ABSTRACT

The mandatory genetically modified organism, GMO labeling law has been applied in many food categories but not in alcohol beverage categories. Yet, many alcohol producers differentiate their wines by adding Non-GMO labels. Previous research shows that production labels tend to have signaling roles that may affect consumer demand. To examine the signal impact of the non-GM/GM labels on consumer alcohol beverage demand, I used wine as a focal product category and conducted an online choice experiment with 1,306 subjects. The results show that Non-GM label stigmatizes unlabeled wines and that consumer demand for unlabeled wines significantly decreased with the introduction of Non-GM label. Furthermore, the significant stigma effect disappeared when all three labels (No label, Non-GM and GM labels) are presented to consumers. Our results contribute to the ongoing discussion of the enactment of mandatory GMO labeling in the alcohol beverage categories by the U.S. Federal Government. Our results suggest that consumers may no longer differentiate between unlabeled products and Non-GM labeled products if the mandatory GM labeling law is in effect.
BIOGRAPHICAL SKETCH

Zekun Ma received her dual B.S. degree in Agricultural Economics from China Agricultural University as well as in Agricultural Economics and Natural Resource from University of Maryland in 2017. She continued her graduate study at the Dyson School of Applied Economics and Management of Cornell University from 2017 to 2019. She had an internship in Food and Agriculture Organization of United Nations in the field of consumer behavior and market research. Her research interests are in the fields of food supply chain efficiency, food and agricultural marketing.
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Last, I would like to thank deeply to my family, particularly to my parents, for giving me unconditional love and support.
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CHAPTER 1: INTRODUCTION

In recent years, research advances in bio-engineering technology of food products seem to open a door into a new paradigm, where many challenges faced by growers/ producers could be overcome. This increasing food supply provides consumers more choices. It means opportunities and challenges for producers as well as consumers. Because of consumer general aversion to GM products and great desire for ingredient transparency, the federal government has passed legislation on a mandatory GMO labeling law, which was officially enacted in 2016. This mandatory GMO labeling law is applied to food and non-alcohol beverages. However, it does not apply to alcohol beverage categories, despite the fact that these categories have been growing substantially over the past decades and consumers require more transparency of how beverages are made. Statista’s (2018) reports that total alcoholic beverage sales in the United States amounted to approximately $234.4 billion in 2017 and that the sale value reached a record high to $254 billion in 2018, up 5.1% from 2017. The huge growth in the alcohol beverage categories requires throughout studies of potential impact of policies like food labeling application in this industry.

In the case of GM technology in alcohol beverage categories, genetically-modified grapes or barley are not approved for commercial wine/ beer production in the US. However, using GMO yeast during the fermentation process or using GM corn for beer brewing is not regulated (Pérez-Torrado, et al. 2015). Recent research breakthroughs in GMO yeast makes it very appealing to producers because GMO yeast may shorten the fermentation process, contribute to quality consistency, reduce hangover, produce desirable product attributes at low costs, and reduce environmental impacts (Pretorius & Bauer, 2002; Denby, et al. 2018). Since the
mandatory GMO labeling law does not apply to the alcohol beverage categories, producers who have used GMO yeast have no obligation to label it. Some producers who do not use GMO ingredients may differentiate their products by adding a non-GMOs label (e.g., “Non-GMO verified project” label) at their own cost. However, most producers have no such labels on their products even though they do not use GMO ingredients.

Ideally, food labels enhance consumer welfare by allowing transparent communication and bridging the knowledge gap between producers and consumers, as well as by expanding the set of available options to consumers. The labeling of the production methods may improve consumers’ welfare by offering more choices as well as benefit producers by allowing them to differentiate their products (Messer, Costanigro and Kaiser 2017). However, producers often express concerns that labels promoting the benefits of one technique also cast the conventional commodity in a negative light (Kanter, Messer and Kaiser 2009). For example, social ethics claims on food packaging (e.g., fair trade) can promote the misperception that foods are lower calorie and therefore lower consumption for conventional foods without such label on them (Schuldt, Muller and Schwarz, 2012).

Many previous studies have documented that food labels, particularly GM labels, may induce signaling impacts that shift demand for unlabeled products in the same product category (Bansal, Chakravarty and Ramaswami, 2013; Costanigro and Lusk, 2014; Hiscox and Smyth, 2011). However, little is known about whether and how a non-GMO label impacts unlabeled product. Furthermore, possible signaling effects of labels have not been studied in the alcohol beverage industry. To fill this gap, this study uses wine as a focal product category to examine: 1) how GMO labels (Non-GMO labels) influence consumers’ willingness to purchase a wine, and 2) whether and to what extent the introduction of Non-GMO labels stigmatizes the same
unlabeled wines.

To answer the research questions and to test the signaling impact of GM/Non-GMO labels, I designed a consumer experiment through Qualtrics survey platform and recruited 1,306 participants with age above 21. The results show that consumers are less likely to purchase the unlabeled wine when they were first presented with the same wine with the non-GM label, suggesting that introducing non-GM label wines stigmatizes unlabeled wines. That is, most conventional wine producers who are not using GM ingredients are penalized by this non-GM label. However, with all three labels available to consumers, our study shows no significant difference of consumer’s WTB between non-GM and unlabeled wines. Furthermore, consistent with previous literature, GM labels decreasing consumers’ willingness to purchase wine.

This study fills the gap of the current literature on the impact of GMO labels on consumer purchase decisions in food products by focusing on alcoholic beverages. It also extends current literature on the signaling impact of GM/non-GM labels on conventional unlabeled products in alcohol beverage industry. The findings shed light on the ongoing discussion of the use of GMO labeling in the alcohol beverage industry. It also provides insights to policy makers that a thorough GM labeling policy to regulate alcohol beverage industries may be helpful to eliminate the stigma effect of the Non-GM labels on conventional unlabeled wines.

In the next section, this study provides the background on the Mandatory GM Labeling Law (The Vermont Law) and the current GM technology application in the wine industry. Then, it reviews previous studies on food labeling and GM food. This is followed by the section concerning the experimental design and econometric model in the current analysis. Next, I report the results and discuss the findings. The paper concludes with a summary of this study and the potential policy as well as managerial implications.
CHAPTER 2: BACKGROUND

2.1 Mandatory GM Labeling Law

Modern Farmer, a quarterly American magazine devoted to agriculture and food, mentioned the earlier GMOs labeling law was a voluntary program that passed by the House in July 2015. In 2016, the Senate voted 63-30 for the bill that producers could claim GMO contents with words, pictures or a barcode (2016). This mandatory GMO labeling law has created huge public debate. Supporters believe this mandatory, nationwide label for food products with GMOs meets consumer demand for greater transparency and reduces state-by-state differences in food labeling and distribution (Reuters, 2016). On the other hand, opponents raise the concern that the labeling can stigmatize GMOs crops and decrease their demand. For example, the chemical and biotechnology company Monsanto argued that “mandatory labeling could imply that food products containing these ingredients are somehow inferior to their conventional or organic counterparts” (2013). This mandatory label might cause firms to switch from GM ingredients to non-GM ingredients, and drive up costs in the process (Carter et al, 2012). Moreover, Reuters (2016) argued that the bill’s vague language and allowance of electronic labels may cause confusion and actually limit consumer access to information about GMOs.

Modern Farmer (2016) also mentioned that, “FDA states that genetically-modified agricultural crops such as corn, soy, canola, and sugar beets would require labeling but not for oil made from soy or canola which don’t fit the law’s definition of “bioengineering” and don’t necessarily contain genetic material”. The guide to U.S. Regulation of Genetically Modified Food and Agricultural Biotechnology Products addresses alcoholic foods (beer, wine, and liquor), which are regulated separately by the Bureau of Alcohol, Tobacco and Firearms of the Department of the Treasury. Even though alcoholic beverages have different regulators, food
labeling of GM involving alcohol beverage categories remain unregulated. In 2003, the United States Food and Drug Administration (FDA) designated the GM yeast strain, ML01 ‘generally recognized as safe’ (GRAS), and the Organic Farmers Association (2014) questioned this FDA’s designation for insufficient studies and unknown long-term marketing impacts. Jamie Goode, a UK wine journalist and blogger, also states that GM yeast will be the next battleground in wine making. In the U.S., yeasts are classified as processing agents and thus wines made with this yeast would need no declaration that they contained GM ingredients while countries such as New Zealand and Australia where yeast is considered as part of ingredients of wine (WINEANORAK, 2015).

2.2 The Non-GM claim label

Like most absence-claim labels in the market such as “gluten free”, “no artificial colors” or “no high fructose corn syrup”, GMO-free or Non-GMO labels are not mandatory or regulated. They are often employed by producers to differentiate their products as more secure, or to generate more profits from consumers who care about beverage ingredients. Because of the consumers’ general aversion to GMOs, producers who are not using GM ingredients may choose to differentiate their products by adding a non-GM label at their own costs. A non-profit organization, the Non-GMO Project, was founded in 2007 to educate consumers and to provide verified non-GMO labels to products. Due to the high demand driven by consumers, the Non-GMO Project has grown steadily with more than 3,000 verified brands. These brands represent over 50,000 products and more than $26 billion in sales in 2014’s article.

In the case of wine, the Non-GMO Project has verified 29 core wines imported from Europe. These verified wines are from five wineries located in Italy, Spain, Austria, France and Greece. The verified wines tend to have a Non-GMO Project Verified badge on the bottle or on
the shelf to help consumers easily identify these products (Non-GMO Project, 2014). Producers who do not use GMO ingredients can choose to have this label at their own cost. However, most producers have no such labels on their products despite the fact that they are not using any GMO ingredients.

2.3 Using GM Yeast in Alcohol Beverage Categories

The United States has a long history using bioengineering technologies in food and agriculture. The Green American Magazine (2013) shows the first commercial GMO food can be traced back to 1994 when the FDA approved the Flavr Savr tomato for sale on the market. In 1999, over 100 million acres worldwide are planted with genetically engineered seeds. As of today, the United States is the largest producer of GM foods, accounting for 45 percent of the world production (NutriNeat, 2018). Currently, many processed foods such as soy oil, corn syrup and sugar from sugar beets are made with bioengineered soybeans, corn and other crops. Although in the alcohol beverage industry, GMO grapes/Barley have not been approved for commercial use (Organic Vineyard Alliance, 2013), using GMO yeast during the fermentation process is not regulated and not uncommon. For example, a GM yeast strain, ML01, has been approved for commercial production in the US as well as Canada, Moldova and South Africa. This yeast can save processing time through one-stop fermentation and reduce “wine headache” by reducing levels of biogenic amines to benefit both winemakers and consumers (Szymanski, 2011). Since the mandatory GMO labeling law does not apply to the alcohol beverage categories, producers who have used GMO yeast have no obligation to label it. Many refined foods would most likely not be subject to labeling because the genetic material has been removed through processing or might not able to detect using current technology. It is questionable to only rely on FDA’s solely reviews and approves of GM microbes such as yeast used in food products. The
Science in Society Archive (2007) pointed out that according to the medical journal, The Lancet, the general public is losing patience and faith in the FDA because approvals are frequently influenced by political pressure. Therefore, it would be necessary to develop validated methods to detect GM wine made using GM yeast ML01.
CHAPTER 3: LITERATURE REVIEW

3.1 Food Labeling as an Informational Role

Research shows that packaging, especially package labels, can influence how consumers evaluate a food product as well as how much they consume (Bublitz, Peracchio, & Block, 2010). A Greek study states that consumers’ food buying behavior has been oriented to quality food products of higher added value through the implementation of various certification strategies and the use of different communication messages (Arvanitoyannis and Krystallis 2004). For example, a study shows that consumers have higher willingness to buy for eco-friendly packaged products than for conventional products (Seo, et al. 2016).

Theoretically, food labels enhance consumer welfare because they bridge the knowledge gap and allow transparent communication between producers and consumers (Messer, Costanigro and Kaiser 2017). Many economic models and empirical analyses show that food labels are identifiers for certain product attributes. For example, the type of production process such as shade-grown coffee and free-range eggs can help consumers select products that they prefer the most (Costanigro and Lusk 2014). An Italian study assesses millennial consumers’ (aged between 18 and 35) interest in and willingness to buy three wines with specific labels certifying environmental, social and ethical attributes. The results reveal that millennials do have higher willingness-to-buy (WTB) for sustainable wine with eco-labels on the products (Pomarici and Vecchio 2014). In these studies, consumers with different preference perceive labels only as information source.

3.2 Food Labeling as a Signaling Role

The underlying assumption is that the preferences for GMOs and non-GMOs are fixed and
free of considering any labeling policies in place. Consumer demand for labeled products is assumed to be exogenous to the mere presence of labels (Bansal, Chakravarty and Ramaswami 2013; Liaukonyte, Streletskaia and Kaiser 2015). However, some researchers believe that, in addition to the informational role, food labels have a signaling role that can potentially affect the entire food marketing system rather than simply provide information to consumers (Caswell and Padberg, 1992). A study examined the “value of information” associated with the declaration of the GM attribute in different labelling contexts. It shows that the information provided in a mandatory labelling context is considerably more valued by consumers than the information provided in a voluntary labelling context (Hu et al., 2005). An empirical study supports this signaling effect by showing that consumers are more likely to believe genetically modified food is unsafe if the mandatory labeling policy for GM food is in place (Lusk and Rozan 2008).

Several behavioral studies also have shown that consumers may infer subjective beliefs from exposure to certain food labels (Lusk, Schroeder, and Tonsor 2014), inducing cognitive bias called “halo effect” or “stigma effect”. The halo effect indicates that one biasedly evaluates some unknown or unspecified characteristics of a product due to the influence of another given attribute of that product (Lee et al. 2013). This concept was originally used in psychology. Nisbett and Wilson (1977) stated this halo effect as an unaware process that can induce altered evaluations of the person’s attributes. For example, a green halo indicates that consumers perceive “eco-friendly” products taste better (Sörqvist et al., 2015). With the uprising trend on organic, consumers may perceive some unknown benefits associated with organic products. For example, researches show that organic labels may be perceived as of higher quality or healthier (Hughner et al. 2007; Larceneux, Benoit-Moreau and Renaudin 2012; Vega-Zamora et al. 2014). An experimental study asked participants to taste and evaluate paired identical and originally
produced food samples with two different labels “organic” and “regular”. The results show that food with organic labels are perceived as lower in calories and better nutrition with a higher willingness-to-pay (Lee et al. 2013). Another health halo of “fair-trade” labels shows that social ethics claims might nudge some perceivers to overindulge that fair-trade labels as of having lower calories (Schuldt, Muller and Schwarz, 2012).

On the other hand, “absence-claim” labels are becoming increasingly popular. Absence labels promote the absence of a particular ingredient or production practice. A wine research estimated how the absence labels of organic wine and wine made with organic grapes impact consumer behavior. The study found that both organic labels carry a significant and very similar willingness-to-pay (WTP) premium while the effects largely disappear when consumers were provided with information about the two organic certification standards and conventional wine-making practices (Streletskaya, Liaukonyte and Kaiser 2019). Labeling food processes can stigmatize food produced with conventional processes even when no actual problem or health risk has been identified (Messer, Costanigro and Kaiser 2017). This stigma effect means that one evaluates some unknown or unspecified characteristics of a product in a negative manner due to the influence of another given attribute of that product. For example, “rBST-free” milk label was found to stigmatize consumers’ preference for conventional unlabeled milk even though the FDA has declared that there is no scientific evidence that synthetically produced natural hormone rBST is harmful to human health (Kanter, Messer and Kaiser 2009). In other words, this stigmatization can have negative effects in the food industry for both consumers and producers (Vilsack, 2018). This finding indicates the benefits of one technique casts the conventional commodity in a negative light where food manufacturers are less incentivized towards innovations in farming and food processing with the concern of negative long-term impact of
absence claims labels. U.S. News (2018) criticized concerns regarding absence-claim labels in the food industry, given that absence-claims labels may provide short-term marketing advantages over competitors, but eventually can damage consumers’ trust and discourage long-term sales. The absence-claim labels play on consumer fears and misconceptions about their food. Recent researches weight more about the concept of stigmatization from food labels. However, the stigmatization concept has not yet been thoroughly studied in the economic literature, particularly in alcohol beverage industry.

3.3 The signaling effects of GM and Non-GM labels

In the case of GM foods, many studies show that consumers’ willingness to purchase for GM foods is significantly lower than their non-GM counterparts (Lusk et al. 2005; Dannenberg 2009; Frewer et al. 2013; Fernandez-Cornejo et al. 2014; Hess et al. 2016). The presence of GM ingredients is valued higher only if it is linked to certain benefits, such as the golden rice with added vitamin A (Lusk 2003; Huffman 2010). GM foods can be grouped in presence-claims labeled foods with genetically modified label on the products and absence-claims labeled foods with Non-GMO label on them. These two label types can have different signaling effects. In the alcohol beverage industry, absence-claims label such as Non-GM certified through the Non-GMO Project has been placed in the market for a long period of time. Little is known whether/how the Non-GMO labeled wines influence the demand for the unlabeled wines.

Presence-claim labels such as the GM label is not mandatory in the alcohol beverage industry and producers who actually use GM yeast in the winemaking process do not label it. Currently, conventional unlabeled products and Non-GM certified products exist in the alcohol beverage market, where people are aware of the existence of genetically modified technology when they see Non-GM products. Therefore, they may not distinguish conventional products
with GM products.

However, these signaling effects of GM/Non-GM labels have not been thoroughly evaluated in the literature and some findings of the existing studies are contradictory. Lusk and Rozan (2008) pointed out that consumers are more likely to infer unsafety of GM products if the mandatory GM labeling law is in place. Another study shows little evidence of a stigma effect resulting from exposure to genetically engineered (GE) labels (Costanigro and Lusk 2014). This study extends current literature on the impact of GMO labels on consumer purchase decisions from food products to alcoholic beverages. It provides more evidence on signaling impact of GM/non-GM labels in food and beverages and further enriches the literature about the stigma effect from absence-claimed food labels. Finally, given that the mandatory labeling law does not apply in alcohol beverage categories, the results provide the potential demand shifts knowledge brought by introducing GM label to other competing product options available in the market to guide the future policy implementation in the industry.
CHAPTER 4: METHODOLOGY

4.1 Survey Design

To evaluate the signaling effects from GM related food labels in alcohol beverage categories, I conducted an online consumer choice experiment using Qualtrics. In this survey, I selected Cabernet Sauvignon at a market price of $10.99 based on average retail prices at the time the survey was conducted, given the generic product picture. Cabernet Sauvignon is ranked the most consumed wine according VinePair’s top 50 wines of 2018 based on wines that are drinkable, interesting and offer great value for money. In 2019 that Cabernet Sauvignon was recognized as the best wine in the world in Vivino’s 2019 Wine Style Awards. I used pre-screen questions to only include people who consume wine regularly and are above 21 years of age. I also run the pilot test to distribute our survey in a graduate class. In order to make sure the participants paid attention to answer each question, the study placed two attention check questions in the survey and excluded the respondents who did not answer them correctly. Then, I officially published the survey through Qualtrics. Participants indicated whether they were willing to purchase the wine presented, via discrete yes/no choice questions. The wine was presented either without any label, or presented with either a “Genetically Modified” (GM) label or a “Not Genetically Modified” (Non-GM) label. We mimic the common settings in grocery stores with the dichotomous yes/no choice on a posted market price with three food labeling presented once a time in different orders.

In this study, participants were randomly assigned to one of the six treatments as shown in Table 1. Each treatment varies according to the order in which labels are presented. For example, participants randomly assigned in treatment group one were presented with the GM-labeled Cabernet Sauvignon first and then made yes/no purchase decision, then were presented with the
unlabeled conventional wine. In Treatment 2, participants were shown the GM-labeled wine first and asked to make a choice, followed by the Non-GM labeled wine. Table 1 lists the complete orderings of labels for all six treatments. The choice of each presented product was on a separate page so that participants cannot go back to change their previous responses. Sample questions in the survey are shown in Figure 1 for the case of GM Cabernet Sauvignon.

Table 1 Ordering of Labels for Each Treatment Group

<table>
<thead>
<tr>
<th>Treatment Group #</th>
<th>Label presented first</th>
<th>Label presented second</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GM</td>
<td>Unlabeled</td>
</tr>
<tr>
<td>2</td>
<td>GM</td>
<td>Non-GM</td>
</tr>
<tr>
<td>3</td>
<td>Unlabeled</td>
<td>GM</td>
</tr>
<tr>
<td>4</td>
<td>Unlabeled</td>
<td>Non-GM</td>
</tr>
<tr>
<td>5</td>
<td>Non-GM</td>
<td>GM</td>
</tr>
<tr>
<td>6</td>
<td>Non-GM</td>
<td>Unlabeled</td>
</tr>
</tbody>
</table>

Figure 1 Sample Survey Question in Case of GM Cabernet Sauvignon
Participants were led to the exit survey section after they completed yes/no purchase choice questions. This section includes the socio-demographic questions such as age, gender as well as the behavioral questions regarding food purchase and attitude toward animal welfare, pesticide residual and food safety. The survey designs a scale from 1 to 7 where higher score represents more concerns about respondents’ attitudes towards animal welfare, pesticide residual in foods and political preference. Besides these, I also asked participants’ specific alcohol drinking questions such as how often they drink wine from 1, “seldom or never”, to 5, the most frequent “everyday” drinking. The self-reported wine experience also uses the scale from 1 to 7 where higher score means more wine experience.

4.2 Data and Empirical Model

A total of 1,306 effective participants were recruited in this survey. Table 2 lists the number of respondents and associated percentage by treatment. Participants were randomly assigned to one of the six treatments; there are slightly different total counts of respondents in each treatment, ranging from 208 to 225 participants per treatment.

<table>
<thead>
<tr>
<th>Treatment #</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. GM_No_Non</td>
<td>208</td>
<td>15.93</td>
</tr>
<tr>
<td>2. GM_Non_No</td>
<td>214</td>
<td>16.39</td>
</tr>
<tr>
<td>3. No_GM_Non</td>
<td>223</td>
<td>17.08</td>
</tr>
<tr>
<td>4. No_Non_GM</td>
<td>215</td>
<td>16.46</td>
</tr>
<tr>
<td>5. Non_GM_No</td>
<td>221</td>
<td>16.92</td>
</tr>
<tr>
<td>6. Non_No_GM</td>
<td>225</td>
<td>17.23</td>
</tr>
</tbody>
</table>

Table 3 summarizes the socio-demographic characteristics, behavioral variables, wine
related variables and GM knowledge variables of the subjects in the sample. The median age of the sample is 50 years. Also, 74.3% of respondents are female and 90.0% of respondents are primary food shopper in our sample, which is consistent with the Private Label Manufacturers Association (PLMA) Consumer Research Study (2013) that females are the primary food shoppers in U.S. households. Furthermore, the sample is slightly skewed toward higher educated respondents with 76% of them with college or higher degree.

Regarding to the behavioral variables, participants spent on average 28% of their food purchases on organic food and they were concerned about food-related issues such as animal welfare (5.47), food safety (5.97) and pesticide residues (5.70) with their mean ratings close to 7. Regarding the wine related variables, participants reported a low level of wine consumption of 1.77 (in a scale from 1 to 5), and wine experience of 3.09 (in a scale from 1 to 7). We perform Tukey’s tests on group means and find no significant differences between the six treatments on any variables listed above.

Table 3 Summary Statistics for Demographic and Behavioral Variables

<table>
<thead>
<tr>
<th>Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Total Respondents</td>
</tr>
<tr>
<td>Median Age</td>
</tr>
<tr>
<td>Split between age groups</td>
</tr>
<tr>
<td>21-29</td>
</tr>
<tr>
<td>30-39</td>
</tr>
<tr>
<td>40-49</td>
</tr>
<tr>
<td>50-59</td>
</tr>
<tr>
<td>60-69</td>
</tr>
<tr>
<td>70 up</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>With children under 18</td>
</tr>
</tbody>
</table>
Primary food shopper 90.0%
Vegetarian or Vegan 4.7%

Education
Less than high school 1.8%
High school 21.8%
College or associate degree 64.4%
Postgraduate 11.9%

Percentage of organic food purchase 28.1%
Political ideology (extremely conservative =7) 4.26
Concern about animal welfare (scale of 1 to 7) 5.47
Concern about food safety (scale of 1 to 7) 5.94
Concern about pesticide residues (scale of 1 to 7) 5.70

Wine experience (scale of 1 to 7) 3.09
How often drink wine (scale of 1 to 5) 1.77

To answer the first question of how GMO and Non-GM labels influence consumer’s willingness to buy, I only included data from the first column, the first choice in Table 1 as so-called “initial demand”, for three labels GM, Non-GM, Unlabeled by each individual. The second stage is aimed to answer the potential signal effects whether the choices made for the products with the same label in other treatments, where participants receive the label in the second order, significantly increased or decreased from the initial demand of the labeled product. In other words, I want to see if for the same individual, the purchase choice made for the second product based on their perception of the first product that they have already seen can significantly changes their purchase decision. This examination includes data from both first and second columns in Table 1.

Under the random utility framework, I employ the logit model using maximum likelihood estimation to estimate the willingness-to-buy (WTB). In the first stage, the subscript $i$ refers to
the participant, and $L$ denotes one of three types of labeling: unlabeled (No label), GM labeled (GM), and Non-GM labeled (NGM). The binary purchasing decision for a product with one type of label ($L$) is thereby denoted as $\text{Choice}_{i,L}$:

$$\text{Choice}_{i,L} = \begin{cases} 
1 & \text{if participant } i \text{ chooses to purchase the product with type of label } L; \\
0 & \text{otherwise} 
\end{cases}$$

Equation (2) presents the empirical equation to estimate the effect of GM and NGM food labels:

$$\log \left( \frac{P_{i,L}}{1-P_{i,L}} \right) = \alpha_0 + \alpha_1 GM + \alpha_2 NGM + \sum k \gamma k, L D_{emoi,k} + \epsilon_i, L$$

The error term is assumed to be identically and independently distributed extreme-value. The variables of interests are $GM$ and $NGM$. Therefore, the coefficients $\alpha_1$ and $\alpha_2$ capture the mean effects of GM label and NGM label on consumer’s WTB. $GM$ and $NGM$ variables and they represent the probability of choosing GM-labeled or NGM-labeled wine. With 1,306 respondents, the mean of $GM$ is 0.246 with a 0.023 standard deviation. And the mean of $NGM$ is 0.448 with a 0.023 standard deviation. The pairwise comparisons show a significant difference between GM label and NGM label choices. The baseline is unlabeled conventional Cabernet Sauvignon. Comparing to the baseline, $\alpha_1$ should be negative and statistically significant if GM label lower the consumer’s WTB and $\alpha_2$ should be positive and statistically significant if NGM label increase the consumer’s WTB. The vector $D_{emoi,k}$ denotes demographic characteristic $k$ for individual $i$ as listed in Table 3.

In stage 2, the probability of participant $i$ buying the label type $L$ product (i.e. $y_{i,L} = 1$) is defined as $P_{i,L}$ where $L$ is specific to unlabeled (No) as the baseline to estimate the change in demand for unlabeled wine after respondents see NGM and GM labeled wine. Equation (3)
specifies the logit function of \( Choice_{i,L} \), which refers to the natural log of the odds that when \( Choice_{i,L} \) equals to one:

\[
(3) \quad \log \left( \frac{P_{i,L}}{1-P_{i,L}} \right) = \beta_0 + \beta_1 After_{-GM} + \beta_2 After_{-NGM} + \sum k \gamma_k, LD_{emi,k} + \epsilon_{i,L}
\]

The error term, is assumed to be identically and independently distributed extreme-value. Here, I use the random utility logit model to estimate the signaling effects of GM-labeled and Non-GM labeled red wine on participant’s purchasing decisions of the wine considering the changes in the choice for the same individual \( i \). A logit model using unlabeled red wine as the baseline is estimated for three types of labeling. The variables of interest, \( After_{-GM} \) and \( After_{-NGM} \), are dummy variables indicating whether the unlabeled wine is shown to the participant after the GM-labeled product or after the Not-GM-labeled product. If \( After_{-GM} = 1 \), the respondent sees the unlabeled wine after seeing GM-labeled wine, and 0 otherwise. If \( After_{-NGM} = 1 \), the respondent sees the unlabeled wine after seeing NGM-labeled wine, and otherwise equals zero.

Therefore, the two coefficients \( \beta_1 \) and \( \beta_2 \), capture the potential signaling effects which the GM or Non-GM label would induce, respectively. If Non-GM stigmatizes the unlabeled wine (unlabeled), then \( \beta_2 \) should be negative and statistically significant. On the other hand, if GM enhances the demand for the unlabeled wine, then \( \beta_1 \) should be positive and statistically significant. I also conducted robust checks for both logit regressions.
CHAPTER 5: RESULTS

5.1 Stage 1 Between Group Study: looking at the first presented label

First, this study considers the choices made for the first presented label only. This is equivalent to a between subject experiment, where each subject group was randomly assigned one type of labels: GM, Non-GM, No Label to see consumer’s willingness to purchase for different labels. Columns 2 and 3 of Table 4 in below show the estimated coefficient of food labels on consumers’ WTB and marginal effects, respectively. The results indicate that the GM label significantly decreases consumer’s WTB for red wine relative to the wine without any label. The probability for consumers to purchase the wine decreased by 25.2 percent points when given GM label in comparison with when given no label. The results also show that the difference between consumer willingness to purchase when presented with Non-GM label and No label is not statistically significant. When just using the data from the first presented label, the study shows no significant difference of consumer’s WTB between Non-GM and unlabeled wines but a significant difference of consumers’ WTB between GM and unlabeled wines.

In addition, gender, age, being the primary food shopper, being conservative and the level wine experience are significant factors influencing consumer’s WTB the wine. Regarding socio-demographic variables, females are 5.7% less likely to buy red wine than males. A one unit increase in age will decrease their willingness to buy red wine by 0.03%. The primary food shopper in a household is 8.6% more likely to buy red wine. More conservative people are 1.6% less likely to buy. Furthermore, wine experience is positively related to consumer’s wine preference that people with more wine experience are 9.1% more likely to buy wine as we expected. All other control variables are not statistically significant.
Table 4 the Effect of Food Labels on Consumers’ WTB with Marginal Effects

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Unlabeled Red Wine-Coefficients</th>
<th>Unlabeled Red Wine-Margins</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>GM</td>
<td>-1.358***</td>
<td>-0.252***</td>
</tr>
<tr>
<td></td>
<td>(0.173)</td>
<td>(0.029)</td>
</tr>
<tr>
<td>NGM</td>
<td>-0.114</td>
<td>-0.021</td>
</tr>
<tr>
<td></td>
<td>(0.148)</td>
<td>(0.028)</td>
</tr>
<tr>
<td>Female</td>
<td>-0.308**</td>
<td>-0.057**</td>
</tr>
<tr>
<td></td>
<td>(0.155)</td>
<td>(0.029)</td>
</tr>
<tr>
<td>Age</td>
<td>-0.017***</td>
<td>-0.003***</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Have kid</td>
<td>0.103</td>
<td>0.019</td>
</tr>
<tr>
<td></td>
<td>(0.155)</td>
<td>(0.029)</td>
</tr>
<tr>
<td>Food shopper</td>
<td>0.466**</td>
<td>0.086**</td>
</tr>
<tr>
<td></td>
<td>(0.229)</td>
<td>(0.042)</td>
</tr>
<tr>
<td>Vege</td>
<td>-0.181</td>
<td>-0.034</td>
</tr>
<tr>
<td></td>
<td>(0.318)</td>
<td>(0.059)</td>
</tr>
<tr>
<td>Buy organic</td>
<td>0.001</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Conservative</td>
<td>-0.088**</td>
<td>-0.016**</td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>Animal welfare</td>
<td>0.028</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>(0.052)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Food safety</td>
<td>-0.049</td>
<td>-0.009</td>
</tr>
<tr>
<td></td>
<td>(0.079)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>Pesticide residual</td>
<td>0.098</td>
<td>0.018</td>
</tr>
<tr>
<td></td>
<td>(0.070)</td>
<td>(0.013)</td>
</tr>
<tr>
<td>Educ</td>
<td>-0.033</td>
<td>-0.006</td>
</tr>
<tr>
<td></td>
<td>(0.074)</td>
<td>(0.014)</td>
</tr>
<tr>
<td>Wine experience</td>
<td>0.490***</td>
<td>0.091***</td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.000*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.519)</td>
<td></td>
</tr>
</tbody>
</table>

Observations 1,306 1,306

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
5.2 Stage 2 Within Group: Change in Choice

In the second stage, I dive deeper to test the signaling effects of GM and NGM labels on no labeled wines. Table 5 shows the marginal effects of the probability choosing different labeled wines. The results show that the coefficient of GM then No Label is not significant, indicating that consumers demand for the unlabeled wine is not influenced by the GM label. The coefficient of Not GM then no Label is negative and significant, which means if consumers see conventional unlabeled wine after the Non-GM wine, they are less likely to buy the unlabeled wine by 6.6%. That is, Non-GM label stigmatizes the unlabeled conventional wine. After exposed to the Non-GM labeled wine, consumers may perceive the No-labeled wine as less desirable or they cannot differentiate unlabeled product from GM products. This finding is consistent with previous research about the absence-claimed label in the case of the rBST-free milk where the authors found significant stigmatization of conventional milk as a result of the introduction of rBST-free labelled milk (Kanter, Messer, and Kaiser 2009).

The coefficients of gender, age and wine experience remain statistically significant. Corresponding with the results in stage 1, females are less likely to buy red wine. Increased in age can discourage consumers buying red wine. And consumers with more wine experience are 10.6% more likely to buy red wine.

Table 5 the Signaling Effect of GM and NGM Labels on Conventional Unlabeled Red Wine

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Estimated Coefficients</th>
<th>Marginal Probability of the Logit Models for Red Wine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>GM then No L</td>
<td>-0.053</td>
<td>-0.010</td>
</tr>
<tr>
<td></td>
<td>(0.190)</td>
<td>(0.037)</td>
</tr>
<tr>
<td>Not GM then No L</td>
<td>-0.350*</td>
<td>-0.066*</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>Coefficient</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>-0.397**</td>
<td>0.194</td>
<td>-0.076**</td>
<td>0.377</td>
</tr>
<tr>
<td>Age</td>
<td>-0.013**</td>
<td>0.006</td>
<td>-0.003**</td>
<td>0.001</td>
</tr>
<tr>
<td>Have kid</td>
<td>0.050</td>
<td>0.186</td>
<td>0.009</td>
<td>0.035</td>
</tr>
<tr>
<td>Food shopper</td>
<td>0.364</td>
<td>0.266</td>
<td>0.069</td>
<td>0.051</td>
</tr>
<tr>
<td>Vege</td>
<td>-0.204</td>
<td>0.401</td>
<td>-0.039</td>
<td>0.076</td>
</tr>
<tr>
<td>Buy organic</td>
<td>0.003</td>
<td>0.004</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>Conservative</td>
<td>-0.042</td>
<td>0.050</td>
<td>-0.008</td>
<td>0.009</td>
</tr>
<tr>
<td>Animal welfare</td>
<td>-0.011</td>
<td>0.061</td>
<td>-0.002</td>
<td>0.012</td>
</tr>
<tr>
<td>Food safety</td>
<td>0.086</td>
<td>0.095</td>
<td>0.016</td>
<td>0.018</td>
</tr>
<tr>
<td>Pesticide residual</td>
<td>0.031</td>
<td>0.083</td>
<td>0.006</td>
<td>0.016</td>
</tr>
<tr>
<td>Wine experience</td>
<td>0.557***</td>
<td>0.050</td>
<td>0.106***</td>
<td>0.007</td>
</tr>
<tr>
<td>Educ</td>
<td>-0.060</td>
<td>0.087</td>
<td>-0.011</td>
<td>0.017</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.614***</td>
<td>0.594</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Observations 871 871

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.3 Consumer's Willingness-to-Buy

Table 6 presents the average predicted WTB under the given label and order in which they are presented, using parameter estimates from Table 5. I define the label that is presented first as the “initial demand” of a given label, which is the mechanism we used to measure the average willingness-to-buy (WTB) of consumer for that given labeled product. The average predicted
initial demand for unlabeled products is the highest (47.6%), followed by Non-GM-labeled products (45.2%) and GM-labeled products (20.2%). Consumer demand for unlabeled and Non-GM labeled wine are significantly higher than GM labeled wine to reflect the general aversion of GM products in public. In this section, we discuss how the WTB changes as the order of product presentation were changed.

Table 6 Average Predicted WTB Under Given Label and Present Order

<table>
<thead>
<tr>
<th></th>
<th>Unlabeled</th>
<th>Non-GM labeled</th>
<th>GM labeled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial demand (present first)</td>
<td>47.6%</td>
<td>45.2%</td>
<td>20.2%</td>
</tr>
<tr>
<td>Presented after GM</td>
<td>46.3%</td>
<td>47.9%</td>
<td>--</td>
</tr>
<tr>
<td>Presented after Non-GM</td>
<td>39.1%</td>
<td>--</td>
<td>13.1%</td>
</tr>
</tbody>
</table>

* Results are calculated using estimates from the three basic logit models. Other socio-demographic and behavioral covariates are held at sample means.

First, the results show significant stigmatization impacts of Non-GM on unlabeled wine with 8.5% (from 47.6% to 39.1%) reduction of consumers’ WTB. However, results indicate that there is no significant halo effect of GM label on unlabeled wine. The initial demand for the unlabeled product (47.6%) is not significantly different from the consumers’ demand for the unlabeled wine after exposed to GM labeled wine (46.3%). Also, there is no significant halo effect of GM label on Non-GM wine as the initial demand for Non-GM product (45.2%) is not significantly different from the Non-GM product after exposed to GM labeled wine (47.9%). In both cases, the changes in demand are relatively small.

Second, the results show that WTB for Non-GM labeled wine presented after GM labels increases is about the same level as the initial demand for unlabeled wine (47.9% versus 47.6%).
This suggests that consumers may not differentiate between unlabeled wine and Non-GM labeled wine after the introduction of GM labels. Lastly, this study is consistent with a body of literature showing that the public has general aversion towards GM products and preferences towards Non-GM products. Consumers’ WTB for Non-GM red wine presented after GM increased by 2.7% and their WTB for GM red wine presented after Non-GM decreased by 7.1%.
CHAPTER 6: CONCLUSION

This study uses a consumer experiment through a Qualtrics survey platform to test consumers’ demand for different food labels estimates the food labeling impact of GM/Non-GM labels on conventional products in alcohol beverage categories, using Cabernet Sauvignon as the focal products. The survey estimated the labeling impact by asking participants to indicate whether they are willing to purchase, using a discrete yes/no choice, given the generic product picture at a market price and one of the three types of labeling: unlabeled (No label), GM labeled (GM), and Non GM labeled (NGM). Participants were randomly assigned to one of the six treatments which the order of choices varies in each treatment. The “initial demand” of a given label is defined as the average willingness-to-buy (WTB) when the label is presented first.

Firstly, I investigate the informational effect of GM/Non-GMO labels on consumers’ willingness to buy. Then I also estimate the signaling effect based on the choices made by individuals. I do this by comparing to the initial demand of unlabeled wine, i.e. whether the probability of choosing unlabeled wine significantly increases or decreases after seeing GM or Non-GM labels. Using consumers’ choice decision data from the first presented wine, the results indicate that GM labels decrease consumer’s WTB in comparison with No labels and Non-GM labels. More importantly, when analyzing possible signaling effects, consumers are less likely to purchase the unlabeled wine when they were first presented with the same wine with the Non-GM label. This indicates that stigmatization effect of Non-GM labeled products on conventional unlabeled product do occur in alcohol beverage categories. Stigmatization exist because a consumer may infer that there are undesired elements on unlabeled wines. The significant signaling impact for Non-GM labels to unlabeled wine is perhaps due to the fact that Non-GM labeled wines have been in the market while GM-labeling wines do not exist in the market.
This finding suggests a possible intervention to alleviate the stigma effect of Non-GM labeled wine on conventional wine by introducing GM labels in the market. With all three labels available to consumers, the study shows no significant difference of Non-GM and unlabeled wine reflecting on consumer’s WTB. However, with only two labels (No labels or Non-GM labels) available to consumers, which is the current situation in the U.S. market (GM labels are not mandatory for alcohol beverages), consumer’s WTB is higher for Non-GM labeled wines than unlabeled wines. The results show that GM labeled wines does not enhance the demand for unlabeled wines (no halo effect).

My study contributes to the economic implications of the stigmatization of goods, which have not been thoroughly examined in the literature. From a producer’s perspective, food manufacturers should be concerned about the negative long-term consequences that may result from the introduction of new similar products. This is also the case for labels touting better production methods, such as rBST-free milk, free-range chicken and a variety of products marketed under the label of fair-trade or eco-friendly. The study sheds light on the ongoing discussion of the use of GMO labeling in alcohol beverage industry that wine makers can actually benefit from the GM labeling law for two reasons. First, producers who use GM yeast in winemaking process can benefit from lower processing cost of labor and capital. Producers who do not use GM yeast can benefit from a GM labeling law to differentiate their product without paying extra money for a Non-GM certification. Second, GM yeast is a breakthrough in winemaking with benefits in economic, health and environment. For example, ML01 replaces hops in fermentation process that requires less water, labor and energy. The final product does not contain any GM ingredients and shows no harm to human beings. From a consumer’s perspective, the GM labeling law allows more transparency of alcohol beverages’ production
content and methods. In addition, this study shows that the public’s general GM knowledge of wine is low. Therefore, besides providing labels on products, educating consumers about GM yeast is critical to differentiate GM yeast in alcohol beverages from general GM foods. Wineries should market and position this new production method, using GM yeast in winemaking process in favor of the healthy and environmental benefits. In order to educate consumers and provide insights to policy makers, a thorough GM labeling policy is needed to eliminate the stigma effect as well as to protect consumers and producers.

The limitations of the study mainly focus on three issues. First, the focal product in this research survey is Cabernet Sauvignon, which only one product in the alcohol beverage category. Further research can apply to other products like beer to provide more evidences and insights for food labeling in this industry. Second, McFadden and Lusk (2016) question the usefulness of results from opinion polls as a motivation for creating public policy surrounding GM food. The results of their study suggest that consumers think they know more than they actually do about GM food, and their beliefs about GM food safety increase after answering queries about GM food (McFadden and Lusk 2016). Last but not least, bioengineering research in other processed food categories is still limited. Food Babe (2014) states that most breads contain GM ingredients such as soy oil, corn starch and GMO bread yeast in some sourdough. Similarly, high fructose corn syrup (HFCS) derived from genetically modified corn is widely used in processed foods. The study of signaling effect in these food categories are needed to fulfill the literature.
REFERENCES


APPENDIX

Supplementary Material

Below is the sample survey for Treatment 1.

Are you willing to purchase this product?
- No
- Yes
Cabernet Sauvignon
Not Genetically Modified
$10.99 per 750ml bottle

Are you willing to purchase this product?

- [ ] No
- [ ] Yes
Below are Socio-demographic Survey Questions

What is your gender?
- Male
- Female

What is your year of birth?

What is the highest level of school you have completed or the highest degree you have received?
- Less than high school degree
- High school graduate (high school diploma or equivalent including GED)
- Some college but no degree
- Associate degree in college (2-year)
- Bachelor's degree in college (4-year)
- Master's degree
- Doctoral degree
- Professional degree (JD, MD)
How many people are living or staying in your household? This includes yourself and any person(s) who have lived with you for at least two months and with whom you share living expenses.

- Do NOT include anyone who is living somewhere else for more than 2 months, such as a college student living away or someone in the Armed Forces on deployment.

- 1
- 2
- 3
- 4
- 5
- 6
- More than 6

Do you have any children (under 18 years old) currently living with you?

- No
- Yes, the number of children currently living with me is: [ ]

Are you the primary food shopper of your household?

- Yes
- No
What percentage of food that you typically buy is Organic?

Percentage

0  10  20  30  40  50  60  70  80  90  100

From extremely liberal (scale = 1) to extremely conservative (scale = 7), where would you place yourself on this scale?

Extremely liberal | Extremely conservative
1 | 2 | 3 | 4 | 5 | 6 | 7

From not concerned at all (scale = 1) to extremely concerned (scale = 7), how concerned are you about animal welfare?

Not concerned at all | Extremely concerned
1 | 2 | 3 | 4 | 5 | 6 | 7

From not concerned at all (scale = 1) to extremely concerned (scale = 7), how concerned are you about food safety?

Not concerned at all | Extremely concerned
1 | 2 | 3 | 4 | 5 | 6 | 7

From not concerned at all (scale = 1) to extremely concerned (scale = 7), how concerned are you about pesticide residues in your fresh produce?

Not concerned at all | Extremely concerned
1 | 2 | 3 | 4 | 5 | 6 | 7

How often do you drink wine?

- Seldom or never
- 1-3 times a month
- Once or twice a week
- 3-5 times a week
- Everyday
From very inexperienced (scale = 1) to very experienced (scale = 7), how much experience do you feel you have with wine?

<table>
<thead>
<tr>
<th>Very Inexperienced</th>
<th>Very experienced</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

From very unknowledgeable (scale = 1) to very knowledgeable (scale = 7), how knowledgeable are you about genetically modified food?

<table>
<thead>
<tr>
<th>Very unknowledgeable</th>
<th>Very knowledgeable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

Please choose between True/False/Not sure for the following statement.
- **Organic wines can contain GMOs.**
  - True
  - False
  - I'm not sure

Please choose between True/False/Not sure for the following statement.
- **Wines made from organic grapes can contain GMOs**
  - True
  - False
  - I'm not sure

Commercial GMO wines in the US are wines made from
- A. genetically modified grapes
- B. genetically modified yeast
- C. both A and B
- D. neither A or B
- E. I'm not sure