Are Country of Origin and non-GM Premia Invariant to Experimental Auction Structure?

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Abstract

A revealed preference auction experiment is used to elicit values for two attributes, one relating to genetic modification and the other to country of origin of the food product, canola oil. A premium for a non-GM canola oil is found to approximate CA$0.4 to $0.6 per litre. Auction format effects are found and hypotheses as to why these may occur are suggested.

Keywords: *Willingness to pay; incentive compatible; Becker-DeGroot-Marschak auction procedure; non-GM food, country of origin; canola oil*

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1. Background and Objectives

Reflecting social dissension about applications of modern agricultural biotechnology in production and marketing of genetically modified (GM) food, there is continuing interest, in the agricultural economics literature, on consumers' responses to product information, labeling strategies and methodologies to estimate consumers' trade-offs and willingness to pay for non-GM food. Some examples are: Hu et al. (2004; 2006), Burton et al. (2001), Chen and Chern (2001), Huffman et al. (2003), Boccaletti and Moro (2000), Lusk et al. (2004), Viella-Vila et al. (2005). The majority, by far, of such studies have applied hypothetical scenarios to generate estimates of willingness to pay for non-GM food products and other food product attributes. Very few of the studies that have been directed at valuation of food product attributes, including GM/non-GM characteristics, have used incentive compatible revealed preference methods to elicit these values. The use of such methods to assess more than one attribute value is even rarer.

This study applies an incentive compatible Becker-DeGroot-Marschak auction procedure to derive estimates of willingness to pay for two credence attributes of a se-

lected food product, canola vegetable oil, as a means to assess (WTP) for explicitly labeled non-GM canola oil versus its GM-derived counterpart and a non-specified alternative. Country of origin is the second attribute included in the study design.

The revealed preference experiment designed for this purpose mimicked a grocery store situation in which consumers revealed their preferences by engaging in actual, binding trading exercises. Food labels were constructed based on wordings recommended by the Canadian Food Inspection Agency and these were shown to each respondent in the course of an experimental auction for the vegetable oil products. Demographic, socio-economic and related information was also provided by each respondent.

The methodology and procedures used in the oil auction experiment are described below in Section 2. Section 3 presents the empirical model; estimation and inferences are outlined in Section 4, and Section 5 concludes with a discussion of major findings and some questions for further research.

2. Instrument and Methodology

An international marketing company was hired to randomly recruit 247 adults from the city of Edmonton and surrounding areas to participate in auction sessions for the study, which was described as a food and agriculture marketing study. These sessions were held on the University of Alberta campus between 6 October 2005 and 23 November 2005. Participants were required to be 18 years of age or older, and be responsible for at least 50% of their household's grocery shopping. Within these constraints, there was an effort to recruit a reasonably balanced sample in terms of age and gender.

Study participants were provided with a cash compensation for their time ($40 or $50 depending on the session), a chocolate bar (which was auctioned as part of an initial

warm-up task), a bottle of canola oil, and the opportunity to acquire a similar quantity of a different type of canola oil during the computer-aided auction process. The participants each faced a series of scenarios on a touch-screen computer in which each individual was shown the labels and price information for the different canola oils that were included in the study. In each scenario, participants were asked if they would trade the oil they had been given for an alternative oil. In some cases they were asked to pay for the alternative oil, in others they were offered a refund if they chose the alternative oil. Respondents were always given the choice of not choosing an alternative oil — that is, of keeping the endowment oil. As was indicated to respondents prior to the auction process, one of the bids made by each respondent was selected at random to be "binding," with the decision made on that task determining the oil product that the participant actually received and the sum that individual was paid (or charged) upon completing the experiment.[2] This auction procedure is incentive compatible, in contrast to the stated choice methods used in the vast majority of studies that estimate possible non-GM premiums. The procedure is consistent with grocery store shopping situations since shoppers can always choose to not to buy any product at an offered price.

The label information that was provided to participants indicated that this was: "100% Canola Oil," in addition to currently required nutrition labeling. Three other items of information were clearly indicated on the labels for each oil: (1) country of origin, (2) type of oil, and (3) price. These features varied from one oil product to the next. The attributes and levels of the canola oils are shown in Table 1. Short titles and coding of

[2] Since each brand of canola oil came in a distinctive bottle, until the time that participants completed the procedure and "checked out," their endowment (or alternate purchase) was indicated by a coupon, and thus not affected by the brand names or the nature of the bottles of the alternative canola oils.

product attributes are indicated in Table 2, while respondent-specific characteristics and codings are listed in Table 3.

In order to test the influence of possible format effects in the revealed preference experiment, a split-sample design was applied and approximately half of the participants were assigned to an auction design format in which only one alternative oil was included in each decision task (*Alt1* is used to denote this format). In the second auction design format, in each bidding task completed by respondents, bid choices were made between the endowed oil and two other canola oil alternatives (*Alt2*). The respondents in the *Alt1* group were presented with a sequence of 20 choice sets and a binding bid based on the decision made in one of these was subsequently determined for each person by random draw. Individuals in the second sub-sample were presented with two choice alternatives (*Alt2*) and completed 10 consecutive bidding tasks. For all respondents, the endowed canola oil was derived from GM processes and explicitly labeled as GM oil. Within each format sub-sample, approximately half of the respondents were endowed with a U.S.-origin canola oil while the other half received a Canadian-origin oil product. Sample characteristics for each format group are in Table 4.

Table 1: Oil Attributes and Levels

Attribute	Levels			
Country of Origin	Canada	U.S.	–	–
Type of Oil	Oil from GM Canola variety	Oil from non-GM Canola Variety	Canola Oil	–
Price	Pay $0.50	Pay $1.00	Refund $0.50	Refund $1.00

Table 2: Oil-Specific Attributes and Codes

Mnemonic	Description
CAN	Indicator: 1 if oil is made in Canada, 0 otherwise
Unspec	Indicator: 1 if GM/non-GM is not explicitly stated on label, 0 otherwise
NonGM	Indicator: 1 if non-GM is explicitly stated on label, 0 otherwise
Price	Premium/Rebate, $
Baseline	Indicator: 1 if option chosen is the endowment, 0 otherwise

Table 3: Respondent-Specific Attributes and Codes

Mnemonic	Description
C	Constant
Age	Respondent's age, in years
Sex	Indicator: 1 if female, 0 otherwise
College	Indicator: 1 if has some post-secondary education, 0 otherwise
Single	Indicator: 1 if lives alone, 0 otherwise
House	Indicator: 1 if two people live in the household, 0 otherwise
Under12	Indicator: 1 if household includes children under 12, 0 otherwise
Income	Log of household income, $
Enviro	Indicator: 1 if donates to environmental organization, 0 otherwise

Table 4: Summary of Sample Statistics

		Alt1	*Alt2*
TOTAL	N	110	120
Age	mean	46	46
Gender	F,% to M,%	56 to 44	47 to 53
College	mean,%	69	70
Single	mean,%	18	14
Couple	mean,%	34	31
Under12	mean,%	23	28
Income	median, CA$ $\times 10^3$	60–70	50–60
Enviro	mean,%	20	15

3. The Empirical Model

To obtain estimates of WTP for attributes, we utilize a hierarchical regression model for the discrete responses $\mathbf{y}_{it}$ with the logit link:

$$\mathrm{E}[\mathbf{y}_{it}] = \mathrm{Logit}(\mathbf{X}_t\boldsymbol{\beta}_i),\ \boldsymbol{\beta}_i \sim \mathrm{G}(\boldsymbol{\Delta}\mathbf{z}_i, \mathbf{V}_\beta), \qquad (1)$$

where $\mathbf{X}_t$ is comprised of stacked-up vector-valued attributes of choice options (canola oils) in the t-th choice set; $\boldsymbol{\beta}_i$ are attribute coefficients (part-worths) that follow a distribution G, whose mean $\boldsymbol{\Delta}\mathbf{z}_i$ is a linear combination of an i-th respondent's characteristics $\mathbf{z}_i$ and population-wide parameters $\boldsymbol{\Delta}$, and whose variance $\mathbf{V}_\beta$ is constant across the sample. The oil-specific attributes $\mathbf{X}_t$ and respondent-specific variables $\mathbf{z}_i$ are given in Tables 2 and 3, respectively, whilst Table 4 provides summary sample statistics for the respondent-specific factors $\mathbf{z}_i$. The hierarchical regression model in Equation (1) has the advantage of being quite flexible in terms of modeling respondent heterogeneity. Specifically, if the distribution G of model coefficients is degenerate ($\mathbf{V}_\beta = 0$), a conventional conditional logit model arises, where the attribute coefficients are completely explained

by the observed socio-demographic factors. A non-degenerate distribution produces a mixed model.

4. Estimation and Inference

An empirical choice model was estimated for both bid choice formats, *Alt1* and *Alt2* specified in the previous section. The conditional logit model (CL) was estimated with regular maximum likelihood techniques. Assuming a multivariate Normal distribution of coefficient shocks, i.e. $\boldsymbol{\beta}_i \sim \text{MVN}(\boldsymbol{\Delta}\mathbf{z}_i, \mathbf{V}_\beta)$, the resulting mixed logit model was estimated with the hierarchical Bayes (HB) procedure (Rossi, Allenby and McCulloch, 2005, Rossi and McCulloch, 2006). All respondent-specific regressors were mean-centered so that the free term coefficients would correspond to the average respondent. The nature of the direction of price changes (i.e., paying a premium or receiving a rebate for an alternative oil product) was tested and found to have no discernible effect.

Median WTP estimates were calculated by dividing each estimated attribute coefficient by the coefficient on the premium/rebate (Hanemann, 1984). Table 5 contains these estimates as derived from the CL model. Each of these estimates, except for the endowment indicator in the *Alt1* format version, are highly significant, while the endowment indicator in *Alt1* is marginally significant. The WTP estimates for the non-GM canola oil range from CA$0.86 per litre in the *Alt1* format to CA$1.36 per litre in the *Alt2* case. The estimated WTP for avoidance of GM canola oil ranges from 20% to 30% of the typical product price in Edmonton, Alberta and is toward the lower half of the range of values reported for avoidance of GM-vegetable oil reported for other locales by Chern et al. (2002). Estimates of non-GM premiums over the discounted prices of GM vegetable

Table 5: Conditional Logit Estimates

	Alt1 Format		*Alt2* Format	
	Estimate	**St. error**	**Estimate**	**St. error**
CAN	0.67	0.08	0.78	0.09
Unspec	1.28	0.16	1.41	0.17
NonGM	1.57	0.16	1.99	0.17
Price	–1.82	0.09	–1.46	0.08
Baseline	0.27	0.13	1.00	0.16
	Median WTP			
CAN	0.37	0.09	0.53	0.10
Unspec	0.70	0.13	0.97	0.20
NonGM	0.86	0.17	1.36	0.32

oil are reported to range from 17–21% in Taiwan to 50–62% in the U.S. and 55–69% in Norway by Chern et al. However, the results reported by these authors were obtained using stated preference surveys, which raises the possibility of WTP inflation due to the hypothetical nature of the instrument (List and Shogren, 1998).

In our study we also find an average WTP for the canola oil for which GM content or absence is not explicitly stated on the label (i.e. where this is unspecified) to be approximately 70% of the WTP for the non-GM product. The analysis also suggests that Canadians are willing to pay a premium of CA$0.37–0.53 per litre for Canadian-origin oil relative to canola oil imported from the U.S.

An interesting feature of the parameter estimates in Table 5 is that there appears to be a format effect which arises from differences in the relative magnitudes of estimated coefficients which consequently affects the WTP values. The estimated coefficients on all the canola oil attributes, except for price, are larger for the estimates based on the *Alt2* format data than for the estimates generated from the *Alt2* format. However, in contrast,

the absolute value of the price coefficient in the *Alt2* analysis is smaller than in the *Alt1* case. The greater values of the coefficients on oil attributes and the smaller estimate of the marginal utility of money in the *Alt2* case lead to significantly greater implied WTP values for the data collected in the *Alt2* format. This feature of the estimates based on the *Alt2* format suggests a distinct apparent endowment effect (Thaler, 1980, Shogren et al, 1994). Comparing *Alt2* to *Alt1,* we observe a larger magnitude and a higher level and significance of the baseline (endowment) attribute, which in turn depicts a tendency for individuals to keep the endowment product, rather than engaging in trade, where two (rather than one) alternatives to the endowment are available.

Posterior distributions of parameters from the Hierarchical Bayes (HB) model are presented in Figure 1; Table 6 gives the HB median WTP quantiles. With the HB approach, the median WTP is actually a distribution, which cannot be directly compared to the CL results. It is observed that the WTP values based on HB medians (50% quantiles) are approximately half of the value estimates based on a CL model. The estimates of WTP for the non-GM canola oil products range from CA$0.45 per litre in the *Alt1* format, to CA$0.62 per litre in the *Alt2* case. The estimated WTP for the non-GM oil is equivalent to some 10 to 15% of the product price in Edmonton, relatively close to the figure of 8–15% reported for non-GM vegetable oil in the U.S. by Chen and Chern (2002). Figure 1 confirms an observation noted earlier from the CL results: posteriors of all coefficients but price definitely stretch to the right in the *Alt2* case, while the distribution of the price coefficient shrinks toward zero in this case. The baseline (i.e. endowment) parameter distribution is centered around zero in the *Alt1* estimates but is noticeably shifted to the right in the *Alt2* case.

Figure 1: Distribution of Heterogeneity, Hierarchical Bayes

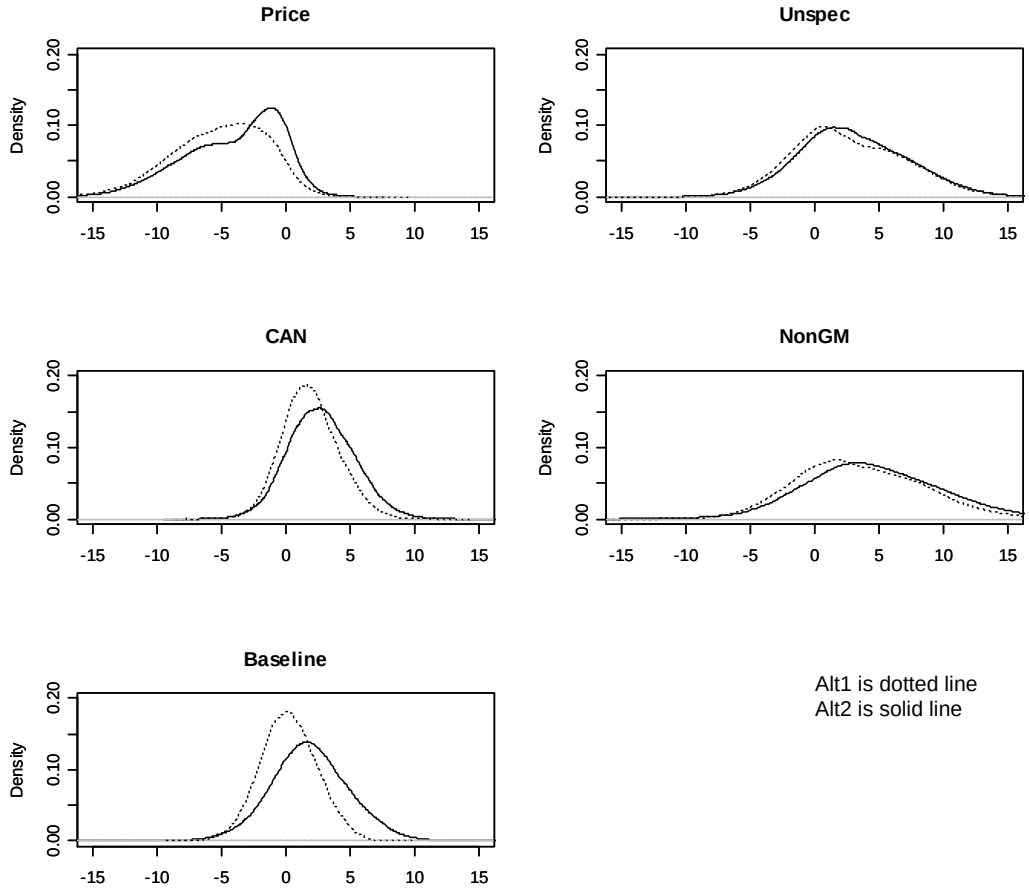

Table 6: Median WTP Quantiles, Hierarchical Bayes

	5%	25%	**50%**	75%	95%
	Estimates Based on the ***Alt1*** Format				
CAN	–1.16	0.04	**0.30**	0.77	3.28
Unspec	–3.90	–0.15	**0.30**	1.47	6.88
Non-GM	–4.19	–0.09	**0.45**	1.85	7.81
	Estimates Based on the ***Alt2*** Format				
CAN	–1.16	0.04	**0.48**	1.36	6.26
Unspec	–9.04	–0.21	**0.36**	2.14	11.10
Non-GM	–11.77	–0.15	**0.62**	3.12	14.53

5. Overview of Current and Future Research

Premiums that respondents were found to be willing to pay (WTP) for non-GM canola oil were CA$0.45–0.60/litre, based on HB estimates in the two different formats. The average WTP for canola oil for which GM status was not explicitly specified was found to be approximately 70% of the WTP for the non-GM product. The data also suggest that on average, Canadians are willing to pay a premium of CA$0.30–0.50/litre for Canadian-origin canola oil, relative to canola oil imported from the U.S. However, some 30% of participants were not prepared to pay any extra for non-GM oils. In general these findings are consistent with other research on consumers' willingness to purchase GM foods, much of which is derived from stated preference methods. Even so, our finding of strong format effects in the context of a revealed preference instrument suggests that additional research is required to understand consumer choices. The demonstration of format effects in the application of the revealed preference instrument seems to suggest that some of the problems that plague hypothetical stated preference approaches can also be found in research that applies revealed preference approaches to WTP estimation. Perhaps "real world" phenomena like responses to complexity or the use of simplifying heuristics are reflected in the differences found here.

Two hypotheses that may explain the format discrepancy are:

(a) Dimensional reduction due to higher choice complexity in the *Alt2* context. Choice complexity might lead some respondents to eliminate consideration of some attributes which could have resulted in instances of some coefficient values in the proximity of zero and could also have increased the occurrence of very large coefficient values. For exam-

ple, if there were instances in which price was disregarded because of a tradeoff contrast (Simonson and Tverski, 1992), this factor could have caused the stretching out, or shrinking toward zero, of posteriors in this context

(b) Insufficient choice variety with *Alt1*. With fewer choices in each bidding occasion and thus less chance to encounter a desired attribute combination (e.g. a Canada-origin non-GM oil) in choices with only two product options, experiment participants may have tended to make their decisions using the most "habitual" criterion — price.

Hypothesis (a) may help to explain the apparent appearance of an endowment effect in the *Alt2* choices but offers no plausible explanation for the weaker influence of price in this two-alternative format. On the other hand, hypothesis (b) may explain the larger price effect in *Alt1* but does not address the endowment phenomenon.

Work is currently in progress on a follow-up study which will mirror the current study but be based on a stated-preference approach. This will also seek additional data in an attempt to shed more light on the role of the instrument format and to enable further analysis of the two speculative hypotheses relative to the observed format effects.

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