimation. These results have important implications for growing markets with an increasingly educated population.

Wine tasting is essential in wine marketing (Batra, 2008). Wine tourism, which includes wine tasting, is an effective way to promote wine. While traveling to wineries, customers create unique experiences, and at the same time, they get educated about local wines through wine tastings. Their stories later become an excellent method of advertisement (Zainurin, Neill, and Schanzel, 2021). Therefore, several variables related to *attendance at wine festivals and tasting wine there*, *visiting local wineries*, and *recommendation of Texas wine* are used to explain how consumers arrive at decisions for purchasing Texas wine.

Previous research also examined the effect of product information provided on a label and expert ratings on the price of wine. Costanigro, McCluskey, and Mittelhammer (2007) showed that the information on the label and the appellation have a positive impact on the price only for inexpensive and mid-to-low price segments. These effects, however, were insignificant or negative for more expensive and reputable wines. Other information related to wine quality can be perceived by consumers through national and international awards (e.g., medals). Throughout history, Texas wines have received numerous awards. To cite just a few recent examples, at the 2021 TEXSOM International Wine Awards, 29 countries and 16 U.S. states presented their wine. Texas wineries brought home 98 medals, five of which were Platinum medals, seven Gold, 45 Silver, and 39 Bronze medals. Thus, information about Texas wine through public channels signals an improvement in the quality of Texas wines. Experts' opinions is another factor that has a positive contribution to wine prices (Hilger, Rafert, and Villas-Boas, 2011).

A study by Eustice, McCole, and Rutty (2019) researched the impact of product information provided on a label on consumers' willingness to pay for wine in an emerging wine region. Their findings show that awards and medals had the greatest impact on consumer willingness to pay. In addition, local production messages on the bottle also increased willingness to pay.

Some recent studies showed that a causal relationship exists between perceived quality and revealed prices. If consumers lack information about the quality of a product, then higher prices signal higher quality perceptions. This is especially relevant for wine, as it is virtually impossible to evaluate the quality of wine in an off-premise setting unless sampling is offered. Schnabel and Storchmann (2010) found price differences to be positively related to wine quality and negatively related to increased information. Lewis and Zalan (2014) examined the relationship between price and willingness to pay for wines by conducting a wine-tasting experiment when the same wines were presented at different prices. The authors concluded that no relationship exists between intrinsic wine characteristics and enjoyment, since individuals rate the same wines differently, and price influences both appreciation and willingness to pay. Another study found that wine rating and willingness to pay are driven by brand, labeling, or by the price of wine (Lewis et al., 2019).

Developing new products for a region/country and introducing them to the market is full of risks and uncertainties. At the introductory stage of any new industry, consumers pay higher prices for

new products until some demand is created and sales increase. The Texas wine industry is not an exception. The survey data used for this study show that the average price paid for a bottle of *Texas wine* in 2021 was $3.87 higher than the average price paid for a bottle of wine in general (see Table 2). Therefore, this paper aims to investigate what perceptions and attitudes drive consumers to pay higher prices when purchasing locally produced wines in the state of Texas and how the significance of these factors has changed over time. This study considers the average price of a bottle of *Texas wine* paid by consumers as an important response variable based on a set of identified explanatory variables. For comparison, the average price paid for a bottle of wine *in general* is surveyed.

Current research aims to achieve the following objectives:

i. To identify factors affecting consumer purchasing behavior of Texas wine;

ii. To compare the changes in factors impacting the price of Texas wine over time; and

iii. To evaluate Texas consumers' perceptions and attitudes toward Texas wine.

Data

Procedures

Two surveys were used for comparative analysis. The surveys were administered online. In both cases, samples were drawn from panels of wine consumers provided by reputable market research companies. The first survey was conducted in 2006 and resulted in a dataset of 502 responses collected from Texas wine consumers. The second survey was conducted in 2021 and obtained a dataset of 895 surveys. After eliminating observations with missing values, the final samples used in the analysis had 344 observations from the 2006 survey and 732 from the 2021 survey.

The two surveys were carried out with the same purpose: to assess local residents' attitudes and perceptions of local wines. The surveys were not entirely identical, but the key questions pertaining to consumer attitudes and perceptions were the same. Measures for these constructs were borrowed from previous research on emerging wine markets (Kolyesnikova, Dodd, and Duhan, 2008; Velikova, Murova, and Dodd, 2013).

Prior to the collection of data, the surveys were pretested. Similar pretesting procedures were used for both surveys. First, an expert panel was asked to review a draft of the questionnaire and provide their feedback on the wording and/or administration of the survey. The expert panels were selected according to the criteria proposed by Ballester et al. (2008) and included people who are knowledgeable in the subject area—industry professionals, scholars, and marketing experts. Based on the experts' feedback, the instruments were scrutinized and refined. Next, online pretesting was conducted by self-administering the surveys to developmental samples of about 50 respondents. Samples for online pretesting were provided by the same marketing companies that distributed the actual surveys and included respondents from the target population (i.e., wine consumers residing in Texas). Participants were asked to answer the survey questions, followed by an additional open-

ended question asking respondents to provide comments regarding the survey. Minor editorial changes were made to the questions, after which the surveys were launched. On average, it took participants about 10 minutes to complete the entire survey.

To make the two datasets comparable, only complete responses to the identical questions asked in both surveys were retained. With the data from the two surveys, we expanded the analysis of consumer attitudes and perceptions by applying econometric modeling to identify which attitudes have changed over the 15 years between the data collection points.

Sample

To participate, respondents had to be of legal drinking age (21+ in the United States), to be Texas residents, and to be wine consumers (the screening question asked if respondents consumed wine within the last 3 months). Both surveys collected information on socioeconomic characteristics, wine consumption behavior, attitudes and consumption/purchasing behavior toward Texas wines, wine purchase frequency, and perceptions regarding the importance of Texas wine attributes. To evaluate wine attribute perceptions, respondents were asked to rate the significance of six product characteristics describing Texas wines. Responses were evaluated on a 5-point Likert scale ranging from 1 = "strongly disagree" to 5 = "strongly agree." The surveys also reported the zip code where the respondents lived. We used these zip codes to construct a variable for the location of the respondents in terms of their residence in urban or rural areas (UT Health Houston, 2015).

Model

Our empirical model is based the Houthaker-Theil model of demand for quality and quantity (Cox and Wohlgenant, 1986). Consumers are assumed to face the following optimization problem to choose:

$$Max_{q\geq 0, b\geq 0}\ \mathrm{U}(\boldsymbol{q}, \boldsymbol{b}, z, \boldsymbol{c}) \text{ subject to } \textstyle\sum_i p_i(\boldsymbol{b}) q_i + z = y \tag{1}$$

where **q** is defined as a vector of commodities, $\boldsymbol{b}$ is a vector of characteristics of the commodities, **c** is a vector of household characteristics, z is numeraire commodity, and y is income.

The hedonic price functions $p_i(\boldsymbol{b})$, reflect price quality tradeoffs. Moreover, since the solutions to the optimization problem include quantity and quality demand functions, which are a function of exogenous variables (i.e., $q_i(\boldsymbol{c}, y)$ and $\boldsymbol{b}(\boldsymbol{c}, y)$, the reduced form for the price functions can be written as $p_i(\boldsymbol{c}, y)$:

$$p_i(\boldsymbol{b}) = p_i(\boldsymbol{c}, y). \tag{2}$$

For empirical estimation, a log linear model can be considered:

$$lnp = \alpha + \textstyle\sum_j \gamma_j c_j + \varepsilon, \tag{3}$$

where p is commodity price, lnp is log of commodity price, α is a constant, the $c_j's$ are household characteristics, the $\gamma_j's$ are parameters to be estimated, and ε is the regression error. This reduced form hedonic price model provides a useful framework for the analysis of the relationship between prices and consumers' characteristics (e.g., Sirmans, Macpherson, and Zietz, 2005; De Haan and Diewert, 2013; Hussein and Fraser, 2018).

Using equation 3, the empirical model for log of a bottle of Texas wine price can be expressed as a function of three groups of household characteristics: demographic variables (b_1), variables describing the wine attribute preferences and behavior toward Texas wines (b_2), and cultural and social variables (b_3) (see Table 1).

$$\mathrm{P} = \alpha + \sum_k \gamma_{1k} b_{1k} + \sum_m \gamma_{2m} b_{2m} + \sum_n \gamma_{3n} b_{3n} + \varepsilon, \quad (4)$$

where k is the number of demographics variables, m is the number of variables describing attribute preferences and behavior toward Texas wine, and n is the number of variables describing consumers' cultural and social characteristics.

Demographic variables included respondents' age (expressed as years old) and the number of years they have lived in Texas. Binary variables were used for gender (1 if male, and 0 otherwise) and the household location (1 if resides in urban area, 0 otherwise). Information about education included three binary variables representing lower than bachelor's degree, bachelor's degree, and advanced degrees (Master/PhD). Income data were grouped into eight categories. The midpoint of the household income was calculated for each category and was used in the model as a continuous variable.

Wine attributes variables included the type of wine, level of sweetness/dryness, and wine consumption behavior variable, approached as wine consumption frequency. Three binary variables were created to represent the type of wine: red wines or not, rose/blush wines or not, and others or not. The taste of wine was collapsed into a binary variable (1 if sweet, 0 otherwise). Wine consumption frequency was also considered, and binary variables were used to indicate whether the respondents consume wine every day, at least once a week, about once a month, and other.

Cultural and social variables included in the model were recommendations of Texas wines to others, whether consumers tasted Texas wines, visited Texas wineries, had seen or heard advertising for Texas wines, and attended a festival involving Texas wine. These variables were binary variables (see Table 1). Since the model in equation 4 has a semi-log form with the natural log of price used as the dependent variable, coefficient estimates can generally be interpreted as the percentage change in price associated with a 1-unit change in the explanatory variable. Two separate regression models were estimated, one for each survey. These separate regressions allow us to assess changes in the relative importance of Texas consumers' characteristics, perceptions, and preferences for prices paid.

Table 1. Characteristics of Texas Wine Consumers

	Household Characteristics
Demographic variables	Age
	Number of years lived in Texas
	Gender
	Location
	Education
	Household income
Attribute preferences and behavior toward Texas wine	Type of wine (red, rose/blush, or others)
	Taste of wine (sweet or others)
	Frequency of wine consumption (daily, at least once a week, about once a month, or other)
Cultural and social variables	Willingness to recommendation Texas wines (yes or no)
	Have tasted Texas wines (yes or no)
	Visited Texas wineries (yes or no)
	Seen or heard advertising for Texas wine (yes or no)
	Been to a festival involving Texas wine (yes or no)

Results

Table 2 presents descriptive statistics of the data, including sociodemographic characteristics of the samples and the prices paid for wine by the respondents. The average price paid for a bottle of wine *in general* was $14.67 in 2006, increasing to $20.87 in 2021. The average price paid for a bottle of *Texas wine* was $16.20 in 2006, rising up to $24.74 in 2021. Thus, prices paid for both types of wines increased, and these differences are statistically significant at least at the 5% level. The differences in prices (increased from $1.53 in 2006 to $3.87 in 2021) were also significant, according to *t*-test results.

A comparison of sociodemographic characteristics between survey participants in 2006 and 2021 shows the average age was similar in magnitude (about 50 year olds), as well as comparable average number of years living in Texas (about 35 years), although both averages across survey periods were statistically significant at the 5% and 10% level, respectively. Most of the survey participants were female (64.53% in 2006 and 54.51% in 2021) and lived in urban areas (78.49% in 2006 and 77.73% in 2021). Chi-square test results suggest that these differences are statistically significant at the 1% level of significance for gender, but not for location. Finally, chi-square test results also show that households levels of education and income levels differed between samples (at the 1% level).

Summary statistics also show that most survey respondents consumed red wine (52.62% in 2006 and 57.51% in 2021); tasted Texas wines (84.30% in 2006 and 93.44% in 2021); would

recommended Texas wines to other people (50% in 2006 and 81.01% in 2021); visited Texas wineries (50.29% in 2006 and 56.42% in 2021); and have seen or heard advertising for Texas wine (54.07% in 2006 and 65.71% in 2021). Participants reported preferring sweet wines considerably more in the 2006 survey (47.67%) than in the 2021 survey (24.45%). Only 21.51% in 2006 had visited a festival involving Texas wine, whereas in 2021 participation in festivals involving Texas wine had increased to 44.54%. Chi-square test results show that all the differences across survey periods are statically significant at the 1% level, except for visiting Texas wineries, which was significant at the 10% level.

Table 2. Socio-Demographic Characteristics of Texas Wine Consumers (Mean and Proportion)

Characteristics	**Survey 2006**	**Survey 2021**	***P*-value[a]**
	Mean (Standard Deviation)	**Mean (Standard Deviation)**	***T*-test**
Average price paid for a bottle of wine in general	14.67 (12.56)	20.87 (21.31)	< .0001
Average price paid for a bottle of Texas wine	16.20 (15.03)	24.74 (23.34)	< .0001
Price difference between Texas and bottle of wine in general	1.53 (15.76)	3.87 (17.75)	0.0293
Age	50.55 (14.26)	52.66 (16.55)	0.0320
Number of years living in Texas	33.53 (19.71)	35.94 (18.76)	0.0580
	Percentage	**Percentage**	**Chi-Square Test**
Gender			0.0019
Male	35.47	45.49	
Female	64.53	54.51	
Location			0.7802
Urban	78.49	77.73	
Rural	21.51	22.27	
Education			0.0075
Lower than bachelor's degree	34.30	42.48	
Bachelor's degree	36.05	35.66	
Master's and PhD degrees	29.65	21.86	
Household Income			< .0001
Under $20,000	3.20	9.70	
$20,000–$39,999	9.30	15.16	
$40,000–$59,999	20.06	14.62	
$60,000–$79,999	18.31	12.98	
$80,000–$99,999	15.70	10.11	
$100,000–$119,999	9.59	9.43	
$120,000–$139,999	6.69	6.56	
$140,000 or more	17.15	21.45	

Table 2. continued

Characteristics	Survey 2006	Survey 2021	*P*-value[a]
	Percentage	Percentage	Chi-Square Test
Type of wine preference			0.2694
Red wines	52.62	57.51	
Rose/blush wines	17.15	16.53	
Others	30.23	25.96	
Taste of wine preference			< 0.0001
Sweet	45.35	75.55	
Other	54.65	24.45	
Frequency of wine consumption			0.0002
Daily	8.14	15.03	
At least once of week	52.62	39.75	
About once a month	21.51	25.55	
Others	17.73	19.67	
Willingness to recommend Texas wines to other people			< 0.0001
Not recommend and not sure	50.00	18.99	
Recommend	50.00	81.01	
Tasted Texas wines			< 0.0001
Yes	84.30	93.44	
No	15.70	6.56	
Visited Texas wineries			0.0597
Yes	50.29	56.42	
No	49.71	43.58	
Seen or heard advertising for Texas wine			0.0002
Yes	54.07	65.71	
No	45.93	34.29	
Visited festival involving Texas wine			< 0.0001
Yes	21.51	44.54	
No	78.49	55.46	

Note: [a] *P*-values correspond to *T*-tests for differences of means and Chi-Square Tests for differences in proportions.

Log Model Estimation Results

To address the research objectives related to the identification of factors affecting consumer purchasing behavior and to analyze changes of factors affecting Texas wine prices over time, two regression models were estimated, one for each survey. Estimated results for two logs of Texas wine price models for the 2006 and 2021 surveys are shown in Table 3.[1] The measure of goodness-of-fit (R^2) for the estimated Texas wine price equation was 0.1933 for 2006 and 0.1088 for 2021. The reduction in the R^2 values might be related to increased consumption heterogeneity due to the well-documented increase in product variety (Neiman and Vavra, 2020). Thus, the same explanatory variables now predict a lower percentage of willingness-to-pay values.

The overall results for the 2006 dataset showed that the consuming wine every day or at least once a week, respondents' age, and whether respondents have tasted Texas wine variables were found to have a negative and significant effect on Texas wine prices. Specifically, Texas wine consumers paid less for Texas wine when they consumed wine every day or at least once a week. They also paid less for Texas wine when they had tasted Texas wine. Older consumers paid less for Texas wine. Higher income consumers were willing to pay more for Texas wine. In addition, consumers paid more for Texas wine when they were likely or extremely likely to recommend Texas wine to others.

For the 2021 dataset, age and advance education degree variables were found to have a negative and significant effect on Texas wine prices. Particularly, older and highly educated consumers paid less for Texas wine. Preferences for red wine, rose/blush wines, income, as well as willingness to recommend Texas wines and visiting festivals have been found to have positive and significant effects on Texas wine prices. This implies that consumers who mostly drink red and rose/blush wine were willing to pay more for Texas wine. Texas wine consumers with higher income, as well as those who would willingly recommend Texas wine to other people, and those who have been to wine festivals, also pay more for Texas wines.

Compared to consumers who drink wine less than once a month, each additional consumer who drinks wine daily was willing to pay 34% less, and an additional consumer who drinks wine at least once a week was also willing to pay about 17% less for Texas wine in the 2006 survey. Furthermore, an additional consumer who had tasted Texas wine paid about 25% less for Texas wine in 2006.

In the 2021 survey, higher educated consumers (those with graduate degrees) were willing to pay about 16% less for Texas wine relative to consumers who have less than an undergraduate degree. Compared to consumers preferring white wine, an additional red wine drinker added about a 20%

[1] We tested to see whether the two surveys should be used as pooled dataset or as separate regression models. The null hypothesis tested whether the interaction between parameter and year dummy are equal to zero. Thus, we rejected the null hypothesis. The test result implies that parameter estimates of the model are different for these two surveys, and it is more appropriate to estimate the model separately for the dataset 2006 and 2021.

increase to the price of Texas wine, and an additional rose/blush wine drinker increased Texas wine price by 24%.

This analysis showed the negative and significant effects of age on purchasing behavior of Texas wine. With each additional increase in age by 1 year, consumers paid 1.2% less for Texas wine in 2006 and 0.3% less in 2021. The observed reduction in percentage of price paid within a 15-year period can be interpreted as the indicator of the improved quality of Texas wine. The variable "*would recommend Texas wine*" produced similar results. Each additional recommendation added about a 17% increase to the price of Texas wine in 2006 and a 25% increase in 2021. These results regarding the two variables in the model—consumers' age and willingness to recommend—attested to the improved quality of Texas wine over the years considered in the study. Additional income increased Texas wine price by 2.9% in 2006 and 1.6% in 2021. Each additional participation in a wine festival added about a 13% increase to Texas wine prices in the 2006 survey and a 15% increase in 2021.

Table 3. Parameter Estimate the Log Model of a Bottle of Texas Wine Price

	Parameter Estimate (Standard Estimate)[a]	
Variable	**2006**	**2021**
Intercept	3.018 (0.200)**	2.462 (0.172)**
Every day	-0.342 (0.181)*	-0.007 (0.086)
Week	-0.169 (0.085)**	0.069 (0.060)
Month	0.038 (0.096)	0.000 (0.060)
Age	-0.012 (0.003)**	-0.003 (0.001)**
# Years living in TX	0.002 (0.002)	-0.001 (0.001)
Male	-0.050 (0.074)	-0.005 (0.049)
BS	-0.020 (0.088)	-0.042 (0.057)
MS and PhD	-0.048 (0.090)	-0.163 (0.075)**
Red wine	-0.012 (0.066)	0.197 (0.056)**
Rose/blush wines	0.047 (0.102)	0.240 (0.068)**
Sweet	0.004 (0.066)	0.007 (0.060)
Recommend	0.173 (0.061)**	0.253 (0.053)**
Income	0.029 (0.010)**	0.016 (0.006)**
Tasted Texas wine	-0.248 (0.092)**	0.121 (0.114)
Visited Texas winery	0.046 (0.067)	0.051 (0.054)
Visited festival	0.129 (0.071)*	0.153 (0.047)**
Seen advertising of Texas wine	0.008 (0.067)	-0.004 (0.047)
Urban residency	0.067 (0.075)	0.010 (0.055)
R^2	0.1933	0.1088
Adjusted R^2	0.1486	0.0863
F-Statistics	4.33 (< 0.0001)	4.83 (< 0.0001)

Notes: [a] Heteroscedasticity consistent standard errors; ** Denotes significance at 5% level, and * denotes significance at 10% level

Importance of Texas Wine Attribute Results

Next, the evaluation of Texas consumers' perceptions and preferences toward Texas wine was carried out by testing six attributes on statistical differences in the average value of each attribute importance between the two surveys ($p < 0.05$) (see Table 4). Three of the six attributes regarding Texas wine were found to be significant. *Well-known, good quality,* and *better than expected* had higher ratings in the 2021 survey than in 2006. These results were significant even after controlling for the sociodemographic characteristics of the respondents, showing that over time Texas wines were improving, were better quality, and earned a good reputation.

Two other attributes—*appropriately priced* and *widely available*—did not show statistical significance in both wine surveys. The *Good value* attribute showed a statistically significant difference at a 10% level of significance when controlling for the sociodemographic characteristics of the respondents.

Testing significance in the average values of each attribute allowed us to answer the third research objective. To summarize, results show that out of six attributes describing Texas wines, three attributes—*well-known, good quality, and better than expected*—were significant over time, reflecting the improved perceptions of consumers about Texas wines, specifically regarding improvements in quality and taste perceptions over time. *Good value* was significant at a higher level of significance, which shows that consumers are aware of the improvements in Texas wine quality, yet they expect the prices of Texas wine to meet their expectations. The remaining two wine attributes—*appropriately priced* and *widely available*—were not significant over time.

Table 4. Importance of Texas Wine Attributes

	Surveys of Texas Wine Consumers		Comparison of the Datasets			
Attribute	**Mean 2006 (Std. Deviation)**	**Mean 2021 (Std. Deviation)**	**Parameter (Std. Error)**	***P*-value**	**Parameter [a] (Std. Error)**	***P*-value [a]**
Good value	3.873	3.969	0.095	0.153	0.112*	0.093
	(1.021)	(0.877)	(0.067)		(0.066)	
Well-known	2.586	3.361	0.775**	< 0.0001	0.776**	< 0.0001
	(1.040)	(1.003)	(0.069)		(0.069)	
Appropriately priced	3.848	3.835	-0.013	0.830	-0.003	0.964
	(0.946)	(0.811)	(0.062)		(0.061)	
Good quality	3.717	4.075	0.358**	< 0.0001	0.364**	< 0.0001
	(1.028)	(0.791)	(0.065)		(0.064)	
Widely available	3.583	3.592	0.008	0.917	-0.001	0.994
	(1.224)	(1.000)	(0.078)		(0.079)	
Better than expected	3.783	4.055	0.271**	< 0.0001	0.280**	< 0.0001
	(1.077)	(0.830)	(0.068)		(0.068)	

Notes: [a] The parameter estimated takes into account for socio-demographic variables ;** Denotes significance at 5% level, and * denotes significance at 10% level.

Discussion and Managerial Implications

The current study examined changes in consumers' attitudes toward a local agricultural product (wine) in an emerging region (Texas) over a 15-year period. Despite the region's early historic connections with wine and the recent exponential growth, the Texas wine industry is still considered new and developing. Consumers in new wine regions are generally faced with a choice between more familiar, established products, which are non-regional (e.g., wines from the Old World), and regional but less-known wines. As the emerging market develops, local consumers' perceptions are likely to evolve as well. It is under this premise that the current study was conducted, with the primary goal to identify the factors that contribute to changes in consumers' attitudes toward local products.

In 2006 when the first survey was administered, the Texas wine industry was still experimenting with grape varieties, different winemaking techniques, and various marketing strategies. Texas wines were not well-known at the time, even to local residents, and the taste of many Texas wines likely needed improvement. To illustrate the dramatic growth of the industry, the number of Texas wineries increased almost 10-fold within the 15 years between the two surveys. Undoubtably, the Texas wine industry has grown considerably. Typical for emerging wine regions, as the market matures, so does the quality of wine. Many experts assert that the quality of Texas wines has noticeably improved (McCreary, 2020; Boot Ranch, 2022). The results of our comparative analysis support these expert opinions.

Our findings indicate that in both surveys, consumers' age was a significant factor contributing to consumer attitudes toward Texas wines, with older consumers paying less for a bottle of Texas wine. Consumer attitudes toward Texas wine have shifted as the younger generation is paying higher prices for locally made wines than the previous generations. With the increase in social media presence of Texas wineries, producers now have better (and more cost-effective) marketing approaches and promote themselves in a manner that is more appealing to younger consumers. On the other hand, older consumers are likely to still perceive the quality of Texas wines as they did in the past. Thus, the industry needs to focus on educating older consumers about local wines and on providing opportunities for these consumers to taste local wines.

One such opportunity could be wine festivals and events. Our findings from the 2021 survey indicate that consumers who visited a local wine festival, on average, pay more for Texas wines. This is likely the effect of wine tasting at the festival, as well as the unique wine tourism experience. Given the tremendous growth in the number of Texas wineries within the last decade, the wine industry has much room to expand in terms of enhancing the frequency of tourist visits. Again, our study suggests that it is the opportunity to taste the wines that largely contributes to changes in attitudes and in paying higher prices. Texans are yet to become acquainted with the abundance of wine tourism resources in the state. The industry needs to focus on designing wine tours and festivals, appealing to the state residents and visitors. The discovery of wineries as a place to gather with friends is a growing trend, especially for younger consumers.

Another factor found to positively contribute to consumers paying higher prices for Texas wines was their willingness to recommend Texas wines to other people. This is a particularly interesting finding, as in 2006, a large cluster of local wine consumers had been found who had higher-quality ratings and assessments of Texas wines; yet, they were not willing to recommend them to others (Kolyesnikova, Dodd, and Duhan, 2008). The wine industry relies heavily on personal recommendations for introducing new products. Thus, it was unfortunate at the time for local wineries that local residents believed in the wine quality, but were not willing to recommend the wines to others. Therefore, it was particularly satisfying to discover in the comparative analysis that willingness to recommend not only increased over the years, but it also contributed to paying higher prices.

These findings are consistent with many previous studies (e.g., Lockshin et al., 2017; Castellini and Samoggia, 2018; Thach, Riewe, and Camillo, 2021) that found recommendation by friends and family to be a very strong influence on consumer choice. By better understanding how information is transferred from one person to the next will assist marketers in their efforts to establish new products or introduce new brands or regional wines.

Not surprisingly, consumers with higher annual household incomes were found to pay more for Texas wines. Texans are known for having pride in their birthplace and being more likely to identify themselves as "Texans" rather than "Americans" when travelling abroad (Texas SEGP, 2014). Having a sense of pride for their state, consumers with higher incomes are likely to support the development and expansion of the local wine industry. Paying higher prices for local wines is one way to support the state's economy.

Somewhat unexpected was the finding that consumers with advanced graduate degrees and those who consume wine frequently were paying less for a bottle of local wine. One possible explanation is that such consumers included many wine connoisseurs. They are typically more knowledgeable about wine than consumers with lower levels of education and those who consume wine only occasionally. Connoisseurs typically prefer imported wine, likely from Europe or more established wine regions. With respect to wine brands, these consumers are likely at least somewhat image conscious. Texas products may be seen as less fitting with their social image. At the same time, such consumers are generally open to wine education and typically seek variety in terms of wine brands. The industry should take advantage of their willingness to try new products and find opportunities to educate them about the improved quality of Texas wines.

With regards to attitudes toward local wines, some significant changes were found. The ratings for the following attitudes—Texas wines are *well-known, good quality,* and *better than expected*—were higher in the 2021 survey, once again illustrating that within the last 15 years, Texas wines have improved, are of better quality, and have earned a good reputation. Importantly, local consumers have recognized these improvements. On the other hand, perceptions of Texas wines as being *appropriately priced* and *widely available* did not change over time. This finding should be a concern for the industry and should be addressed by better marketing promotions and, in some cases, adjusting prices.

To conclude, by using a comparative analysis of the local residents' wine consumption behavior and attitudes toward local wines in two studies conducted 15 years apart, the current study outlined the factors contributing to changes in these attitudes. The key to developing a successful marketing strategy in an emerging wine region is to first undertake a rigorous assessment of the local market (Jovanović et al., 2017; Mehta and Bhanja, 2018). The findings of the current study contribute to a more comprehensive understanding of consumer attitudes that leads to the commercial success of new products in an emerging region.

Limitations and Future Research

The findings from this research shed light on many questions concerning characteristics and factors contributing to local residents' attitudes and prices paid for local wines. This study was exploratory in nature and hopefully provides impetus for further investigations into this research area. There were two limitations, however. First, we investigated only one emerging wine region. The results, therefore, could be region-specific. Regarding an emerging region being linked to local residents buying the product and the prices they pay for it, future research efforts in other emerging wine regions of the United States or other countries would be useful in determining the generalizability of the results.

Second, the two surveys used for comparison were developed with a broader purpose in mind, such as the analysis of socioeconomic characteristics of wine consumers, wine festivals, marketing, and wine tourism in Texas. While the current study used only the identical variables for the comparative analysis, more variables specifically tailored to study consumers' perceptions and attitudes toward local products may be lacking. For example, measuring changes in per capita consumption of Texas wine over time may shed light on how loyalty, acquired wine tastes, and preferences among consumers develop with time. Ethnicity can be used as a cultural factor influencing attitudes toward wine. Using ethnicity by generational cohorts in a study may show changing trends in the consumption of wine within an ethnical group if observed over time or between ethnical groups. Wine education, measured through variables like information on the label about local products and awards, and a short presentation about wine at wine festivals or wine-tasting events, can also be used in research related to consumer perceptions and attitudes.

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Food Distribution Research Society

Journal of Food Distribution Research
Volume 54, Issue 2, pp. 47–75

VIDALIA Branding and Co-labeling Strategy: A Cluster Analysis of Sweet Onion Buyers and Potential Buyers

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Abstract

The study focuses on several branding, labeling, and co-labeling strategies for sweet onions with a special focus on Vidalia. We evaluated buyers' and potential buyers' preferences for external attributes of sweet onions. We identified market segments for sweet onion buyers and potential buyers based on cluster analysis, followed by a multinomial logit analysis to determine segment membership. Results suggest that producers can attract out-of-state, younger, and higher-educated consumers through a combination of labels, while older consumers tend to focus more on a specific label. Price is the main driver of potential buyers' decisions. Results also suggest the need to increase the amount of information provided to potential buyers, directly on the product sold, using a co-labeling strategy.

Keywords: conjoint analysis, market segment, sweet onions, Vidalia

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Introduction

Like many other states in the United States, Georgia has been using branding and advertising strategies to build a reputation for some of its crops. If the state is well-known for its "*three P's*," peaches, poultry, and peanuts, other agricultural products are also well-known thanks to a successful regional branding strategy. The VIDALIA® brand used for sweet onions is one of them (Carter, Krissoff, and Zwane, 2006). The name emerged in 1949 and became a brand when the "Vidalia Onion Act" was passed in 1986 (Georgia General Assembly, 1986; Oder, 2019). The ownership of the brand was then granted to the state Department of Agriculture and, most importantly, the act stipulated a "region of production" (i.e., 13 counties[1] and parts of seven other counties[2]) to become the official growing area for Vidalia onions. In 1989, the U.S. Department of Agriculture (USDA) provided federal protection to the Vidalia brand, its use, and its restricted area of production. The Vidalia Onion Committee was also created to support marketing and research initiatives (Code of Federal Regulations enacting the Federal Marketing Order No. 955, 1989). In 1990, the Vidalia Sweet Onion was officially designated as the official state vegetable (Georgia Code, 1990).

Regarding consumption, onions occupy the third position in the fresh vegetable sector, behind potatoes and tomatoes, with an average of 21 pounds per capita in 2020 (USDA ERS, 2021). In terms of the value of utilized production, the onion industry represented the third most-valuable fresh vegetable after lettuce (head) and tomatoes, reaching about $1 billion (USDA NASS, 2020) on average every year since 2015, despite an important decrease in numbers of acres planted in the last 20 years (-40%). Although the USDA points out that 2020 was characterized by a widespread decline in fresh vegetable production, the annual utilized production of onions shows a slight rebound of +3% compared to 2018 and 2019 (USDA ERS, 2021). The four largest production regions are Washington, Idaho–Eastern Oregon, California, and Texas (USDA NASS, 2020). However, Georgia, ranked 4th at 12% of the national value of cash receipts for onions in 2020 (USDA ERS, 2020), most of which can be attributed to spring production of the Vidalia sweet onion (UGA CAED, 2021). More precisely, only 9 out of the 13 counties[3] allowed to produce Vidalia account for about 92% of the state's total production (value of about $122,000), a decrease from the 99.9% in 2010 (UGA CAED, 2021).

Hence, determining what specifically makes a region-of-production branding strategy like Vidalia effective is challenging. Thus, the potential contribution of other attributes should be considered when products are sold to new markets (i.e., consumers located outside of the region of production). This paper presents a novel segmentation for the sweet onion market based on the results of a conjoint analysis including characteristics on indication of origin (Georgia, Southeast, United States, and Peru), other labels (Certified Naturally Grown, USDA Organic, Pesticide Free, Non-GMO Verified, and Sustainably Grown), and region-of-production branding (Vidalia, Walla Walla,

[1] Emanuel, Candler, Treutlen, Bulloch, Wheeler, Montgomery, Evans, Tattnall, Toombs, Telfair, Jeff Davis, Appling, and Bacon counties, Georgia.
[2] Jenkins, Screven, Laurens, Dodge, Pierce, Wayne, and Longco counties, Georgia.
[3] Top producing counties: Candler, Emanuel, Evans (3rd), Laurens, Montgomery, Tattnall (1st), Telfair, Toombs (2nd), and Wayne.

and Texas). This study aims to address how key attributes are valued or associated with benefits as perceived by buyers and potential-buyers (not currently purchasing onions) and how a region-of-production branding strategy works in an extended area of sales (miles from Vidalia, GA, the epicenter of where Vidalia onions can legally be grown). This paper shows that branding is essential as it allows producers to differentiate their commodities, thereby potentially increasing demand and revenues. We also show that other characteristics, such as labeling on production practices or origin, are important, but importance varies by market segment.

Motivation and Literature Review

Onions are classified as a vegetable by the U.S. Department of Agriculture, Agricultural Marketing Service, which establishes grade standards (USDA AMS, 2021). According to the National Onion Association (2017), onions from the United States can be divided into two categories based on when they are harvested and sold: spring, summer fresh market versus fall, winter storage onions. This seasonality factor affects their water content (reduced for fall/winter), shelf-life (reduced for spring/summer), and flavor (sweeter for spring/summer), and as a result influences the consumers' preferences toward one category or the other, as well.

Despite a narrow area of production, Vidalia's national recognition is mainly attributed to the "geographical-origin-based branding strategy" (Carter, Krissoff, and Zwane, 2006). By definition and according to research findings, such a strategy is used to convey additional information about the product that consumers find useful and can result in price premiums over generic commodity prices (Simonsen and Lillywhite, 2014). The U.S. fruit and vegetable industry offers multiple examples of similar success with "Country of Origin Labeling" (COOL) (Umberger et al., 2003; Wimberley et al., 2003; Loureiro and Umberger, 2003; Mabiso et al., 2005; Lusk et al., 2006; VanSickle, 2008), state branding like Arizona Grown, South Carolina Grown, or Georgia Grown (Naasz, Jablonski, and Thilmany, 2018), or region-of-production branding (Carter, Krissoff, and Zwane, 2006; Grebitus, Roosen, and Seitz, 2015).

Three major factors—a significant product differentiation, a control of the supply chain, and a broad advertising effort—have proven to be key for the geographical-origin-based branding strategy to be successful in the case of fresh produce (Boyhan and Torrance, 2001; Carter, Krissoff, and Zwane, 2006; Deselnicu et al., 2013). Focusing on product differentiation, literature suggests that taste, freshness, and quality are intrinsic product-based attributes attached to the brand image by consumers (Simonsen and Lillywhite, 2014). In the case of Vidalia, the marketing effort has primarily used flavor to set these onions apart from other sweet onions and onions in general (Costa et al., 2003).

Research findings are also prolific, pointing out the importance of extrinsic characteristics also known as credence attributes and their impact on consumers' willingness to pay. Price premiums have been often associated with specific labeling strategies, such as organic (Yiridoe, Bonti-Ankomah, and Martin, 2005; Batte et al., 2007; Haghiri, Hobbs, and McNamara, 2009; Li and Kallas, 2021), locally grown (Darby et al., 2008; Carpio and Isengildina-Massa, 2009; Onken and

Bernard, 2010; Hu et al., 2012), or a label indicating the absence of genetically engineered material (McFadden and Lusk, 2017).

Additionally, numerous studies (James, Rickard, and Rossman, 2009; Yue and Tong, 2009; Adams and Salois, 2010; Onozaka and Thilmany-McFadden, 2011; Campbell et al., 2014; Chen, Gao, and House, 2015; McFadden and Huffman, 2017) convey that the attribute "local" is increasing in relevance when compared to organic certification or informative labeling like "non-GMO." Moser, Raffaelli, and Thilmany-McFadden (2011) concluded a decade ago that the attribute "local" is generally relevant to the decision to buy fresh fruits and vegetables. Local products are assumed to be fresher and better tasting and, most importantly, they may enhance the trust of consumers who personally know the producers of their fruits and vegetables (Midmore et al., 2005; Rodriguez-Ibeas, 2007; Thilmany, Bond, and Bond, 2008). More recent studies underscored that consumers were willing to pay a substantial premium for locally grown produce if labeled with origin information or that utilize a state or regional branding program (Curtis, Gumirakiza, and Bosworth, 2014; Shi, Halstead, and Huang, 2016).

In contrast, the organic label seems to vary in relevance to consumers depending on the product or the geographic area, despite a recent increase in demand for the organic attribute and price premiums obtained for the organic onion compared to conventional ones (+75% for organic price in $ per pound in 2021, according to USDA ERS, 2021). A key assertion is that consumers weigh the potential benefits of organic by its costs, which are likely to endure throughout their future purchases of organic product (Bezawada and Pauwels, 2013). Well-documented benefits given by consumers include health, nutritional value, taste, animal welfare, ethics, and environmental protection (e.g., Bourn and Prescott, 2002; Fotopoulos and Krystallis, 2002; Makatouni, 2002; Zanoli and Naspetti, 2002), but costs are typically perceived to be higher for organic products than conventional products and more difficult to find in the exact form, flavor, and quantity the consumer prefers (Michelsen et al., 1999).

Another key assertion lies in the fact that many consumers perceive benefits of local foods to be similar to expected benefits from organic foods (e.g., Hempel and Hamm, 2016a, b; Wägeli and Hamm, 2016, Denver and Jensen, 2014). Meas et al. (2015) highlighted that "local has become the new organic." They found strong substitution between organic and local production claims in U.S. consumers' willingness to pay for these products, respectively. Curtis, Gumirakizab, and Bosworth (2014) illustrated this point with products grown conventionally in Utah (locally), outweighing either organically or conventionally grown of unknown origin; specific benefits were associated with local, such as quality, vitality of rural areas, short transportation distances, and freshness (Roininen, Arvola, and Lähteenmäki, 2006).

Despite research efforts to quantify the impact of using labeling, co-labeling, and branding strategies in selling produce, credence attributes tend to be more difficult to evaluate precisely, as the evaluation can reveal consumers' misperceptions or lack of awareness (Lee and Yun, 2015). Among credence features, local tends to always be ranked higher than other attributes, such as organic, certification, brand, and origin, even with no clear definitions or regulating body in place to monitor such claims (Moser et al., 2011). However, the shorter the distance between producer

and consumer (geographically and culturally), the higher the effectiveness of local geographical indicators (Marchesini, Hasimu, and Regazzi, 2007). Other labels such as pesticide free (Baker 1999), non-GMO verified, Certified Naturally Grown, and Sustainably Grown add to the complexity of consumers' perceptions. For example, McFadden and Lusk (2017) pointed out that in the presence of a non-GMO material label, organic is not necessarily valued (i.e., consumers are not willing to pay more for both labels because their perception is that organic does not include genetically modified material).

Data and Methods

Data

An online survey was administered to a nationwide panel of U.S. residents by Toluna, Inc., during the 2018 Vidalia distribution period in June. Survey participants were recruited by a panel provider. A total of 2,211 panelists were randomly selected to participate in a survey regarding their knowledge and potential purchasing behavior of sweet onions. The final recruited sample totaled 1,572 participants. The respondents were classified as "buyers" and "potential-buyers" based on their response to a qualifying question regarding whether or not they bought onions in the last 12 months. Table 1 provides the demographic information related to these two groups. The buyers and potential-buyers then answered questions regarding the factors that affected their decisions to buy produce, their preferred location to buy produce in general, their source of information regarding fresh produce, their ranking of various produce labels, and a conjoint section on their wiliness to buy sweet onions. In addition, the buyers answered specific questions regarding onions, including the types of onions they buy, the frequency and quantity of purchase, their preferred type and brand of onions, and their familiarity with the types and brands of onions. The potential-buyers were asked follow-up questions regarding reasons for not buying onions.

Table 1. Descriptive Statistics by Buying Behavior

	Potential-Buyer		**Buyer**	
	Average	**STD**	**Average**	**STD**
Region				
Northeast	19%		17%	
South	44%		46%	
Midwest	15%		16%	
West	22%		21%	
Age (median years)	53.5		55	
Generation				
Baby boomer and older	54%		58%	
Gen X	31%		33%	
Millennial and younger	15%		9%	
Gender (1 = male)	63%		38%	
Race (1 = caucasian)	81%		83%	

Table 1. Continued

	Potential-Buyer		Buyer	
	Average	**STD**	**Average**	**STD**
Where live				
Metro	36%		29%	
Suburb	50%		48%	
Rural	15%		23%	
Number adults in household (#)	2.15	1.06	2.14	0.98
Number persons under 18 years in household	0.50	1.00	0.56	0.96
Education				
High school or less	20%		25%	
Some college	39%		34%	
Bachelor's degree	25%		25%	
Greater than bachelor's	16%		16%	
Household income (median $)	$55,000		$55,000	
Primary grocery shopper (1 = yes)	80%		97%	
Food neophobia scale	33.4	9.7	27.1	10.5
Distance from Vidalia, GA (miles)	735.6	594.2	732.8	642.9
Observations	124		1,448	

Methodology

Conjoint analysis is a widely used technique to understand consumer preferences for attributes of various agricultural produce. Past examples of its application include apples (Manalo, 1990; Onozaka and Thilmany-McFadden, 2011), bell peppers (Frank et al., 2001), citrus fruit (Campbell et al., 2004; Campbell et al., 2006), strawberries (Darby et al., 2008), peaches (Campbell, Mhlanga, and Lesschaeve, 2013), tomatoes (Onozaka and Thilmany-McFadden, 2011), cucumbers (Jiménez-Guerrero et al., 2012), and produce in general (Campbell et al., 2010).

The first step of a conjoint study is to identify the key attributes and the levels associated with the attributes. As discussed previously, our study focuses on credence attributes and, more specifically, the attributes related to labeling, co-labeling, and branding strategies impacting consumer preferences when purchasing sweet onions. We identified the attributes for this study after consulting with experts and a review of the relevant literature (see Table 2). Product price is usually one of the most important attributes in purchasing decision. In our study the price attribute had four levels, ranging from $0.79/lb to $2.49/lb, which contains the current price of a pound of sweet onions within the interval. The levels for the origin attribute included information on region, state, country, and no label (Georgia, Southeast, USA, Peru, and no label) for exploring consumer preferences for local and imported onions. Other than Vidalia, the regional branding attribute included two more well-known sweet onion brands in the United States, which are competitors—Walla Walla (a regional brand from Washington) and Texas (a state brand). In addition to the origin and regional branding, we investigated other labels that could be added to the description of

a fresh produce that might affect consumer preferences. Our list included Certified Naturally Grown, USDA organic, Non-GMO, Sustainably Grown, and Pesticide Free labels. Since allowing respondents to evaluate each combination of attribute levels would be overwhelming, we utilized a fractional factorial design for the study. Our final design consisted of 32 product profiles after maximizing D-efficiency, whereby D-efficiency allows for comparison of the orthogonal balance of the design with design efficiency (Kuhfeld, 2010). Many of the conjoint studies involving agricultural products have restricted such profiles to 25 or less to limit respondent fatigue; however, studies in marketing and business have used a higher number to evaluate products (see Moskowitz, Gofman, and Beckley, 2006). There are studies of agricultural products using 30+ profiles (Campbell et al., 2010; Campbell, Mhlanga, and Lesschaeve, 2013; Campbell, Mhlanga, and Lesschaeve, 2016; Ong et al., 2021).[4]

Table 2. Attributes and Levels Used in the Conjoint Analysis

Attribute	**Levels**				
Price per pound	\$0.79	\$1.29	\$1.79	\$2.49	
Regional/state branding	Sweet (none)	Vidalia	Walla Walla	Texas	
Sweet onion origin	No origin	Georgia	Southeast	USA	Peru
Certified naturally grown label	No label	Labeled certified naturally grown			
Organic label	No label	Labeled USDA certified grown			
Pesticide-free label	No label	Labeled pesticide free			
Sustainably certified grown label	No label	Labeled sustainably certified grown			

The 32 product profiles were randomized, and the respondents were asked to state their willingness to purchase 1 pound of the product specified in those profiles on a scale of 0–100, where 0 represented "definitely would not buy," and 100 represented "definitely would buy." The respondents were free to choose anywhere within this interval. Figure 1 provides an example of how the different attributes were presented to the respondents. SAS mkt commands (Kuhfeld, 2003) were used to establish the number of sets as well as their design.

[4] There is no consensus regarding the "right" number of product profiles. In the case of choice experiments, Louviere, Hensher, and Swait (2000) observed that most studies evaluated between 8 and 16 choice sets. However, Louviere (2004) later updated that in marketing and transport research, humans will respond to "dozens" of choice sets. Several studies (Stopher and Hensher, 2000; Hensher, Stopher, and Louviere, 2001) that investigated the impact of number of choice sets provided to respondents reported that the number of choice sets had little impact on response rate, no impact on respondent fatigue, and little impact on the mean WTP (Caussade et al., 2005; Hensher, 2006).

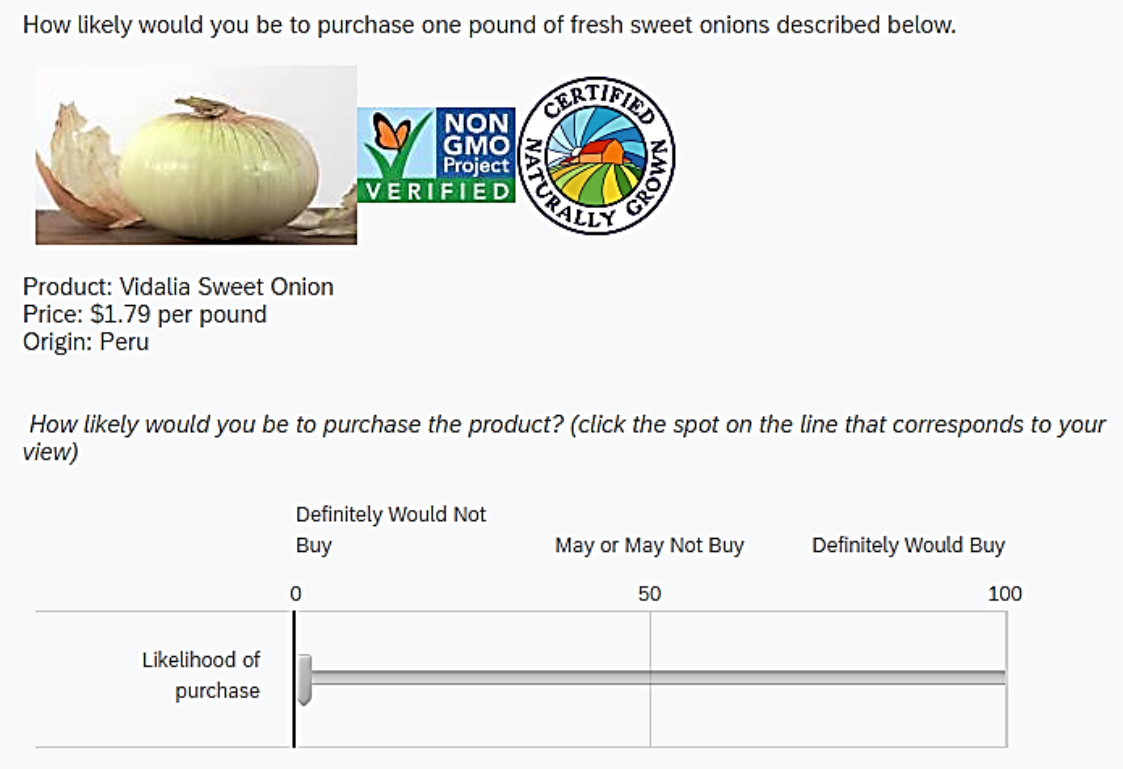

Figure 1. Example of a Set Presented to the Respondents

A consumer's overall utility from consuming the product is the sum of the individual utilities derived from all the attributes that make up the product. Following Lusk and Schroeder (2004), a consumer's willingness to purchase rating is characterized by

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{1}$$

where U_{ij} is the total utility of the ith respondent for the jth product, ε_{ij} is the stochastic error term, and V_{ij} is the systematic portion of the utility function. Given the continuous nature of the willingness-to-purchase rating, we use individual level Ordinary Least Square (OLS) regression to obtain the part-worth utilities associated with each attribute level. The model is specified as

$$Y_{ij} = \beta_0 + \beta_i X_{ij} + \varepsilon_{ij} \tag{2}$$

where Y_{ij} is the rating for willingness to purchase (a scale of 0 to 100), β_0 is the intercept, β_i is a vector of part-worth utilities, X_{ij} is a vector of product-related attributes, and ε_{ij} is the error term, which is assumed to be independent and identically distributed. The attribute levels were effects coded to transform them as deviations from the mean (Hair et al., 2010). By doing so, the effects coded part-worth utility can now be added to or subtracted from the intercept to determine the change in willingness to purchase, holding all other attribute levels constant. We then computed

the relative importance by taking the range of levels within each attribute and dividing by the sum of the range across all attributes (Hair et al., 2010).

After running the regressions, we assigned respondents to segments (clusters) by similarity of preferences represented by part-worth utilities (Green and Helsen, 1989). We used Ward's linkage to cluster respondents and then used a pseudo J statistical test to determine the optimal number of segments following Kotler and Armstrong's (2001) criteria, notably that they be measurable, accessible, substantial, differentiable, and actionable. Ward's linkage is a hierarchical clustering technique that seeks to join groups in a way that minimizes the increase in the error sum of squares (StataCorp LP, 2021).

Finally, after determining the optimal number of segments, we applied a multinomial logit model (MNL) and estimated the corresponding marginal effects to establish profiles for each consumer segment. The MNL model (Greene, 2003) specification was the following:

$$Prob\ (S_i = j) = \frac{e^{\beta'_j x_i}}{\sum_k e^{\beta'_k x_i}} \tag{3}$$

where $Prob\ (S_i = j)$ is the probability that respondent i belong to segment j, k_i is a set of variables related to demographics, purchasing behavior, familiarity with the different origins and onions brands, and food attitudes of the respondents, and β is a vector of parameters. Regarding food attitude, we included an index of food neophobia of the participants. Pliner and Hobden (1992) developed a Food Neophobia Scale (FNS) consisting of a list of five positive and five negative statements regarding food consumption. Participants respond to those 10 statements on a 7-point Likert scale ranging from "strongly disagree" to "strongly agree." The lower the score on FNS, the lower the extent of participants' neophobia.

Zip codes were collected from the respondents and were used to compute the distance between each respondent and Vidalia, GA, using the SAS macro "sashelp.zipcode." We used STATA for all data analysis.

Results and Discussion

Overall Sample

Respondents who reported purchasing sweet onions during the past 12 months represent 92.3% and the buyers' part of our sample. People from the South were oversampled due to our focus on Vidalia and represent 46% among the buyers' category. The remainder of the buyers' sample is composed of 21% from the West, 17% from the Northeast, and 16% from the Midwest. Among these buyers, nearly one-third (29.9%) would be considered as "regular" as they reported eating sweet onions weekly, and another third (29.5%) would be considered as "occasional" as they reported purchasing sweet onions monthly. When considering Vidalia sweet onions specifically, via a multiple choice question, nearly 60% thought of freshness, followed by taste or flavor (45.1%), Georgia (28.7%), and mild (22.1%).

On the question of the origin, when asked where Vidalia onions were grown, 35.7% correctly noted in Georgia, while 14.3% reported some other state, and an additional 7.4% reported Georgia but also added an additional state.

Noticeably, the potential buyers of our sample scored 33.4 on average on the FNS, which is higher than the buyers who scored 27.1 on average, suggesting that the potential-buyers are food neophobic (less likely to try new food).

The following segment analysis is based on the results of the conjoint analysis using different attributes (price, branding, origin, and labeling) and reveals the variability of preferences for buyers and potential-buyers.

Buyers' Market Segments

By clustering buyers with similar preferences based on their part-worth utilities, we identified five market segments. Three of those indicate a strong preference for Vidalia brand and Georgia origin, namely, price-sensitive Georgia-Vidalia lovers, origin sensitive, and price-sensitive Southeast-Vidalia lovers. These three segments represent 52% of our sample of buyers. The other two segments characterize nondiscriminating and price-sensitive respondents and constitute 48% of the buyers. Notably, similar segments have been found, such as price sensitive, origin, and brand (Campbell, Mhlanga, and Lesschaeve, 2013; Behe et al., 2017; Campbell, Berning, and Campbell, 2021). The results of the conjoint analysis and the corresponding marginal effects are presented in Tables 3 and 4, respectively.

Table 3. Sweet Onion Buyer Conjoint Analysis Results: Relative Importance and Part-Worth Utilities

		Non-discriminating		**Price-sensitive GA Lovers**		**Price-sensitive**		**Origin-sensitive**		**Price-sensitive Southeast lovers**	
		Mean		**Mean**		**Mean**		**Mean**		**Mean**	
		Relative Importance[a]									
Price		**21%**		**33%**		**64%**		25%		**30%**	
Type of onion		**17%**		14%		8%		10%		12%	
Origin		**22%**		**25%**		12%		**43%**		**29%**	
Certified naturally grown label		8%		6%		3%		4%		7%	
Organic		**10%**		6%		3%		4%		**15%**	
Pesticide label		8%		6%		3%		5%		2%	
Sustainably grown certified		7%		5%		3%		4%		1%	
GMO label		7%		6%		3%		4%		4%	
		Part-Worth Utilities[b]									
		Mean	**STD**	**Mean**	**STD**	**Mean**	**STD**	**Mean**	**STD**	**Mean**	**STD**
Constant		69.28	23.11	60.91	18.35	48.59	15.13	57.05	13.44	28.57	0.03
Attribute	Attribute level										
Price per pound	0.79	**0.49**	7.23	**10.86**	8.49	**37.13**	11.29	**13.38**	12.63	**21.61**	1.50
	1.29	-0.61	5.09	3.27	6.15	5.28	12.42	4.58	7.93	13.76	0.80
	1.79	0.56	4.50	0.20	6.14	-9.22	9.78	-0.72	6.47	-8.68	0.23
	2.49	-0.44	6.71	-14.34	10.19	-33.18	12.36	-17.25	15.55	-26.69	0.46
Type of sweet onion	Vidalia	-0.08	5.18	**2.30**	7.39	**1.19**	5.16	**3.38**	6.71	**3.24**	0.21
	Walla Walla	-0.10	4.64	-0.79	5.98	-0.65	4.34	-3.53	5.88	1.13	0.37
	Texas	**0.38**	4.30	-0.22	5.92	-0.31	4.34	1.09	5.99	7.45	1.43
	Sweet	-0.21	4.80	-1.29	5.51	-0.24	4.50	-0.93	5.07	-11.81	0.85
Sweet onion origin	No origin	-0.06	5.37	0.49	8.06	0.35	5.65	2.41	11.86	9.29	1.29
	Georgia	-0.76	5.05	**3.56**	7.70	1.48	4.49	**15.27**	9.18	11.54	1.04
	Southeast	-0.13	4.65	1.93	6.17	1.01	4.58	7.97	8.97	**18.37**	0.71
	USA	-0.20	4.82	2.89	6.56	1.25	4.78	10.77	7.91	-11.12	0.44
	Peru	**1.14**	7.88	-8.88	10.19	-4.10	7.39	-36.42	12.44	-28.08	0.02

Table 3. Continued

		Non-discriminating		**Price-sensitive GA Lovers**		**Price-sensitive**		**Origin-sensitive**		**Price-sensitive Southeast lovers**	
		Part-Worth Utilities[b]									
		Mean	**STD**	**Mean**	**STD**	**Mean**	**STD**	**Mean**	**STD**	**Mean**	**STD**
Constant		69.28	23.11	60.91	18.35	48.59	15.13	57.05	13.44	28.57	0.03
Attribute	Attribute level										
Certified naturally grown label	No label	-0.26	3.20	-1.55	3.51	-0.51	2.51	-2.05	3.35	**5.98**	0.53
	Labeled certified naturally grown	**0.26**	3.20	1.55	3.51	0.51	2.51	**2.05**	3.35	-5.98	0.53
Organic label	No label	-1.03	4.94	-0.66	3.94	0.02	3.02	**0.30**	4.10	**12.00**	0.32
	Labeled USDA certified grown	**1.03**	4.94	**0.66**	3.94	-0.02	3.02	-0.30	4.10	-12.00	0.32
Pesticide label	No label	-0.76	3.90	-1.13	3.47	-0.45	3.09	-1.95	4.78	**1.49**	0.41
	Labeled pesticide free	**0.76**	3.90	**1.13**	3.47	**0.45**	3.09	**1.95**	4.78	-1.49	0.41
Sustainably certified grown	No label	-0.51	3.11	-1.30	3.47	-0.51	2.22	-1.37	3.09	**0.64**	0.15
	Labeled sustainably certified grown	**0.51**	3.11	**1.30**	3.47	**0.51**	2.22	**1.37**	3.09	-0.64	0.15
GMO	No label	-0.65	3.12	-1.12	4.19	-0.36	2.46	-0.96	3.78	-3.38	0.26
	Labeled Non-GMO verified	**0.65**	3.12	**1.12**	4.19	**0.36**	2.46	**0.96**	3.78	**3.38**	0.26
r2		58%		74%		90%		84%		79%	
adjr2		19%		49%		81%		68%		59%	
Observations		378		407		322		241		100	
Buyers' market share		26%		28%		22%		17%		7%	
Overall market share (buyers + potential-buyers)		24%		26%		20%		15%		6%	

Note: [a] Relative importance values that are bolded represent the highest relative importance values for each segment.

[b] Part-worth utilities that are bolded are significant at the $p \leq 0.10$ level.

Table 4. Marginal Effects Associated with the Multinomial Logit Model for Sweet Onion Buyers

	Non-discriminating		**Price-sensitive GA Lovers**		**Price-sensitive**		**Origin-sensitive**		**Price-sensitive Southeast Lovers**	
	Marg. Eff.	***p*-value**	**Marg. Eff.**	***p*-value**	**Marg. Eff.**	***p*-value**	**Marg. Eff.**	***p*-value**	**Marg. Eff.**	***p*-value**
Gen X	**0.169**	**0.000**	-0.048	0.170	-0.023	0.473	**-0.086**	**0.000**	-0.011	0.540
Millennial and younger	**0.318**	**0.000**	**-0.168**	**0.000**	-0.018	0.690	**-0.111**	**0.000**	-0.020	0.439
Gender (1 = male)	0.030	0.318	**-0.093**	**0.003**	0.028	0.314	**-0.060**	**0.007**	**0.095**	**0.000**
Race (1 = caucasian)	-0.052	0.186	0.048	0.233	-0.041	0.282	0.032	0.294	0.012	0.564
Suburb	-0.020	0.543	-0.047	0.171	**0.060**	**0.055**	-0.017	0.477	0.024	0.219
Rural	-0.015	0.702	-0.059	0.149	**0.110**	**0.010**	**-0.069**	**0.011**	0.033	0.236
Number adults in household (#)	0.020	0.168	0.005	0.766	-0.024	0.122	-0.002	0.899	0.000	0.994
Number persons under 18 yrs in household	0.019	0.242	0.005	0.779	**-0.034**	**0.064**	0.001	0.936	0.009	0.360
High school or less	**-0.065**	**0.092**	0.029	0.519	-0.022	0.547	**0.068**	**0.094**	-0.011	0.644
Some college	**-0.077**	**0.029**	0.002	0.959	-0.011	0.736	**0.087**	**0.017**	0.000	0.995
Greater than bachelor's	**0.083**	**0.087**	**-0.104**	**0.018**	-0.046	0.253	0.051	0.292	0.016	0.560
Household income ($)	0.001	0.647	**0.010**	**0.004**	**-0.006**	**0.093**	-0.004	0.128	-0.001	0.424
Primary grocery shopper (1 = yes)	**-0.183**	**0.077**	0.049	0.589	0.049	0.483	**0.127**	**0.000**	-0.041	0.472
Food neophobia scale	0.002	0.110	0.000	0.936	**-0.002**	**0.062**	0.001	0.423	-0.001	0.272
Distance from Vidalia, GA (miles)	**0.004**	**0.061**	0.000	0.884	0.002	0.439	**-0.007**	**0.004**	0.001	0.299
Quantity of sweet onions purchased	**0.005**	**0.000**	-0.001	0.690	**-0.005**	**0.008**	0.001	0.298	0.000	0.531
Purchased Vidalia onions (1 = yes)	0.007	0.847	-0.034	0.401	**-0.071**	**0.051**	**0.099**	**0.000**	-0.001	0.980
Familiarity with Vidalia onions	**0.001**	**0.001**	0.000	0.653	-0.001	0.129	0.000	0.870	**-0.001**	**0.040**
Familiarity with Texas onions	0.000	0.563	0.001	0.275	0.000	0.589	-0.001	0.108	0.000	0.746
Familiarity with Walla Walla onions	0.000	0.472	0.001	0.291	0.000	0.734	0.000	0.721	0.000	0.500
Familiarity with Maui onions	0.001	0.397	-0.001	0.370	**0.001**	**0.048**	**-0.001**	**0.051**	0.000	0.653
Familiarity with Peru onions	0.000	0.858	0.000	0.609	-0.001	0.231	**0.001**	**0.043**	0.000	0.688
LR chi^2	392.92									
Prob chi^2	0.000									
Log likelihood	-1596.834									
R^2	0.1096									

Note: Marginal effect coefficients that are bolded are significant at the $p \leq 0.10$ level.

For the price-sensitive Georgia onion lovers (28%, representing the biggest segment), the decision to purchase onions is mainly based on the price tag (33% relative importance), followed by the origin of sweet onions (25% relative importance), with Georgia being the most preferred origin. This segment represents the older participants of the sample (i.e., female Baby Boomers and Boomers with a higher income, who focus more on price and Georgia-grown products). More specifically, Millennials and younger consumers were 16.8% less likely to be in this segment compared to Baby Boomer and older consumers, and male consumers were 9.3% less likely compared to female consumers to belong to this segment. Consumers were 1% more likely to be in this segment for a $10,000 increase in average income. And finally, consumers with higher than a bachelor's degree were 10.4% less likely to be in this segment compared to consumers with a bachelor's degree.

Origin is the main driver for 17% of the buyers' market for sweet onions. The **origin-sensitive group** are also Baby Boomer and older females with education level higher than a bachelor's degree. In addition, they are likely to be the primary grocery shoppers of the household and have familiarity with purchasing Vidalia onions. They also live more in urban areas. More precisely, a Gen X consumer is 8.6% and a Millennial consumer is 11.1% less likely to be in the origin-sensitive category. Male consumers are 6% less likely to be origin sensitive compared to female consumers, and rural consumers are 6.9% less likely to be in this segment compared to the consumers from the metro areas. Consumers with a high-school level education and with some college education are 6.8% and 8.7% more likely, respectively, to belong to this segment compared to consumers with a bachelor's degree or less. Buyers in this segment are likely located in Georgia, as the results show that they become 0.7% less likely to be location sensitive with each 100-mile increase in the average distance from Vidalia, GA.

For the price-sensitive Southeast-loving segment, representing 7% of the buyers' market share, price (30%), origin (29%), and the organic label (15%) are their major purchasing drivers for sweet onions. As indicated by the marginal effects, consumers in this segment are less familiar with Vidalia onions and are 9.5% more likely to be male. In fact, they indicated preferring sweet onions from the Southeastern region, demonstrating their potential lack of knowledge about sweet onion brands or region of origin.

The non-discriminating segment makes up 26% of the buyers' sample. All attributes (i.e., origin [22%], price [21%], type of onion [17%], and organic label [10%]) impact this segment's purchasing decision. As with the price-sensitive Southeast-loving segment, USDA Organic has the strongest preference among all labels. Based on utilities' results and compared to the other four segments, the preference for additional labels (naturally grown, pesticide free, sustainably certified grown, and Non-GMO verified) is likely to be higher. This segment consists of younger, more educated consumers who are not the primary grocery shoppers of the household. More specifically, the marginal effects for the nondiscriminating section indicate that compared to consumers who identify as Baby Boomers and older, Gen X consumers are 16.9% and Millennials are 31.8% more likely to be in this segment. Buyers with a high school education and some college education are 6.5% and 7.7% less likely to be in this segment, respectively, while buyers with more than a bachelor's degree are 8.3% more likely to be in this segment compared to consumers with only a

bachelor's degree. Familiarity with Vidalia onions and purchasing a higher quantity of sweet onions annually increases the likelihood of a consumer belonging to this segment. Additionally, we find that a buyer becomes 0.4% more likely to be in this segment with each 100-mile increase in the average distance from Vidalia, GA. Therefore, buyers from this segment are likely not residents of Georgia, although they have knowledge of the Vidalia brand and trust the information conveyed by labels. This finding is consistent with the latest marketing studies (Hartman Group, 2017), pointing out that younger generations tend to be most interested in learning about the companies they buy from, their brands, and certifications compared to older consumers who rely more on information such as ingredients and nutritional facts to evaluate the fit with their preferences.

The last significant segment is **price-sensitive** and represents 22% of the buyers. As indicated, buyers' purchases of sweet onions are mainly guided by the lowest price ($0.79 per pound), while they heavily discount the highest price presented ($2.49 per pound). The marginal effects for this price-sensitive segment indicate that consumers are 6% and 11% more likely to live in the suburbs and rural areas, respectively, compared to the consumers from metro areas. Consumers with a higher income and more children (below 18 years old) are less likely to be in this segment, as well as consumers with experience buying Vidalia onions (7.1% less likely).

Across the buyers' sample, the cluster analysis reveals that beyond price consistently influencing the purchase of sweet onions, sensitivity to origin and demographic indicators also clearly contribute to identifying buyers' characteristics. Additionally, the USDA Organic label on packaging is more preferred as a source of information compared to other labels presented to respondents.

On the contrary, a sweet onion brand like Vidalia is not discriminant by itself. Studies on region-of-origin have highlighted the importance of the reputation (Shapiro, 1983, cited in Deselnicu et al., 2013; Stefani, Romano, and Cavicchi, 2006) and its association with quality connotations that may be suggested through intrinsic (physical features) or extrinsic (price, brand, or region of origin) cues. More specifically, Costanigro, McCluskey, and Goemans (2010) show that geographical indications are a key differentiation tool within a market of homogeneous food products. However, when purchasing more expensive products, consumers are incentivized to learn about differences in "quality" across brand names.

Hence, for marketing purposes (i.e., capturing a larger share of the premium), the results of our study suggest that for Vidalia onions, state branding (e.g., Georgia Grown) should be associated with the region-of-production branding when selling to older generations. It becomes especially relevant when selling outside of the area or state of production. Regarding attracting younger generations, we also find that using co-labeling strategies would be particularly relevant. These generations are more sensitive to information directly available on the product, such as with USDA Organic or Certified Naturally Grown labels, which indicates producers' practices, especially sustainably oriented. Jensen et al. (2019) pointed out the "origin-organic" (prefer organic and local products with a higher degree of purchases coming from direct sales channels) sensitivity of younger generations. Our results argue that producers should not rely solely on a region-of-origin

branding strategy when building their reputation. As mentioned previously, the quality connotations that consumers use to make their purchase decisions are based on different characteristics, including other information or labels. Therefore, addressing the preferences of the identified "brand-origin-organic" sensitive younger consumers should be integrated in onion producers' marketing equation.

Potential-buyers' Market Segments

As shown in Table 5, our sample of potential-buyers (7.7% of total sample) indicated their dislike of sweet onions as the first reason for not purchasing them (31%), or taste (15%). While a little more than a fourth did not know why they did not purchase Vidalia onions, 9% and 8% mentioned quality and preparation time as main reasons, respectively. Lastly, 6% of these potential buyers prefer another variety. Therefore, more than half of potential-buyers (54%) could be considered as a market potential because they do not dislike sweet onions per se. Other factors explain their lack of purchase.

Table 5. Main Reason Respondents Do Not Purchase Vidalia Onions (Multiple Choice)

Reason	Mean (%)
Taste	15%
Preparation time	8%
Quality	9%
Prefer onion powder	3%
Prefer other variety	6%
Do not like sweet onions	31%
Do not know	28%
Other	20%

We identified four segments among the potential-buyers. Two of these are identified by the relevance of origin in the respondents' potential decision to purchase sweet onions, namely, the nondiscriminating segment and the origin-sensitive segment. The nondiscriminating segment makes up 49% of the potential-buyers' market share, and the origin-sensitive represents 13%. The last two segments are price-sensitive (23%) and/or origin-indifferent (15%). The results of the conjoint analysis and the corresponding marginal effects for the potential buyers are presented in Tables 6 and 7, respectively.

Table 6. Sweet Onion Potential-Buyers Conjoint Analysis Results: Relative Importance and Part-Worth Utilities

		Price-sensitive		**Non-discriminating**		**Origin-sensitive**		**Price-sensitive Origin-indifferent**	
		Mean		**Mean**		**Mean**		**Mean**	
		Relative Importance[a]							
Price		**47%**		**19%**		21%		**58%**	
Type of onion		10%		**17%**		12%		9%	
Origin		16%		**24%**		**42%**		13%	
Certified naturally grown label		5%		7%		3%		3%	
Organic		5%		8%		7%		5%	
Pesticide label		6%		10%		6%		4%	
Sustainably grown certified		7%		7%		5%		4%	
GMO label		4%		8%		5%		3%	
		Part-Worth Utilities[b]							
		Mean	**STD**	**Mean**	**STD**	**Mean**	**STD**	**Mean**	**STD**
Constant		52.351	20.749	38.905	29.859	55.252	17.706	42.145	12.835
Attribute	Attribute level								
Price per pound	0.79	**16.146**	7.331	-0.647	5.091	7.964	10.161	**40.346**	9.485
	1.29	2.555	6.219	0.872	3.936	1.363	5.785	5.318	9.132
	1.79	-3.591	5.897	-1.140	4.868	-2.575	6.954	-16.543	9.442
	2.49	-15.109	9.049	0.915	4.121	-6.753	12.194	-29.121	13.500
Type of sweet onion	Vidalia	-1.604	3.039	-0.267	4.255	4.003	8.475	1.520	5.140
	Walla Walla	**1.689**	4.890	1.023	4.526	-2.707	5.684	**2.617**	6.198
	Texas	0.598	2.808	0.837	3.632	2.746	3.711	-2.654	3.710
	Sweet	-0.683	3.941	-1.593	4.137	-4.042	5.848	-1.482	3.488
Sweet onion origin	No origin	0.727	4.661	-0.589	5.805	1.623	9.633	**2.452**	5.449
	Georgia	-0.394	4.637	-1.281	4.806	10.992	11.083	1.728	5.991
	Southeast	-2.402	5.550	-0.958	3.549	7.818	7.321	1.473	5.283
	USA	0.585	4.050	3.763	6.261	8.709	6.576	1.480	5.044
	Peru	**1.485**	6.052	-0.934	6.340	-29.143	14.954	-7.132	12.300
Certified naturally grown label	No label	-0.008	2.667	-0.270	2.593	-1.346	2.452	-0.095	2.599
	Labeled certified naturally grown	**0.008**	2.667	0.270	2.593	1.346	2.452	**0.095**	2.599

Table 6. Continued

		Price-sensitive		**Non-discriminating**		**Origin-sensitive**		**Price-sensitive Origin-indifferent**	
		Mean		**Mean**		**Mean**		**Mean**	
		Part-Worth Utilities[b]							
Organic label	No label	-0.225	4.653	1.525	3.586	1.641	4.500	**3.105**	3.143
	Labeled USDA certified grown	**0.225**	4.653	-1.525	3.586	-1.641	4.500	-3.105	3.143
Pesticide label	No label	-0.804	2.945	-1.284	3.451	-1.306	5.573	-1.534	3.886
	Labeled pesticide free	**0.804**	2.945	1.284	3.451	1.306	5.573	**1.534**	3.886
Sustainably certified grown	No label	**0.156**	3.387	0.353	2.462	-1.565	3.900	**1.676**	3.211
	Labeled sustainably certified grown	-0.156	3.387	-0.353	2.462	1.565	3.900	-1.676	3.211
GMO	No label	**0.144**	1.734	-0.668	3.147	0.201	3.253	-0.628	3.417
	Labeled Non-GMO verified	-0.144	1.734	0.668	3.147	-0.201	3.253	**0.628**	3.417
r2		76%		48%		75%		86%	
adjr2		54%		-1%		51%		73%	
Observations		29		61		16		18	
Potential-buyers' market share		23%		49%		13%		15%	
Overall market sShare (buyers + potential-buyers)		2%		4%		1%		1%	

Note: [a] Relative importance values that are bolded represent the highest relative importance values for each segment.

[b] Part-worth utilities that are bolded are significant at the $p \leq 0.10$ level.

Table 7. Marginal Effects Associated with the Multinomial Logit Model for Sweet Onion Potential-Buyers

	Price-sensitive		**Non-discriminating**		**Origin-sensitive**		**Price-sensitive Origin-indifferent**	
	Marg. Eff.	***p*-value**	**Marg. Eff.**	***p*-value**	**Marg. Eff.**	***p*-value**	**Marg. Eff.**	***p*-value**
Gen X	0.014	0.930	-0.325	0.129	0.021	0.471	0.290	0.101
Millennial and younger	-0.131	0.328	0.080	0.726	-0.007	0.526	0.058	0.759
Gender (1 = male)	**0.329**	**0.015**	**-0.617**	**0.000**	0.031	0.379	**0.257**	**0.023**
Race (1 = caucasian)	0.162	0.160	**-0.307**	**0.020**	0.006	0.482	**0.140**	**0.034**
Suburb	-0.035	0.817	-0.062	0.723	0.021	0.433	0.075	0.418
rural	0.060	0.794	-0.107	0.688	0.022	0.675	0.025	0.883
Number adults in household (#)	0.093	0.280	-0.059	0.562	0.012	0.392	-0.046	0.397
Number persons under 18 yrs in household	-0.131	0.261	**0.236**	**0.071**	-0.018	0.390	-0.087	0.239
High school or less	0.090	0.683	-0.164	0.513	0.013	0.687	0.062	0.714
Some college	0.032	0.842	-0.203	0.310	0.012	0.591	0.159	0.220
Greater than bachelors	0.071	0.757	0.016	0.949	0.034	0.656	-0.120	0.115
Household income ($)	0.000	0.661	0.000	0.675	0.000	0.476	0.000	0.273
Primary grocery shopper (1 = yes)	0.020	0.896	-0.006	0.976	0.016	0.426	-0.031	0.806
Food neophobia scale	0.003	0.594	0.002	0.734	0.000	0.463	-0.005	0.119
Distance from Vidalia, GA (miles)	0.000	0.544	0.000	0.434	0.000	0.393	0.000	0.126
Reason for not buying: taste	**-0.369**	**0.000**	**0.466**	**0.000**	-0.010	0.453	-0.088	0.164
Reason for not buying: preparation time	**-0.289**	**0.001**	**0.386**	**0.000**	-0.009	0.485	-0.089	0.242
Reason for not buying: quality	0.169	0.682	-0.501	0.045	0.174	0.582	0.159	0.624
Reason for not buying: variety	**-0.241**	**0.002**	-0.038	0.919	0.385	0.282	**-0.107**	**0.059**
Reason for not buying: do not like	0.311	0.325	-0.279	0.365	0.023	0.599	-0.055	0.613
Reason for not buying: do not know	**-0.301**	**0.073**	**0.458**	**0.015**	0.037	0.570	-0.194	0.081
Reason for not buying: other	**-0.264**	**0.059**	**0.333**	**0.066**	0.001	0.949	-0.070	0.518
LR chi2	105.27							
Prob chi2	0.0015							
Log likelihood	-79.947752							
R^2	0.397							

Note: Marginal effect coefficients that are bolded are significant at the $p \leq 0.10$ level.

The non-discriminating segment represents 49% of the potential-buyers (4% of the total sample). The preference of these respondents is driven by knowing the origin of the produce (24%), price (19%), and brand (17%). Male and non-causasian respondents were 61.7 % and 30.7% less likely, respectively, to be in this segment. Having one additional child (below 18 years of age) in the household increased the probability of a respondent being in this group by 23.6%. Participants who responded taste and preparation time as reasons for not buying were 46.6% and 38.6% less likely, respectively, to be in this segment.

For the origin-sensitive segment, Georgia was the most preferred, while Peru was the least. None of the demographic variables used to analyze the consumer profile of this segment were significant.

It's worth highlighting that the **price-sensitive** segment is mainly composed of males (32.9% more likely). This group indicated a surprising preference for sweet onions grown in Peru. Additionally, potential-buyers who indicated taste, preparation time, and other varieties as reasons for not buying sweet onions are 36.9%, 28.9%, and 24.1% less likely, respectively, to be in this segment.

Finally, for the **price-sensitive origin-indifferent segment**, the "No origin" label was preferred the most, suggesting that the location where the onions were grown was not as important. The marginal effects associated with this group of consumers indicate that male and caucasian potential-buyers are 25.7% and 14%, respectively, more likely to be in this segment. Respondents who indicated variety as the reason for not buying were 10.7% less likely to belong to this segment.

Results from the cluster analysis suggest that most potential buyers are price-sensitive, and one segment is origin-sensitive (but origin is not determined). Beyond the primary reasons given for not buying sweet onions (e.g., taste and time of preparation), there might be a lack of information on the different brands of sweet onions available. This paper suggests the need to promote and increase the amount of information provided to consumers directly on the product or package sold.

Conclusion

This study explores the most effective branding and labeling strategy for sweet onions with a particular focus on Vidalia and the region of production in Georgia. By testing and assessing the importance of different credence attributes, such as indication of origin, region-of-production branding, and other additional labels on buyers' and potential-buyers' purchases, we show that producers, marketers, and retailers should consider stronger co-labeling strategies to attract new segments of consumers who appear to be "brand-origin-organic" sensitive. However, before enacting this strategy, producers and marketers should consider the time and costs associated with obtaining organic certification.

Across the buyers' sample, the cluster analysis reveals that price is a strong discriminant when purchasing sweet onions. A low price represents a large incentive for most of the sample (buyers and potential-buyers), especially with older generations. The sweet onion brand Vidalia alone does not significantly impact preferences. The origin, indicated by a region, a state, or a country, is preferred by the majority of buyers, especially among older generations. Additionally, the USDA

Organic label emerges as the most preferred label on production practices. Results highlight that younger generations rely more on multiple kinds of information provided on the packaging, such as brand, origin, and organic. For marketing purposes, this study suggests that state branding (e.g., Georgia Grown) should be associated with the region-of-production branding (e.g., Vidalia) as well as the USDA organic label.

Overall, this study suggests the need to promote and increase the amount of information provided to consumers directly on the product or package sold. This strategy would be particularly relevant when selling outside the region-of-production and for potential-buyers who, beyond the obvious reasons they gave for not buying sweet onions (e.g., taste and prep time), might have a lack of information on the different brands of sweet onions available and their different benefits.

Our results also point out that intrinsic characteristics of sweet onions—quality, freshness, and taste—are still valued. These results corroborate previous findings (Simonsen and Lillywhite, 2014) on certification and branding programs lacking standards of quality and freshness, which decreased consumers' interest and constituted an incentive to choose an alternative. In addition to considering efficient co-labeling strategies, growers exploring certification and branding strategies need to be committed to continued assessment of product quality to build or maintain the brand's value and reputation.

Acknowledgments

This research received funding from the VIDALIA onion committee. The authors acknowledge the VIDALIA onion committee for their support and advice to conduct this study. The authors declare no competing interests. The data that support the findings of this study are available from the corresponding author, Anwesha Chakrabarti, upon reasonable request.

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Food Distribution Research Society

Journal of Food Distribution Research
Volume 54, Issue 2, pp. 76–104

Resilience and Recovery: Understanding the Underlying Drivers of Long-term Instability in Food Supply Chains

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Abstract

The risk of disruption to a supply chain can be explained as any incident that negatively affects a business's operations and is typically short-term and localized due to crises. There is scarce information on extended and global supply chain disruptions (SCD) impacting supply chain (SC) stability. The paper aims to use regional census data from a prominent food production company to identify and quantify the drivers of instability during a long-term disruption. This research uses multivariate control charting methodologies, data mining, and feature analysis to determine how geographical, demographic, and product characteristics impact SC stability.

Keywords: food supply chain resilience, feature analysis, multivariate control chart methodology

Introduction

The motivation behind this study stems from the significant challenges presented by the COVID-19 pandemic and its wide-ranging effects on the global supply chain. Although much research has been done on the supply chain (SC) risk management topic, there is no universally accepted

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definition and classification for supply chain disruptions (SCD) and risk sources. Generally, SC risks can be categorized into natural disasters like hurricanes, earthquakes, outbreaks of epidemics, and man-made disasters like terrorist acts, political instability, and labor strikes; also, the nature of the disruption, high frequent-low impact vs. low frequent-high impact, is critical to resilience strategies.

Among the risks mentioned above threatening the SC, widespread public health incidents like outbreaks deserve precise attention for business decisions due to their distinct characteristics. Typically, outbreaks impose both short- and long-term disruptions that adversely impact the firm's efficiency and performance (Sodhi, 2016; Guan et al., 2020; Ivanov, 2020), and as disturbance propagates beyond its origin and across the entire SC network, known as the ripple effect, it negatively impacts the firm's resilience and sustainability (Ivanov and Dolgui, 2020b).

Unlike any other epidemics that SCs encountered in recent years, such as the SARS epidemic in late 2002 or the H1N1 epidemic in early 2009, the coronavirus pandemic (COVID-19) is a notable example of disruption in the SC due to its multidimensional characteristics. It was not limited to a specific region or time and held more intense and dynamic features, affecting all the SC members (Chowdhury et al., 2021).

Although purchasing behavior is a complex and dynamic process, the severe impact of the COVID-19 pandemic on SCs greatly affected consumers' buying patterns and behavior (Hasan, Islam, and Bodrud-Doza, 2021). On the one hand, stressed SCs suffered from delays in delivering products to customers, which in the food SC caused food security concerns (Ivanov and Dolgui, 2020a; Siche, 2020), and the ability of SCs to provide needed products became a critical topic on the evening news and 24-hour news cycle.

On the other hand, the visible shortages of products, the perception of product scarcity, and the inability to predict and estimate the level of disaster generated uncertainty in communities and contributed to the competition for limited resources and hoarding behavior (Tukachinsky Forster and Vendemia, 2021). Seen explicitly in healthcare-related and food products, panic buying and stockpiling drove unforeseen demand spikes (Barneveld et al., 2020; Deaton and Deaton, 2020; Hobbs, 2020; Richards and Rickard, 2020; Paul and Chowdhury, 2021). An unfortunate result was increasing public concern about the food SC instability and resiliency (Hobbs, 2020), food security (Deaton and Deaton, 2020; Siche, 2020), and food waste (Dente and Hashimoto, 2020; Sharma et al., 2020) as the pandemic worsened.

Chowdhury et al. (2021) revealed that most of the evaluated studies investigated "disruptions in each area/function of a supply chain in isolation" (p. 16), which is in line with the frequent short-term nature of the previous disruptions. However, the recent pandemic profoundly impeded the global SC, allowing the opportunity to investigate the factors that drive SC instability over intermediate and extended periods and build foundations for improving the performance of the SC under long-term crises. Using large data sources, feature extraction/mining, multivariate factor analysis, and analytics, this paper's primary goal is to analyze and understand the factors that contribute the most to the instability of the food SC network under a pandemic with long-term

and global impact. This analysis will contribute to SC resilience and disruption theory by evaluating the impacts of geography, economic indicators, and population on the instability of the stressed food SC network. In addition, the result of this study will help supply chain and distribution leaders prepare for future disruptions.

The rest of the paper is organized as follows. The Literature Review section explores the SCD and consumer behavior literature. The Data and Methodology section describes the study data and the methodology used to analyze instability and causality. The Findings and Discussion section illustrates the results of our analysis, and the Conclusions and Future Research section offers the resulting theoretical and managerial implications and future research directions.

Literature Review

Supply Chain Disruptions (SCD)

SCDs are common and frequent and pose high levels of risk that affect enterprises' performance (Blackhurst et al., 2005; Gunasekaran, Subramanian, and Rahman, 2015; Chen, Das, and Ivanov, 2019). SCDs are unplanned and unanticipated interruptions in the typical SC flow continuity with a negative impact (Craighead et al., 2007; Xu, 2008). Examples include a lightning strike at the Philips NV Microchip plant in New Mexico (2001), the 9/11 terrorist attack (2001), the SARS outbreak (2003), Hurricane Katrina (2005), the Ebola outbreak (2008), the housing market depression (2008), the Eyjafjallajokull volcano (2010), the Japanese tsunami (2011), and the Evonil chemical plant fire in Germany (2012).

We recognize that SC networks are becoming more global and interconnected (Blackhurst et al., 2005; Chen et al., 2019) in the way that local events can have a global impact, although not at the scale and length of disruptions seen starting in 2020. The COVID-19 pandemic differed from past disruptive events both in scope and duration.

Economic challenges, performance effects, financial losses stemming from sales, loss of jobs, unavailable resources, insufficient raw materials, and negative impacts on shareholder wealth and operating performance are some of the adverse effects of SCDs. These events often lead to many firms declaring bankruptcy due to insufficient preparation for the SCD (Macdonald and Corsi, 2013). Although globalization aids in minimizing costs and increasing economic profit, disruptions increase the global vulnerability to risk and uncertainty by increasing dependency and limiting local flexibility (Christopher and Peck, 2004).

In response to supply chain disruptions and their severe impacts, companies can restore their operations by employing resilience, agility, collaboration, redundancy, hardening, and flexibility, depending on the context, location, and severity of the disturbance (Zsidisin and Wagner, 2010). Resilience is often associated with dynamic capabilities, referring to an organization's ability to adapt and reconfigure processes and resources in response to environmental changes and turbulence (Teece, Pisano, and Shuen, 1997).

Most previous disruptions, such as hurricanes, tornadoes, tsunamis, and earthquakes, were relatively short-lived, lasting less than three months. However, a few supply chain disruptions, such as Y2K and epidemics like Ebola, SARS, and pandemics, had longer-lasting impacts. The COVID-19 pandemic is a notable example of an enduring and highly challenging period for businesses globally. Therefore, it becomes crucial to comprehend the effects of an extended SCD timeframe on firms' operational capabilities and their responses to risk management.

Consumer Behavior and Demographic Factors

Consumer behavior is a multidisciplinary notion that incorporates studying all related activities to purchasing, consuming, and disposing of goods and services. It can be defined as the actions taken by individuals who directly obtain economic goods and services, along with the decision-making process that guides these actions. (Engel, Blackwell, and Miniard, 1986).

Consumer behavior is one of the well-studied phenomena in the marketing field. It is rooted in the theory of reasoned action (TRA), suggested by Fishbein and Ajzen (1975), and the theory of planned behavior (TPB) (Ajzen, 1991), which note that consumer behavior is influenced by different factors such as the individual's beliefs, subjective norms, and attitude. The main goal of consumer behavior studies is to understand people's wants and decision-making process via three major approaches: psychographics, consumer typology, and their characteristics (Yousaf and Huaibin, 2013). Accordingly, some scholars (Fisher, 1951; Lydall, 1955; Zwick, 1957; Pol, 1991; Lee, 2005) have studied the effects of the consumer's demographic characteristics like gender, age, ethnicity, income, and educational level on the consumer's purchasing decision process, and others analyzed the impacts of external issues, such as economic crises and natural disasters on consumers' purchasing behavior (Wen, Gu, and Kavanaugh, 2005; Filip and Voinea, 2011; Levine and Shin, 2018).

Scholars recognized fear, anxiety, depression, loss, guilt, irritability, isolation, and stigmatization as the general psychological reactions to disease outbreaks (Omar et al., 2021). Also, they showed that demographic factors are associated with fear, panic, anxiety, and stress (Alfuqaha et al., 2022).

The rise in global crises over the past decade has led to an increase in research studies examining the impact of scarce resources and stressful situations on consumer behavior, "triggered by the 2008 financial crisis, and likely to be accelerated by scarcity related to the COVID-19 global pandemic" (Pol, 1991; Goldsmith, Griskevicius, and Hamilton, 2020).

Omar et al. (2021) identified that during COVID-19 consumer buying behaviors were influenced by uncertainty, perceived severity, perceived scarcity, and anxiety. Moreover, panic buying behavior is one of the expected responses to the fear of scarcity and anticipated regret of a missed opportunity (Chua et al., 2021). Literature links the perception of scarcity and demographic factors, such as age, employment status, experience, income level, and marital status, with panic buying behavior (Wang, Shen, and Gao, 2018; Arafat et al., 2020; Li et al., 2021). By employing the react-cope-adapt (RCA) model, Kirk and Rifkin (2020) showed that hoarding behavior and rejecting

behavioral mandates are two reactions that consumers may show to the perceived scarcity and regaining control of lost freedoms.

Crosta et al. (2021) found that during the COVID-19 pandemic, consumer purchasing behavior differed depending on the product categories essentials vs. nonessentials. Duygun and Şen (2020) explained that people have the propensity to purchase essential products like food, beverages, shelter, and clothing to satisfy their physiological needs. Baker et al. (2020) revealed a significant increase in household expenditures for essentials and food products. Schmidt, Benke, and Pané-Farré (2021) reported growth in purchasing nonperishable food and hygiene products. Sidor and Rzymski (2020) revealed the changes in consumer dietary habits and consumption patterns during the pandemic lockdown in Poland. These findings confirm that the crisis caused by the COVID-19 pandemic is a long-lasting and fundamental phenomenon with global societal and economic impacts.

In addition, analyzing the relationship between consumer purchasing behavior and SC challenges is not a new subject; however, the impact of consumer behavior and purchasing patterns during the COVID-19 pandemic on the food SC, in particular, has been unattended to by scholars and practitioners. Hence, it is crucial to reconsider and understand the effect of the consumer's demographic factors on purchasing behavior during an extended global crisis for supply chain decision makers and managers to design necessary strategies.

Data and Methodology

Data Description

Our data are from a large multinational food producer that manufactures and distributes staples and nonessential snacks to retailers and restaurants in North American countries. The data comprise a census of all 2019 and 2020 wholesale-to-wholesale orders and shipments for the United States Midwest region. We selected this period to understand how a long-term disruption (COVID-19) affected this manufacturer's SC before and during the pandemic.

Because the data are a census representing an entire population, the analysis was approached without working assumptions and sampling. Based on the authors' best knowledge, there is no research publication analyzing a global, extended pandemic that specifically addresses instability and distribution.

As a result, an inductive method, grounded theory, was used to approach this extensive dataset (Strauss, 1998; Eisenhardt, Graebner, and Sonenshein, 2016) to allow the theoretical implications of the data to emerge through analysis rather than using deductive methods with preconceived theory. This deep dive into archival data enabled the authors to examine and capture essential aspects of the focal phenomenon (Eisenhardt, Graebner, and Sonenshein, 2016). The grounded theory approach promoted ongoing analysis to drive additional data collection within the company through interviews to develop clearer constructs and better knowledge of relationships and

associated processes (Eisenhardt, Graebner, and Sonenshein, 2016). This approach aimed to derive theory from data that resembles reality (Strauss, 1998).

We used a big data approach to understand SC dynamics in this extended disruption. The data come from proprietary ERP (Enterprise Resource Planning) information for all product lines. The raw data contained 22 features and 6,451,370 observations (including headers and empty ERP-generated lines). Each observation was a product request from 385 regional distribution centers (DCs) to five fulfillment hubs. After data cleaning, each of the 6,047,137 observations contained the numerical and classification features shown in Table 1. No observations were missing any feature data. The orders comprised 457,213,759 pallets consisting of between 55 to 60 million tons of product. Although the number of items on these standard shipping pallets (1.066 meters square) varies, each pallet is counted as a standard unit for analysis. Total orders account for roughly 22 billion delivery boxes.

Table 1. Summary of Midwest U.S. Wholesale-to-Wholesale Distribution Data

Feature	Definition	Feature Description (6047137 observations)	Categorical Levels
From entity	From a distribution center	Categorical	Levels = 5
To entity	To a distribution center	Categorical	Levels = 385
Sales date	The date on which a transaction occurred	Categorical	Levels = 658
Product name	The name of the product	Categorical	Levels = 524
Brand level 3 name	Products families	Categorical	Levels = 33
Ordered units	The quantity of requested units	Continuous	Integer
Shipped units	The quantity of shipped units	Continuous	Integer
Shipping adds	The quantity of units exceeding the requested amount	Continuous	Integer
Shipping cuts	The quantity of units reduced from the requested amount	Continuous	Integer
Claims	The quantity of damaged, returned, stolen units	Continuous	Integer
Received units/deliveries	The quantity of received units	Continuous	Integer

To better tie the distribution data to communities, we used a mapping API to identify each entity's latitude, longitude, county, and state data fields. Based on this information, we merged county data using U.S. Census data (projected data through 2020) and current unemployment data from the U.S. Bureau of Labor Statistics (U.S. Department of Commerce, 2021).

Of the 524 products made by the company, there are 33 product families. We deleted five product families due to having less than 100 observations. For analysis and clustering, we explored

groupings of the data comparing purchase cost (high/low) and consumption pattern of food type (snacks, staples, and comfort foods).

The data were not severely imbalanced, negating the need for over or under-sampling when using our analysis methodologies. In addition, there was an ordering pattern where Mondays had the highest and Wednesdays had the lowest ordering values used for reconciliations. Therefore, we aggregated orders per week for analysis to reduce day-to-day noise. Once aggregated, we looked at pairwise correlation and checked for autocorrelation. There was little evidence of extensive autocorrelation in any of the variables. Our analysis indicated the data had minimal autocorrelation by using ACF (Autocorrelation Function) and PACF (Partial Autocorrelation Function). Table 2 shows the correlation matrix between time-aggregated (week-to-week) variables. Additionally, an unsurprisingly high correlation among ordered, shipped, and received units was found, and a varying correlation among other numerical features was observed, indicating a possible temporal feature correlation.

Table 2. U.S. Midwest Correlation Matrix between Time-Aggregated (Week-to-Week) Variables Using Pearson's Correlation Coefficients)

	Received Units/Deliveries	**Claims**	**Shipping Cuts**	**Shipping Adds**	**Shipped Units**	**Ordered Units**
Received units/deliveries	1.00	0.09	-0.03	0.12	0.99	0.88
Claims	-0.09	1.00	0.04	0.02	0.04	0.03
Shipping cuts	-0.03	0.04	1.00	0.01	-0.03	-0.25
Shipping adds	0.42	0.02	0.01	1.00	0.43	0.01
Shipped units	0.99	0.03	-0.02	0.43	1.00	0.88
Ordered units	0.88	0.03	-0.25	0.01	0.88	1.00

In Figure 1, we show the assignment of DCs to fulfillment hubs. The overlaps among regions occur because drivers have the opportunity to purchase routes from the producer. For the anonymity of the producer, we do not add the location of the regional fulfillment hubs.

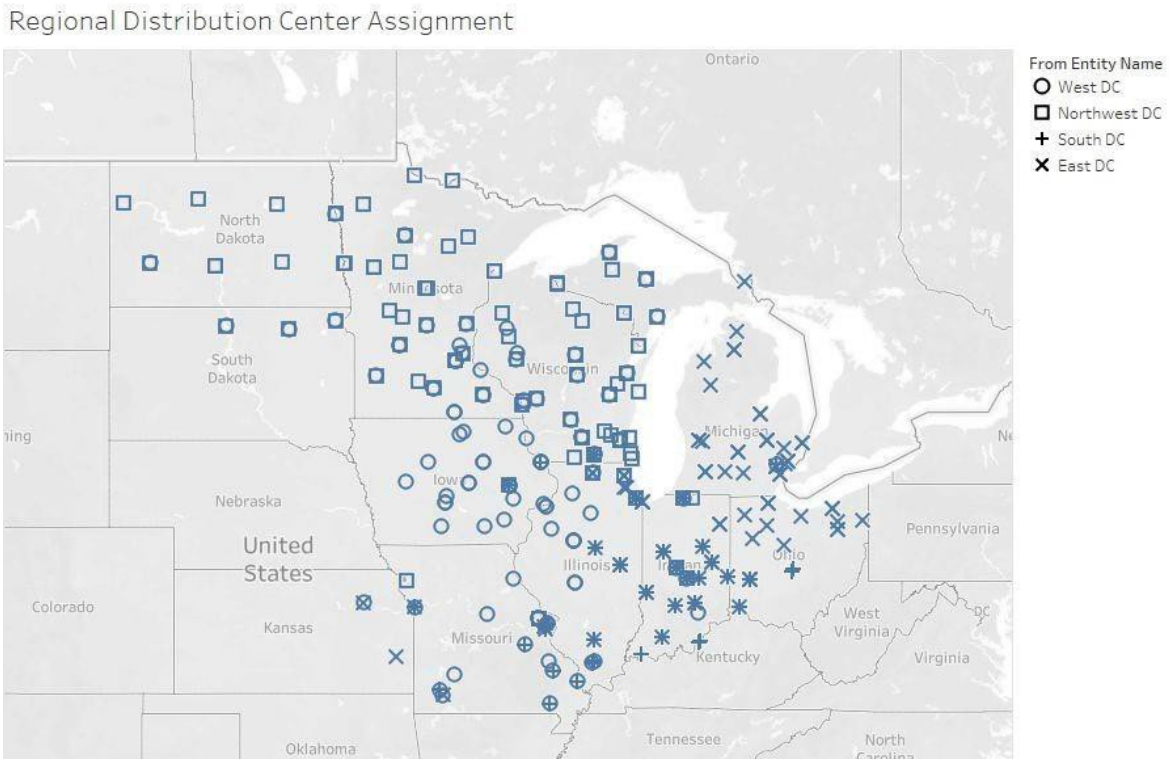

Figure 1. U.S. Midwest Wholesale Distribution Map of the Food Producer

To evaluate the progression of the pandemic, the SC's response, and to consider specific events that impacted consumption in the United States during the pandemic, we divided 2020 into three separate phases, each starting with the following circumstances:

Phase 1: Disaster onset (January 20, 2020—CDC confirms first U.S, COVID-19 case)

The first confirmed COVID-19 case in the United States was reported in Snohomish County, north of Seattle. In the next few weeks, the number of infected people in the United States increased significantly as the disease spread rapidly in other parts of the country. As a result, multiple cities and states had to enforce closures of businesses, schools, and public areas to slow the spread of the virus (Stein, 2020).

Phase 2: First adjustment (April 16, 2020—White House announces gating criteria to reopen economy)

During this time, the White House released a comprehensive plan for returning to work, church, restaurants, and other venues. The plan summarizes the concept of gating criteria, which call for states or metropolitan areas to achieve standards in reducing COVID-19 cases or deaths before moving toward the next step for reopening (AJMC, 2021).

Phase 3 Long-term recalibration (July 2, 2020—states reverse reopening plans)

Governors in several states, like Washington, California, Florida, and Texas, postponed or reversed some of their reopening plans as coronavirus cases rose in more than 30 states across the country, and the United States recorded 50,000 new cases of COVID-19, the most significant one-day spike since the pandemic's onset.(Higgins-Dunn, 2020)

Consequently, while we analyzed the entire 2020 period versus 2019, we also examined the specific pandemic windows to examine for pre-pandemic differences; the windows show observably unique demand phases during 2020.

Table 3 presents state-by-state data for claims, shipment from facilities, total deliveries to the targeted facilities, shipping cuts, and shipping adds across the Midwest United States from 2019 to 2020.

Given the significant increase in orders across the region, the company surged deliveries by 22% during Phase 1. However, increased shipments are concentrated in urban centers and markets close to the regional DCs. While this research does not look at causative effects, we theorize that because in rural America there was a significant disparity between the way Covid was perceived and the actual reality (Weber, 2021), and in early 2020, rural areas did not quarantine to the same levels as places closer to urban centers, international ports of entry, and large airports. They have a degree of self-reliance not found in urban areas.

Table 3. State-by-State Receipts, Cuts, Adds, and Claims for January 2019–December 2020

All 2020 and 2019 (statistic = sum)										
	Claims (2020)	**% Change**	**Shipment (2020)**	**% Change**	**Deliveries (2020)**	**% Change**	**Cuts (2020)**	**% Change**	**Adds (2020)**	**% Change**
Illinois	1.87E+05	90%	3.01E+07	13%	2.99E+07	13%	-1.67E+06	134%	4.59E+05	79%
Indiana	2.04E+05	-7%	2.17E+07	18%	2.15E+07	18%	-9.75E+05	160%	1.71E+06	169%
Iowa	2.22E+05	105%	2.06E+07	19%	2.04E+07	18%	-9.26E+05	26%	6.86E+05	87%
Michigan	1.82E+05	36%	3.24E+07	6%	3.23E+07	6%	-1.90E+06	162%	3.51E+05	156%
Minnesota	7.54E+04	0%	1.14E+07	42%	1.13E+07	43%	-6.34E+05	99%	1.48E+05	46%
Missouri	1.09E+05	15%	2.33E+07	16%	2.32E+07	16%	-1.87E+06	252%	9.09E+05	389%
North Dakota	1.80E+04	37%	1.47E+06	14%	1.45E+06	14%	-5.81E+04	155%	1.77E+04	100%
Ohio	1.41E+05	-5%	2.87E+07	5%	2.86E+07	5%	-1.64E+06	145%	2.46E+05	94%
Wisconsin	3.12E+05	15%	3.44E+07	14%	3.41E+07	14%	-1.42E+06	113%	1.13E+06	94%
Total	1.45E+06	25%	2.04E+08	14%	2.03E+08	13%	-1.11E+07	133%	5.65E+06	136%
Comparison of Period 1 (2020 and 2019) (statistic = sum)										
	Claims (2020)	**% Change**	**Shipment (2020)**	**% Change**	**Deliveries (2020)**	**% Change**	**Cuts (2020)**	**% Change**	**Adds (2020)**	**% Change**
Illinois	1.70E+04	-5%	8.34E+06	25%	8.32E+06	25%	-7.05E+05	261%	1.56E+05	29%
Indiana	3.51E+04	-29%	5.61E+06	27%	5.58E+06	27%	-3.91E+05	360%	5.77E+05	279%
Iowa	3.46E+04	53%	5.85E+06	32%	5.81E+06	32%	-3.86E+05	227%	2.79E+05	65%
Michigan	2.12E+04	-11%	8.13E+06	11%	8.11E+06	12%	-6.82E+05	194%	4.93E+04	6%
Minnesota	1.17E+04	-30%	3.45E+06	57%	3.44E+06	57%	-2.56E+05	106%	2.18E+04	-54%
Missouri	1.45E+04	-23%	8.81E+06	18%	8.79E+06	18%	-8.30E+05	315%	4.94E+05	405%
North Dakota	3.19E+03	-50%	3.69E+05	8%	3.66E+05	9%	-2.27E+04	238%	1.30E+03	-74%
Ohio	1.56E+04	-43%	7.29E+06	13%	7.27E+06	13%	-6.70E+05	341%	4.00E+04	31%
Wisconsin	1.15E+05	73%	9.49E+06	26%	9.37E+06	26%	-5.56E+05	201%	4.18E+05	157%
Total	2.68E+05	7%	5.73E+07	22%	5.71E+07	22%	-4.50E+06	247%	2.04E+06	144%

Table 3. Continued

Comparison of Period 2 (2020 and 2019) (statistic = sum)										
	Claims (2020)	**% Change**	**Shipment (2020)**	**% Change**	**Deliveries (2020)**	**% Change**	**Cuts (2020)**	**% Change**	**Adds (2020)**	**% Change**
Illinois	4.58E+04	110%	6.69E+06	14%	684E+06	14%	-2.63E+05	75%	8.13E+04	98%
Indiana	4.53E+04	-18%	4.96E+06	24%	4.92E+06	25%	-1.92E+05	197%	4.23E+05	281%
1owa	3.58E+04	55%	4.36E+06	20%	4.33E+06	20%	-1.54E+05	-63%	1.26E+05	102%
Michigan	4.97E+04	75%	7 20E+06	3%	7.15E+06	3%	-5.33E+05	330%	6.65E+04	313%
Minnesota	1.65E+04	68%	2.44E+06	41%	2.43E+06	41%	-1.23E+05	157%	2.87E+04	82%
Missouri	1.65E+04	-20%	4.43E+06	26%	4.41E+06	26%	-2.08E+05	147%	1.80E+05	810%
North Dakota	4.54E+03	361%	3.33E+05	18%	3.29E+05	17%	-1.27E+04	366%	3.77E+03	518%
Ohio	4.46E+04	6%	6.46E+06	4%	6.42E+06	4%	-3.03E+05	132%	4.64E+04	83%
Wisconsin	3.75E+04	-25%	7.77E+06	14%	7.73E+06	14%	-3.05E+05	160%	3.05E+05	147%
Total	2.96E+05	18%	4.48E+07	14%	4.45E+07	14%	-2.10E+06	85%	1.26E+06	203%
Comparison of Period 3 (2020 and 2019) (statistic = sum)										
	Claims (2020)	**% Change**	**Shipment (2020)**	**% Change**	**Deliveries (2020)**	**% Change**	**Cuts (2020)**	**% Change**	**Adds (2020)**	**% Change**
Illinois	1.24E+05	111%	1.49E+07	7%	1.48E+07	6%	-7.05E+05	90%	2.22E+05	137%
Indiana	1.24E+05	8%	1.11E+07	12%	1.10E+07	12%	-3.91E+05	74%	7.08E+05	91%
Iowa	1.52E+05	141%	1.04E+07	12%	1.02E+07	11%	-3.86E+05	92%	2.81E+05	107%
Michigan	1.11E+05	37%	1.71E+07	4%	1.70E+07	4%	-6.82E+05	85%	2.36E+05	215%
Minnesota	4.72E+04	-3%	5.51E+06	35%	5.46E+06	35%	-2.56E+05	73%	9.71E+04	158%
Missouri	7.75E+04	41%	1.00E+07	12%	9.96E+06	12%	-8.30E+05	236%	2.36E+05	245%
North Dakota	1.03E+04	78%	7.69E+05	16%	7.59E+05	16%	-2.27E+04	71%	1.26E+04	290%
Ohio	8.04E+04	3%	1.50E+07	1%	1,49E+07	1%	-6.07E+05	73%	1.60E+05	126%
Wisconsin	1.59E+05	4%	1.72E+07	9%	1.70E+07	9%	-5.56E+05	52%	4.05E+05	fi37%
Total	8.84E+05	35%	1.02E+08	9%	1.01E+08	9%	-4.50E*06	93%	2.36E+0E	105%

Methodologies

In the analysis, we generate descriptive measures for each product and product family. During the research, we tested several methods, including Naïve Bayes, K Nearest Neighbor Clustering with various distance measures, Support Vector Machine with and without One-Class unstructured separation, and Partition Trees. We found the best method was to use a $T2$ Hotelling Control Chart using $\alpha = 0.05$ to quantify when multivariate data showed either an outlier or if the process became out of control using ARL (average run length) metrics. Another reason for using the control chart methodology was the large weekly subsample size. Because there were 385 ordering locations, our ARL and upper control limit calculations were sufficient to detect process shifts. Hotelling control chart methodologies have precedence in literature for food SC monitoring and other nonmanufacturing applications (MacCarthy and Wasusri, 2002; Lim, Antony, and Albliwi, 2014; Juhászová, 2018). Traditional Statistical Process Control (SPC) assumes independence between observations (Montgomery and Mastrangelo, 1991). Appropriately, our five numeric features do not show autocorrelation in week-to-week data. The single exception was the claims feature in the second half of 2020 (Montgomery and Mastrangelo, 1991; Kandil, Hamed, and Mohamed, 2013; Mostajeran, Iranpanah, and Noorossana, 2018). Based on the low degree of autocorrelation, the upper control limits for determining outliers and out-of-control processes do not require Monte Carlo simulation or the use of residuals (Lim, Antony, and Albliwi, 2014; Vanhatalo and Kulahci, 2015). However, this study's aim is not to make more sensitive control charts but rather to identify substantial distribution shifts.

The Hotelling control chart is a multivariate extension of standard SPC procedures where k numeric features are assumed to be normally distributed. The observational vector $\mathbf{x}$ is a k-dimensional, $\boldsymbol{\mu}$ is a vector of means for each k variables, and $\boldsymbol{\Sigma}$ is a square (k x k) covariance matrix. The Hotelling function is:

$$f(\boldsymbol{x}) = \frac{1}{(2\boldsymbol{\pi})^{\frac{p}{2}} |\boldsymbol{\Sigma}|^{\frac{1}{2}}} e^{-(x-\mu)\Sigma^{-1}\frac{\boldsymbol{x}-\mu}{2}} \quad (1)$$

To determine the T^2 statistic, we consider the sample covariance matrix $\mathbf{S}$ and the sample mean vector $\boldsymbol{\mu}$ such that:

$$T^2 = (x - \bar{x})' \boldsymbol{S^{-1}} (x - \bar{x}) \quad (2)$$

For small subsample sizes, the upper control limit for this chart is represented as:

$$UCL = \frac{(m-1)^2}{m} F_{\alpha,k/2,\frac{q-k-1}{2}} \quad (3)$$

where we use the F distribution, α as the confidence level, k as the number of features, m as the number of observations per period, n as the number of periods, and $q = \frac{2(n-1)^2}{3n-4}$. However, because m>38, the UCL calculation becomes $UCL = \chi^2_{\alpha,k}$ (Faraz and Moghadam, 2009a).

Using the T^2 chart, we separate an outlier from a process shift by considering the average run length (ARL) between points above UCL. ARL is a measure of whether an outlier indicates an aberration or a process shift. Because ARL_0 is the count of observations between outlier points, a small result indicates the lack of control where $(\mu \neq \mu_0)$. If this occurs after COVID-19, the inference is that the SC is not resilient and is exhibiting instability. Due to the large subgroup size in the data and relative independence in the samples, the ARL is computed directly rather than correcting for small sample sizes and autocorrelation (Faraz and Moghadam, 2009b).

In the case of the COVID-19 SC, ARL (approximates as $\frac{1}{\propto}$) is an indicator of process control. For this measure, the distance of the shift is d where $d^2 = (\mu - \mu_o)'\boldsymbol{\Sigma}^{-1}(\mu - \mu_o)$. An in-control process would be where d = 0, $\alpha = \Pr(T^2 > UCL|d = 0)$.

Although there is a significant chance that a genuine shift is not detected, as the α is set relatively high at 0.05, such that ARL should be less than 20. In cases where the quantitative analysis did not answer disruption and SC actions, researchers asked the company officials for more information.

We merged U.S. Census data and projections with company data to capture variables of interest, which included unemployment, education, income, rural influence, economic influence, and ethnic information scaled and normalized for analysis. Because U.S. Census estimates were only accurate for 2019, we merged 2020 poverty and unemployment estimates from the U.S. Bureau of Labor Statistics (BLS) to ensure the data represented the fluid nature of joblessness during the pandemic.

Our methodology for feature analysis was a random forest algorithm using bootstrap aggregation. This method is consistent with the disruption detection literature and robust given the sizes of our samples (Reif et al., 2006; Gharroudi, Elghazel, and Aussem, 2014; Ludwig, Feuerriegel, and Neumann, 2015; Lei et al., 2019; Alfaro-Cortés et al., 2020; Arora and Kaur, 2020). Although bootstrap forest is not the most powerful algorithm for regression and prediction, it is an efficient method for feature analysis given a large amount of data (Lei et al., 2019). The random forest algorithm uses bagging or bootstrap aggregation to analyze a dataset with $\boldsymbol{X}_p$ features and y_n targets B times with replacement, fitting trees for each iteration using a random sample of features (usually and in our methods √ p). This sampling of features allows us to compare the aggregated efficacy of each feature to predict the target t_b for each b = 1,…,B. This prediction is expressed as: $\hat{f} = \frac{1}{B}\sum_{b=1}^{B} f_b(\hat{y})$, where $\hat{y}$ are the predictions for test samples in that iteration.

We utilized established generalized linear modeling with K-Fold validation and partial least squares techniques to determine the effects of individual locations and generate *p*-values to check whether a factor was statistically significant. For the initial data processing, cleaning, exploration, and clustering parameter search, the research team used Python 3.7.3 (64 Bit) with NumPy and Pandas with an AMD Radeon RX 550 for parallel computation.

Findings and Discussion

Influential Factors Impacting Instability

In this analysis, we used bootstrapped random forest (B = 10000) with the count of out-of-control T^2 Hotelling points as the target (y) variable. We thought that demographic factors driving instability would change from 2019 to 2020 and between phases of the pandemic, which was only manifested in Period 1 2020, the initial surge, with unemployment moving from eighth most influential to first and the percent of adults with a high school diploma moving from third to sixth place. For all other examined periods, the drivers of instability remained consistent relative to each other (see Table 4). Although there are slight differences in feature contributions, it is evident that education rates and household financial indicators rates undoubtedly relate to instability in food SCs. In other words, this analysis indicates the stark reality that the ability to pay and education are always influential regardless of the level of uncertainty in a food SC.

Also, As COVID-19 policies drove the loss of jobs, unemployment's influence dominated SC variation for period 1. However, this dominance was short-lived, as the education factors returned to their previous influential level in periods 2 and 3.

We found no evidence of ethnic origin, racial groupings, age groups, migration (domestic and international), economics, education, and the rural nature of counties driving variability.

Our findings propose:

P1*:* Features contributing to supply chain instability remain stable during the majority of an extended global disruption. Other than the initial shock of immediate unemployment, the most important features include economic indicators (education level, percentages of poverty, and unemployment) with less influence from urban/rural composition and no effect from age groups, ethnicity, and migration.

Table 4. Feature Analysis of Economic, Educational, and Population by County Impacts to Instability by Period (Sums of Squares Vary Significantly between Periods Because of Varying Period Length) (n = 1000).

Period 1 (2019)

Feature	Contribution	SS
Percent of adults some college or associate's degree	0.1241	99.8227
Total population	0.1194	96.0235
Percent of adults with high school diploma	0.1117	89.8467
Percent of adults with no high school diploma	0.1043	83.8595
Percent of adults with bachelor's degree	0.1038	83.4813
Percent in poverty	0.0952	76.6084
Medan household income	0.0941	75.6857
Unemployment percentage	0.0889	71.5023
Rural code	0.0875	70.9431
Economic influence code	0.0711	57.1721

Period 1 (2020)

Feature	Contribution	SS
Unemployment percentage	0.2575	16.1532
Percent of adults some college or associate's degree	0.1141	86.8717
Percent of adults with no high school diploma	0.1041	79.2655
Total population	0.0915	69.9633
Percent in poverty	0.0831	63.2849
Percent of adults with high school diploma	0.0806	61.3499
Percent of adults with bachelor's degree	0.0761	57.9855
Median household income	0.0685	52.1542
Rural code	0.0631	48.0677
Economic influence code	0.0615	46.8294

Period 2 (2019)

Feature	Contribution	SS
Percent of adults some college or associate's degree	0.1356	218.8649
Percent of adults with no high school diploma	0.1366	210.8287
Total population	0.1095	176.7655
Percent of adults with high school diploma	0.1092	176.2579
Percent in poverty	0.0922	106.0629
Percent of adults with bachelor's degree	0.0959	154.7887
Median household income	0.0911	146.9921
Rural code	0.079	127.4788
Economic influence code	0.0752	121.2697
Unemployment percentage	0.0746	120.4429

Period 2 (2020)

Feature	Contribution	SS
Percent of adults some college or associate's degree	0.1361	172.8036
Percent of adults with no high school diploma	0.1255	159.3194
Percent of adults with high school diploma	0.1223	155.1894
Percent in poverty	0.113	143.4324
Percent of adults with bachelor's degree	0.1129	143.2837
Total population	0.1028	130.5094
Median household income	0.0936	118.7462
Unemployment percentage	0.074	93.9019
Economic influence code	0.0642	81.5361
Rural code	0.0556	70.5559

Table 4. Continued

Period 3 (2019)		
Feature	**Contribution**	**SS**
Percent of adults some college or associate's degree	0.1511	633.7475
Percent of adults with high school diploma	0.133	588.0499
Percent of adults with bachelor's degree	0.1138	47.5535
Total population	0.1112	466.4572
Percent of adults with no high school diploma	0.1028	431.2579
Percent in poverty	0.0918	385.1189
Median household income	0.087	364.8233
Rural code	0.0785	329.339
Unemployment percentage	0.069	289.5422
Economic influence code	0.0619	259.6125

Period 3 (2020)		
Feature	**Contribution**	**SS**
Percent of adults some college or associate's degree	0.1403	577.8019
Percent of adults with no high school diploma	0.1295	533.6164
Percent of adults with high school diploma	0.1215	500.3256
Percent in poverty	0.1185	488.1232
Total population	0.115	471.6895
Percent of adults with bachelor's degree	0.1057	435.5596
Median household income	0.0938	386.2434
Unemployment percentage	0.0619	254.0484
Rural code	0.0579	237.3302
Economic influence code	0.0569	234.5131

As shown in Figures 2a and 2b, one of the significant findings of our analysis was that area population was correlated with the amount of demand growth. Quartiles 3 and 4 increased receipts by 15% and 14%, while quartiles 1 and 2 grew by 9% and 7%. The shipping adds in quartile 4 were 17 percentage points higher than other quartiles, suggesting that urban areas received disproportionate food supplies during periods of fluctuating demand (see Table 5a).

Conversations with the company's representative led us to theorize that it was not a deliberate action but was based on available transportation and distances between wholesale customers and DCs to reduce the risk of delayed delivery and ensure supplies' smooth flow. Therefore, we suggest that it is critical to keep in mind that:

P2: During prolonged global disruptions, food supply chains tend to prioritize meeting the pandemic-related demand shift of higher population areas first. This preference is primarily influenced by factors such as proximity to the distribution centers and the availability of transportation infrastructure.

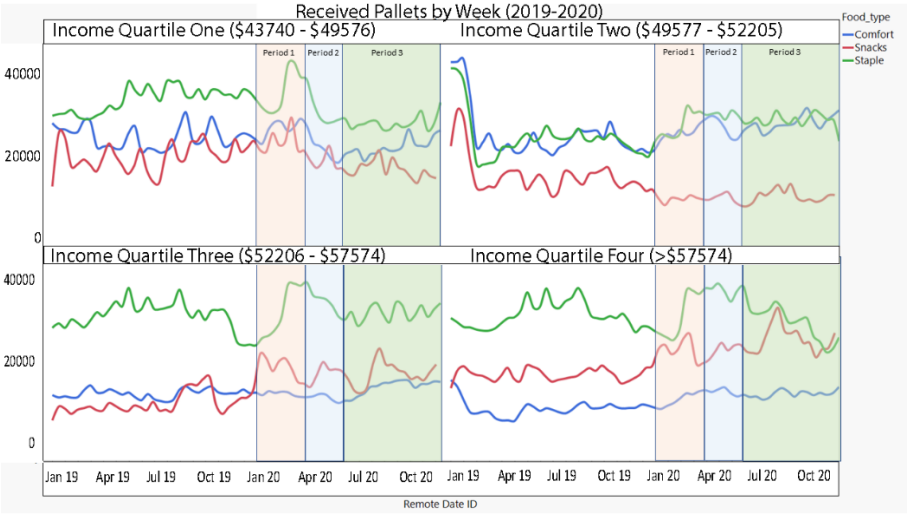

Figure 2a. Receipts Separated by Food Type

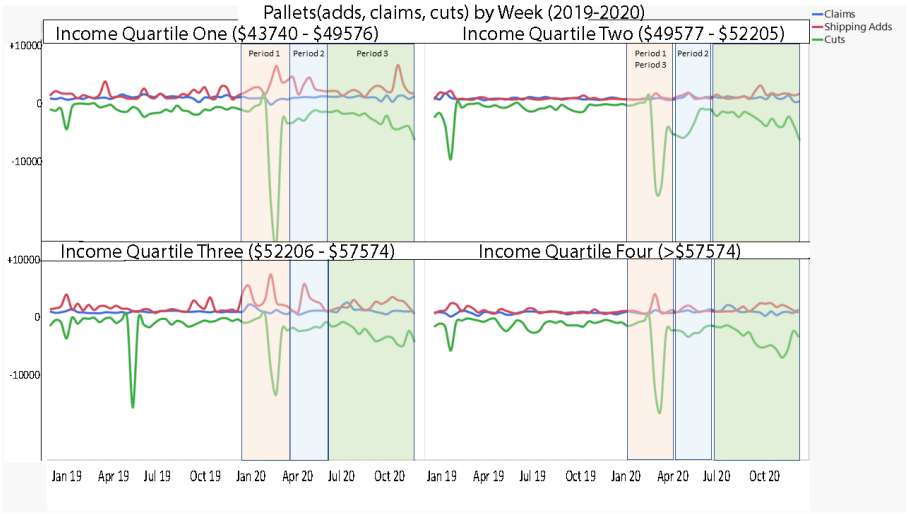

Figure 2b. Receipts Separated by Cuts, Adds, and Claims by County Population

Table 5a. Percent Changes in Cuts, Additions, and Receipts by County Median Income Quartiles

2019 to 2020 Increases by Median Income Quartile, Period, and Food Type										
		Period 1			Period 2			Period 3		
Median Income Quartile (in USO)	Food Type	Received % Change	Adds % Change	Cuts % Change	Received % Change	Adds % Change	Cuts % Change	Received % Change	Adds % Change	Cuts % Change
One ($43,740–$49,576)	Comfort	28%	58%	82%	18%	74%	69%	31%	57%	62%
	Snacks	39%	79%	80%	23%	82%	74%	23%	65%	67%
	Staple	37%	50%	78%	15%	42%	41%	20%	77%	51%
Two ($49,577–$52,205)	Comfort	29%	28%	72%	15%	86%	75%	26%	64%	51%
	Snacks	6%	-144%	-33%	-48%	60%	28%	-15%	22%	63%
	Staple	41%	48%	78%	17%	59%	88%	24%	86%	68%
Three ($52,206–$57,574)	Comfort	29%	-62%	66%	15%	28%	62%	24%	77%	68%
	Snacks	55%	73%	63%	41%	82%	-153%	38%	48%	79%
	Staple	27%	33%	71%	3%	-96%	56%	12%	4%	1%
Four ($57,575–$61,492)	Comfort	40%	-11%	73%	31%	66%	64%	33%	67%	57%
	Snacks	41%	46%	51%	21%	73%	75%	39%	58%	79%
	Staple	29%	-82%	73%	12%	-29%	15%	7%	61%	12%

Another surprise in our analysis of product features was that cost was never prominent in any period, but food type was always a top contributing factor. Three food types were analyzed in our research. Snacks that are savory, ready-to-eat products; comfort foods that are typically sweeter and require more consumer preparation; and staples are foods that make up a dominant portion of the population's diet.

As presented in Figures 3a and 3b, for quartiles 1, 3, and 4 for median country income, demand for snacks increased by 28%, 44%, and 36%, respectively. Quartile 2 was the only income group for which staples were the food type, with the highest growth (27%) and decreased snack demand (-15%). For all income levels, snacks (30%) outgrew staples (20%) and comfort food (27%) (see Table 5b). We theorize that all income groups except quartile 2 enjoyed a higher availability of disposable income throughout 2020, which drove high demands for foods other than staples. It is probable that quartile 2 hosts a large portion of essential workers that stayed active and depended on their earned income; thus, they did not change their consumption habits. Similarly, looking at counties by population, only the lowest populated counties did not have increased demand for snacks, as evidenced by receipts (-2%), while all three higher populated quartiles increased demand for snacks by 15%, 28%, and 16%, respectively (see Figures 3a and 3b). Considering the unemployment support and pandemic relief payments from the government in addition to increased disposable income due to lack of dining out and entertainment options because of shelter-in-place and quarantine mandates, available funds were bolstered for families; therefore, we propose the following:

P3*:* Sufficient supplies of food staples and availability of disposable income support increased demand for nonessential food types during an extended global disruption.

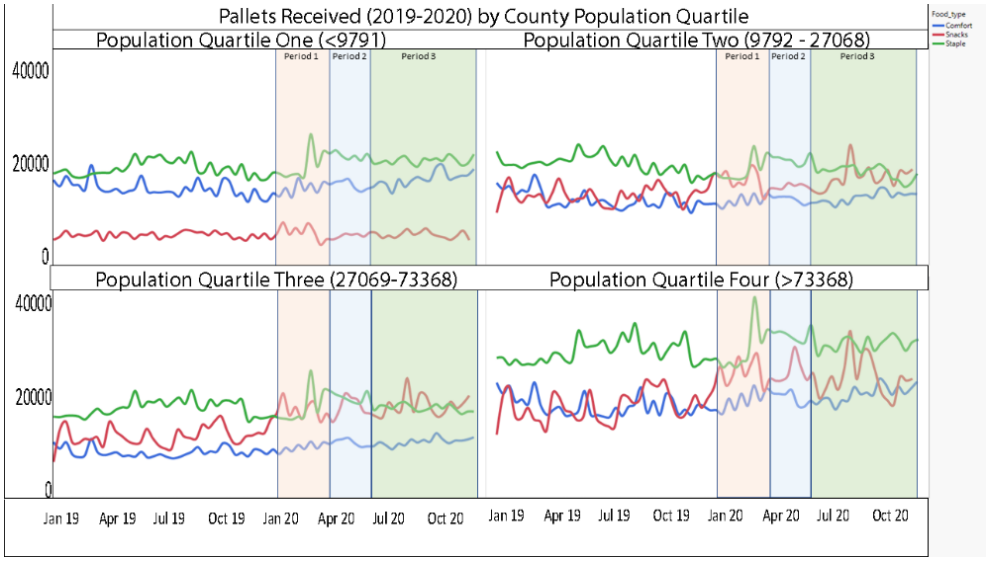

Figure 3a. Receipts Separated by Food Type

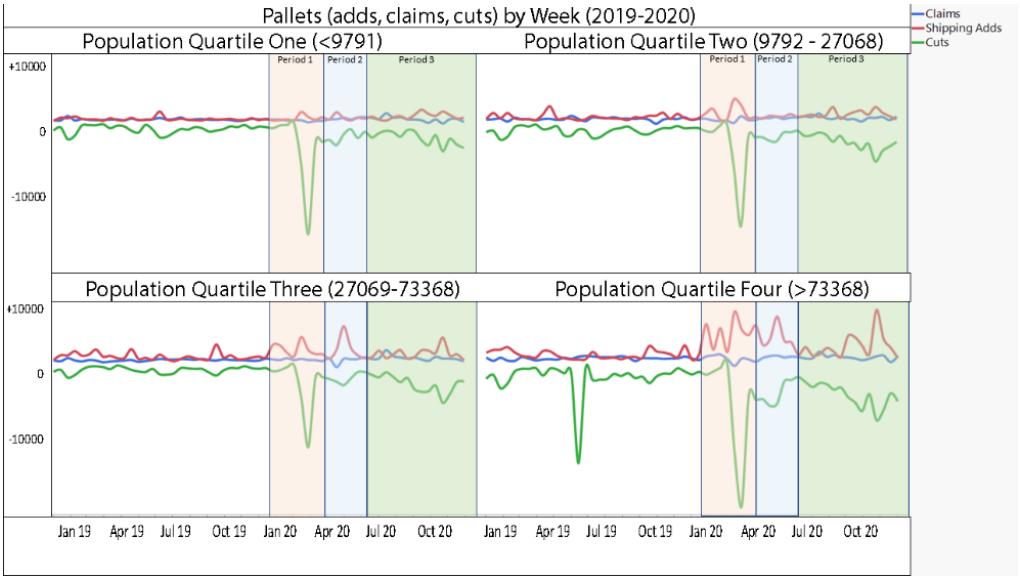

Figure 3b. Receipts Separated by Cuts, Adds, and Claims by County Median Income

Table 5b. Percent Changes in Cuts, Additions, and Receipts by County Median Population Quartiles

2019 to 2020 Increases by Median Income Quartile, Period, and Food Type										
		Period 1			Period 2			Period 3		
Median Population Quartile	Food Type	Received % Change	Adds % Change	Cuts % Change	Received % Change	Adds % Change	Cuts % Change	Received % Change	Adds % Change	Cuts % Change
One (0–9,791)	Comfort	12%	20%	76%	19%	69%	71%	14%	43%	47%
	Snacks	11%	-34%	52%	-2%	68%	65%	-8%	56%	67%
	Staple	18%	34%	77%	12%	9%	53%	0%	66%	24%
Two (9,792–27,068)	Comfort	0%	0%	76%	12%	74%	62%	11%	70%	56%
	Snacks	19%	68%	55%	10%	0%	62%	15%	20%	69%
	Staple	6%	49%	74%	5%	-15%	-4%	-6%	46%	18%
Three (27,069–73,368)	Comfort	6%	-88%	68%	23%	41%	68%	19%	63%	62%
	Snacks	28%	62%	53%	33%	86%	62%	25%	48%	79%
	Staple	7%	-40%	69%	7%	-159%	47%	0%	34%	17%
Four (73,369–5.2 million)	Comfort	12%	-18%	75%	21%	72%	70%	15%	69%	59%
	Snacks	28%	78%	55%	25%	90%	-91%	6%	52%	67%
	Staple	16%	10%	74%	16%	44%	80%	7%	62%	48%

Conclusions and Future Research

SCDs are common but most often very focused and of limited duration. They affect production, transportation, demand, supply, and different parts of a supply chain. Preparing and responding to SCDs can be the difference between a company's long or short-term success and failure. It is crucial to remember that consumer purchasing behavior is constantly changing, and there is no guarantee of predicting their response to various circumstances. However, understanding the drivers of SC stability from the point of view of the consumer's behavior in the food SC can have significant outcomes for businesses and communities worldwide.

The impact of COVID-19 on consumers' behavior is not comparable to any other previous calamity, as it caused massive changes to people's lives and the way they interact with the world around them.

During the COVID-19 pandemic, consumers worldwide have shown panic buying and stockpiling activity, resulting in empty shelves and causing disturbance in SCs and consumer behaviors (Taylor, 2021).

Images of empty shelves and news about people's stockpiling and panic buying shared by media and social media intensified fear and generated the perception of scarcity among people. Simultaneously, based on literature, the perception of the unavailability of products or services

results in a perception of limited stocks and causes panic buying. In other words, the perception of scarcity created one.

Our study's results align with Kirk and Rifkin (2020), who evaluate consumer behavior during the COVID-19 pandemic by adapting the react-cope-adapt model. Accordingly, our initial observation reveals that consumers react to uncertainty at the onset of an epidemic by over-purchasing products, which boosts the pressure on the SC and imposes a disruption. Over time, although the consumers began to cope with the new environment by adopting new behaviors, the impaired SC struggled to return to regular operations due to the excessive damages created by the sudden growth in demand.

Also, the uncertain climate and perceived scarcity of resources imposed by COVID-19 undoubtedly contributed to anxiety and negative emotions that constitute an adverse change in consumer purchasing behavior and its effect on the SC compared to pre-COVID-19.

Our deep dive into data related to global and extended SCDs provides unique insight into food SC elements. As such, the findings articulated here offer broad insights to scholars and managers and opportunities for future research.

Contributions to the Theory

Because this paper is grounded in consumer behavior theory, it sharpens the understanding of how a global and extended food SCD affects demand variations. During the disaster, perceived scarcity, uncertainty about the future, and fear of losing control resulted in hoarding behavior, severely impacting the SC and contributing to SCD (Sim et al., 2020). Our study showed that the SCD length extends the uncertainty period, worsening demand fluctuations as SCD conditions change and other variability factors (shipping cuts, adds, and claims) are magnified as demand signals change. As a result, this high level of noise in the system increases the difficulty of returning the system to the pre-SCD stability position.

Also, the prominent demographic factors that account for SC variation are primarily economic in nature. Prior to the pandemic, education factors tied to economic power (high school diploma, college education, etc.) contributed the most to SC variation. This study contributes to the literature by showing that with the rise of the COVID-19, loss of jobs and unemployment were the dominant factors of SC variation. However, when the governmental policies and mandates relaxed and the economy started to reopen, the education factors returned to their previous influential level.

These remarkable results can be explained by the distribution of government funding and cost reduction policies that blunted what consumer behavior theory would typically indicate, which is that the external issue of unemployment would become the driving factor during a crisis with extended unemployment. In other words, the unemployment factor resulted in an initial change in features until the modifying elements were fully in place. So, expected crisis dynamics were blunted or changed when governments and employers acted in ways that changed the features that are traditionally associated with crisis consumption.

Although based on the dynamic capability theory, while the company grew its distribution to communities of all population sizes, rural areas received less product. It was noteworthy that the increased demand associated with the pandemic drove perceived scarcity and focused the SC response on increasing the supply to cities, the highest populated areas. High-population areas have more media presence and often are close to DCs. The combination of closer proximity and enhanced awareness of scarcity influence SC's efforts to meet these visible needs.

Furthermore, the results of our study revealed a unique phenomenon unattended in the marketing literature's consumer behavior theory in that nonessential food consumption increased during the pandemic. In other words, even with the global, extended nature of the COVID-19 pandemic, food insecurity was not visible in this company's SC. Demand for staples grew, but staples growth was dominated by comfort food and snacks, which experienced 7 and 10 percentage points more growth. Government payments to families and the ability of individuals to work remotely maintained a level of income that met basic needs with staples and drove higher demand for snacks and comfort foods. This demand may have been a response to the boredom of lockdowns, which is in line with the result of Porter et al. (2022), as they report a significant increase in snack and junk food consumption during COVID-19 around the world.

Contributions to Practice

This study explains the variation in the demand for food products based on the demographic factors that affect consumers' purchasing behavior. Our analysis could assist businesses in better understanding consumers' decision-making processes during an extended global crisis to transform and progress with the times. Our research points to the following managerial insights to better address extended global SCDs for food SCs. First, widespread humanitarian SCDs create fear and concern for food security, leading to changes in consumer behavior and increased demand for specific products. So, based on their capabilities, companies need to work to meet immediate demand, assess their network design, and examine the results of temporary fixes to understand what is driving instability.

Finally, our study is notable in that considering the role of demographic factors on SC instability assists policy makers and managers in understanding customers' purchasing behavior during an extended crisis and developing appropriate strategies to maintain a stable SC. It reveals that consumers will not respond in the same way under the same critical situation, resulting in unexpected demand patterns during SCD. The company examined in this study experienced the highest demand growth in snacks and comfort food, revealing that companies should be aware that they may meet the basic survival needs of consumers (in this case with staples) but experience a higher demand for nonessentials that may be important for other humanitarian reasons, like morale or mental health.

Limitations and Future Research

The results of this research will have some generalizability for companies that provide essential products for affected populations during SCDs. Since our analysis is related to the food supply

chain, some of the propositions may not apply entirely to firms in other industries. Moreover, companies with less shelf life or damage issues may have different dynamics and may need to have additional analyses.

Although our data are from an international food manufacturer that produces and distributes in North American countries, our analysis was limited to the data related to the wholesale-to-wholesale orders and shipments for the United States Midwest. We tried to characterize the immense amount of this data and uncover some general findings related to long-term SCDs. However, much more can be explored with this data and this company. In future research, we expect to expand our Midwest study to the entire United States. Additionally, there are other SC dynamics that we could not cover in this paper. Future research should examine pandemic factors driving bullwhip effects, how to better interpret distribution data (adds, cuts, claims, etc.) during a supply chain disruption, and the dynamic nature of distribution/transportation networks in response to disturbances.

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Food Distribution Research Society

Journal of Food Distribution Research
Volume 54, Issue 2, pp. 105–120

COVID-19 and Beef Consumption in Mexico

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Abstract

This study evaluated Mexican consumers' perceptions of the association between COVID-19 transmission and food consumption and assessed changes in their preferences for beef product attributes before and during the pandemic. Data were collected through two online consumer surveys (n = 2,020). Nearly half of the respondents (48.2%) perceived high/medium risks of being infected with COVID-19 through food. Results indicated a reduction in the ratings (i.e., preferences) of sensory and organoleptic attributes (freshness, flavor, and color) and food safety before and during the pandemic. Conversely, there was an increase in the ratings of extrinsic and production-related characteristics (organic labeling, production system, and traceability).

Keywords: preferences, perceptions, COVID-19

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Introduction

Since the beginning of the pandemic, COVID-19 has been associated with the meat supply chain, as the earliest cases of COVID-19 were linked to a food market in Wuhan City, China, where wild animals were being sold (Maxmen, 2021). In the United States, COVID-19 outbreaks in meatpacking plants received extensive news media coverage. By July 2020, it was estimated that livestock plants were associated with a large number of COVID-19 cases and clusters in rural areas (Taylor, Boulos, and Almond, 2020). China imposed testing requirements for meat imports as well and reportedly found coronavirus on the surface of meat packaging samples from several countries (He and Mu, 2021).

While some studies have reported certain short-term modifications in meat consumption and increased demand for plant-based protein, it is too early to tell whether the pandemic will result in long-term changes in consumers' preferences for meat products (Master, 2020). However, there is some evidence that past public health crises, including the Avian Health Influenza in 2013 and the 2019 African Swine Flu in Asia, had long-term adverse effects on consumers' demand for poultry and pork, respectively, because of food safety concerns (Zhou et al., 2016; Pan, 2019).

Similarly, Bovine Spongiform Encephalopathy (BSE) outbreaks in the United Kingdom and Canada during the 1980s and 1990s led to a long-term reduction in beef sales and heightened risk perceptions of consuming beef (Burton, Young, and Cromb, 1999). While previous health crises have been regionally localized, COVID-19 is a pandemic, and thus, it might affect consumers' preferences globally. Several studies have been conducted to study food consumption habits during the pandemic, but they have focused primarily on developed countries (BfR, 2020; McFadden et al., 2021).

No evidence links food consumption with COVID-19 transmission, and major international agencies have provided guidance to clarify this misconception and allay consumers' concerns. However, widespread rumors, misconceptions, and confusion persist (Mardones et al., 2020; World Health Organization, 2020). This study's objective was to evaluate Mexican consumers' perceptions of the potential association between COVID-19 transmission and food consumption. Further, the study also assessed changes in consumers' preferences for beef products' attributes using data collected before the pandemic (December 2019–February 2020) and during the pandemic (December 2020).

Mexico is located in the southern portion of North America and has a population of approximately 130 million. Although the country is still classified as a developing upper-middle country, it is among the 15 largest economies globally and the second-largest in Latin America (World Bank, 2020). It was estimated that the Mexican economy contracted by 8.2% in 2020. The United States Department of Agriculture (USDA) also reported decreased beef and pork consumption in Mexico, attributable largely to a decrease in households' income because of the pandemic (USDA Foreign Agricultural Service, 2020). Less is known about the potential effect on food consumption habits of changes in consumers' food safety concerns because of COVID-19. The first case of COVID-19 was detected in Mexico on February 27, 2020. Overall, the country has experienced two

pandemic waves—the first with a peak in mid-July 2020 and the second in mid-January 2021. As of October 1, 2021, the country reported the fourth-highest number of deaths attributable to COVID-19 globally (more than 277,000). The Mexican government's COVID-19 response to the pandemic has been controversial as, for example, its president indicated initially that the pandemic's potential effects on people's health were less severe than the evidence suggested (Ibarra-Nava et al., 2020).

Material and Methods

The study data were obtained from two Qualtrics online surveys of 2,020 Mexican consumers. The first survey (n = 1,000) was carried out before the pandemic (December 2019–February 2020), while the second (n = 1,020) was conducted in December 2020 during the pandemic. The surveys were designed to collect data from a representative sample of Mexican meat consumers. Respondents were required to be 18 years old and those responsible for (or who help with) meat purchases in the household. Both surveys collected information on socioeconomic demographic characteristics, meat consumption habits, and perceptions of the importance of various meat products' attributes. The question about attributes asked respondents to evaluate the significance of 13 product characteristics when purchasing beef. The questions were answered on a 5-point Likert scale that ranged from 1 = "least important" to 5 = "most important." The attributes considered included freshness, flavor, color, tenderness, juiciness, food safety, price, preparation ease, product leanness, country of origin, traceability, organic labeling, and production system.

The second survey also included two questions about the relation between COVID-19 and food consumption: i) What do you think are the risks of being infected with the coronavirus (COVID-19) through food? and ii) What do you think are the risks of being infected with the coronavirus (COVID-19) through the consumption of meats from the following countries: Mexico, United States, Canada, and Nicaragua? These questions were adapted from the Corona-Monitor study conducted in Germany by the German Federal Institute for Risk Assessment (BfR, 2020). The countries named in the second question are the leading providers of beef products to Mexico, as the original project's emphasis was on beef demand (UN Comtrade, 2019). In both cases, the following choices were possible answers: there is no risk, low risk, medium risk, high risk, and I don't know.

Three types of statistical analyses were conducted. First, summary statistics of the variables of the sociodemographic characteristics were calculated. Second, Chi-square tests were used to evaluate the association between risk perceptions of COVID-19 contamination through food and sociodemographic characteristics and the association between risk perceptions of COVID-19 contamination through meats and country of origin. Finally, linear regression models were used to assess changes in consumers' perceptions of beef product attributes in the periods before and during the pandemic. Two versions of the linear regression models were estimated. The first version used the attributes importance rating as the dependent variable (y) and a dummy indicating the survey period (0 = Pre-pandemic, 1 = Pandemic) as explanatory variable (d) (unadjusted model):

$$y = \alpha + \gamma d + u, \quad (1)$$

where α is the model intercept, γ is the coefficient measuring the change in average attribute ratings during the pandemic relative to the prepandemic period, and u is an error term. The second version also had the attribute importance rating as the dependent variable. As explanatory variables, it included the dummy indicating the survey period (d) as well as respondents' age, household size, gender dummy, location dummy (urban vs. rural), a dummy for the presence of children, education level, and income group (adjusted model):

$$y = \tilde{\alpha} + \tilde{\gamma} d + \boldsymbol{\beta}' \boldsymbol{x} + \tilde{u}, \quad (2)$$

where $\tilde{\alpha}$ is the model intercept, $\tilde{\gamma}$ is the coefficient measuring the change in average ratings during the pandemic relative to the prepandemic period after controlling for the vector of characteristics $\boldsymbol{x}$ (with associated vector of coefficients $\boldsymbol{\beta}$), and $\tilde{u}$ is an error term.

Our analyses were based on Lancaster's (1966) consumer demand theory. According to Lancaster, consumers have preferences for products' attributes; thus, each good represents a bundle of attributes. Accordingly, we evaluated the link between the COVID-19 health crisis and consumers' perceived importance of food attributes.

After observations with missing values for the primary outcomes of interest (risk perceptions and beef attributes importance) were eliminated, 814 observations from the first survey and 1,020 from the second survey were available for statistical analyses.

Results

Most of the survey participants were female (59%), had a professional level of education (70.3%), lived in a household with children (75%), and lived in urban areas (93%). The respondents' mean age was 34 years, and the average household had approximately four members (see Table 1). The respondents' median monthly household income was between 8,000–12,999 Pesos (400–650 USD). The comparison of the sociodemographic characteristics among samples reflected certain differences in their composition, the most considerable of which were in education and income. The sample collected before the pandemic had a higher proportion of professional individuals (76.4% before, 65% during the pandemic) and a higher proportion of households with higher income levels (e.g., 19.66% of the pre-pandemic sample had incomes higher than 30,000 pesos, while only 10% in the pandemic sample had this income level).

How do the samples compare to the general population of Mexican consumers? Individuals in the samples were older and more educated than the average person in the Mexican population (see Table 1). The samples also had more female respondents and more urban dwellers. However, some of these differences are expected because the survey target was not the general Mexican population but the population of meat shoppers, which is likely to include more females and older individuals with higher education levels. Further, using an online survey likely resulted in a sample with a higher proportion of urban individuals relative to the general population. With respect to income,

the sample in the second survey was designed to have the same income composition as that observed in the population (National Institute of Statistics and Geography, 2018) (see Table 1).

Table 1. Consumers' Sociodemographic Characteristics

Characteristics	Both Samples	Before Pandemic (Dec. 2019)	During Pandemic (Dec. 2020)	INEGI (2018)
Total observations	1,834	814	1020	
		Mean (standard deviation)		
Age	33.94 (9.79)	34.53 (9.78)	33.48 (9.79)	27
Household size	3.94 (1.65)	4.00 (1.56)	3.89 (1.73)	3.6
		Category percentage (%)		
Gender				
Male	41	44	38	48.9
Female	59	56	62	51.1
Location				
Urban	93	93	93	85.2
Rural	7	7	7	14.8
Household with children				
Yes	75	77	73	
No	25	23	27	
Education				
Middle school or below	5.4	4.1	6.5	44.8
High school	24.3	19.5	28.1	23.2
Professional (technicians, BS, graduate degree)	70.3	76.4	65.4	32
Monthly household income				
Under 3,000 pesos	7.1	3.8	9.7	10
3,000–4,999 pesos	8.9	7.9	9.7	10
5,000–7,999 pesos	10.7	11.6	10.0	10
8,000–12,999 pesos	23.9	16.1	30.2	30
13,000–19,999 pesos	20.2	20.4	20.0	20
20,000–30,000 pesos	14.9	20.6	10.3	10
More than 30,000 pesos	14.3	19.7	10.1	10
Food budget spent on beef				
Less than 20%	24.0	26.6	21.9	
20%–less than 40%	42.4	41.8	42.9	
40%–60%	23.9	23.1	24.6	
More than 60%	9.7	8.5	10.6	

Table 1. Continued

Characteristics	Both Samples	Before Pandemic (Dec. 2019)	During Pandemic (Dec. 2020)	INEGI (2018)
Total observations	1,834	814	1,020	
Frequency of purchase of beef products				
Daily	20.5	19.4	21.3	
Weekly	64.3	65.3	63.4	
Biweekly	12.4	13.4	11.6	
Monthly	1.8	1.5	2.1	
Less than once a month	1.0	0.4	1.6	

Nearly half of the respondents (48.2%) perceived high/medium risks of getting infected by COVID-19 through food, 43.6% indicated that there were low or no risks, and 8.2% indicated that they did not know about the risk of contracting the disease (see Table 2). The Chi-squared test results suggest consumers' risk perceptions were associated with age, the presence of children in the household, and income ($p < 0.05$) but not with gender, location of residence, or education. The proportion of individuals who indicated the risk of COVID-19 infection was high/medium was higher among younger individuals, individuals living in households with children, and lower-income individuals. For example, more than half of the individuals in the 18–34 age group (53.4%) perceived a medium or high risk of COVID-19 infection, compared to 40.9% and 35.1% in the 35–54 and 55–higher age groups, respectively.

Table 2. Risk of Being Contaminated with COVID-19 through Food Consumption by Sociodemographic Groups

Characteristics	Total Sample *n* (%)	Risk Preferences					*P*-value [a]
		I Don't Know	No-Risk	Low Risk	Medium Risk	High Risk	
		n (%)					
Total	1.020 (100.0)	84 (8.2)	175 (17.2)	269 (26.4)	295 (28.9)	197 (19.3)	
Age group							< 0.001
18–34 years	616 (60.4)	54 (8.8)	84 (13.6)	149 (24.2)	197 (32.1)	132 (21.4)	
35–54 years	367 (36.0)	27 (7.4)	79 (21.5)	111 (30.3)	89 (24.3)	61 (16.6)	
55 years and older	37 (3.6)	3 (8.1)	12 (32.4)	9 (24.3)	9 (24.3)	4 (10.8)	
Gender							0.6685
Female	628 (61.6)	52 (8.3)	104 (16.6)	158 (25.2)	187 (29.8)	127 (20.2)	
Male	392 (38.4)	32 (8.2)	71 (18.1)	111 (28.3)	108 (27.6)	70 (17.9)	
Location							0.1426
Rural	75 (7.4)	10 (13.3)	16 (21.3)	12 (16.0)	21 (28.0)	16 (21.3)	
Urban	945 (92.6)	74 (7.8)	159 (16.8)	257 (27.2)	274 (29.0)	181 (19.2)	
Education							0.2114
Middle school or below	66 (6.5)	5 (7.6)	7 (10.6)	15 (22.7)	21 (31.8)	18 (27.3)	
High school	287 (28.1)	22 (7.7)	46 (16.0)	67 (23.4)	97 (33.8)	55 (19.2)	
Professional (technicians, BS, graduate degree)	667 (65.4)	57 (8.6)	122 (18.3)	187 (28.0)	177 (26.5)	124 (18.6)	
Household with children							0.004
No	274 (26.9)	32 (11.7)	54 (19.7)	73 (26.6)	80 (29.2)	35 (12.7)	
Yes	746 (73.1)	52 (7.0)	121 (16.2)	196 (26.3)	215 (28.8)	162 (21.7)	
Household income							< 0.001
Under 5,000 pesos	198 (19.4)	20 (10.1)	33 (16.7)	43 (21.7)	63 (31.8)	39 (19.7)	
5,000–12,999 pesos	410 (40.2)	31 (7.6)	59 (14.4)	92 (22.4)	136 (33.2)	92 (22.4)	
More than 13,000 pesos	412 (40.4)	33 (8.0)	83 (20.2)	134 (32.5)	96 (23.3)	66 (16.0)	

Note: [a] χ^2 test of proportions

Perceived risks of COVID-19 infection through meat consumption were found to be associated with the country of origin ($p < 0.05$) (see Table 3). Nicaragua was the country of origin about which respondents knew the least, as 18.2% indicated they did not know about the risk of contamination with COVID-19 by consuming meat from this country. On the other hand, the United States was the country of origin with the highest percentage of individuals who indicated that the risk of contamination was medium or high (45.7%), followed by Nicaragua (42.5%), Mexico (41.8%), and Canada (38%). Statistically significant differences in the mean value of the attribute importance ratings for the prepandemic and pandemic periods were found in 7 of the 13 beef products attributes considered ($p < 0.05$) (see Table 4). Freshness, flavor, color, and food safety experience had lower ratings during the pandemic than the prepandemic period. In contrast, traceability, organic labeling, and production system experienced increased average ratings. The results were similar after controlling for the sociodemographic characteristics of the respondents. The robustness of these analyses was also evaluated by estimating ordered probit models instead of linear regression models. The ordered probit model estimated coefficients were similar to those obtained using the linear regression model (see Table 5).

Table 3. Risk of Being Contaminated with COVID-19 through Meat Consumption by Country

Category	Mexico	United States	Canada	Nicaragua	*P*-value [a]
	n (%)				
I don't know	100 (9.8)	112 (11.2)	132 (13.1)	183 (18.2)	< 0.001
No risk	237 (23.3)	193 (19.2)	204 (20.3)	174 (17.4)	
Low risk	255 (25.1)	239 (23.8)	288 (28.6)	220 (21.9)	
Medium risk	281 (27.6)	246 (24.5)	260 (25.8)	230 (22.9)	
High risk	144 (14.2)	213 (21.2)	122 (12.1)	196 (19.5)	
Total (n)	1,017	1,003	1,006	1,003	

Note: [a] χ^2 test of proportions

Table 4. Relative Importance of Beef Products' Attributes

	Before Pandemic (Dec. 2019–Feb. 2020)	Pandemic (Dec. 2020)	Change in Importance Rating (Pandemic—Before Pandemic)			
Attribute	Mean (Std. deviation)	Mean (Std. deviation)	Unadjusted Model (Std. Error)	*P*-value	Model 1[a] (Std. Error)	*P*-value
Freshness	4.75	4.65	-0.099**	0.0075	-0.096**	0.0116
	(0.72)	(0.86)	(0.037)		(0.038)	
Flavor	4.67	4.55	-0.126**	0.0016	-0.093**	0.0200
	(0.75)	(0.95)	(0.040)		(0.040)	
Color	4.56	4.44	-0.117**	0.0050	-0.118**	0.0061
	(0.79)	(0.98)	(0.042)		(0.043)	
Tenderness	4.52	4.47	-0.048	0.2526	-0.021	0.6212
	(0.86)	(0.93)	(0.042)		(0.042)	

Table 4. Continued

	Before Pandemic (Dec. 2019–Feb. 2020)	Pandemic (Dec. 2020)	Change in Importance Rating (Pandemic—Before Pandemic)			
Attribute	Mean (Std. deviation)	Mean (Std. deviation)	Unadjusted Model (Std. Error)	*P*-value	Model 1[a] (Std. Error)	*P*-value
Juiciness	4.46	4.46	0.005	0.9048	0.032	0.4590
	(0.86)	(0.95)	(0.043)		(0.044)	
Food safety	4.46	4.34	-0.116**	0.0108	-0.108**	0.0209
	(0.92)	(1.01)	(0.046)		(0.047)	
Price	4.00	4.00	-0.001	0.9852	-0.037	0.5058
	(1.08)	(1.20)	(0.054)		(0.056)	
Preparation ease	3.95	4.03	0.083	0.1035	0.092*	0.0708
	(1.05)	(1.10)	(0.051)		(0.051)	
Product leanness	3.84	3.77	-0.069	0.2004	-0.022	0.6896
	(1.09)	(1.18)	(0.054)		(0.054)	
Country of origin	3.80	3.80	0.004	0.9314	0.020	0.7292
	(1.18)	(1.23)	(0.057)		(0.058)	
Traceability	3.75	3.87	0.120**	0.0255	0.129**	0.0203
	(1.14)	(1.15)	(0.054)		(0.055)	
Organic labeling	3.73	3.91	0.180**	0.0011	0.191**	0.0008
	(1.18)	(1.17)	(0.055)		(0.057)	
Production system	3.70	3.88	0.179**	0.0012	0.179**	0.0015
	(1.17)	(1.17)	(0.055)		(0.056)	

Notes: [a] The estimated change values correspond to the parameters of regression models with importance rating as the dependent variable and a dummy indicating the survey period (0 = Pre-pandemic, 1 = Pandemic) (Unadjusted Model column) as explanatory variable. Estimated changes displayed under Model 1 correspond to regression models that also include as explanatory variables: age, household size, gender dummy, location dummy (urban vs. rural), dummy for presence of children, education level, and income group.

Table 5. Relative Importance of Beef Products' Attributes (Ordered Probit Model Results)

	Before Pandemic (Dec, 2019–Feb. 2020)	**Pandemic (Dec. 2020)**	**Ordered Model Coefficient (Pandemic Dummy)**			
Attribute	**Mean (Std. deviation)**	**Mean (Std. deviation)**	**Unadjusted Model[a] (Std. Error)**	***P*-value**	**Model 1[a] (Std. Error)**	***P*-value**
Freshness	4.75	4.65	-0.124*	0.0570	-0.135*	0.0510
	(0.72)	(0.86)	(0.065)		(0.069)	
Flavor	4.67	4.55	-0.132**	0.0340	-0.081	0.2170
	(0.75)	(0.95)	(0.062)		(0.065)	
Color	4.56	4.44	-0.098*	0.0870	-0.106*	0.0760
	(0.79)	(0.98)	(0.057)		(0.060)	
Tenderness	4.52	4.47	-0.038	0.5120	-0.002	0.9670
	(0.86)	(0.93)	(0.058)		(0.060)	
Juiciness	4.46	4.46	0.066	0.2390	0.105*	0.0740
	(0.86)	(0.95)	(0.056)		(0.059)	
Food safety	4.46	4.34	-0.122**	0.0300	-0.118**	0.0460
	(0.92)	(1.01)	(0.056)		(0.059)	
Price	4.00	4.00	0.026	0.6230	-0.011	0.8410
	(1.08)	(1.20)	(0.053)		(0.055)	
Preparation ease	3.95	4.03	0.108**	0.0680	0.115**	0.0330
	(1.05)	(1.10)	(0.052)		(0.054)	
Product leanness	3.84	3.77	-0.051	0.3160	-0.014	0.7920
	(1.09)	(1.18)	(0.051)		(0.054)	
Country of origin	3.80	3.80	0.031	0.5450	0.043	0.8100
	(1.18)	(1.23)	(0.051)		(0.053)	
Traceability	3.75	3.87	0.136***	0.0080	0.142***	0.0080
	(1.14)	(1.15)	(0.051)		(0.053)	
Organic labeling	3.73	3.91	0.188***	0.0000	0.196***	0.0000
	(1.18)	(1.17)	(0.051)		(0.054)	
Production system	3.70	3.88	0.186***	0.0000	0.184***	0.0010
	(1.17)	(1.17)	(0.051)		(0.053)	

Note: [a] The reported parameters come from estimated ordered probit models with importance rating as the dependent variable and a dummy indicating the survey period (0 = Pre-pandemic, 1 = Pandemic) (Unadjusted Model column) as explanatory variable. Estimated parameters displayed under Model 1 correspond to ordered probit models that also include as explanatory variables: age, household size, gender dummy, location dummy (urban vs. rural), dummy for presence of children, education level, and income group.

Discussion

Although there has been much discussion about the effects of the COVID-19 pandemic on food market demand and supply components, it is too early to tell whether the pandemic will have long-term effects on these issues. Multiple factors including prices, income, and consumers' perceptions of food attributes affect consumers' demand. While several institutions collect and report data on food products' quantities and prices and consumers' income, data on consumers' perceptions of food quality attributes are not readily available. Thus, this study focused on consumer concerns and perceptions of COVID-19 and meat consumption.

A substantial fraction of the sample (approximately 50%) was found to believe the risk of contracting COVID-19 through food consumption was medium or high. According to the World Health Organization (2020), there is no evidence that people can be infected with COVID-19 through food consumption; however, this concern still appears to be prevalent among Mexican consumers. A review of the Mexican government COVID-19 website did not show any information related to this issue either in the "Frequent Questions" or "Myths and Realities" sections. A Google search using "alimentos" (food) and "COVID" and "Mexico" identified multiple sources with information mainly related to food production, distribution, prices, and diet quality; however, only a few discussed the association (or lack thereof) between food consumption and COVID-19 infection (Secretariat of Health of Mexican Federal Government, 2020). Therefore, it appears that few efforts have been invested in educating the public about the risks of contracting COVID-19 through food consumption. In the United States, the nation's public health protection agency, the Centers for Disease Control and Prevention (CDC), has generated and communicated food safety information related to COVID-19 to the public through its website (CDC, 2020). Similarly, U.S. industry groups have made various efforts to inform the public about the safety of food consumption during the pandemic (e.g. ["Beef. It's What's for Dinner," n.d.]). These efforts can be used as guides for food safety communication campaigns in Mexico.

Since the pandemic's beginning, the German Federal Institute for Risk Assessment (BfR) has been surveying the German population on several aspects of the COVID-19 health emergency, including the perceived risks of becoming infected with coronavirus via food (BfR, 2020). In the first survey conducted in March 2020, 34% of respondents indicated that the risk of contamination through food was medium or high, compared to 29% in December 2020. Another study conducted in Kenya in April 2020 found that 33.5% of the survey respondents identified food consumption as a potential source of coronavirus infection (Carpio et al., 2020). In the United States, a survey found that, on average, consumers' level of concern about COVID-19 transmission through food was below 3 on a 1 to 5 scale (1 = very concerned, 3 = neither unconcerned nor concerned, and 5 = very concerned) (McFadden et al., 2021). In contrast, a study in the Arab region from April to June 2020 found that nearly 70% of the respondents were concerned about eating food that contained the virus (Faour-Klingbeil et al., 2021). The differences in these findings may reflect differences in the studies' context (e.g., the pandemic situation when the surveys were conducted and trust in institutions) and methods. Overall, Mexican consumers' perceptions of the risks of contracting COVID-19 through food consumption were high relative to other countries, even nearly a year into the pandemic (Carpio et al., 2020).

The proportion of survey respondents who indicated that the risk of COVID-19 transmission from meat consumption was medium/high was lower than the proportion who indicated medium/high risk of COVID-19 infection from food consumption in general. For example, 41.8% of survey respondents perceived that the risk of COVID-19 transmission from consuming Mexican meats was medium/high, compared to 48.2% who perceived that the risks from food were medium/high, reflecting heterogeneity in consumers' perceptions of risk depending on the type of food. A study in the United States found heterogeneity in concerns about COVID-19 infection from different food groups as well. U.S. consumers were more concerned about COVID-19 transmission from meats, fruits, and vegetables relative to breads and grains (McFadden et al., 2021).

The survey results also reflected risk perceptions heterogeneity associated with the foods' country of origin and consumers' sociodemographic characteristics. With respect to the country of origin, Mexican consumers perceived that the risk of COVID-19 transmission from consuming domestic meat is lower or equal relative to the risk of COVID-19 from consuming imported meat products (see Table 3). Still, the perceptions of the risk of contracting COVID-19 from meat consumption are high relative to other countries (Carpio et al., 2020). These differences in risk perceptions may be associated with two factors: First, consumers' perceptions or knowledge about food safety protocols and institutions in the countries of origin (for example, low trust or knowledge about food safety in Nicaragua, a relatively new source of meat imports in Mexico), and second, consumers' perceptions about the COVID-19 situation in each country of origin. Around the time the survey was conducted, the number of accumulated total COVID-19 cases reported per 1 million individuals in the United States was approximately four times (42,000) higher than the numbers reported in Canada and Mexico (approximately 10,000 and 9,000, respectively [Our World in Data, 2020]).

With respect to the association between risk perceptions of COVID-19 and sociodemographic characteristics, this study's findings are consistent with research from the United States and the Arab countries that reported a negative association between risk concerns and the respondents' age (Faour-Klingbeil et al., 2021; McFadden et al., 2021), in which, younger respondents were found to be more concerned about COVID-19 transmission from food. However, the results in the association with other sociodemographic characteristics differed. The study in the United States found that females were less concerned about COVID-19 contamination from food than males and that the level of concern increased with education but not with income. In the study conducted in Arab countries, COVID-19 transmission from food was not associated with other sociodemographic characteristics, including gender, education, marital status, household income, and residence location.

In contrast, this study found evidence of a positive association between risk perceptions of COVID-19 transmission from food and children's presence in the household and income. Differences in findings are not uncommon in studies about food safety risk perceptions, as they are likely to be context-specific. Nonetheless, these findings may be helpful in designing food safety information campaigns. For example, this information can be used to design campaigns that target groups of households and individuals more concerned about COVID-19 transmission from food (e.g., younger individuals, households with children, and low-income households).

The comparison of beef attribute importance ratings before and during the pandemic (see Table 4) provides clues to the pandemic's potential long-term impact. The results indicated a decrease overall in the ratings of sensory and organoleptic attributes (freshness, flavor, and color) and remarkably, food safety. In contrast, there was an increase in the ratings related to extrinsic and production-related attributes (organic labeling, the production system, and traceability). Still, the magnitude of all the changes observed in the attribute importance ratings was small (less than 5% in absolute value), and sensory and organoleptic attributes had the highest scores.

Given the COVID-19 health crisis and consumers' high levels of risk perceptions about COVID-19 transmission through food, it was expected that importance ratings of food safety would have increased relative to other attributes. However, the mean value of the food safety ratings decreased, and the ranking of importance did not change overall (before and after was the sixth attribute most valued). It is possible that consumers believe that the risk of COVID-19 contamination through food is only temporary, and the industry may not be able to do a great deal to reduce these risks.

On the other hand, the increase in the importance of production-related attributes (organic labels and traceability) appears to be consistent with the long-term rise in demand for extrinsic and credence meat attributes in the region overall, which seems to have continued even during the pandemic (Rojas, Stuardo, and Benavides, 2005; Castillo and Carpio, 2019; Forbes Mexico, 2021; Estévez-Moreno, Miranda-de la-Lama, and Miguel Pacheco, 2022). Further, the increase in the ratings for organic labels may be explained by consumers' perception that organic products are healthier than conventional products (Pew Research Center, 2016). Although related to food safety, the improved ratings in the traceability attribute may also capture consumers' increased interest in knowing more about production systems. Some research that evaluated the pandemic's effect on the food value chain in Latin America, including Mexico, found evidence of increased participation of producers selling food directly to consumers, which may have increased their interest in knowing more about food production systems. Thus, changes in the importance of the whole domain of attributes may reflect both long-term changes in consumer preferences and COVID-19-related impacts; however, data limitations do not allow us to separate these two effects.

Conclusions

Even a year into the pandemic, Mexican consumers reported high levels of perceived risks of COVID-19 transmission through food consumption in general and meats in particular, in domestic and imported products. Remarkably, consumers' ratings of food safety as an important attribute of meat products decreased slightly during the pandemic, which suggests that consumers' concerns over COVID-19 contamination through food consumption might not have long-term consequences in consumer demand. On the other hand, the increase in importance during the pandemic of credence attributes, including organic labels and production systems, suggests that COVID-19 may have affected preferences for other meat attributes or, at the minimum, that the pandemic did not affect long-term trends in the evolution of consumers' preferences for meat attributes.

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Food Distribution Research Society

Journal of Food Distribution Research
Volume 54, Issue 2, pp. 121–134

Savor the Flavor: Consumer Preferences and Variety Seeking Associated with Spicy Foods

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Abstract

Individuals have a basic internal need for variation in their daily lives. This study aims to expand the discussion of variety seeking consumers' interest and willingness to incorporate spicy flavors in their daily diets. Primary data was collected through an online survey, to run MANOVA and ANOVA analysis. Results provide details of attribute-level variety seeking and their interest in different types of spicy food items specifically associated with differences in age, race, and education. These differences were associated with two spicy foods categories, snack/chip food, and fresh peppers. This project was funded by the New Mexico Chile Association.

Keywords:

Introduction

Marketing of chile and chile-related products has expanded throughout the Unites States, along with the increasingly appealing spicy and hot flavors. Consumer tastes have been evolving as they enjoy more bold, authentic, interesting flavors. Most recently, 61% of consumers say they like or

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love spicy foods (Nation's Restaurant News, 2022). This trend has continued to grow from the original 22% in 2007 (Glazer, 2007). According to the "2015 Flavor Consumer Report", 58% of males and 51% of females reported they prefer "spicy" food flavors. The report also states that 78% of consumers enjoy moderately spicy foods and 55% crave spicy food flavors (Tristano, 2016). Consumers are embracing spicy flavors and incorporating many of these flavors into their daily diets.

Each variety of chile peppers has varying spice levels and varying levels of intensity. The different forms of chile include fresh, frozen, dried (where it can be sold in pods), canned, jarred (in puree form), pepper flakes, and powder (which is finely ground). Chile can also be used in a variety of foods as a flavor enhancer, as well as an ingredient, in toppings, and in sauces. Chile peppers can be utilized to enhance and differentiate foods while providing some unique spicy culinary experiences associated with consuming chile.

Research is needed to explore and evaluate U.S. consumers' variety-seeking interests and preferences for spicy chile and chile products. Through the utilization of a national online survey tool and panel survey company, CINT data were collected. The objective of this research will provide perspective about U.S. consumers' variety-seeking habits, specifically related to chile and spicy foods. The results of this research will allow for the development of appropriate marketing strategies, direction for product development, and will benefit grocery retailers, chile growers, and processors.

Literature Review

Spicy Food Consumption

Lillywhite (2013) used primary data collected in December 2012 from an online survey exploring consumer preferences and shopping behaviors for both spicy peppers and chile peppers. Researchers found that of the 1,096 respondents, 33% stated, "I love spicy food," and 41% stated, "I enjoy some spicy foods." Researchers found that many consumers enjoy spicy peppers, and that consumption varies by pepper type and form. According to survey results, of pepper types available in the market, the most popular are not necessarily the "hottest" or "mildest." This study provides a better understanding of the demand for U.S. spicy peppers, as well as U.S. consumer preferences for them.

Ludy (2012) investigated the differences in sensory, personality, physiological, and cultural attributes in regular spicy food users and non-users. Subjects completed a screening session for sensory perception and experience with spicy foods, finding that users have an increase in frequency of chili pepper consumption, like chili pepper burn, and like the taste of chili pepper in food. Chili users reported chili pepper makes food taste better, without hot spices, food tastes too bland. Sensation seeking was greater among users who had consumed spicy foods since childhood. It is important to understand the underlying acquisitions of spicy food preferences, as trends in spicy food consumption are surpassing U.S. population growth.

There are a number of theoretical implications that pertain to the discussion of variety seeking. It has been conceptualized as an integral part of consumer decision making and choice behavior (Trijp, 1995). However, it is just one aspect of the many branches associated with consumers' choice behavior. Variety-seeking behavior has been defined as "the biased behavioral response by some decision-making unit to a specific item relative to previous responses within the same behavioral category, due to the utility inherent in variation per se, independent of the instrumental or functional value of the alternatives or items" (Trijp, 1995). Further defined as "the tendency of individuals to seek diversity in their choices of services and goods" (Kahn, 1995) or "the tendency for a person to switch away from a choice made on the last occasion" (Kim and Drolet, 2003). It can also be defined as "internal or personal motivations and external, or derived, driving forces based on external situations" (Kahn, 1995). One of the earliest findings by Maddi (1968) was that human beings seek varied or novelty experiences for the inherent satisfaction they bring (Maddi, 1968; Tang and Chin, 2007).

Initial discussions of variety seeking focused on brand switching and the motivation behind brand switching. Hans (1996) used data acquired through a computerized panel of 1,000 Dutch households to examine variety-seeking behavior over time. Seven major predictor variables were measured: need for variety, involvement, perceived differences between brands, hedonic features, strength of preference, purchase frequency, and purchase history. Results show all interactions to be statistically significant and that product category-level variables exert their effects on behavior in interactions with the person's need for variety.

Erdem (1996) used estimated market structure models on four products using A.C. Nielsen scanner panel data for margarine, peanut butter, yogurt, and liquid detergent. These models studied variety seeking across brands within each of these four product categories. The results provide strong evidence for variety seeking and examples of habit persistence associated with brands consumed in the past.

Tang and Chin (2007) used A.C. Nielsen Homescan data to examine variety-seeking behavior over time to understand and predict the two types of purchases, repeat purchase and brand switching in Hong Kong from July 2002 to December 2002. This research included several food items: packaged rice, liquid milk, and instant noodles in addition to other non-consumables. Utilizing the same five predictor variables from Hans (1996), researchers found "people who have a higher need for variety are more likely to engage in variety-seeking behavior than in repeat purchasing. Variety-seeking behavior is more intense in product categories with larger numbers of brand alternatives, and it is dependent upon the consumers' purchase history.

Olsen (2016) used a national Norwegian representative survey to better identify the differences and similarities between impulse buying and variety seeking. This research examined the Big Five personality traits: extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience. The traits were measured using an extended version of the TIPI developed by Gosling (2003). The results suggest that variety-seeking buyers are more calm and emotionally stable than impulse buyers (Olsen, 2016).

The variety-seeking conversation continues with Inman (2001), who deviates from the product offering level and brand switching conversation. Inman breaks down variety seeking to reflect the specific product attributes. Attribute-level variety seeking is important to "gain a deeper understanding of the product-based mechanisms underlying exploratory behavior. These variety seeking attributes provide specific details to consumer switching behavior and to managers trying to develop new products" (Inman, 2001,). This research evaluated 1,900 households in St. Louis, Mo., using A.C. Nielsen wand panel data over a 3-year period and focused on tortilla chips and cake mix purchases. This research provides evidence that consumers tend to switch more intensively between flavors, which is a sensory attribute of the product, versus switching brands, a non-sensory attribute.

Attribute-level variety seeking has also been associated with both hedonic and utilitarian products. Baltas (2017) was successful in recognizing that consumers seek more variety in hedonic-type products, specifically when considering the sensory attributes. When considering utilitarian-type products, there is little known about any level of variety seeking. For products that are clearly not hedonic or utilitarian, variety-seeking behavior does not differ across sensory and functional attributes (Baltas, 2017).

For the purpose of this research, we are interested in attribute-level variety seeking as it pertains to consumers' decisions based on attributes of unique spicy foods. These spicy foods are considered hedonic types of products, and individuals are intrinsically motivated for variation in their consumption decisions (Hans, 1996).

Objective

This research explores the U.S. consumer's preferences and attribute-level variety-seeking practices as they relate to consumption of two hedonic food categories: highly processed spicy snack/chip foods and fresh spicy peppers. Our aim is to better understand current U.S. consumers' attribute-level variety-seeking interests and to identify differences among consumer groups for U.S. consumption of spicy foods and spicy peppers.

Methodology

Population and Sample

A survey was developed using Qualtrics XM, an online survey tool, and approved by the NMSU IRB (#22526). The survey was compatible with both mobile and desktop devices. The instrument was then distributed by CINT, a global online survey panel management company. Survey participants received a small amount of monetary compensation if they completed the survey negotiated by the respective panel company. The survey was distributed from January 17, 2022, to January 25, 2022. Distributing the questionnaire over different time frames assisted with the collection of diverse demographics of respondents. A total of 2,908 responses were collected with an average time to complete the survey of 14 minutes. The sample is representative based on the current U.S. Census for gender, age, and ethnicity. In the initial cleaning of the data, data cells left

blank were seen as an error and were screened out as were those surveys completed in under a minute, resulting in a final sample size of 2,034 respondents. Respondents' demographics are reported in Table 1.

To better understand the respondents and how they are involved with household meal prep, questions pertaining to their current cooking habits were included. When asked if they were "primarily responsible for making food purchasing decisions?" 83% identified they were the primary food purchaser within the household. Seventy-nine percent confirmed they were "responsible for making cooking decisions" within their household. When asked, "Are you willing to try new recipes?" 92% indicated they were willing. Finally, when asked, "How willing are you to try new foods, ingredients, or products?" 83% indicated they were willing "about half the time" or better to try new products.

Table 1. Demographics

Variables	Frequency	Survey (%)
Gender	*N* = 2,024	
Males	974	48.10%
Females	1,050	51.90%
Age	*N* = 2,036	
18–34 years	626	30.70%
35–44 years	460	22.60%
45–54 years	316	15.50%
55–64 years	323	15.90%
65 or older	311	15.30%
Race	*N* = 2,036	
White or Caucasian	1,396	68.60%
Black or African American	308	15.10%
American Indian or Alaska Native	45	2.20%
Asian	127	6.20%
Native Hawaiian or Other Pacific Islander	12	0.60%
Other	148	7.30%
Hispanic or Latino	*N* = 2,036	
Hispanic or Latino (of any race)	413	20.30%
Not Hispanic or Latino	1,623	60.10%
Annual Household Income	*N* = 2,036	
Less than $25,000	485	18.10%
$25,000–$49,999	570	19.70%
$50,000–$99,999	583	28.70%
$100,000–$149,999	257	15.30%
$150,000 or more	141	6.90%

Table 1. Continued

Variables	Frequency	Survey (%)
Education	*N* = 2,036	
Less than high school graduation	109	9.10%
High school graduate (or equivalency)	501	27.60%
Some college or associate's degree	683	25.80%
Bachelor's degree	501	23.40%
Graduate or professional degree	242	11.90%

Methods

The data were analyzed using IBM SPSS Statistics version 25 to conduct a multivariate analysis of variance (MANOVA) to provide empirical estimates related to model variables. MANOVA analyses are designed to examine multiple dependent variables to recognize interactions between independent variables and to detect whether groups differ among each other (Field, 2014). The consumption of Highly Processed Snack/Chip type products and Fresh Spicy Peppers were utilized as the dependent variables. These two dependent variables represent the extreme opposites of food products with similar "spicy" taste profiles. To break this down further, within the survey participants were asked to indicate if "they consume Hot/Spicy Chips (Hot Cheetos®, Takis®, Hot Funyuns®, Lays Kettle Cooked Jalapeno®)" by selecting "yes" (n = 1,115) or "no" (n = 920). Respondents were asked if "they consume Spicy Peppers (jalapenos, serrano, habanero, green chile)" by indicating "yes" (n = 1225) or "no" (n = 810). Overall, 900 respondents indicated they consumed both spicy products. A Pearson correlation coefficient was computed to assess the linear relationship between Hot/Spicy Chips and Spicy Peppers. There was a positive correlation between the two variables, r (2032) = [.457], p = [.001].

The eight independent demographic variables included: Age, Gender, Annual Household Income, Race, Education, Hispanic or Latino, Number of Adults in Household, and Number of Children in Household. The independent variables found to be statistically significant within the MANOVA will be further analyzed using an ANOVA to specifically identify where the differences are located within each of the individual demographic groups. The two dependent variables remain the same, Highly Processed Snack/Chip type products and Fresh Spicy Peppers.

Results

MANOVA

MANOVA was conducted to evaluate the differences between the populations of consumers who eat highly processed snack/chip type products and fresh spicy peppers. The Levene's Test is utilized to assess the null hypothesis that the variances in separate groups are equal (Field, 2014). Levene's test indicated the variances are significantly different in separate groups: Highly Processed Snack/Chip Products (F [1,2021] = 5.705, p = .017) and Fresh Spicy Peppers (F [1,2021] = 9.089, p = .003). Table 2 reports the results for the MANOVA Tests Between-Subjects Effects utilizing the Pillai's Trace. The demographic variables *Gender* (p = .001)*, Age* (p = .000)*,*

Hispanic or Latino ($p = .003$), *Annual Household Income* ($p = .039$), and *Number of Children in Household* ($p = .000$) were found to be significant. Differences were considered significant at an alpha level of .05 ($p < .05$).

Table 2. MANOVA Tests of Between-Subjects Effects

Variables	*df*	*F*	*Sig.*
Gender			
Highly processed snack/chip products	[1, 2023]	10.706	.001*
Fresh spicy peppers		8.401	.004*
Age			
Highly processed snack/chip products	[1, 2023]	179.991	.000**
Fresh spicy peppers		27.434	.000**
Race			
Highly processed snack/chip products	[1, 2023]	.180	.671
Fresh spicy peppers		1.055	.305
Hispanic or Latino			
Highly processed snack/chip products	[1, 2023]	11.485	.001*
Fresh spicy peppers		4.184	.041*
Annual household income			
Highly processed snack/chip products	[1, 2023]	.369	.543
Fresh spicy peppers		6.256	.012*
Education			
Highly processed snack/chip products	[1, 2023]	.069	.793
Fresh spicy peppers		1.740	.187
Number of adults in household			
Highly processed snack/chip products	[1, 2023]	3.134	.077
Fresh spicy peppers		.308	.579
Number of children in household			
Highly processed snack/chip products	[1, 2023]	20.483	.000**
Fresh spicy peppers		8.913	.003*

Note: *= $p < .05$, **= $p < .000$

ANOVA

Highly Processed Snack/Chip Products and Fresh Spicy Peppers were considered dependent variables with Gender, Age, Hispanic or Latino, Annual Household Income, and Number of Children in Household as the independent variables (see Table 3). Differences were considered significant at an alpha level of .05 ($p < .05$); significant differences are *Gender* for Fresh Spicy Peppers ($p = .023$), *Age* for both Highly Processed Snack/Chip Products ($p = .000$) and Fresh Spicy Peppers ($p = .000$), *Hispanic or Latino* for both Highly Processed Snack/Chip Products ($p = .000$) and Fresh Spicy Peppers ($p = .000$), *Annual Household Income* for Fresh Spicy Peppers ($p = .004$), and *Number of Children in Household* for both Highly Processed Snack/Chip Products ($p = .000$) and Fresh Spicy Peppers ($p = .000$). The MANOVA also identified three demographic variables:

Race (p = .590), Education (p = .396), and Number of Adults in Household (p = .073) to not be statistically significant, requiring no additional testing.

Table 3. ANOVA Output Results

Variables	*df*	*F*	*Sig.*
Gender			
Highly processed snack/chip products	[1, 2022]	1.256	.263
Fresh spicy peppers		5.196	.023*
Age			
Highly processed snack/chip products	[5, 2034]	59.853	.000**
Fresh spicy peppers		10.298	.000**
Hispanic or Latino			
Highly processed snack/chip products	[1, 2034]	65.023	.000**
Fresh spicy peppers		16.911	.000**
Annual household income			
Highly processed snack/chip products	[4, 2034]	1.083	.363
Fresh spicy peppers		3.789	.004*
Number of children in household			
Highly processed snack/chip products	[2, 2034]	60.409	.000**
Fresh spicy peppers		17.802	.000**

Note: *= $p < .05$, **= $p < .000$

Significant Variables

Gender was found significant in the MANOVA, requiring the additional step of employing an individual ANOVA to identify where the differences were located within each of the Gender groups. The Gender Mean Plot (see Figure 1) reports the relationship of gender on consuming fresh spicy peppers; males (μ = .63) (n = 611) consume more Fresh Spicy Peppers than females (μ = .58) (n = 606). There was no significant relationship between gender and the Highly Processed Snack/Chip Products dependent variable.

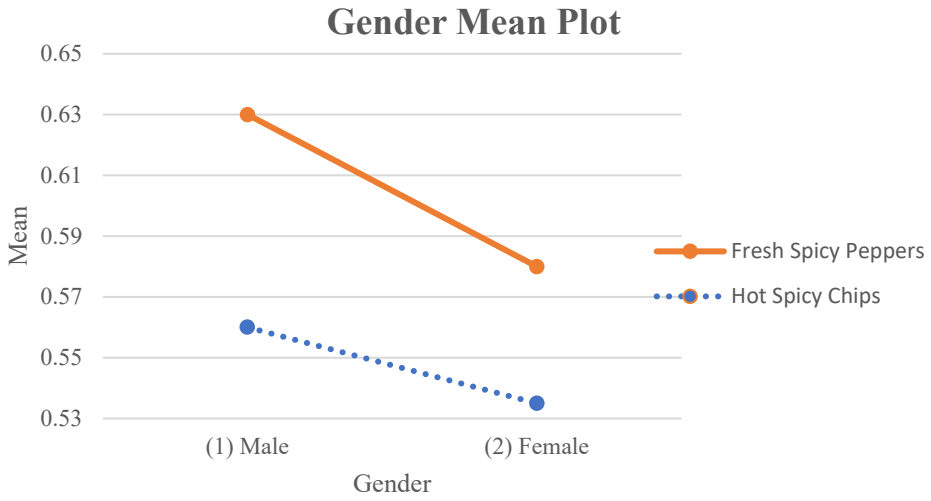

Figure 1. Gender Mean Plot

Age as a variable was found significant within the MANOVA; thus, an ANOVA analysis was completed. The ANOVA revealed statistical significance for both Highly Processed Snack/Chip Products and Fresh Spicy Peppers. These relationships displayed in the Age Mean Plot (see Figure 2) for Highly Processed Snack/Chip Products show the level 1 age category (n = 119), those 18 to 20 years, consumes more spicy snack/chip type products (μ = .84) than the other five groups. As age increases for Highly Processed Snack/Chip Products, consumption decreases. In addition, the Fresh Spicy Peppers relationship demonstrates the level 2 age category (n = 334), those 21 to 34 years, consumes more fresh spicy peppers (μ = .69) than the other groups.

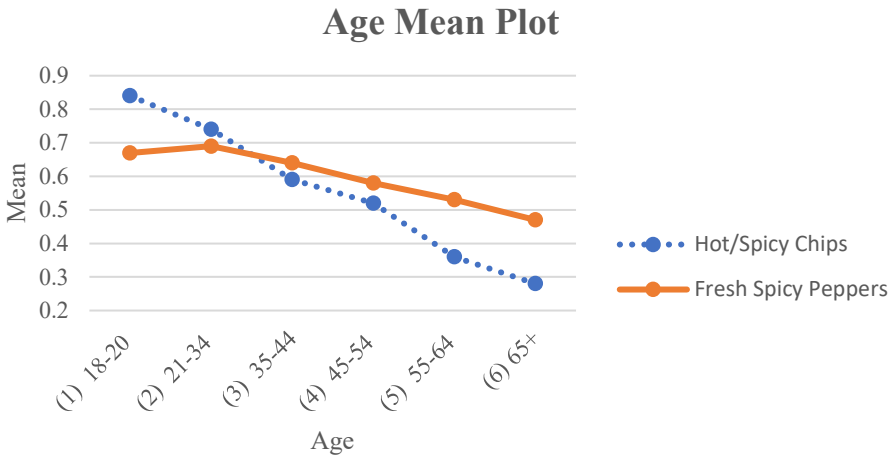

Figure 2. Age Mean Plot

Those respondents who indicated they identify as Hispanic or Latino were found significant within the MANOVA, requiring ANOVA analysis. The ANOVA results displayed in Figure 3 revealed that those who identified as Hispanic or Latino were significant for both Highly Processed Snack/Chip Products (μ = .72) (n = 298) and Fresh Spicy Peppers (μ = .69) (n = 285) compared to those who do not identify as Hispanic or Latino.

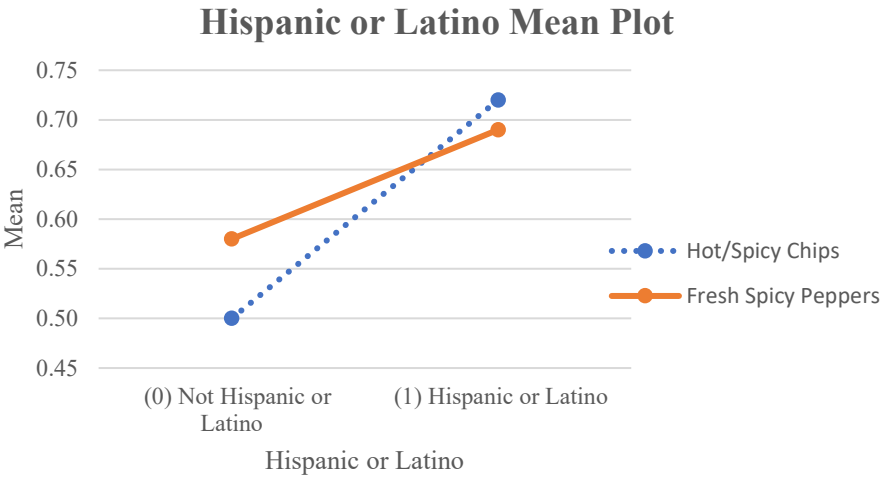

Figure 3. Hispanic or Latino Mean Plot

The MANOVA identified Annual Household Income as significant. The ANOVA was completed, and the Annual Household Income Mean Plot (see Figure 4) provides the details, where Annual Household Income was found significant for Fresh Spicy Peppers (μ = .67). The level 5 income category (n = 78), which is $150,000 or more, consumes more fresh spicy peppers when directly compared to the other income level categories. Interestingly, there was no significant difference among annual household income levels when evaluating the highly processed snack/chip category.

Number of Children in Household was statistically significant within the MANOVA; therefore, an ANOVA was conducted. The ANOVA identified Number of Children in Household as significant for both Highly Processed Snack/Chip Products (μ = .71) and Fresh Spicy Peppers (μ = .71). Figure 5 illustrates those consumers in the level 2 category (*n* = 116), who represent households with three or more children, and consume more of both spicy snack/chip products and fresh spicy peppers than those with no children or one to three children.

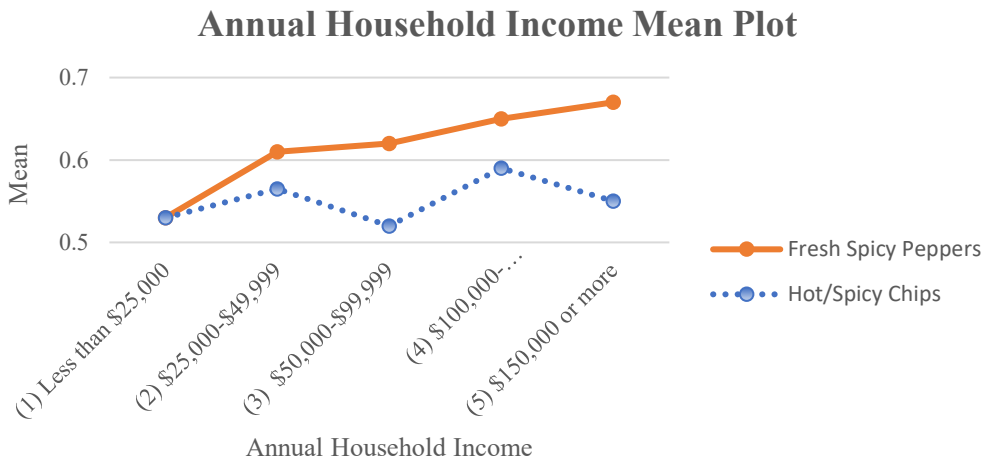

Figure 4. Annual Household Income Mean Plot

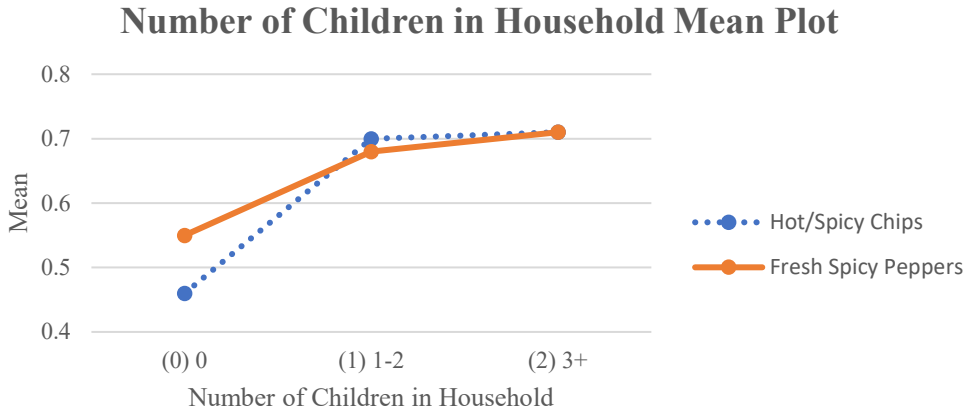

Figure 5. Number of Children in Household Mean Plot

Discussion

This research provides some direction to better understand the attribute-level variety-seeking tendencies of consumers for both spicy snack/chip products and fresh spicy peppers. The eight variables—gender, age, education, Hispanic or Latino, income, number of adults in household, and number of children within the home all provide insight into the variety-seeking efforts of these consumers.

When considering gender's effect on consumption of these two product categories, there was no difference between the two groups pertaining to processed snack/chip products. Both males and females enjoy these spicy snack/chip products. However, when considering the fresh spicy peppers, males are more likely to consume than females.

The age variable was significant for spicy snack/chip products with the 18–20-year-old age group consuming the most is no surprise. These products are easily sourced, require no additional effort to prepare, and are affordable. These young consumers add variety into their daily diets and enjoy the spicy taste attribute of these snack items. When evaluating the fresh pepper consumers, there is a similar trend with consumption being higher in the younger age groups and tapering off as they get older. When considering these two products, the rate of consumption declines for both as age increases. However, fresh pepper consumption declines at a slower rate, with many consumers enjoying these spicy additions to their daily diets well past 65 years of age.

Those consumers who identify as Hispanic or Latino consume more of both spicy snack/chip products and fresh spicy peppers than consumers who do not identify as Hispanic or Latino. This supports Tang and Chin's (2007) argument that a consumer's variety seeking is reflective of past experiences. The five income levels provide evidence of consumers' continued consumption of spicy snack/chip products. As incomes increase, the consumption of spicy snack/chip products remains relatively stable. This trend is not reflected for the consumers who eat fresh spicy peppers. The spicy pepper consumers with the lowest income bracket have the lowest level of consumption; however, this consumption increases along with the income brackets. Consumers in the highest income bracket of $150,000-plus consume the most fresh spicy peppers. Those consumers with high incomes have more disposable income to allow for purchases of fresh spicy peppers.

The final variable, number of children within the household, also provides an interesting perspective. Families with three or more children consume higher levels of both spicy snack/chip products, as well as fresh spicy peppers than those families with fewer than three children. Larger families with more than three children have a larger demand for food in general for meals or snacks.

Conclusion

Understanding consumers' desires for variety can offer clear and actionable implications for retailers (Baltas, 2017), processors, and producers. This study provided evidence of consumers' attribute-level variety-seeking tendencies associated with spicy products. This project also provides evidence and guidance for spice processors, food manufacturers, and chile producers

interested in developing new food products to meet today's demands from these attribute-level variety-seeking consumers. Being able to specifically identify variety-seeking consumer differences provides direction for new product development and an opportunity to improve the demand for spicy products. The demographic details shed light on developing new products and marketing campaigns to attract interest from variety-seeking consumers searching for the spicy profile of familiar attribute-level products.

The two types of products included in this research provide very different examples of spicy food products while providing perspectives pertaining to the differences among consumers who enjoy them. The products are offered in many forms and variations; however, both represent the spicy taste profile, and both have different types of consumer interest. Overall, the survey results and analysis provide added perspectives about U.S. consumers' behavior associated with spicy attribute-level variety seeking.

Attribute-level variety-seeking consumers of all ages, genders, annual household incomes, races, education levels, Hispanic or Latino identifications, number of adults in household, and number of children in household are eating highly processed spicy snack and chip products. Of the consumers who like to explore and consume spicy processed snack foods, such as Hot Cheetos®, Takis®, Hot Funyuns®, and Lays Kettle Cooked Jalapeno®, evidence of differences among study participants were found in age, Hispanic/Latino, income, and number of children in the household. Interestingly, there were no differences between the categories for gender, race, education, and number of adults in household. These results provide evidence that males and females of all races and education levels enjoy spicy snack/chip products. The willingness to try new products and recognize the similar spicy taste profile of these products allows for attribute-level variety-seeking opportunities for these consumers.

However, the attribute-level variety seeking associated with the consumption of fresh peppers provided a different perspective. Attribute-level variety seeking for spicy peppers depended on gender, age, Hispanic or Latino, annual household income, and number of children in household. Within this product category, race, education, and number of adults in household were not found to have differences related to the consumption of spicy peppers. This product category provided evidence that attribute-level variety seeking and consumers' willingness to consume fresh spicy peppers is not associated with differences in race, education levels, or number of adults within the household.

Attribute-level variety seeking provides a "deeper understanding of the product-based mechanisms underlying exploratory behavior. These variety seeking attributes provide specific details to consumer switching behavior and to managers trying to develop new products" (Inman, 2001). In marketing spicy food products, managers should consider the product category and demographic details associated with the food category. Attribute-level variety seeking associated with spicy foods can provide opportunities to associate a familiar taste experience with new products. Marketers should consider providing consumers with new spicy products while recognizing the importance of demographics. More importantly, marketers should realize race, education, and number of adults in household have less of an effect on consumption than gender, age, income,

and number of children in the household. Consumers will continue to search for variety in their daily diets and incorporate spicy products, often inferring details associated with attribute-level variety seeking.

Limitations and Further Work

This study suffered from limitations involved with conducting an online survey and using CINT panel data. The survey data were collected through the online distribution with expectations the sample would represent the U.S. Census breakdown for age, gender, and ethnicity. Limitations with CINT include the inability to confirm respondents' true location. To ensure those completing the survey were located in the United States, respondents provided their zip code. Upon further evaluation, some of these zip codes were incomplete, which may indicate the sampling completed by CINT may have occurred outside of the United States. Another limitation is that the survey instrument was based on respondents' ability to recall, introducing a possible source of error.

There are opportunities for further work analyzing the survey results. This data may provide additional details regarding the respondents and their shopping habits, consumption patterns, and interest in spicy foods, as well as chile. Obtaining shopping cart data to further explore consumer purchases is another option for analyses trends related to attribute-level variety seeking, as is investigation into which attributes are essential to consumption when evaluating spicy foods. Conducting interviews of those spicy food consumers could provide insight on their perceptions, priorities, and requirements of spicy products.

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