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Consumer Preferences for GM Food Labeling: A Market Segments Analysis

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Abstract

Consumer demand for labeling information regarding the genetically modified (GM) content of foods has increased in recent years. This had led to a growing number of products labeled as non-GMO in the marketplace under a voluntary GM labeling program. However, many consumers support stricter regulation in the food industry via a mandatory labeling program for GM ingredients. Although considerable research exists documenting consumers' willingness to pay to avoid GM foods, less in known about how two such labeling programs affect individual decision making in the marketplace. The goal of this project is to better understand how individuals value GM foods, examining responses to both a voluntary style label (non-GMO) and a mandatory style label (this product contains GM). Importantly, the heterogeneity of consumer preferences will be analyzed explicitly with a latent class model (LCM) in order to carry out a market segments analysis. The market segments analysis will help to identify the characteristics of individuals who are most likely to avoid GM foods and how different groups of consumers react to the two labeling approaches. The results of this study will provide valuable information to agribusiness firms and policy makers by furthering our understanding of how consumers' preferences are influenced by labeling approach and how preferences vary across different segments of consumers. Three unique market segments were found that had different preferences toward the non-GMO (voluntary) and GM (mandatory) labeling program. These results indicate that there are two unique market segments that agribusiness firms could market non-GM chicken products toward.

Keywords: genetically modified foods, consumer preferences, market segmentation

Introduction and Literature Review

Since the introduction of genetically modified organisms (GMOs) in American food production, consumers have increasingly stated a willingness to pay (WTP) a premium to avoid genetically modified (GM) foods (Lusk et al., 2005; Dannenberg, 2009). Sales of foods labeled as non-GMO continue to increase and the number of cropland acres planted in non-GMO is outpacing growth in organic acres (Kowalski, 2017). Much of the growth in non-GMO acreage has been driven by market premiums available for non-GMO corn (average of 7% premium) and non-GMO soybeans (average of 11% premium) (Kowalski, 2017). Consumer demand for products free of GMOs has been driving this growth in the non-GMO market. However, U.S. crops such as corn and soybeans, are still dominated by GM acreage with over 90% of total production in GM crops (USDA, 2017).

A large portion of Non-GMO crops are used as feed for livestock. Livestock products labeled as being fed a non-GMO diet is another growing sector of the non-GMO market. In 2013, the USDA's Food Safety and Inspection Service approved the first non-GMO labelling language to be used on meat and liquid egg products. The approved label is managed by the Non-GMO Verified Project (www.nongmoproject.org). Since the approval, the Non-GMO Verified Project has seen substantial growth in the use of its label on livestock products.

More recently, the increasing demand for non-GMO foods and calls for the mandatory labeling of GM ingredients has led the U.S. congress to pass new legislation regarding GM food labeling. Traditionally, the U.S. has taken a voluntary approach to the labeling of GM ingredients (Golan and Kuchler, 2011). The voluntary approach is well represented in the market by companies who label their products as non-GMO. However, the new law passed by congress moves the U.S. towards a mandatory labeling approach. Under a mandatory labeling program,

foods containing GM ingredients are required to label such content. Under the new U.S. mandatory labeling program, consumers will be able to see the GM content information printed on the package label, or by scanning a "QR code" (Charles, 2016). Despite the growing consumer demand for products free from GMOs in the U.S., it is still not fully understood how individuals respond to the various labeling options available to agribusinesses. While overall demand for GM labeling is strong, groups of individuals may value labels quite differently.

The goal of this project is to better understand how individuals value GM foods, examining responses to both a voluntary style label (non-GMO) and a mandatory style label (this product contains GM). Importantly, the heterogeneity of consumer preferences will be analyzed explicitly with a latent class model (LCM) in order to carry out a market segments analysis to identify the characteristics of individuals who are most likely to avoid GM foods. Recognition of the heterogeneity of consumer preferences is important for accurately predicting the welfare effects associated with the two types of GM labels we will examine here.

The results of this study are expected to yield valuable marketing information to agribusiness firms in Arkansas. From an economic standpoint, understanding how consumers in different market segments value non-GM foods can help agribusiness firms develop better product, marketing, and pricing strategies. From a policy perspective, these results can also inform the ongoing GM labeling debate concerning the best approach to labeling the GM content of foods. Consumers continue to express a demand for information regarding the GM content of food on their product labels. This study helps to identify different groups of consumers who have different preferences for GM labels.

Literature Review

According to Klein, Wolf, Wu, and Sanford (1998), "GMOs are organisms whose genetic make-ups have been changed by mutating, inserting, or deleting genes, by using genetic engineering techniques or biotechnology" (p. 1). When agriculture biotechnology was introduced in the 1990s, it was highly controversial (Stewart and McLean, 2008). Research on consumer preferences for GM food products is extensive due in part to the controversy surrounding the introduction of the technology. There is substantial evidence that consumers are willing to pay sizable premiums to avoid GM foods (Lusk, 2011). A meta-analysis by Lusk et al. (2005) offers a summary of 57 studies that estimated the WTP for non-GM foods. This study showed that consumers around the world are averse to GM foods and are willing to pay a premium for these products. 82% of reviewed studies reported positive WTP premiums for non-GM food and all studies reporting negative premiums for non-GM foods were based on valuations of a GM food product that provided a direct benefit to consumers, like improved nutrition.

Lusk et al. (2005) also found interesting differences between consumer preferences for various types of non-GM food products. Consumers in these reviewed studies were most opposed to the use of biotechnology in the production of livestock and meat products compared to produce, processed foods, and oil. Consumers were willing to pay 28% more for non-GM meat products than they were for non-GM produce, 41% more for non-GM processed food, and and 49% more than for non-GM oil, respectively. Komirenko et al. (2010) also found that consumers in Canada showed high levels of concern in relation to GM feeds. Consumers who had a lower level of trust in the food industry were shown to have a higher concern about GM feeds. Unlike Lusk, the researchers were not fully able to determine levels of concerns seen in the consumers translated into premiums for non-GM fed meat products. Dannenberg (2009) expanded on Lusk et al. (2005) by extending the analysis from 51 studies to 114. The results of

the two meta-analyses were consistent. Dannenberg (2009) found a slightly higher average of 45% premium for non-GM food and concluded that demand for non-GM food has been growing in the U.S. Many countries have enacted laws governing the development, use, production and release of GM crops. The regulatory approach adopted by the U.S. historically has been the voluntary approach. Under this approach, food companies can follow a voluntary labeling process but are not required to label the GM content of products. This approach by the U.S. has promoted policies which hold that GM foods are substantially equivalent to conventional foods (Golan and Kuchler, 2011). The voluntary approach has led to virtually no products being labeled as "containing GM" and a constantly growing number of products labeled "non-GMO".

Recent legislation will impact GM labeling in the U.S. going forward. In 2016, Congress passed a bill requiring mandatory labeling of GM foods and the bill was signed into law by President Obama (Charles, 2016; Poinski, 2017). The bill requires food containing GM ingredients to be labeled and allows companies to comply by using written text, a symbol, or smartphone scanning codes (Poinski, 2017). The bill also requires the U.S. Department of Agriculture (USDA) to implement the standard by July 2018 (Poinski, 2017). However, regulations involving GMO labeling are in limbo due to President Trump's executive order requiring federal agencies to cut two regulations before a new regulation is implemented (Blackwell et al, 2017).

Food labels are not the only factor that can influence consumers' preferences for GM food products. A broad range of research has demonstrated the importance of key demographic variables including income (Delwaide et al., 2015), age (Liaukonyte et al., 2013), education (Dannenberg et al., 2011), and gender (McFadden and Lusk, 2015) in predicting the consumers' preferences for GM foods. These differences observed across individuals demonstrate the need

to account for preference heterogeneity in the analysis of choice data. Accounting for preference heterogeneity enables unbiased estimation of individual preferences which increases the reliability of welfare estimations (Green, 2008). One modeling approach to account for heterogeneity which has grown in popularity recently is the latent class model (LCM) (Hensher et al., 2015). LCM can be used to identify the sources of heterogeneity at the segment (or group) level which allows the welfare impacts of various GM labels on different segments of the population to be estimated (e.g., Kikulwe et al., 2011).

Materials and Methods

Theoretical Background

We use a discrete choice experiment (DCE) grounded in Lancasterian demand theory (Lancaster, 1966) which posits that consumers derive satisfaction from the attributes that good provide rather than from the goods themselves. The econometric framework for the DCE is the random utility model (McFadden, 1974) which integrates consumer behavior with economic valuation. In the estimation of consumer preferences, the heterogeneity of the preferences across individuals in the sample must be accounted for by using an appropriate model. Accounting for preference heterogeneity allows for the estimation of unbiased individual preferences and increases the accuracy and reliability of model estimations (Greene, 2008). Various models have been used to account for preference heterogeneity including the mixed logit model (Green and Hensher, 2003) and the latent class model (LCM) (Louviere et al., 2000). The LCM captures heterogeneity at the group level which is useful for analysis here in the identification of consumer groups and how these groups may differ in response label statements regarding GM foods.

The LCM approach describes the population as made up of an identifiable and finite number of segments (groups of consumers). Within segments, preferences are assumed to be homogeneous; however, preferences differ substantially across segments. The optimal number of segments is determined by the data and segment membership of individuals is probabilistic and dependent upon socio-economic and demographic characteristics as well as perceptions and attitudes. The LCM approach has been used previously in a number of studies to estimate consumers' preferences for agricultural and food products (see Scarpa et al., (2003), Kontoleon and Yabe (2006) and Kikulwe et al. (2001) for examples).

Market Segments Analysis

The LCM will be used to complete the market segments analysis. The approach suggests that individual behavior depends on observable attributes and on latent heterogeneity that varies with factors that are unobserved (Hensher et al., 2015). LCM describes a population as consisting of a finite and identifiable number groups (segments) of individuals. Within segments, preferences are relatively homogeneous but differ substantially from one segment to another. The optimal number of segments is determined endogenously by the data and the determination of which segment best fits an individual is probabilistic and dependent upon social, economic and demographic characteristics as well as their perceptions and attitudes (Kikulwe et al., 2011).

For the LCM used in this study, we will analyze respondent preferences using a discrete choice framework consistent with random utility theory (McFadden, 1974) and Lancaster consumer theory (Lancaster, 1966). The utility that consumer *i,* belongs to a segment *s,* gains from choosing one of the poultry product alternatives can be written as:

$$U_{ij/s} = \beta_s X_{ij} + \varepsilon_{ij/s} \quad (1)$$

where X_{ij} is a vector of attributes associated with the poultry product alternative *j* and consumer *i*, and β_s is a segment-specific vector of taste parameters. Importantly, the differences in β_s vectors allow the LCM to capture the heterogeneity in preferences across segments. If error terms are identically and independently distributed, the probability of alternative *j* being chose by the *i*th individual in segment *s* is given by:

$$P_{ij/s} = \frac{(\exp\beta_s X_{ij})}{\sum_{h=1}^{c} \exp(\beta_s X_{ih})} \quad (2)$$

The membership likelihood function for consumer *i* and segment *s* are given by:

$$M_{is}^{*} = \lambda_s Z_i + \varsigma_{is} \quad (3)$$

M* is a segment membership likelihood function that categorizes each respective consumer into one of the *S* finite number of latent segments with some probability $P_{is..}$ *Z* represents household characteristics (e.g. socio-economic and demographic characteristics) and also attitudes, knowledge, and perceptions. Using the assumption that the error terms in the consumer membership likelihood function are identically and independently distributed (I.I.D.) across consumers and segments, then the probability that consumer *i* is a member of segment *s* can be described as:

$$P_{is} = \frac{\exp(\lambda_s Z_i)}{\sum_{k=1}^{s}(\lambda_k Z_i)} \quad (4)$$

where λ_k (k = 1, 2, . . ., S) are the segment-specific parameters to be estimated. If we observe a negative (positive) and significant λ this suggests that the correlated consumer characteristic, Z_i, increases (decreases) the probability that consumer *i* is a member of segment *s*. For each individual consumer *i* the probability, P_{is}, of being a member across all *S* segments sums to 1 where $0 \leq P_{is}, \leq 1$. For this study, consumer *i* is considered to be a member of the segment *s* where the individual's probability of membership, P_{is}, is the largest across all *S* segments.

By combining equations (3) and (4), a mixed-logit model can be constructed that accounts for boneless, skinless chicken breast product choice and segment membership at the same time. The joint unconditional probability of individual *i* being in segment *s* and choosing the chicken alternative *j* is given by:

$$P_{ijs}=(P_{ij/s})*(P_{is})=\left[\frac{(\exp\beta_s X_{ij})}{\sum_{h=1}^{c}\exp(\beta_s X_{ih})}\right]*\left[\frac{\exp(\lambda_s Z_i)}{\sum_{k=1}^{s}(\lambda_k Z_i)}\right] \quad (5)$$

Experimental Design and Data

The product selected for evaluation was fresh boneless skinless chicken breast due to its popularity with American consumers and its importance to producers in Arkansas. The data used for this project was collected, as part of a related project, using a national online survey using Sawtooth Software in 2015. The 490 respondents-who are the primary household grocery shoppers-to the survey were provided by Survey Sampling International. Respondents participated in a two-part experiment: a survey and choice experiment. The sample was balanced by the four main U.S. Census regions and by sociodemographic questions. The survey consisted of a set of questions on policy and food labeling preferences and questions relating to demographics. The choice experiment required everyone in the experiment to complete eight choice tasks that included two experimentally designed options and a "none of the two" option. The experimentally designed options were varied by the following attributes and levels. The first attribute was price, which has four distinct levels. The second attribute was the GM content of the products, which had three different levels: (1) Non-GMO Project Verified; (2) this product is composed of genetically engineered ingredients; (3) no information. The third attribute was carbon footprint and the fourth attribute were for local production (Table 1). The allotment of attribute levels to products was created using a sequential design and D-efficient criterion

(Bliemer and Rose, 2010). The finished designed involved 32 choice tasks, arranged into four blocks of eight tasks. Respondents were randomly assigned to one of the four blocks. This was done to prevent choice fatigue in the respondents. An example of the choice tasks can be found in the appendix.

A total of 490 participants were sampled for this experiment. 68.5% of the sample was female and 31.5% was male, this was expected since women are the primary household grocery shopper in majority of households. Each category was well represented in the data, except for the 18-24 years old range. This range accounted for 5.3% of the sample. The largest group of participants $59,999 or under of annual income with 55.4% of the sample. The data collection was controlled by region from each of the four main census regions (Northeast, Midwest, South, and West. Relatively, 25% of the respondents came from each region. A bulk of the respondents had a high school diploma up to a bachelor's degree (4-year degree) with 83.9% of the sample. Full results of the counts and percentages of the sample characteristics can be found reported on Table 2.

Results

Latent Class Model

The determination of the optimal numbers of segments requires the comparison of model fit estimates across models built using an increasing number of segments. Models are compared with a baseline model (multinomial logit model (MNL)) without segments where individuals are assumed to have homogenous preferences. All subsequent models examining increasing numbers of segments (from 2 up to 4 segments) and model fit criteria are compared with the baseline in terms of significant improvements to model fit - using the Akaike information criterion (AIC) and Bayesian information criterion (BIC). Akaike information criterion is an assessment of a

constant plus the relative distance between the unidentified true likelihood function of the data and the proper likelihood function of the model (Dziak et., al, 2012). Bayesian information criterion is an assessment of a function of the probability that the model is true (Dziak et., al, 2012). Determination of the best-fitting model requires a balance of the statistics in Table 3. Because the log-likelihood decreases (improves) as more segments are added, it is critical to compare model fit metrics which are not as biased by the number of parameters included in the model. Log-likelihood, BIC, and AIC are both maximized at segment one (the basic model). The log-likelihood, BIC, and AIC for the baseline model are -3869.1 7804.4, and 7754.2, respectively. The full results of the baseline MNL model can be found on Table 3. As more segments are added, the model fit criteria continue to improve (decrease), but after the fourth segment the marginal improvement diminishes (Table 3). This suggests that after the fourth segment is added, our sample cannot be divided into more segments. The log-likelihood, BIC, and AIC are all minimized at the four-segment model. The log-likelihood, BIC, and AIC for the four-segment model are -2862.9, 6015.3, and 5795.7, respectively. The full details on the four-segment model can be found in Appendix Table 8. However, the relatively minimal gains in model fit by adding the fourth segment does not necessarily indicate that it is the best model. Model fit statistics generally improve as new parameters are added to the model. Hence, when additional segments are added, some gains in fit are experienced due simply to increasing the number of parameters (Hensher et., al, 2015). The BIC for the three-segment model was 6133.1 and the BIC for the four-segment model was 6015.3. This small improvement in model fit could indicate that the four-segment model is overfitting the data with too many segments. Common signs of overfitting the model with too many segments are the presence of unusually large parameter estimates, huge standard errors, and insignificant parameters that, behaviorally, should

be significant (Henser et., al, 2015, p. 791). This suggests that the four-segment model may not be the optimal model despite its relatively better fit statistics. In the selection of the optimal model, there needs to be a balance between model fit and how well the results reflect reality (Hensher et., al, 2015). The three-segment model (Table 5) was selected as the optimal model because it has better model fits statistics than the two-segment model and the more reasonable coefficient estimates in a behavioral sense than the four-segment solution. Therefore, the presentation of results that follow are limited to the three-segment model found in Table 5.

Market Segments

Segment 1

The size of each segment is found by inserting the estimated coefficient into Eq. (4) and using it to create a string of probabilities that a participant belongs to a segment. Participants are then named to a segment established by the larger of the probability scores. We find that 39.3% of the participants reside in segment 1 (Table 6). For consumers in segment 1, the coefficient estimates indicate that the most important (significant) attributes are price (μ=-0.54; *p*-value < 0.01), non-GMO (μ=1.67; *p*-value < 0.01), "this product contains GM ingredients" (GM) (μ=-0.57; *p*-value < 0.01), and local production (μ=0.44; *p*-value < 0.01). Consumers in this segment also appear to have positive preferences for the low and medium carbon footprint labels (μ=.34; *p*-value < 0.10; μ=0.28; *p*-value < 0.10). The negative price and GM coefficients indicate that consumers in segment 1 experience less satisfaction when prices are higher and when a product contains GM ingredients. The positive coefficients for non-GMO and local production indicate that consumers in segment one finds more satisfaction when a product contains non-GMO ingredients and when the product is produced locally. The demographic characteristics of consumers in segment 1 reveal that they are more likely to be female, age 55 or older, and white.

(Table 6). These consumers are also more likely to live in the western part of the U.S. Segment 1 members were found to have the second highest marginal willingness to pay (WTP) premium for the non-GMO (voluntary) label on chicken products ($3.11 per lb.) They also required the second highest discount (negative WTP) to consume a chicken product with the GM label (-$1.07 per lb.)

Segment 2

After determining the proper segment for each consumer, we find that 30.3% of participants reside in segment 2. For consumers in segment 2, the coefficients estimates reveal that the most important attributes are price (μ=-0.32; *p*-value <0.01) and local production (μ=0.26; *p*-value < 0.01). Consumers in this segment also appear to have a negative preference for the GM label (μ=-0.24; *p*-value < 0.05) and a positive preference for a high carbon footprint label (μ=0.26; *p*-value < 0.10). The negative coefficients for price and GM indicate that consumers have less satisfaction when price is higher, and the product contains GM ingredients. The positive coefficient for the high carbon footprint label indicates that consumers have more satisfaction when the product has a label that indicates it has a high carbon footprint. The demographic characteristics indicate that members of segment 2 are likely to be female, between the ages of 35 and 54, and white (Table 6). These consumers are also more than likely to live in the southern part of the country (Table 6). Members of this segment were found to be unwilling to pay a premium for Non-GMO (voluntary) label of chicken products with (-$0.03 per lb) and they would require a discount of -$0.76 per lb to purchase chicken products with the GM label (Table 7).

Segment 3

After determining the proper location for each participant, 30.4% of participants reside in segment 3. For consumers in segment 3, coefficients estimates reveal that the most important attribute by a wide margin is the non-GMO label (μ =2.30; *p*-value <0.01). Other significant attributes were the low carbon footprint label (μ =0.44; *p*-value <0.01) and local production (μ =0.53; *p*-value < 0.01). These positive coefficients indicate that consumers in this segment gain satisfaction from purchasing non-GMO products, having the low carbon footprint label, and if the product was produced locally. Importantly, the price coefficient was not found to be significant; this could indicate that consumers in segment 3 are searching primarily for the non-GMO label and disregarding prices. The demographic characteristics of consumers in this segment are more likely to be white, female, age 34 or lower, and to live in the western part of the country (Table 6). These consumers were found to have the highest WTP for the non-GMO label, with an average premium of $87.81 per lb. (Table 7). Considering the market price of chicken and the prices included in our experiment, this WTP value is unreasonably high. However, given that members of segment 3 are essentially ignoring price changes and attending only to the non-GMO label, the high WTP values are not too surprising.

Conclusion

One purpose of this study was to model the preference heterogeneity of the participants using a latent class market segments analysis. We have discovered that each segment has unique differences in preferences and have identified three unique market segments. Because the focus of our study is on GM labeling and WTP, we will focus our discussion accordingly. Segment 1 represents 39.3% of the sample and individuals in this segment have significant preferences for the attributes of price, non-GMO and contains GM. These participants are more likely to be white, female and older in age. These participants are also more likely to be living in the western

region of the U.S. Our results indicate that consumers in segment 1 are willing to pay a premium for the non-GMO labels and require a discount to consume a chicken product with a GM label. Segment 2 represents 30.3 percent of the sample. Consumers in segment 1 do not have significant preferences for the non-GMO label but do have significant negative preferences for the GM label. Consumers in this segment are more likely to be white, female and middle aged and to reside in the southern part of the nation. These consumers are not willing to pay a premium for the non-GMO label but would still require a discount to purchase chicken products with a GM label. Segment 3 represents 30.4% of the sample and consumers in this segment have significant preferences for the non-GMO label but no significant preference for the GM label. Importantly, the consumers also do not have significant preferences for lower prices. These consumers are more likely to be white, female, younger in age, and to live in the western part of the U.S.

The non-GMO label is associated with large WTP values in segments 1 and 3; however, segment 2 consumers are not willing to pay a premium for the non-GMO label. Segments 1 and 2 also indicate that a discount would be required for them to consume a product labeled as containing GM ingredients. This demonstrates that there may not be a "one size fits all" labeling solution to fit the preferences of all U.S. consumers. Consumers in segments 1 and 3 in our study appear to highly value the voluntary style of non-GMO label and to attach less value to the mandatory GM label.

From a marketing perspective, segment 3 appears, on the surface, to be the ideal target market for agribusiness firms. This segment has the highest WTP values for the non-GMO label at $87.11 per lb. Agribusiness firms might be tempted to target these consumers who live in the western part of the U.S. and tend to be younger consumers. However, consumers in this segment

are essentially ignoring price in our hypothetical experiment. This is a concerning result and agribusiness firms should use caution in placing confidence in the responses from consumers in the segment 3. These consumers appear to be focusing on the non-GMO label without event considering the prices associated with the product. Would this behavior extend to the real-world? We cannot answer this question directly with our study; however, the estimated WTP premium of $87.11 per lb of chicken breast appears to be extremely high and because this WTP value is based on a price coefficient that was not significant, this WTP is also not significant.

The more actionable segment for an agribusiness firm is segment 1. Consumers in this segment have significant WTP premiums for the non-GMO label at $3.11 per lb. This estimate represents a substantial premium over average prices in the market for boneless skinless chicken breast. Although the WTP premium for consumers in segment 1 is much lower than from segment 3, agribusiness firms should be more confident in the results from these consumers because they appear to be considering both the GM labels and the price attached to products in our experiment.

Assuming that segment 1 is the preferred market segment for an agribusiness firm considering labeling products with the non-GMO label, we discuss briefly additional labeling preferences of these consumers to provide a more robust depiction of segment 1 consumers. Individuals in segment 1 indicated in our survey that they are more likely to read food labels; however, they also report being less knowledgeable about the GM content of their food with 58.8% of segment members not being aware or unsure if they have ever eaten food containing GM ingredients (Table 9). Consumers in segment 1 also prefer information about the GM content of their foods on the front of the package (Table 9). Segment 2 also provides valuable marketing information for agribusiness firms. More likely to be southern and middle aged,

consumers in segment 2 also report that they read food labels less frequently, are more knowledgeable about the GM content of their food, and if GM labeling were required, they would be more likely to prefer the information to be on the back of the package as part of the ingredients (Table 9). Segment 2 consumers are not WTP a premium for the non-GMO label but would require a discount to consume boneless skinless chicken breast carrying a GM label.

Our study provides important marketing information to agribusiness firms considering entering the non-GMO market as part of a diversification strategy. However, our study does have important limitations. First, our data set is limited with only 490 participants. With a more robust data set we may be able to identify more market segments and document additional differences between the segments. Second, our study is hypothetical and consumers did not exchange money for real products. As demonstrated by the results from segment 3, one of the problems with a hypothetical study is that individuals may not fully consider price because they are not actually making a purchase. Finally, our sample is not representative of the U.S. population because we focused on the primary grocery shopper in the household. Our results are therefore not generalizable to the U.S. overall.

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Table 1. Choice Experiment Attributes, Coding, Levels and Descriptions

Attributes	Coding	Levels/Descriptions
Price (4)	$2.99	$2.99
	$6.99	$6.99
	$10.99	$10.99
	$14.99	$14.99
	0	No-buy[1]
GM Content (3)	0, 0	No information
	1, 0	Non-GMO verified
	0, 1	Contains GM
	0, 0	No-buy[1]
Carbon Footprint (4)	0, 0, 0	No information
	1, 0, 0	79 oz CO2e/lb (low)
	0, 1, 0	90 oz CO2e/lb (medium)
	0, 0, 1	112 oz CO2e/lb (high)
	0, 0, 0	No-buy
Local (2)	0	No information
	1	Local production
	0	No-buy[1]

[1] No-buy option is an alternate specific constant rather than an attribute level

Table 2. Sample Characteristics, Counts and Percentages

Characteristic	Sample Statistics	
Gender	Count	Percent
Male	160	31.5%
Female	348	68.5%
Age group	Count	Percent
18–24 years	27	5.3%
25–34 years	121	23.8%
35–44 years	94	18.5%
45–54 years	76	15.0%
55–64 years	88	17.3%
65 years or older	102	20.1%
Education Level	Count	Percent
Some Grade School	0	0.0%
Some High School	9	1.8%
High School Diploma	159	31.3%
Associates Degree (2-year degree)	110	21.7%
Bachelors Degree (4-year degree)	157	30.9%
Masters Degree	58	11.4%
Doctoral Degree	15	3.0%
Income	Count	Percent
Under $20,000	60	11.8%
20,000-39,999	115	22.6%
40,000-59,999	107	21.1%
60,000-79,999	76	15.0%
80,000-99,999	67	13.2%
100,000-119,999	30	5.9%
120,000-139,999	19	3.7%
140,000-159,999	16	3.1%
160,000 and above	18	3.5%
Region	Count	Percent
Northeast	126	24.8%
Midwest	126	24.8%
South	128	25.2%
West	128	25.2%
Race	Count	Percent
American Indian or Alaska Native	6	1.2%
Asian	22	4.3%
Black or African American	43	8.5%
Native Hawaiian or Other Pacific Islander	0	0.0%
White	420	82.7%
Mixed	9	1.8%
no response	8	1.6%
Hispanic	Count	Percent
Hispanic or Latino	40	7.9%
Not Hispanic or Latino	468	92.1%

Note: The sample size used is made up of the primary household grocery shoppers for individual households

Table 3. Model Fit Statistics

Number of segments	Number of parameters	Log likelihood (LL)	BIC	BIC/N	AIC	AIC/N	AIC3	AIC3/N
1	8	-3869.12	7804.44	1.99	7754.25	1.98	7762.25	1.98
2	17	-3340.47	6821.59	1.74	6714.93	1.71	6731.93	1.72
3	26	-2959.01	6133.14	1.56	5970.02	1.52	5996.02	1.53
4	35	-2862.87	6015.33	1.53	5795.75	1.48	5830.75	1.49

Note: The sample size is 3920 choices from 490 consumers (N). Equations: BIC (Bayesian information criterion) as $-LL + (P/2) * \ln(N)$;

Table 4. Multinomial Logit (MNL) Model Results (One-Class Solution,

Variables	Coeff.	Estimate	Standard Errors	*p* -values
PRICE	μ	-0.22 ***	0.01	0.00
NON-GM (NG)	μ	1.06 ***	0.07	0.00
GM (GM)	μ	-0.29 ***	0.06	0.00
LOWCO2 (LO)	μ	0.17 **	0.07	0.01
MEDIUMCO2 (MD)	μ	0.08	0.07	0.22
HIGHCO2 (HI)	μ	0.07	0.06	0.28
LOCAL (LC)	μ	0.32 ***	0.04	0.00
No-buy (NONE)	μ	-1.77 ***	0.08	0.00
N. parameters		8		
Log likelihood		-3869		
BIC		7804		
BIC/N		1.99		
AIC		7754		
AIC/N		1.98		
AIC3		7762		
AIC3/N		1.98		

***, **, * Significance at 1%, 5%, 10% level

Table 5. Three-Segment Latent Class Model (LCM) Results

Variables	Coeff.	Estimate	Standard Errors	*p* -values
Random Utility Parameters in Latent Class 1				
PRICE	μ	-0.54 ***	0.03	0.00
NON-GM (NG)	μ	1.67 ***	0.21	0.00
GM (GM)	μ	-0.57 ***	0.14	0.00
LOWCO2 (LO)	μ	0.34 *	0.19	0.07
MEDIUMCO2 (MD)	μ	0.28 *	0.15	0.06
HIGHCO2 (HI)	μ	0.09	0.16	0.56
LOCAL (LC)	μ	0.44 ***	0.12	0.00
No-buy (NONE)	μ	2.36 ***	0.18	0.00
Random Utility Parameters in Latent Class 2				
PRICE	μ	-0.32 ***	0.00	0.00
NON-GM (NG)	μ	-0.01	0.17	0.95
GM (GM)	μ	-0.24 **	0.11	0.03
LOWCO2 (LO)	μ	-0.01	0.16	0.97
MEDIUMCO2 (MD)	μ	0.20	0.14	0.16
HIGHCO2 (HI)	μ	0.26 *	0.15	0.08
LOCAL (LC)	μ	0.26 ***	0.10	0.01
No-buy (NONE)	μ	5.09 ***	0.29	0.00
Random Utility Parameters in Latent Class 3				
PRICE	μ	-0.03	0.02	0.15
NON-GM (NG)	μ	2.30 ***	0.18	0.00
GM (GM)	μ	-0.19	0.12	0.11
LOWCO2 (LO)	μ	0.44 ***	0.15	0.00
MEDIUMCO2 (MD)	μ	0.15	0.15	0.32
HIGHCO2 (HI)	μ	-0.03	0.15	0.85
LOCAL (LC)	μ	0.53 ***	0.11	0.00
No-buy (NONE)	μ	-0.08	0.21	0.69
Estimated latent class probabilities				
Class 1	prob.	0.39 ***		
Class 2	prob.	0.30 ***		
Class 3	prob.	0.30 ***		
N. parameters		26		
Log likelihood		-2959		
BIC		6133		
BIC/N		1.56		
AIC		5970		
AIC/N		1.52		
AIC3		5996		
AIC3/N		1.53		

***, **, * Significance at 1%, 5%, 10% level

Table 6. Attributes and Characterisitcs for Segments

Segment	**1**		**2**		**3**	
Class Prob	39.3%		30.3%		30.4%	
Price	-0.53582	***	-0.31843	***	-0.02617	
NG	1.66802	***	-0.01077		2.29788	***
GM	-0.57106	***	-0.24299	***	-0.18771	
LO	0.34057	*	-0.00609		0.44479	***
MD	0.28443	*	0.20014		0.14779	
HI	9230		0.26458	*	-0.0277	
LC	0.4407	***	0.2649	***	0.52753	***
NONE	-2.35622	***	-5.09494	***	-0.08368	
	Count	Percent	Count	Percent	Count	Percent
Female***	**149**	**77.3%**	85	57.1%	100	67.0%
Age34***	29	15.0%	50	33.6%	**67**	**44.9%**
Age35	56	29.0%	60	40.3%	49	32.8%
Age55***	**107**	**55.5%**	39	26.2%	33	22.1%
Income1	107	55.5%	80	53.8%	82	54.9%
Income2	67	34.7%	57	38.3%	46	30.8%
Income3	18	9.3%	12	8.1%	**21**	**14.1%**
Rural	41	21.3%	33	22.2%	40	26.8%
Education1	67	34.7%	49	32.9%	46	30.8%
Education2	101	52.4%	74	49.7%	82	54.9%
Education3	24	12.4%	**26**	**17.5%**	21	14.1%
Region1	49	25.4%	39	26.2%	37	24.8%
Region2	49	25.4%	33	22.2%	33	22.1%
Region3	42	21.8%	**44**	**29.6%**	39	26.1%
Region4	**52**	**27.0%**	29	19.5%	**40**	**26.8%**
Cliv	36	18.7%	33	22.2%	42	28.1%
White***	169	87.6%	124	83.3%	**112**	**75.0%**
Not Rural	151	78.3%	116	78.0%	109	73.0%
N	491		491		491	
Segment N	193		149		149	

note: Female is anyone not male, Age34 is any age 34 or below, Age35 is anyone between the ages of 35 and 54, Age55 is anyone 55 and older, Income1 is annual income of 59,999 and below, Income2 is annual household income between 60,000 and 119,999, Income3 is annual household income of 120,000 and above, Rural is anyone who lives in a rural area, Education1 is a high school diploma or below, Education2 is between an associates and bachelors degree, Education3 is masters degree and above, Region 1 is the northeast, Region2 is the midwest, Region3 is the south, Region 4 is the west, Cliv is any children living at home, White is anyone of the white race, and Not Rural is anyone is does not live in a rural area (e.g. suburban and urban).

Table 7. Willingness to Pay for Non-GMO (Voluntary) and GM (Mandatory) Labels on Chicken Products

	Non-GMO	GM
MNL	4.86	-1.32
Segment 1	3.11	-1.07
Segment 2	-0.03	-0.76
Segment 3	87.81	-7.17

note: These are dollar values in price for pound premiums for boneless skinless chicken breast.

Table 8. Four-Segment Latent Class Model (LCM) Results

Variables	Coeff.	Estimate	Standard Errors	*p* -values
Random Utility Parameters in Latent Class 1				
PRICE	μ	-0.65 ***	0.42	0.00
NON-GM (NG)	μ	0.26	0.34	0.45
GM (GM)	μ	0.82 ***	0.17	0.00
LOWCO2 (LO)	μ	0.58 **	0.27	0.03
MEDIUMCO2 (MD)	μ	0.26	0.21	0.21
HIGHCO2 (HI)	μ	0.29	0.23	0.21
LOCAL (LC)	μ	0.52 ***	0.17	0.00
No-buy (NONE)	μ	-3.72 ***	0.00	0.00
Random Utility Parameters in Latent Class 2				
PRICE	μ	-0.72 ***	0.10	0.00
NON-GM (NG)	μ	-1.56 *	0.80	0.05
GM (GM)	μ	-0.20	0.43	0.64
LOWCO2 (LO)	μ	-1.24 **	0.56	0.03
MEDIUMCO2 (MD)	μ	-0.21	0.53	0.69
HIGHCO2 (HI)	μ	-1.21 **	0.58	0.04
LOCAL (LC)	μ	-0.69	0.43	0.11
No-buy (NONE)	μ	-11.82 ***	1.45	0.00
Random Utility Parameters in Latent Class 3				
PRICE	μ	-0.07 ***	0.02	0.00
NON-GM (NG)	μ	0.96 ***	0.14	0.00
GM (GM)	μ	-0.29 ***	0.09	0.00
LOWCO2 (LO)	μ	0.20 *	0.11	0.07
MEDIUMCO2 (MD)	μ	0.20 *	0.11	0.07
HIGHCO2 (HI)	μ	0.08	0.11	0.43
LOCAL (LC)	μ	0.35 ***	0.07	0.00
No-buy (NONE)	μ	-2.45 ***	0.23	0.00
Random Utility Parameters in Latent Class 4				
PRICE	μ	-0.18 ***	0.03	0.00
NON-GM (NGE)	μ	3.18 ***	0.26	0.00
GM (GME)	μ	-0.58 **	0.29	0.04
LOWCO2 (LOE)	μ	0.11	0.21	0.58
MEDIUMCO2 (MDE)	μ	-0.57 **	0.22	0.01
HIGHCO2 (HIE)	μ	-0.32	0.20	0.11
LOCAL (LCE)	μ	0.43 ***	0.15	0.00
No-buy (NONE)	μ	0.66 **	0.26	0.01
Estimated latent class probabilities				
Class 1	prob.	0.31 ***		
Class 2	prob.	0.16 ***		
Class 3	prob.	0.32 ***		
Class 4	prob.	0.22 ***		
N. parameters	35			
Log likelihood	-2862.87			
BIC	6015.33			
BIC/N	1.535			
AIC	5795.75			
AIC/N	1.479			
AIC3	5830.7			
AIC3/N	1.48744			

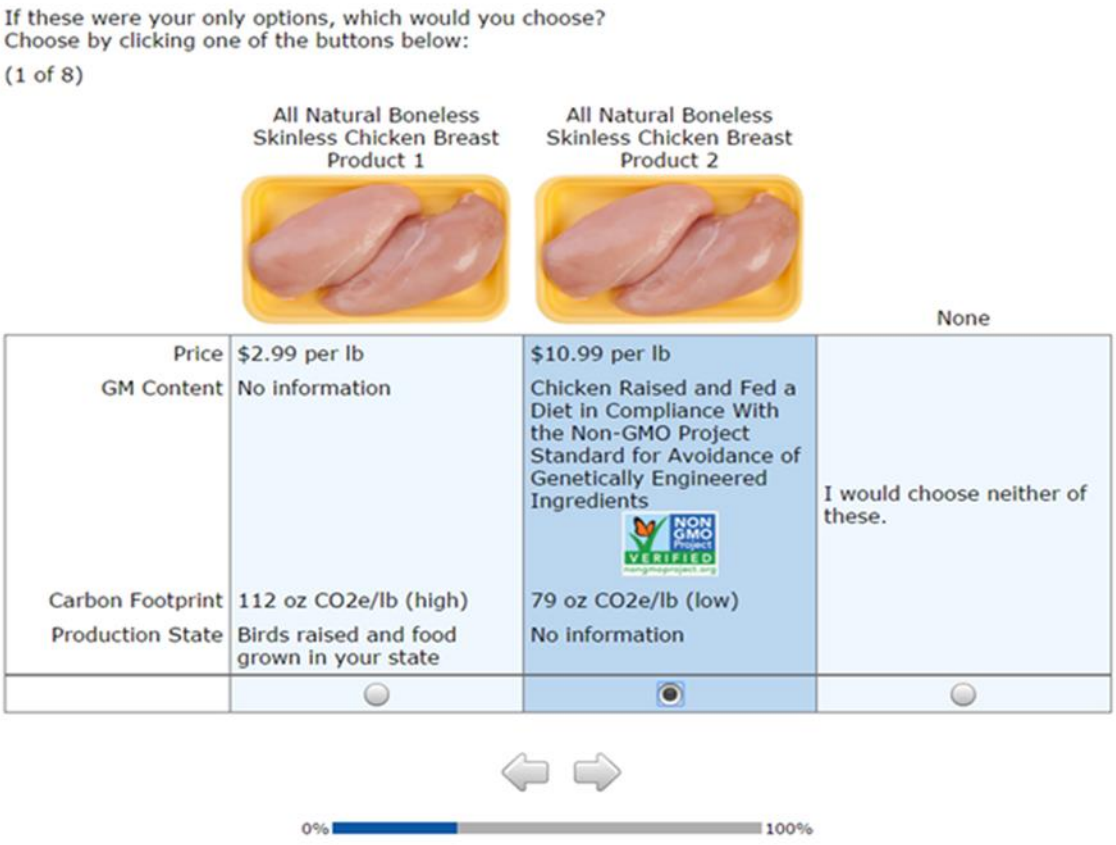
***, **, * Significance at 1%, 5%, 10% level

Table 9: Food Label Information Survey Responses

Segment	**1**		**2**		**3**		
Class Prob	39.3%		30.3%		30.4%		
Beyond looking at brand name, how often do you read food labels							
	Count	Percent	Count	Percent	Count	Percent	Test Statistic
Never	1	0.5%	2	1.3%	0	0.0%	
Rarely	21	10.9%	21	14.1%	8	5.4%	
Sometimes	57	29.7%	51	34.2%	31	20.8%	
Frequently	78	40.6%	58	38.9%	67	45.0%	$\chi 2$: 25.510
Always	35	18.2%	17	11.4%	43	28.9%	*p* -value: 0.001
Have you ever eaten any food containing genetically modified ingredients?							
	Count	Percent	Count	Percent	Count	Percent	Test Statistic
Yes	79	41.1%	76	51.0%	82	55.0%	
No	11	5.7%	13	8.7%	22	14.8%	$\chi 2$: 21.684
I am not sure	102	53.1%	60	40.3%	45	30.2%	*p* -value: 0.000
If genetically modified ingredients were requied to be labeld, where do you feel the best place to display these ingredients on a food product label							
	Count	Percent	Count	Percent	Count	Percent	Test Statistic
Back part of the ingredients	30	15.6%	38	25.5%	26	17.4%	
Back separate from ingredients	30	15.6%	30	20.1%	15	10.1%	
On the front of the package	83	43.2%	65	43.6%	64	43.0%	$\chi 2$: 22.915
On the front displayed as a warning	49	25.5%	16	10.7%	44	29.5%	*p* -value: 0.001

Note: $\chi 2$ test statistics compare differences between all three segments.

Figure 1.


If these were your only options, which would you choose?
Choose by clicking one of the buttons below:
(1 of 8)
All Natural Boneless Skinless Chicken Breast Product 1
All Natural Boneless Skinless Chicken Breast Product 2
None
Price
$2.99 per lb
$10.99 per lb
GM Content
No information
Chicken Raised and Fed a Diet in Compliance With the Non-GMO Project Standard for Avoidance of Genetically Engineered Ingredients
I would choose neither of these.
Carbon Footprint
112 oz CO2e/lb (high)
79 oz CO2e/lb (low)
Production State
Birds raised and food grown in your state
No information
0%
100%

Appendix

Survey Instrument

IMPLIED CONSENT INFORMATION

[Participants will be given this information as well as a link to the survey.]

Dear Consumer,

This research is being conducted by researchers at the University of Arkansas. The purpose of this survey is to better understand how you make decisions on purchasing food products and what types of food labels you prefer. There are no anticipated risks to participating. The survey should take 20 minutes to complete. Your participation is completely voluntary. Your responses will be recorded anonymously and no identifying personal information will be collected on the survey. Responses will be aggregated for presentation.

The survey has three parts. The first part is a choice experiment where you will be asked to make choices between different sets of products. The second part is a series of questions to help us better understand your purchasing decisions in the choice experiment and your preferences for different approaches to labeling food. The third part is a short series of demographic questions. You are free to refuse to participate in the research and to stop completing the survey at any time.

If you have any questions about this survey itself, please contact Nathan Kemper by email or phone at nkemper@uark.edu or 479-575-2697. You may also contact the University of Arkansas Research Compliance office listed below if you have questions about your rights as a participant, or to discuss any concerns about, or problems with the research: Iroshi (Ro) Windwalker, CIP, IRB/RSC Coordinator Research Compliance, 109 MLKG Building, Fayetteville, AR 72701, Ph. 479.575.2208, Fax 479.575.6527

Sincerely,

Nathan Kemper

IRB #15-10-192
Approved: 10/19/2015
Expires: 10/18/2016

Part 1. Choice Experiment

[*Participants will first be presented with a set of instructions that are common across all surveys*]

Instructions:

The United States does not follow a mandatory approach to the labeling of genetically modified food. Therefore, food producers are not required to label the genetically modified content of their food. As a result, under our current voluntary system the foods that typically carry a label are those carrying a non-genetically modified label. In the choice experiment portion of this survey, you will be asked to choose between food products that may or may not carry label statements regarding the genetically modified content of the food. Please consider all information provided for each product before making each purchase decision. Thank you.

Label Terms Defined:

Genetically Modified Organism (GMO): in this survey, genetic modification (GM) refers to the production of heritable improvements in organisms for specific uses via genetic engineering (GE) and a genetically modified organism (GMO) is a plant produced through GM. The GM information on the labels in this survey refer only to the ingredients in the diet fed to the chickens.

The Non-GMO Project: a non-profit organization committed to preserving and building the non-GMO food supply, educating consumers, and providing verified non-GMO choices. Poultry carrying a Non-GMO Project Verified label indicates the bird was raised on a diet containing non-GMO feed.

Carbon Footprint: the total amount of Greenhouse Gas Emissions associated with a product, along its supply chain, including emissions from consumption, end-of-life recovery and disposal. Expressed in ounces (oz) of carbon dioxide equivalent (CO_2e) per pound (lb) of meat.

Production State: the production location refers to BOTH the production of the feed AND the location of where the birds were raised.

Screening Questions

1. In my household…
   _____I am solely responsible for making all grocery purchasing decisions *[proceed]*
   _____I have shared responsibility for making grocery purchasing decisions *[proceed]*
   _____I do not have any responsibility for making grocery purchasing decisions *[discontinue]*

2. How many times have you purchased *chicken breast meat* in the past 12 months?
   _____0 *[discontinue]* _____1-6 *[proceed]*
   _____7-12 *[proceed]* _____13 or more *[proceed]*

Part 2. Survey

1. Perceived Consequentiality

1. To what extent do you believe that answers from this survey will be taken into consideration by decision makers such as producers, manufacturers, retailers, and/or policy makers?

   Not taken into account (1) (2) (3) (4) (5) Definitely taken into account

2. To what extent do you believe that answers from this survey will be taken into consideration by decision makers who bring food products to market?

   Not taken into account (1) (2) (3) (4) (5) Definitely taken into account

3. To what extent do you believe that answers from this survey will be taken into consideration by decision makers in a way that can change the price of food (thus impacting your budget)?

   Not taken into account (1) (2) (3) (4) (5) Definitely taken into account

2. Risk Preferences

4. How do you see yourself: are you generally a person who is willing to take risks or do you try to avoid taking risks? Please select a number on the scale, where the value 0 means: 'not at all willing to take risks' and the value 10 means: 'very willing to take risks'.

Not at all willing to take risks — Very willing to take risks

0	1	2	3	4	5	6	7	8	9	10

5. People can behave differently while engaged in different activities. How would you rate your willingness to take risks while engaged in the following activities? Please select a number on the scale, where the value 0 means: 'not at all willing to take risks' and the value 10 means: 'very willing to take risks'.

	Not at all willing to take risks										Very willing to take risks
How willing are you to take risks...	0	1	2	3	4	5	6	7	8	9	10
…while driving?											
…when making investments?											
…in recreation and sports?											
…concerning your career?											
…with your health?											
…with the food you eat?											

3. Preferences for GM Labeling Programs

The United States uses a voluntary approach to the labeling of genetically modified food. Foods that are labeled under the current voluntary approach are products displaying a non-genetically modified statement and/or label certified by a third-party agent. Some argue that the United States Department of Agriculture should play a more active role in the voluntary approach by setting national standards for the certification of genetically modified (non-bioengineered) food.

6. Do you agree or disagree that the current voluntary approach with third-party certification should be left as is and NOT be changed?
   _____Strongly Disagree (1)
   _____Disagree (2)
   _____Neither Agree nor Disagree (3)
   _____Agree (4)
   _____Strongly Agree (5)

7. Do you agree or disagree that the USDA should become more involved in the voluntary approach by developing a national certification program?
   _____Strongly Disagree (1)
   _____Disagree (2)
   _____Neither Agree nor Disagree (3)
   _____Agree (4)
   _____Strongly Agree (5)

Some citizens in the United States argue that the federal government should adopt a mandatory labeling approach that requires labels on any food containing genetically modified ingredients.

8. Do you agree or disagree that the federal government should require mandatory labeling?
   _____Strongly Disagree (1)
   _____Disagree (2)
   _____Neither Agree nor Disagree (3)
   _____Agree (4)
   _____Strongly Agree (5)

9. Do you agree or disagree that taxpayers should pay for the cost of a federal mandatory labeling program?
   _____Strongly Disagree (1)
   _____Disagree (2)
   _____Neither Agree nor Disagree (3)
   _____Agree (4)
   _____Strongly Agree (5)

10. How would you rate your trust in the different sources of label certification for food products?

	Very Untrustworthy (1)	Untrustworthy (2)	Neutral (3)	Trustworthy (4)	Very Trustworthy (5)
Private Company					
Independent Third Party (non-governmental)					
Government – Local or State					
Government – National					

4. Food Label Information

11. Beyond looking at the brand name, how often do you read food labels?
    _____Never (1)
    _____Rarely (2)
    _____Sometimes (3)
    _____Frequently (4)
    _____Always (5)

12. As far as you know, have you ever eaten any food containing genetically modified ingredients?
    _____Yes
    _____No
    _____I am not sure

13. Do you agree or disagree that labelling the genetically modified ingredients in food should be required?
    _____Yes
    _____No

14. If genetically modified ingredients were required to be labeled, where do you feel is the best place to display these ingredients on a food product label?
    _____On the back of the package in the list of ingredients (1)
    _____On the back of the package separate from the ingredients (2)
    _____On the front of the package (3)
    _____On the front of package prominently displayed as a warning (4)

15. Different institutions publish research or report information on the advantages and disadvantages of genetically modified food. How trustworthy are each of the following sources?

	Very Untrustworthy (1)	Untrustworthy (2)	Neutral (3)	Trustworthy (4)	Very Trustworthy (5)
Government					
Private Sector					
University					
Nonprofit Consumer Advocacy Group					
Food Manufacturer					
Media					

5. Cultural and Political Views

People in our society often disagree about how far to let individuals go in making decisions for themselves. How strongly do you agree or disagree with the following two statements?

16. Sometimes government needs to make laws that keep people from hurting themselves.
    _____Strongly Disagree (1)
    _____Disagree (2)
    _____Neither Agree nor Disagree (3)
    _____Agree (4)
    _____Strongly Agree (5)

17. The government should stop telling people how to live their lives.
    _____Strongly Disagree (1)
    _____Disagree (2)
    _____Neither Agree nor Disagree (3)
    _____Agree (4)
    _____Strongly Agree (5)

People in our society often disagree about issues of equality and discrimination. How strongly do you agree or disagree with the following two statements?

18. We have gone too far in pushing equal rights in this country.
    _____Strongly Disagree (1)
    _____Disagree (2)
    _____Neither Agree nor Disagree (3)
    _____Agree (4)
    _____Strongly Agree (5)

19. Our society would be better off if the distribution of wealth was more equal.
    _____Strongly Disagree (1)
    _____Disagree (2)
    _____Neither Agree nor Disagree (3)
    _____Agree (4)
    _____Strongly Agree (5)

20. How would you describe your political views on social issues?
    _____Very liberal
    _____Liberal
    _____Moderate
    _____Conservative
    _____Very Conservative
    _____none of these

21. How would you describe your political views on fiscal issues?
    _____Very liberal
    _____Liberal
    _____Moderate
    _____Conservative
    _____Very Conservative
    _____none of these

6. Demographic Information

22. In what state do you currently live?
    _____state [*drop down list*]

23. How would you describe your home environment?
    _____Rural
    _____Suburban
    _____Urban

24. What is your age?
    [census age categories]

25. What is your gender?
    _____Male
    _____Female

26. Do you live alone or with others?
    _____Live alone
    _____Live with others

    [Skip Logic: if live alone, skip next question]

27. How many people in your household are in the following age categories?
    _____Adults and children age 15 and older
    _____Children age 7 to 14 years old
    _____Children 6 years old and younger

28. What is your highest level of education? (check one):
    _____Some High School
    _____High School Diploma
    _____Associate's Degree (2-year degree)
    _____Bachelor's Degree (4-year degree)
    _____Master's Degree
    _____Doctoral Degree

29. What is your race?
    [census race/ethnicity]

30. What is your total net (after tax) household income?
    [census income categories]