Consumers' Willingness to Pay for Genetically Engineered Edamame

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Introduction

- Edamame is a soybean vegetable that is harvested near the end of the pod filling stage (Fig. 1). It is popular in Asia and is experiencing increasing demand in the United States.
- Created in 2012, American Vegetable Soybean and Edamame Inc. is the first processing plant in the United States to commercially produce "made in the U.S." edamame.
- Located in Mulberry, Arkansas, a town of 1,655 people, edamame is sourced from the nearby Arkansas River Valley and the company was supported by an economic development loan.
- All edamame produced is Non-GMO.
- Discussion about GM food labeling legislation are ongoing.
- Dr. Pengyin Chen, soybean breeder at the University of Arkansas, faces difficulties when developing new varieties as approval of herbicides for use on edamame is a new EPA hurdle.
- Genetically engineered edamame is expected to cost less to produce because the beans will have higher yields and cheaper production cost.

Objectives

- Does genetically engineered edamame taste different than Non-GMO edamame?
- How does a consumer's willingness to pay for edamame change when labeled as:
  - "Genetically Engineered" (**GM+**)
  - "Non-GMO" (**GM-**)
  - "Unlabeled" (**NoLabel**)
- How do different demographic factors influence willingness to pay for edamame? Are these effects statistically significant?
  - Income, gender, age, household size, frequency of consumption, education, knowledge and opinion about GM foods

Methods

- GM+ and GM- soybeans grown at the Arkansas Agricultural Research and Extension Center in Fayetteville, AR were harvested, blanched, packaged and labeled near the end of the pod filling stage of soybean growth.
- Participants were randomly recruited from a database of paid volunteers (Table 1). In total, 117 people participated in a taste test of GM+ and GM- edamame followed by a non-hypothetical auction.
- A random N^{th} price auction was used to determine willingness to pay for three 8 oz. frozen edamame products (GM+, GM- and NoLabel as shown in Fig. 1).
- Before the auction, a practice candy bar auction and quiz was used to clarify the auction procedures. It is important that participants understand the procedure and provide accurate results.
- Participants also answered questions about their typical level of edamame consumption, their opinions (Table 2) and knowledge (Table 3) about genetically engineered food.
- A random effects TOBIT model was designed to test for statistical significance of factors and estimate marginal effects of individual factors. Three model specifications were compared across frequency of consumption.

Table 1. Demographic and other information with response frequencies of the participants.

Age		Quarterly Consumption		Opinion Score	
Min. 25 Avg. 38.6 Max. 54		Less than 10 servings	57%	1.33	1%
		More than 10 servings	43%	1.67	5%
Education		**Monthly Income**		1.83	3%
Less than Bachelor's	50%	Less than $2,999	39%	2.00	4%
Bachelor's Degree	25%	$3,000-$5,999	42%	2.17	12%
Graduate Degree	25%	More than $6,000	19%	2.33	11%
Children		**Gender**		2.50	15%
None	50%	Male	25%	2.67	9%
More than 0	50%	Female	75%	2.83	16%
Number in Household		**Knowledge Rating**		3.00	9%
1	21%	0	8%	3.17	8%
2	25%	1	16%	3.33	3%
3	19%	2	36%	3.50	2%
4	25%	3	21%	3.67	1%
5	9%	4	19%	4.00	1%
7	1%				

Figure 1. Edamame at various stages of processing at the Arkansas Research and Extension Center in Fayetteville, AR.

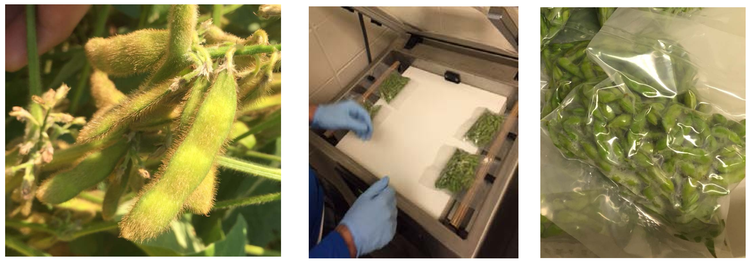

Figure 2. Empirical mean willingness to pay per 8oz. package of edamame for various demographics comparing the three products auctioned.

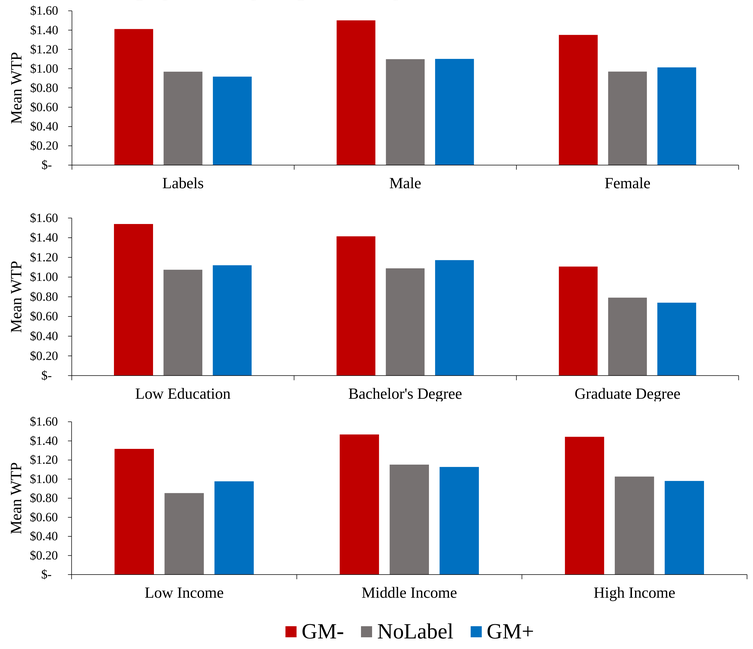

Table 2. Questions used to form opinion variable towards GM technology

Question	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
Genetically engineered food such as Roundup Ready® Soybeans present no danger for future generations.	o 1	• 2	o 3	o 4
I think it is safe for me to eat genetically engineered food.	o 1	o 2	• 3	o 4
Physical harm to mankind is bound to happen as a result of genetically engineered foods.	o 4	o 3	• 2	o 1
Growing genetically engineered crops will be harmful to the environment.	• 4	o 3	o 2	o 1
There are benefits to developing genetically engineered foods such as higher yields and a more sustainable food source.	o 1	o 2	• 3	o 4
Small-scale farmers are negatively impacted by the development of genetically engineered foods as the cost of seed will be higher.	o 4	o 3	o 2	• 1
Opinion Score (1 = GM+ favorable, 4 = unfavorable)		(2+3+2+4+3+1)/6 = **2.5**		

Table 3. Questions used to form knowledge variable towards GM technology

Question	True	False	Not Sure
Planting RoundUp Ready® soybean allows farms to grow soybean and spray RoundUp® herbicide to control weeds without killing soybean.	• 1	o 0	o 0
Some soybean oil sold in the U.S. is derived from Roundup Ready® soybean.	• 1	o 0	o 0
In addition to Roundup Ready® soybean, other genetically engineered crops are currently grown in the U.S..	• 1	o 0	o 0
Chemicals in RoundUp® herbicide remain effective for weed control in the soil forever.	o 0	• 1	o 0
Knowledge Rating (0 = No Correct, 4 = All Correct)		(1+1+1+1) = **4**	

Figure 3. Hedonic means comparing GM+ and GM- during taste test

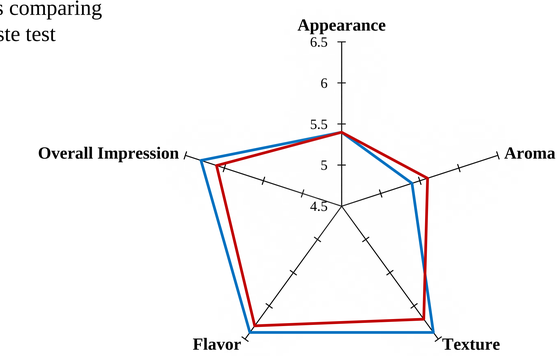

Table 4. Average marginal effects of the random effects TOBIT model with frequency of quarterly consumption subgroups.

	General (117 obs)		High Consumption (50 obs)		Low Consumption (67 obs)	
Variables	ME (dy/dx)	P-value	ME (dy/dx)	P-value	ME (dy/dx)	P-value
GM-	0.427	0.000***	0.442	0.000***	0.428	0.000***
GM+	0.003	0.962	-0.165	0.107*	0.119	0.162
Female	-0.030	0.892	-0.069	0.831	0.039	0.885
Age	-0.005	0.701	-0.008	0.702	0.006	0.659
Bachelor's Degree	0.004	0.988	-0.588	0.085**	0.589	0.112*
Graduate Degree	-0.213	0.371	-0.422	0.290	-0.161	0.566
$3,000-$5,999	0.218	0.341	0.683	0.035***	-0.090	0.749
More than $6,000	0.064	0.823	0.824	0.029***	-0.631	0.047***
Knowledge Rating (0-4)	0.043	0.596	-0.178	0.159	0.187	0.073**
Opinion Score (1 – 4)	-0.177	0.379	0.049	0.872	-0.117	0.664
# of people	-0.173	0.101*	-0.406	0.012***	0.005	0.971
Children	0.307	0.249	0.816	0.071**	-0.017	0.954
Over 10 servings	0.329	0.103*	Yes		No	

Results

- Respondents are generally willing to pay significantly more for GM- product than the NoLabel product (at least 42 cents based on marginal effects). This finding is also evident for both low and high frequency consumption respondents (Table 4) .
- WTP values for NoLabel and GM+ products are not significantly different.
- GM+ and GM- were not significantly different in the taste test. The products had very similar results with seven people choosing GM+ over the GM- (51 vs 44) (Fig. 3).
- High frequency consumption respondents tend to bid higher than low frequency consumption respondents but both groups equally value the GM- product significantly higher than NoLabel and GM+ products.

Discussion

- The results imply that in the presence of GM- labeled product, a NoLabel product would be valued similarly as a GM+ labeled product.
- This finding has significant implications for GM labeling policy since presence of credible labeling of GM- products would generally mean that a NoLabel or GM+ product counterpart would be significantly discounted in the market.
- Future work on this project will determine what type of information (positive or negative) about genetically engineered edamame will influence consumers' WTP for GM and Non-GM products.
- With estimated discounts for GM+ products, yield improvement with GM+ edamame and likely to a lesser extent, cost savings in comparison to GM- edamame, will need to be significant to justify GM+ edamame breeding efforts.