Explore Food Product Preferences with Choice-based Conjoint Analysis

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Background

As noted in the popular press, government policies on labeling food products as "genetically modified" is a controversial topic. Little is understood in terms of consumer behavior with regard to such labels. To help understand consumer behavior in this space, we have collected choice-based conjoint data on consumer preferences. The attributes and levels for the study are as follows:

	Type	Production Method	Price per Pound
Level 1	Tuna	Wild	$13.99
Level 2	Halibut	Farm Raised	$16.99
Level 3	Salmon	Farm Raised/Genetically Modified	$19.99

Raw Data

A fractional factorial design was used to develop 9 profiles to be evaluated by consumers. Consumers offered a binary yes/no decision to the question of whether would they buy each profile. A sample of 109 consumers completed the study.

	A	B	C	D	E	F	G	H	I	J
1	id	task	buy	tuna	halibut	salmon	wild	farm	farm_gmo	price (in $10's)
2	1	1	1	1	0	0	0	1	0	1.999
3	1	2	1	0	1	0	0	0	1	1.399
4	1	3	1	0	1	0	1	0	0	1.999
5	1	4	0	0	0	1	1	0	0	1.699
6	1	5	0	0	0	1	0	0	1	1.999
7	1	6	1	1	0	0	1	0	0	1.399
8	1	7	0	0	0	1	0	1	0	1.399
9	1	8	1	1	0	0	0	0	1	1.699
10	1	9	1	0	1	0	0	1	0	1.699

Raw Data

id	respondent id
task	task index (9 tasks per respondent)
buy	purchase index (1 is would buy, 0 is would not buy)
tuna, halibut, salmon	dummy code for product type
wild, farm, farm_gmo	dummy code for production method
price	price in tens of dollars

Modeling

Binary Logit Model

- The Utilty of Buying (buy=Yes=1):

uY=a+b1*tuna+b2*halibut+c1*wild+c2*farm+d*Price

- The Utilty of Not Buy (buy=No=0):

uN=0

**here I treat "salmon" as the baseline type and "farm-raised/genetically modified" as the baseline production method.*

Modeling

buy*Prob(Y)+(1-buy)*Prob(N)

id	task	tuna	halibut	wild	farm	price (in $10's)	buy	uY	uN	EXP(uY)	EXP(uN)	Prob(Y)	Prob(N)	Likelihood	Log-Likelihood
1	1	1	0	0	1	1.999	1	-1.7581465	0	0.172364	1	0.147023	0.852977	0.1470226	-1.917168736
1	2	0	1	0	0	1.399	1	-2.2897151	0	0.101295	1	0.091978	0.908022	0.0919783	-2.38620215
1	3	0	1	1	0	1.999	1	-0.623853	0	0.535876	1	0.348906	0.651094	0.3489056	-1.052953749
1	4	0	0	1	0	1.699	0	0.1236855	0	1.13166	1	0.530882	0.469118	0.469118	-0.756900958
1	5	0	0	0	0	1.999	0	-2.3955346	0	0.091124	1	0.083514	0.916486	0.9164862	-0.087208309
1	6	1	0	1	0	1.399	1	0.0956007	0	1.10032	1	0.523882	0.476118	0.523882	-0.646488829
1	7	0	0	0	1	1.399	0	-0.8767037	0	0.416152	1	0.293861	0.706139	0.7061387	-0.347943638
1	8	1	0	0	0	1.699	1	-2.4236194	0	0.0886	1	0.081389	0.918611	0.0813892	-2.508512194
1	9	0	1	0	1	1.699	1	-1.6242422	0	0.197061	1	0.164621	0.835379	0.1646207	-1.804111523

Log(likelihood)

For Respondent 1, his/her answers to 9 tasks:

Calculate utility using the model set before

setting random values to model parameters to start

exp(utility)

$$\frac{\exp(uY/N)}{\exp(uY) + \exp(uN)}$$

Modeling

- sum up to get a total log-likelihood
- Use Solver to maximize total log-likelihood

uY=-0.5001-0.3125*tuna-0.4631*halibut
+2.2348*wild+0.9499*farm-0.9482*Price

Attribute Importance

Attribute	Max Utility	Min Utility	Difference	% Importance
Type	0	-0.4631	0.4631	14.18%
Production Method	2.2348	0	2.2348	68.41%
Price	-1.3265	-1.8954	0.5689	17.41%

From the results, it seems that consumers value more on production methods more compared to product type and price.

Dollar-metric Valuation

$$uY=-0.5001-0.3125*\text{tuna}-0.4631*\text{halibut}+2.2348*\text{wild}+0.9499*\text{farm}-0.9482*\text{Price}$$

The price coefficient is **-0.9482,** which means one unit (tens of dollars) of the price will lead to a 0.9482 unit decrease in utility.

Holding the production method constant:
shifting from **salmon to tuna**, the change in utility is -0.3125;
shifting from **salmon to halibut**, the change in utility is -0.4631

dollar value of tuna to salmon	**(-0.3125/-0.9482)*10=3.2962**
dollar value of halibut to salmon	**(-0.4631/-0.9482)*10=4.884**

Similarly, we could calculate the dollar value of production method changes holding type constant.

Market Share Analysis

Assume the following market with four products and a “None” option:

Product	Type	Method	Price
1	Tuna	Wild	$19.99
2	Halibut	Wild	$18.99
3	Salmon	Wild	$15.99
4	Salmon	Farm	$13.99
None	---	---	---

I'll then use the logit model to predict market share for these products.

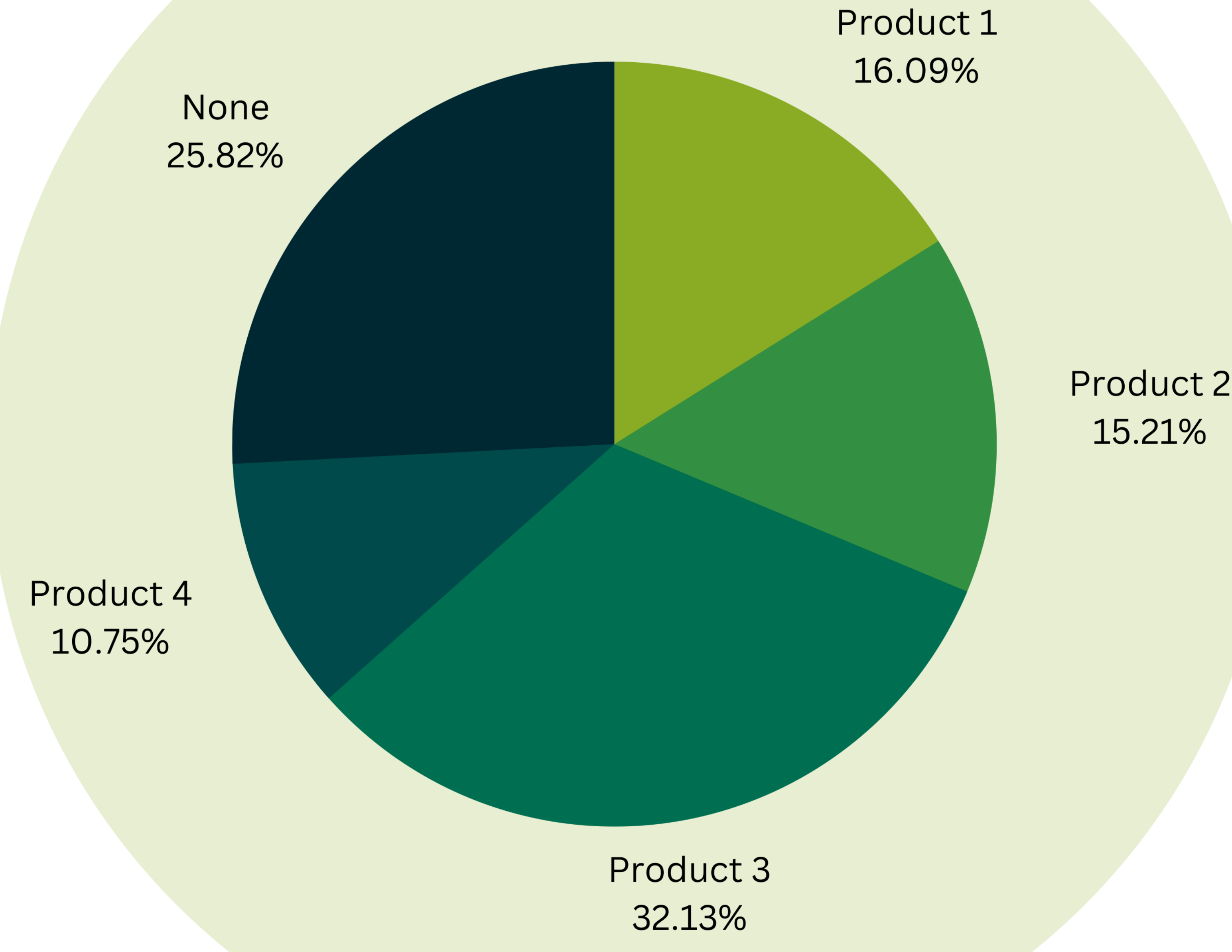
Market Share analysis

Calculated from the model

take exponential

Product	Type	Method	Price	Predicted uY	EXP(uY)	Market Share
1	Tuna	Wild	$19.99	-0.4733	0.6229	16.09%
2	Halibut	Wild	$18.99	-0.529	0.5892	15.21%
3	Salmon	Wild	$15.99	0.2185	1.2442	32.13%
4	Salmon	Farm	$13.99	-0.8767	0.4162	10.75%
NONE	/	/	/	0	1	25.82%

$$Share_j = \frac{\exp(U_j)}{\exp(U_1) + \exp(U_2) + \ldots + \exp(U_J)}$$



Price Elasticity analysis

Keep Product 4 as Farm/GMO Salmon at $13.99. Holding the price of Product 1, Product 2, and Product 4 constant, I calculated the product shares when the price of Product 3 (the Wild Salmon) varies from $13.99 to $19.99 in increments of $3.00:

				% Change	Elasticity
Price of Product 3	$13.99	$16.99	$19.99	0.3531	
Product 1	16.07%	17.77%	19.32%	0.1838	0.5204
Product 2	15.20%	16.81%	18.27%	0.1838	0.5204
Product 3	38.79%	32.29%	26.41%	-0.3799	-1.0759
Product 4	4.15%	4.59%	4.99%	0.1838	0.5204
NONE	25.79%	28.53%	31.01%	0.1838	0.5204

To smooth out the effect of increase/decrease, calculate the % change **using the average**:

$$\%\Delta \text{ in Share: } \frac{S_1 - S_2}{\left[\frac{S_1 + S_2}{2}\right]} \qquad \%\Delta \text{ in Price: } \frac{P_1 - P_2}{\left[\frac{P_1 + P_2}{2}\right]}$$

$$\text{Elasticity: } \frac{\%\Delta \text{ in Share}}{\%\Delta \text{ in Price}}$$

The aggregate model can be used to do market share analysis. However, we can see this model yields **counterintuitive patterns of cross-price effects** which needs further improvement efforts.

THANK YOU

Welcome to contact
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