Designing a stated choice survey to study food product eco-labels

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Abstract

Eco-labels were first introduced to the U.S. in the early 1970s to certify organic fruits and vegetables. These labels have evolved since then to represent various aspects of sustainable agricultural practices, environmental health, wildlife preservation, etc. This article describes the design of a large-scale stated choice survey to investigate consumer reactions to eco-label characteristics such as price premiums, pesticide use, environmental practices, and certification, for two common food products, apples and eggs. This work is part of a multi-year, multi-site project to study demand impacts and implementation of eco-labels funded by the U.S. Department of Agriculture.

Keywords: agricultural economics, discrete choice, environment, marketing, multinomial logit, sustainability.

1 Background

1.1 Research team

The research team collaborating on this work include:

- Cathy Durham (Agricultural and Resource Economics Department, Oregon State University);
- Aaron Johnson (Agricultural and Resource Economics Department, Oregon State University);
- Rob King (Department of Applied Economics, University of Minnesota);
- Jill McCluskey (School of Economic Sciences, Washington State University);
- Iain Pardoe (Department of Decision Sciences, Lundquist College of Business, University of Oregon);
- Cathy Roheim (Department of Environmental and Natural Resource Economics, University of Rhode Island).

1.2 Research plan

The overall research plan covers three objectives:

1. Evaluate eco-label characteristics that lead to increased product demand and how to effectively reach consumers with that information in retail settings. Tools for addressing this objective include focus groups and surveys that measure willingness-to-pay for eco-label characteristics.
2. Test eco-labeling promotion and evaluate the impact on retail demand by collecting data from grocery stores over time and evaluating promotional signage variation at those stores.
3. Assess how well results from the willingness-to-pay analyses compare with those of the demand study through looking at the demand impact of signage at points of purchase, and the implied demand effect of the willingness-to-pay results.

1.3 Survey question example

This article focuses on the first of these objectives, in particular the design of a stated choice experiment as part of a survey on consumer attitudes to eco-labels. The remainder of the article describes in detail how the experiment was designed, resulting in questions based on four alternatives in a series of choice sets such as that in Table 1. The text accompanying these alternatives states the following: "If you were planning to buy apples, and you were able to select from the following choices that were all equally ripe and fresh, which choice would you buy? Consider all 3 production practices (Pesticide Usage, Provision for Wildlife Habitat, Water Protection), Certifier and Price when selecting your answer. A blank space means no special practice is undertaken."

2 Designing The Stated Choice Experiment

The stated choice experiment considered here is based on the multinomial logit model of McFadden (1974). The approach is also known as choice-based conjoint modeling since it provides an alternative to full-profile conjoint modeling by applying a non-linear model to aggregate choice data (rather than applying linear models to disaggregate data as in traditional conjoint). The modeled probabilities of individual i choosing alternative j from choice set C_i is

$$\Pr(Y=j|\boldsymbol{x}_i) = \frac{\exp(\boldsymbol{\beta}^T\boldsymbol{x}_{ij})}{\sum_{h\in C_i}\exp(\boldsymbol{\beta}^T\boldsymbol{x}_{ih})},$$

where $\boldsymbol{x}_{ij}$ represents covariates that can be characteristics of both the individual choosing and the choice alternative.

We used SAS software to design and analyze the choice experiment due to software availability and the extensive support available for discrete choice modeling in SAS. In particular, Kuhfeld (2005) provides a comprehensive background to the area and many examples, while there are a variety of useful macros at `support.sas.com/techsup/technote/ts722.zip`.

Table 1: Example of four alternatives in a choice set.

1	NO Synthetic Pesticides Allowed	On-Farm Wildlife Habitat Provided	Water Protection Provided	Government Certifier	Price $1.19/#
2	Integrated Pest Management			3rd Party Certifier	Price $1.49/#
3	Conventional Pesticides				Price $0.89/#
4	I would Not Buy any of these products				

2.1 Factors, levels, choice sets

From earlier focus group work, we selected the following five factors with 3/2/2/3/4 levels for the choice experiment on apples:

- Pesticides (conventional, organic, integrated pest management);
- Wildlife habitat provision (no, yes);
- Water protection (no, yes);
- Certification (none, 3rd party, government);
- Price ($0.89, $1.19, $1.49, $1.79 per pound).

There were four alternatives selected to be in each choice set:

- Two "eco-labeled" alternatives (which cannot be $0.89 to reflect practical reality in which eco-labeled products are seldom, if ever, priced less than their conventional counterparts);
- One near-constant "conventional" alternative (which can only be $0.89 or $1.19, again to reflect reality as closely as possible);
- One constant "none" alternative (to capture circumstances where a respondent finds none of the first three alternatives appealing).

2.2 Choice experiment design

The choice experiment design needed for this set up is essentially *generic* (since there are no "brands"), but with a slight twist in that the third alternative is always the "conventional" option. This has the potential to create some difficulties with standard methods for creating optimal experimental designs, as do the various other constraints that need to be satisfied (e.g., that the eco-labeled alternatives cannot be $0.89 and the conventional alternative must be $0.89 or $1.19).

Furthermore, the design should be *large* enough to allow estimation of the most complicated model anticipated, including:

- possible interactions of price with other factors;
- possible alternative-specific effects for eco-labeled versus conventional;
- possible cross-effects of (say) conventional price on eco-labeled alternatives;
- demographic effects.

By contrast, the design should be *small* enough to be practical. In particular, the full survey, of which the choice experiment is a part, asks many other questions too. To balance the criteria of estimability (which prefers larger designs) with practicality (which prefers smaller designs), we restricted the choice experiment to 8 choice sets per respondent for each food product, apples and eggs (i.e., a total of 16 choice sets per person).

Taking all these requirements together, 24 seems to be a reasonable design size for each food product since it divides 2, 3, and 4 (the number of factor levels) and 8 (the maximum number of choice sets per subject). We used the `%MktEx` SAS macro to create a complete list of candidate choice sets. This macro enables the use of "flags" to restrict the alternatives:

- the first two have at least one non-low level for each factor (to ensure they are not conventional on all factors) and one of the three highest prices;
- the third has low levels for each factor (to ensure it is the conventional alternative) and one of the two lowest prices;
- the fourth has missing values for each factor (corresponding to the "none" alternative).

We next used the `%ChoicEff` macro to search the list of candidate sets for an efficient design with a total of 24 choice sets. This macro iteratively swaps alternatives from the candidate sets in and out of the design using a modified Fedorov algorithm (Fedorov, 1972; Cook and Nachtsheim, 1980) to optimize the choice model variance matrix.

As discussed previously, for this application a design with 24 choice sets is too large to show all the sets to each subject. Thus we next used the `%MktBlock` macro to block the design into 3 blocks of 8 choice sets each. This macro tries to create a block factor that is uncorrelated with every attribute of every alternative. While that turns out to be impossible to achieve here, the macro comes reasonably close.

It is clearly not possible to find a perfectly balanced, orthogonal design for this application given all the practical requirements for the choice experiment discussed previously. Nevertheless, the procedure just described does produce a workable design that is intended to be as balanced and orthogonal as possible. To illustrate, the first two choice sets in the first block for the final selected design are as follows:

Block	Set	Alt	x1	x2	x3	x4	x5
1	1	1	IPM	No	No	3rd	$1.79
		2	Org	Yes	Yes	None	$1.49
		3	Conv	No	No	None	$1.19
		4	.	.	.	.	.
1	2	1	Conv	Yes	Yes	Govt	$1.49
		2	IPM	No	No	3rd	$1.79
		3	Conv	No	No	None	$1.19
		4	.	.	.	.	.
etc.							

3 Testing The Design

Since the design is complex and data collection is expensive, we first evaluated the design to make sure it would work before collecting any real data. We generated artificial data to check that the most complicated models we could anticipate fitting are in fact estimable with this design. Then we estimated a series of models with the artificial data using SAS procedure PROC PHREG (since it turns out that the likelihood for proportional hazards regression is equivalent to that of the multinomial logit model). In particular, we tried a basic multinomial logit model, plus: interactions between price and other factors; alternative-specific price effects for eco-labeled versus conventional; a cross-effect of conventional price on eco-labeled alternatives; and interactions between demographics and choice factors. Results indicated all model terms should be estimable with the design.

4 Next Steps

With the final design in place, we generated the surveys for running the choice experiments. The surveys consisted of 8 apple choice sets (one block per subject), 8 egg choice sets (using the same design, but with respondents receiving a different block from their apple choice sets); supplementary questions covering demographics, shopping habits, attitudes towards eco-labels, etc. The factors and levels for the egg choice sets were broadly equivalent to the apple factors and levels, e.g., free-range and free-roaming in place of the pesticide factor, use of antibiotics in place of the wildlife habitat factor, and sustainability practices in place of the water protection factor.

Then we administered surveys in late summer 2006 using tablet computers in three locations, Portland, OR, Minneapolis, MN, and Rhode Island. There were also a variety of types of location, including farmers' markets, conventional grocery stores, and natural food stores. We obtained approximately 500 respondents at each location, helped no doubt by a $5 coupon incentive that we were able to offer participants. Early results indicate price effects in the expected direction (i.e., increased price decreases demand), significant positive results for the eco-label characteristics, but possibly ambiguous results with regard to certification (further investigation needed). Final results and conclusions will be reported elsewhere at a later date.

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References

Cook, R. D. and Nachtsheim, C. J. (1980). A Comparison of Algorithms for Constructing Exact D-optimal Designs. *Technometrics*, 22, 315–324.

Fedorov, V. V. (1972). *Theory of Optimal Experiments*, translated and edited by W. J. Studden and E. M. Klimko. New York: Academic Press.

Kuhfeld, W. (2005). Marketing Research Methods in SAS. [http://support.sas.com/techsup/tnote/tnote stat.html#market]

McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior. In P. Zarembka (ed), *Frontiers in Econometrics*, p. 105–142. New York: Academic Press.