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Consumer Acceptance of a New Traceability Technology: A Discrete Choice Application to Ontario Ginseng

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Abstract

New technologies can limit the threat of economic adulteration but consumers may not accept them. A choice experiment was used to elicit consumer preferences for 'internal tags,' a new technology for enhanced traceability and quality assurance. Further, two basic branding options and two signals of product origin are investigated. Results suggest consumers are accepting of products with 'internal tags' added and prefer a regional over a national brand. Consumer valuation of the branding options was found to be affected by the presence of one product origin signal. Implications for marketing management decisions are discussed with focus on study design.

Keywords: traceability, quality assurance, new technology acceptance, branding, discrete choice

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Background and Motivation

Reducing the likelihood and impact of public health threats due to contaminated foods is a responsibility of both government and industry. In recent years, economic or economically motivated adulteration has been a growing concern worldwide (Spink and Moyer 2011; Moore, Spink and Lipp 2012). According to the U.S. Food and Drug Administration's working definition, economically motivated adulteration is the ''fraudulent, intentional substitution or addition of a substance for the purpose of increasing the apparent value of the product or reducing the cost of its production, i.e. for economic gain" (Lutter 2009). It undermines public and private efforts to raise food safety levels, because the adulterations are unconventional. Branded products or their ingredients are typically counterfeited to reap a premium for an inferior, fraudulent and possibly dangerous product or ingredients. In a recent study, the Grocery Manufacturers Association (GMA) and A.T. Kearny (2010) estimate the annual cost of economic adulteration and counterfeiting of branded products to be $10 to $15 billion globally. For an individual company, GMA and A.T. Kearny (2010) estimate the cost of an economic adulteration case to range from 2% to 15% of annual revenues, with smaller companies being relatively more severely impacted than larger ones. The Melamine case which affected more than 30 local and international milk brands and almost 300,000 consumers, with 50,000 hospitalizations, illustrates the potential scale of this global problem (GMA and A.T. Kearney 2010). However, many cases of economic adulteration go unnoticed because regular quality assurance and analysis procedures do not discover the adulteration, or there is no public health damage which would trigger an investigation. Even if discovered, manufacturers or retailers may not inform the public, as long as no public health threat exists or they are required by law to report subsequent recalls.

To stay ahead of fraudsters, or with a more pessimistic view: to keep up with them, industry has a very strong incentive to invest in counter measures for enhanced quality assurance and traceability. Investment areas include rapid analysis techniques and market surveillance systems. The latter raise red flags when changes in prices for ingredients and final products of different quality create incentives for fraud. Since investments in both areas also serve regular quality assurance activities, it is not possible to determine how much of the investments are directed at economic adulteration.

In this paper, we present a study of elicited consumer preferences for a new technology that is aimed at curbing economic adulteration of foods and natural health products. The proposed technology inserts so-called 'internal tags' into foods and natural health products in very small quantities, equivalent to one to five millionths of the product's weight. 'Internal tags' are specific carbohydrate sequences that are synthesized from natural materials (Low et al. 2009). They can be monitored through rapid analysis methods for presence and concentration throughout subsequent stages of the supply chain[1]. In addition, there is virtually no limit to the synthesis of sequences so that different sequences can be used for different production periods. This provides the potential for complementing and strengthening existing technologies to curb economic

[1] At the time of the study, development of the 'internal tag' technology was primarily aimed at applications to processed products, such as apple juice or ginseng extract and powder.

adulteration. For example, established traceability technologies, such as barcodes and imprinted lot numbers, are usually applied to the product packaging and easier to counterfeit. Further, established analysis methods for food authenticity, such as DNA or isotope analysis, are only suitable under certain circumstances.

Four focus group interviews had been conducted as pre-study in January 2010 to inform the design of this study. A total of 36 women between the ages of 25 to 65 and over who buy natural health products for personal consumption participated (Informa 2010). The focus groups revealed that scientific details would not be useful for most respondents, e.g. that the 'internal tags' are synthesized from oligosaccharides from starch, inulin and pectin, that there are near infinite forms for them to be unique identifiers, that their actual size is 30 to 40 nanometers, or how exactly monitoring would work. Focus group participants stated that the benefits of the technology were tangible to them but also expressed concerns about possible risks, despite a current lack of evidence of health risks. Provided that the latter was confirmed during authorization of the technology, managers would have all the reason to expect that consumers would be accepting of products with 'internal tags.' However, there have been promising food-related technologies that have not been taken up in the past. Among the technologies that have faced significant barriers to acceptance, genetic modification and food irradiation have probably received the most attention in both public debate and academic analysis (Olsen, Grunert and Sonne 2010,45).

Strategic management decisions need to be informed about potential acceptance issues of new technologies. Reluctant uptake by industry may turn a first mover advantage into an outsider position and compromise investments. Findings from preference elicitation studies can be shared with supply chain partners to identify additional barriers. Finally, consumer research can be used to develop and implement effective communication strategies. Findings are likely specific to a product or industry, depending on the risk of economic adulteration and awareness of that among consumers. Here, ginseng was chosen for the product-specific analysis. More particularly, the Ontario Ginseng Growers Association had become an industry partner of the project, as they were considering a provincial branding strategy coupled with an effort to increase the level of ginseng processing in the province. For the growers' association, the lack of market research information about ginseng users is a major constraint. Even broad information about the prevalence of ginseng use is not available in recent publications[2]. The industry saw the potential of the 'internal tags' to contribute to safeguarding future investments in processing and branding. Hence, the study was perceived as providing relevant information by answering three important questions for strategic management decisions.

a) Will consumers accept this technology? Although it has clear and tangible benefits to consumers, they might object to the fact that "something" is added to the natural health product that does not naturally occur in its key ingredients.

[2] The most recent source of information was Singh and Levine (2006). Based on the 2000-2001 National Population Health Survey, they estimate the prevalence of ginseng use among adults in Canada between 2.6% and 4.8%.

b) Will consumers be willing to pay a premium for a regional brand? In light of the suggested branding efforts, it would be of particular interest to the growers' association to determine whether consumers would be willing to pay a premium for a regional brand.
c) Which established signals of traceability and quality assurance are consumers willing to pay a premium for? In addition to the brand, the growers' association could use a manufacturer's guarantee or the Product of Canada label to signal the quality and origin of the ginseng product. Consumers will likely value these signals differently, and their presence could also affect the valuation of the regional brand.

The objective of this paper is thus to illustrate how to get valid answers to these questions to inform strategic agribusiness management decisions about potential acceptability issues of a new technology. The first step is the choice of an appropriate research approach that fits the conceptual model of consumer decision making.

To start, one has to acknowledge that it is appropriate to treat the new technology as a product attribute that is either present in the product or not. Consumers do not use this technology themselves but are subjected to it through consuming a product. More particularly, the new technology represents a so-called credence attribute. For individual consumers, it is impossible or, at least, cost prohibitive to verify its presence. Further, the study is aimed at providing information for pricing and branding decisions for a new product, which requires study participants to state their preferences for the salient product features, including the new technology. Therefore, the discrete choice approach has been chosen for this study. It can be used to provide estimates of consumers' willingness to pay for specific product attributes, which would include the presence of 'internal tags.'

The remainder of the paper is organized as follows. The next section opens with a review of previous discrete choice studies on consumer preferences for food irradiation and genetic modification, two food technologies that have been affected by lack of consumer acceptance. It then discusses the role of information in choice experiments and consumer valuation of traceability. It concludes with a discussion of interaction effects among quality assurance signals, including traceability – an important topic for marketing communication that has received little attention in the literature so far. No attempt is made to provide a comprehensive review of these matters. Instead, it is deliberately selective to illustrate relevant implications for managerial decisions. The third section then presents the methodological foundations of the discrete choice approach and describes the data collection process. This is followed by the presentation of results in section four. The concluding section highlights key findings and discusses how limitations of the current study can be addressed in further research.

Consumer Preferences for New Food Technologies and Traceability

This section presents findings from previous discrete choice analyses of consumer preferences for food irradiation and genetically modified foods that were used to inform the design of our study. In addition, their introduction has raised public controversy, thus their analysis should provide useful insights regarding possible consumer responses.

Food Irradiation and Genetic Modification

Giamalva, Bailey and Redfern (1997) were among the first to report willingness-to-pay estimates from a choice experiment for food irradiation. The technology was described in terms of its benefits, i.e. elimination of the potential risk of food-borne bacteria. They found that more than two thirds of respondents were willing to pay a positive amount for the right to exchange a regular meat sandwich for an irradiated one. They interpreted the significant and positive willingness to pay as indicating consumer acceptance. Subsequent studies produced similar results of general consumer acceptance based on an average willingness-to-pay that exceeded the cost of irradiation, as for example Nayga, Woodward and Aiew (2006) and Shogren et al. (1999) did in semi-controlled field experiments in supermarket settings.

Opposite to food irradiation, the majority of studies investigating consumer acceptance of genetically modified foods reported negative willingness to pay estimates; see for example the review of previous studies by Costa-Font, Gil and Traill (2009). However, when GM foods are linked to tangible benefits to the consumers these products tend to be more acceptable and consumers have also been found to exhibit positive average willingness to pay (Lusk et al. 2002; Lusk 2003). Owing to the credence nature of new food technologies, consumer valuation of different labeling regimes has played a particularly important role in the study of consumer acceptance of genetically modified foods. In a choice experiment with Swedish consumers, e.g., Carlsson, Frykbom and Lagerkvist (2007) could not reject the hypothesis of equal willingness to pay for mandatory labeling and an outright ban of GM products. Similarly, Hu, Veeman and Adamowicz (2005) report for a choice experiment with Canadian consumers that mandatory labeling was valued more than voluntary labeling. Within this context, it is not surprising that labeling strategies from a corporate perspective have received little attention. If so, it is primarily at the level of conceptual considerations, such as MacDonald and Whellams (2007) who point out that North American companies have no ethical obligation to label GM foods. They argue that empirical evidence of consumer concerns is not sufficient, as long as solid evidence of risks to human health is lacking.

The Role of Information for Consumer Acceptance of New Food Technologies

Given the complexity of new technologies from the average consumers' perspective, the impact of information has received due attention in the analysis of technology acceptance. Obviously, discrete choice studies can only focus on essential elements of information and communication and are thus not intended to replicate the full complexity of the real world in their design. Consumers' information activities are embedded in networks, depend on general education and specific knowledge, utilize different media and assign varying levels of credibility to information sources, to name just a few factors. Not surprisingly, the choice of an appropriate technology description is already a challenge, as single words can invoke different responses. Hence, the discrete choice studies on food irradiation by Giamalva, Bailey and Redfern (1997), Nayga, Woodward and Aiew (2006), Shogren et al. (1999) and Teisl and Roe (2010) presented neutrally phrased descriptions of benefits with the aim to have respondents at similar levels of knowledge. However, Hayes, Fox and Shogren (2002) showed that, while separately provided positive and negative information increased and decreased acceptance similarly respectively, negative information was clearly dominating when presented jointly.

While the impact of positive vs. negative information was also of interest to studies on consumer acceptance of genetic modification, research questions addressing the communication of second generation GM foods were practically more relevant. Lusk et al. (2004) found that positive information, i.e. about benefits of genetic modification generally reduced the compensation respondents demanded for the GM product. This was, on average more pronounced among the study locations in the US than in the EU.

Consumer Valuation of Food Traceability

For this study, consumer evaluation of traceability is highly relevant, because the ‘internal tagging technology’ is also a facilitator of traceability. Indeed, many studies report willingness to pay estiamtes for traceability that are significantly larger than zero (Cicia and Colantuoni 2010; Dickinson and Bailey 2005; Loureiro and Umberger 2007). However, from a marketing perspective, traceability serves the specific purpose of facilitating assurance of credence attributes that consumers value and are willing to pay a premium for in order to differentiate oneselves from competitors. Hence, Verbeke and Roosen (2009) see a rather limited potential for product or supplier differentiation on the basis of traceability alone.

Interaction Effects among Signals of Quality Assurance

There is growing body of studies of consumer preference for food safety and quality attributes that are typically presented in the form of labels to participants in choice experiments (Olsen, Grunert and Sonne 2010; Moser, Raffaeli and Thilmany-McFadden 2011; Teisl and Roe 2010). Research in this area is primarily concerned with investigating main effects of these attributes in isolation, while interaction effects among attributes have received less attention. From a practical perspective this is justified, because main effects account for most of the variation in consumer choice. Interaction effects are less often significant and usually significantly smaller in magnitude. Furthermore, taking account of them requires allocating more resources to experimental design (Hensher, Rose and Green 2005,16ff.). However, they can provide additional valuable insights particularly for marketing communication. A significant interaction effect is present when the consumer valuation of one attribute, say a brand, varies depending on the level of another attribute, e.g. a third party certification seal of sustainable production. If two attributes reinforce each other, i.e. increase willingness to pay above the sum of the main effects, the interaction effect is positive and complementary in nature. If the sign is negative, the presence of both attributes reduces the sum of their isolated impacts; they act as substitutes in the consumer valuation process.

Enneking (2004) explores the brand-specific impact of the safety and quality label (Q&S) on German consumers’ willingness to pay for liver sausage. The Q&S label had been introduced to the German meat market in response to the first genuine German BSE (‘mad cow’) case in 1999. He estimated the brand-specific willingess to pay for the attribute “Q&S label” and thus could show how brand and label interacted: The presence of the Q&S label on a premium brand increased consumer willingness-to-pay more than when present on a less-well known brand. Ubilava and Foster (2009) elicited preferences for safety and quality information attributes among Georgian consumers. A negative interaction effect between quality certification and traceability was found to be strong and robust across model specifications. However, the two attributes also had significant and considerably larger positive main effects, From a marketing perspective, these results suggest that, despite the negaitve interaction effect, signalling both attributes on a product would provide the opportunity for a significantly larger price premium than signalling only one attribute.

Ortega et al. (2011) examine Chinese consumers' choices of pork under various safety certification attributes: price, traceability system, government certification, third-party certification, and a product information label. While the traceability system and the product information label have no significant main effect, i.e. they do impact consumers' utility separately, their interaction effect is significant and positive. In other words: the complementary interaction effect increases consumer utility and thus the likelihood of purchasing. This might be due to the perception among consumers that a product information label is only trustworthy when its accuracy is assured by a traceaibility system.

Methods

Discrete Choice and Random Utility Theory

To elicit consumer preferences for a currently non-existing product discrete choice experiments have been chosen for data collection. Discrete choice models are derived under random utility theory (McFadden 1974; Ben-Akiva & Lerman 1985; Train 2003). When coupled with the assumption that consumers derive utility from consumption of attributes (Lancaster 1966), willingness-to-pay for individual product features can be computed.

To develop the main concept of random utility maximization, assume the rational individual, *i*, faces a choice among $j = 1,\dots, J$ alternatives. The decision maker could obtain a certain level of utility from each alternative. Thus the derived utility of individual *i* associated with the choice of an alternative *j* is denoted U_{ij}, as follows:

$$(1) \qquad U_{ij} = V_{ij} + \varepsilon_{ij}$$

where V_{ij} is the observable systematic component of individual *i*'s utility determined by the alternative *j*, and ε_{ij} is the random component which captures the non-systematic factors that affect true utility, but are not included in V_{ij}. Assuming a maximizing utility behavior, the individual selects the alternative that yields the highest utility from among the possible alternatives. McFadden (1974) showed that if the difference in the error term is independent and identically distributed with a type I extreme value distribution, the resulting choice probability is the conditional logit choice probability. Hence the choice probability changes depending on how the characteristics of alternatives affect the consumers' utility. The conditional logit model can represent the conditional choice probability of selecting alternative *j* for individual *i*:

$$(2) \qquad Prob\left(y_{ij} = j \middle| x_{ij}\right) = \frac{exp(V_{ij})}{\sum_j^J exp(V_{ij})} = \frac{exp(\beta x_{ij})}{\sum_j^J exp(\beta x_{ij})}$$

where y_{ij} takes a value of 1 when alternative *j* is chosen by individual *i* and 0 otherwise and x_{ij} is a row vector of explanatory variables (or product attributes) that individual *i* obtains from choosing alternative *j*, and all other variables are as explained before.

Main and Interaction Effects

The chosen empirical specification of the utility reflects the objective of this study. We estimated a model (Eq. 3) that includes utility from individual attributes and from the interaction of pairs of attributes. Assuming V_{ij} is linear in parameters, the deterministic component of the full empirical model for conditional logit estimation is formulated as follows:

$$(3) \qquad V_{ij} = \beta_P p_{ij} + \beta_k x_{ij} + \gamma' d_{ij}$$

where p_{ij} is a price variable for alternative j, x_{ij} is a vector of product attributes, and d_{ij} is a vector of interaction terms of attribute pairs of alternative j. β_P is a price coefficient, β_k is a vector of attribute coefficients, and γ' is a vector of interaction term coefficients.

Willingness-to-Pay as a Measurement of Technology Acceptance

An important outcome of discrete choice analysis is the marginal willingness-to-pay for a change in a product attribute. This measure is defined by the ratio of the attribute and price coefficients:

$$(4) \qquad \text{willingness-to-pay}_k = -\frac{\beta_k}{\beta_P}$$

where β_k is the estimated coefficient for attribute k and β_P is the estimated coefficient for price of alternatives. The empirical interpretation of willingness-to-pay is shown in the monetary values that the consumer places on each attribute. Generally, a higher willingness-to-pay for an attribute indicates a greater utility derived from it. For a new technology, as in this study, a willingness-to-pay that is significantly larger than zero can hence be interpreted as an indication of consumer acceptance, while a negative willingness-to-pay would signal a tendency toward rejection.

Experimental Design and Survey Tool

Design of choice experiments leads to the choice of product alternatives or profiles with different attribute combinations. These are to be presented to respondents in choice sets. For efficient design, sufficient variation in product attribute combinations to estimate main and interaction effects at acceptable task complexity is the objective. The first step is the selection of attributes which was based on an analysis of the market for ginseng products and consumer focus groups. As shown in Table 1, three product attributes were chosen in addition to price and the presence/absence of internal tags. The four price levels from $13.99 to $19.99 per bottle with 60 250mg-capsules reflect actual retail prices of three national brands at two pharmacy chain stores - Shopper's Drug Mart and Rexall - at the time of the survey.

Table 1. Attributes and levels in the choice experiment

Attributes	Levels of Attribute
Internal tag added	Yes / No
Price/bottle with 60 capsules	\$13.99 / \$15.99 / \$17.99 / \$19.99
Manufacturer	National Manufacturer Brand / Ontario Association of Ginseng Producers
Canadian Ginseng Guaranteed	Yes / No
Product of Canada	Yes / No

The three remaining product attributes present signals of quality assurance or of assurance of origin implying traceability that are currently used in the market. The attribute 'Manufacturer' showed either "National Manufacturer Brand" or the "Ontario Association of Ginseng Producers" as a regional, province-based brand. The two remaining signals are either present or absent in the product profile presented to respondents. The "Canadian Ginseng Guaranteed" label was presented to the respondents as a manufacturer's guarantee that all ginseng material used in this product is from Canada. The "Product of Canada" was described as certifying that at least 51% of expenditures for producing the product were spent in Canada.

The *macro* procedure in SAS 9.2 software was used for a D-optimal experimental design that would allow estimating the interaction effects in the analysis (Hensher, Rose and Greene 2005; Kuhfeld 2005). Using the D-efficiency criterion, D-optimal designs maximize the determinant of the variance of covariance matrix, otherwise known as the determinant of the information matrix. Attributes in D-optimal designs are nearly balanced, nearly orthogonal and designed to yield the maximum amount of information about the coefficients of the attributes in the choice set. We chose to use a full factorial design, because the one four-level attribute and four two-level attributes only have a small number of possible combinations, i.e. 4*2*2*2*2 = 64. The *% MktBlock macro* was then used to create 32 choice sets with two alternatives each and to divide these choice sets in four blocks of eight sets each. The D-efficiency of this design was 60.54. Each respondent was randomly allocated to one of the blocks of eight choice sets and asked to complete each choice task, an example of which is presented in Figure 1.

Option A and B represent two different ginseng extract products. Please check (√) the option (A or B) that you would be most likely to purchase.		
Product attribute	**Option A**	**Option B**
Price	\$13.99	\$15.99
Internal tag added	No	Yes
Manufacturer	National Manufacturer Brand	Ontario Association of Ginseng Producers
Canadian ginseng guaranteed	No	No
Product of Canada	Yes	No
I would choose:	□	□

Figure 1. Example of Choice Set in Experimental Design

The experimental design did not include the option "I would choose neither A or B". The omission of the "no choice" option may seem problematic because respondents are forced to choose an alternative, if they would rather choose none. Hensher, Rose and Greene (2005), however, suggest that including the no-choice alternative is a decision that must be made according to the objective of the study. By forcing respondents to make a choice, they have to trade off the attribute levels of the available alternatives. Hence, obtaining data from the existing attribute levels and choices leads to a better estimation of the impact of the relationship between different attribute levels (Hensher, Rose and Greene 2005). Further, we could not rule out the possibility that many participants, despite being regular ginseng users would choose neither option in all eight tasks, because the package size or formulation was not their preferred one. This may have led to insufficient sample size. Finally, previous studies did not provide a no-choice option either (Enneking 2004) or showed that there were no significant differences between with and without "no-choice" option data (Carlsson, Frykbom and Lagerquist 2007).

The choice experiment was administered through the Ontario Food Panel[3] in April/May 2010 through an online survey. The introduction to the survey provided respondents with a basic understanding of the purpose of the study and a definition of natural health products. Regular users of ginseng products were then identified based on a sequence of screening question about natural health product consumption in the past 6 months. The main body of the survey consisted of four sections. The first set of questions was aimed at capturing respondents' natural health product consumption and purchasing habits, as well as their perception of product safety and trustworthiness of the various stages in the natural health product supply chain.

The choice experiment constituted the second part. At its beginning respondents received a short description of the new technology and its intended use, "*… to help protect consumers from adulteration and fraudulent activities such as mislabeling, dilution and substituting with inferior material."* Risks were not mentioned in this description, because the Health Canada approval of the technology required for its commercialization would not be obtained, if risks were evident. To reduce hypothetical bias that leads to inflated willingness-to-pay estimates, a so-called cheap talk script that reminded participants to not neglect the budget effect of their decisions (Lusk 2003) was applied in this study.

In the third section, participants were randomly assigned to positive, negative, and ambiguous information about the new technology, and a control group without any information prior to being asked questions about institutional trust and product safety. Finally, in the fourth section socio-economic and demographic characteristics were elicited. This paper is based on data from section one and two of the survey.

Data and Results

Sampling Procedure

An e-mail invitation to participate in the linked survey was sent to all Ontario Food Panel members but did not mention the topic of the survey. Of the total 5,057 invitations sent out, 286

[3] The Ontario Food Panel was initially funded by the Advanced Foods and Materials Network, AFMNet. It is administered through the Department of Food, Agricultural and Resource Economics at the University of Guelph.

failed to reach the panel member, while 1,647 members participated, yielding a response rate of 34.5%. This is rather high compared to similar studies using different survey methods (Baker and Burnham 2001; Lusk, Roosen and Fox 2003; Loureiro and Umberger 2007). Of the completed surveys, 1,436 (87.2%) were from respondents who had consumed natural health products in the past 6 months. Of the 1,436 natural health product users, 178 had consumed ginseng products. The next section will address the non-response error and possible further biases that will require adjustment through survey weights for data analysis. Although our analysis employs data of the ginseng users only, the assessment of biases will be based on the sample of natural health product users, as valid demographic information from outside sources was only available for this larger group.

Non-Response, Possible Biases and Survey Weights as Counter Measures

If not accounted for, non-response error can lead to wrong inferences from biased results (Hensher, Rose and Green 2005). Among the ways to identify non-response error proposed in the literature, comparison of respondents and non-respondents is applicable to this study (Lindner, Murphy and Briers 2001). Ideally the comparison should be based on variables that are directly related to the research purpose, i.e. propensity to accept new technologies. But information on these was not available for non-respondents. Hence, the demographic variables gender, age and education are used, as previous research has investigated links between these variables and risk perception and acceptance of new technologies. Table 2 presents the distributions of these variables for the Canadian population, the sample frame (Ontario Food Panel), non-respondents, respondents, the sample and the target population of natural health product users in Canada.

A second source of bias is related to using the Ontario Food Panel as sample frame. The part of the population that does not use the internet or does not participate in online survey research is obviously not represented in the panel, which may lead to a non-coverage bias. Due to the widespread use of Internet among the general public in 2010, it is a reasonable assumption that this bias was small. A panel selection bias can be observed when comparing panel membership (column 2) to the general population (column 1). The panel is characterized by a higher share of female, older and more highly educated people.

The data for assessing the non-response error is presented in columns 3 and 4 in Table 2. The respondent group includes more female, older and more highly educated panel members than the non-respondent group. Combined with the selection bias of the Ontario Food Panel membership reported in the preceding paragraph, it leads to substantive differences in the gender, age, and education distributions between our sample (column 5) and the target population of natural health product users (column 6). Hence, we had to weight the data to the target population of natural health product users (Biemer and Christ 2008; Gaudino and Robinson 2012). Before describing the chosen adjustment procedure, it is important to address the question whether the observed bias in demographic variables could lead to a bias in new technology acceptance.

Previous research has shed light on the linkages between consumers' demographic characteristics and their attitudes towards and acceptance of new food technologies. Although the diversity of specific study objectives, designs and contexts has produced mixed results, the following evaluations are relevant for this study. First, values and beliefs are generally better predictors of attitudes and acceptance than demographic characteristics (Lyndhurst 2009). Second, despite generally mixed results, a gender effect appears to prevail with a particular direction, i.e. females being less favorable toward new technologies, while higher education levels are weakly associated with being more accepting of biotechnology and irradiation (Teisl, Fein and Levy 2009). Given the nature of the observed bias, this information would lead one to expect that adjusting for the bias through demographics-based survey weights only has a weak impact on estimation results.

Table 2. Distribution of gender, age and education for Canadians, OFP[a] members, respondents, non-respondents, the sample of NHP[a] users and NHP users in Canada

	1: Canadian population 20-69 years	2: OFP members	3: OFP non-respondents	4: OFP respondents	5: Sample of NHP users	6: NHP users in Canada[b]
N		5057	3,410	1,647	1,436	
Gender						
Female	51.0%	65.1%	63.2%	69.2%	71.8%	55.9%
Age						
20-34	30.5%	24.5%	27.6%	18.0%	17.1%	32.4%
35-54	45.6%	50.5%	50.7%	50.1%	50.6%	45.3%
55-69	23.9%	25.1%	21.8%	31.9%	32.3%	22.3%
Education[c]						
High school degree or less	49.3%	20.0%	21.8%	16.6%	15.5%	44.0%
Trade school or college degree	28.1%	35.3%	35.9%	34.0%	32.6%	30.0%
University	22.6%	44.7%	42.4%	49.5%	51.9%	26.0%

[a] *OFP stands for 'Ontario Food Panel'; NHP stands for' natural health product.'*
[b] *Estimated by combining data from Ipsos Reid (2005) and 2006 census data from Statistics Canada (2006).*
[c] *The education data for OFP members and OFP non-respondents included an additional category "Some post-secondary education – not completed." 13% of panel members fell into that category. This category was dropped, because there was no equivalent in census data. The shares in columns 2 and 3 were proportionately adjusted to yield 100%. The data for OFP respondents and the sample came from our survey.*

Since we had no information to substantiate how the observed non-response bias in demographic variables would affect the variable of interest, i.e. acceptance of a new technology, we engage in probability weighting only and not in post-stratification adjustment (Gaudino and Robinson 2012; Lusk, Roosen and Fox 2003). Probability weighting is aimed at making the sample distribution of the chosen variables representative of the target population. For our analysis, we chose the variables 'Gender' and 'Education' for probability weighting, because of their magnitude of bias and the stronger evidence of impacting attitudes and acceptance of new technologies reported in the literature review by Teisl, Fein and Levy (2009). In short, the probability weights are obtained by dividing the relative frequency (in %) reported in each cell of the 'Gender' x 'Education' cross tabulation of the target population by the corresponding value in the sample cross tabulation. The weighting of the data was implemented through the STATA 11 command *pweight* (StataCorp, LP. 2009).

Two further features of the weighting process deserve mentioning. First, age was not included as a variable for weighting, because it would have produced sample cross tabulation classes with absolute frequencies of less than ten. This should be avoided as additional biases could be introduced, because the likelihood of bias increases with decreasing cell count and the bias would be amplified through a large survey weight, which also increases as cell count decreases (Biemer and Christ 2008). Second, no original data about the joint distribution of 'Gender' and 'Education' was available for the target population of natural health product users in Ontario. The cross-tabulation was constructed by assuming that the share of natural health product users among female (78%) and male (64%) respondents that was reported for the total sample in Ipsos Reid (2005) also holds for each education category. Knowing the distribution of Canadians across education levels from 2006 census data (Statistics Canada 2006) and the usage rates for the three education levels in Ipsos Reid (2005) then allowed estimating the share of females and males in each education category among natural health product users. However, if the estimated population distributions are inaccurate, estimates from weighted data could have greater bias than the ones from the original data (Biemer and Christ 2008). Since our assumption about the joint distribution of gender and education in the target population cannot be verified we will present the results for the unadjusted data first and then compare them to those for the weighted data.[4]

Finally, before turning to describing the sample of ginseng users as the particular group this research is interested in, a brief discussion is in order whether the sample size of 178 respondents is sufficient. As Hensher, Rose and Green (2005) point out determining the minimum required sample size for discrete choice experiments is still not well understood. Early on, rules of thumbs were used like that of Sawtooth Technology (Orme 2010: 65). However, in recent years research has increasingly focused on the relationship between sample size and experimental design (Kerr and Sharp 2010; Rose and Bliemer 2013). Johnson et al. (2013: 6) show for three simulation studies with optimal designs for conditional logit estimations that, "(…) precision increases rapidly at sample sizes less than 150 and then flattens out at around 300 observations." However, they do not indicate the number of choice tasks per respondent in these studies, which plays an important role in determining minimum sample size. In this regard, Rose (2011) suggests for a D-efficient design with nine or twelve choice tasks, minimum sample sizes of 86 and 55, respectively. Since our design with eight choice tasks is also D-optimal, we can state with some confidence that our sample size of 178 is sufficient for the results to be reliable.

Describing the Sample of Ginseng Users

An overview of the demographic and consumption characteristics of the sample of ginseng users, their motivations to consume ginseng and their consumption and purchase behavior are presented in Table 3. Since no reliable outside information was available, it is not possible to assess whether biases exist with regard to the listed variables. However, compared to the sample of natural health product users in column 5 in Table 2, ginseng users are more likely to be male, more likely to be in the 20-34 years age bracket, and more likely to be in the education level 'High school degree or less'.

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[4] The construction of survey weights has primarily increased the numbers of males in the lowest education category and reduced the number of females in the highest education category. A complete description of the weighting process is available from the authors upon request.

Table 3. Ginseng users sample (n=178): Distributions of characteristics

Characteristic	Level	Share
Gender	Female	68.5%
Age	20-34	21.5%
	35-54	47.7%
	55-69	30.8%
Education	High school or less	13.5%
	Trade school or college	35.9%
	University	50.6%
Use frequency	Once a week or more	33.6%
	Once a month or more but less than once a week	19.7%
	Less than once a month	46.8%
Usual purchase location	Pharmacy	30.1%
	Supermarket	27.8%
	Health store	27.3%
Reasons for taking ginseng products	Preventing an illness or health condition	90.4%
	Maintaining or promoting my general well-being	49.2%
	Treating an illness or health condition	45.2%

There appears to be no single dominant purchase location type, as pharmacy, supermarket and health store were all stated by about 30% of the respondents as usual purchase location. However, the frequency of using ginseng is rather low, as slightly less than 50% of respondents indicated to use it less than once every month. This does not contradict the fact that 90% of respondents use ginseng products to prevent an illness (i.e. cold), as part of episodic health management likely leading to seasonal use patterns.

Determinants of Product Choice

In the first survey section respondents were asked how important seven factors were in their decision to purchase ginseng products. Figure 2 presents the distribution of importance scores of each factor. The results show that the respondents placed higher values on direct signals of product quality and origin, than on brand, price, and advice from family and friends.

Although none of the signals refer directly to product safety, the focus group interviews in the qualitative stage of this study clearly showed that certified quality and origin, as well as brand very often serve as indicators of safety. Given the high importance scores, in particular for certified quality and origin, we would assume that a new technology for quality assurance and traceability would generally be met with consumers' acceptance.

Further, the importance scores provide an opportunity to cross-check with the results from the choice experiment whether the willingness to pay for the different signals of quality assurance and traceability have the same ranking as the importance scores.

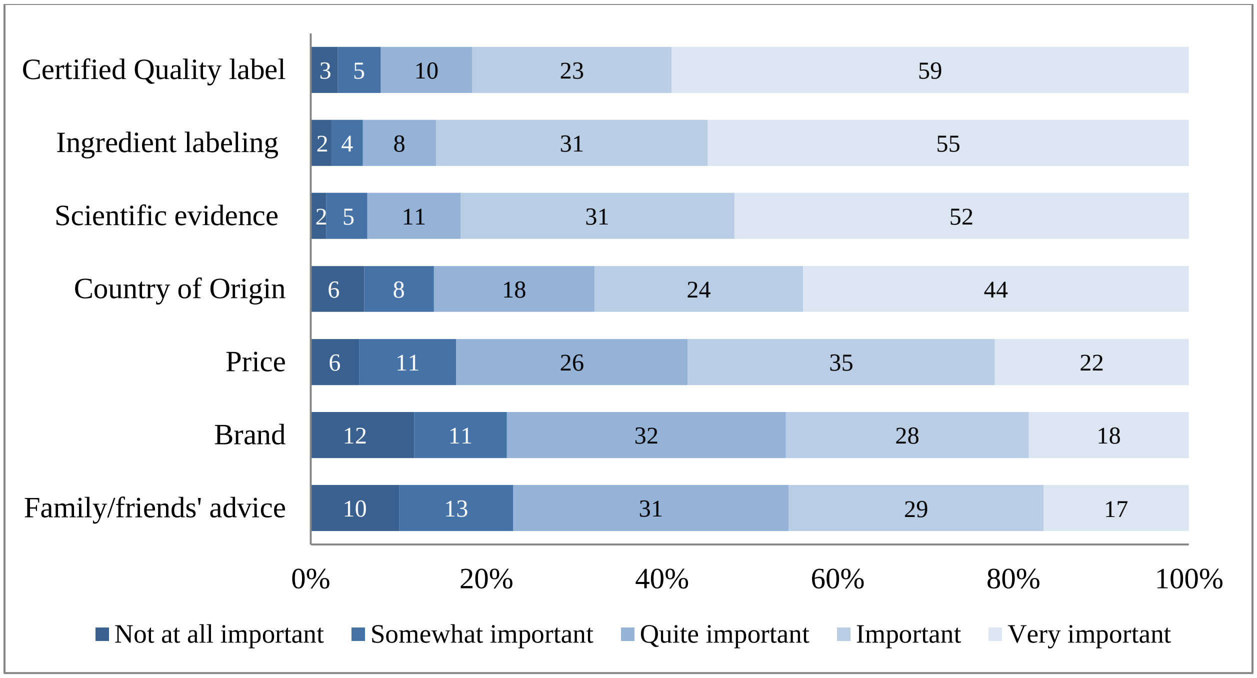

Figure 2. Importance scores distributions of purchase decision factors of ginseng users

Results from the Choice Experiment

The codes and short descriptions of the independent variables for the conditional logit regression are presented in Table 4.

Table 4. Variable descriptions for the Discrete Choice Analysis

Variables	**Code**	**Description**
Price	Price	price at \$13.99, \$15.99, \$17.99, or \$19.99/ bottle of 60 ginseng supplement capsules
Internal tag added	Tag	Dummy =1 if product has internal tag added, 0 otherwise
Manufacturer	Brand	Dummy =1 if product is labeled ‘National Manufacturer Brand’
Canadian guaranteed	CanG	Dummy =1 if product has ‘Canadian ingredient guaranteed’ label
Product of Canada	PoC	Dummy =1 if product has ‘Product of Canada’ label

Estimation results for two model specifications are reported in Table 5. Model 1 includes main effects only, while model 2 includes main effects with two-way interaction effects among quality signals. For model 2, the results are shown for the original, unadjusted data and for the weighted data.

Interpretation of results starts with assessing model fit. Although not exactly analogous to the R^2 statistic of the linear regression model, the pseudo R^2 of 0.30 for the models with unadjusted data would be equivalent to R^2 in the range of 0.6 to 0.7 in ordinary least squares (OLS) regression (Hensher, Rose and Greene, 2005). This model fit is acceptable according to Louviere, Hensher and Swait (2000), who stated that pseudo R^2 values between 0.2 and 0.4 are acceptable for choice models. The likelihood ratio (LR) test for nonlinear restrictions (Elrod, Louviere and

Davey 1992) was used to check for significant differences in fit between models. No significant differences were found between model 1 and model 2 for unadjusted data. When comparing between unadjusted and weighted data for model 2, it has to be noted first that model fit has decreased significantly for the weighted data. Pseudo R^2 is 0.248, compared to 0.305 with the unadjusted data; Log pseudo-likelihood is -745.8 compared to -677.8. The decline in model fit should, however, not be seen as a reason for dismissing the results with the weighted data, since model fit is still in the acceptable range.

Table 5. Conditional logit coefficients (standard errors), (n=178)$^+$

Attributes	Model 1, unadjusted data		Model 2, unadjusted data		Model 2, weighted data	
Tag	0.573***	(0.086)	0.527***	(0.193)	0.533**	(0.267)
Price	-0.191***	(0.018)	-0.190***	(0.018)	-0.155***	(0.026)
Brand	-0.286***	(0.084)	-0.444**	(0.215)	-0.575*	(0.338)
CanG	1.564***	(0.095)	1.805***	(0.177)	1.593***	(0.260)
PoC	1.090***	(0.092)	1.088***	(0.178)	1.012***	(0.240)
Tag*Brand			0.081	(0.189)	-0.013	(0.253)
Tag*CanG			-0.007	(0.183)	-0.014	(0.259)
Tag*PoC			0.028	(0.186)	-0.112	(0.248)
Brand*CanG			-0.101	(0.183)	-0.071	(0.257)
Brand*PoC			0.273	(0.189)	0.585**	(0.275)
CanG*PoC			-0.317*	(0.169)	-0.381	(0.254)
Pseudo-R^2	0.302		0.305		0.248	
Log likelihood	-680.7		-677.8		-745.8	

,*,* denote significance at the 10 percent, 5 percent, and 1 percent levels respectively.*
$^+$ *Each respondent was presented with 8 choice tasks, yielding a total of 1,424 (=8*178) possible observations of product choice. 17 choice tasks were not completed so that the total number of observations for the estimation is 1,407.*

Turning to the main effects for the product attributes, the signs and magnitudes of the regression coefficients are fairly robust across the models. In most cases, they remain significant at the 1% level. Only for 'Brand' the significance level drops from 1% to 5% from model 1 to model 2. The negative price coefficient is in line with a downward sloping demand curve: a price increase results in a decline in utility derived from the ginseng products, which, in turn, leads to a reduced purchase probability. The coefficients for internal tags imply that the participants in this survey derived higher utility from purchasing ginseng products with the tags than without them. The highest utility is derived from ginseng products with 'Canadian Guaranteed' labeling, followed by the labels indicating 'Product of Canada.' The negative coefficient of 'Brand' shows that respondents prefer a regional brand of Ontario producers over a national brand, which may reflect within-province support for producers and additional trust in their products.

When turning to the interaction effects among the product attributes signaling quality assurance and traceability, we are most interested in those between brand and the two signals of quality assurance. We also included interaction terms for internal tags*quality assurance signals, because, depending on the applicable authorization path, including the 'Internal Tags' under their technical identifier may be necessary. In both models, all coefficients involving 'Internal Tags' are far from being significant at the 10% level. Instead, the simultaneous use of the 'Canadian Guaranteed' label for key ingredients and the 'Product of Canada' label are found to have a negative impact on choice probability, which is significant at the 10% level. This result has to be interpreted as respondents seeing the two labels as substitutes. The change in the significance level for the 'Brand'*'Product of Canada' interaction term from unadjusted data to weighted data in model 2 will be discussed below for the corresponding willingness-to-pay estimate.

For ease of interpretation in the context of management decisions, the regression coefficients have been transformed into willingness-to-pay estimates that are presented in Table 5.

Table 6. Willingness-to-pay estimates ($/bottle with 60 capsules)

Attributes	**Model 1**		**Model 2, unadjusted data**		**Model 2 weighted data**	
Tag	3.006***	(0.515)	2.778***	(1.021)	3.427**	(1.725)
Brand	-1.501***	(0.474)	-2.341**	(1.169)	-3.698*	(2.201)
CanG	8.209***	(0.809)	9.518***	(1.219)	10.245***	(2.097)
PoC	5.719***	(0.645)	5.735***	(1.027)	6.507***	(1.738)
Tag*Brand			0.425	(1.004)	-0.086	(1.629)
Tag*CanG			-0.038	(0.966)	-0.092	(1.664)
Tag*PoC			0.149	(0.981)	-0.718	(1.601)
Brand*CanG			-0.532	(0.973)	-0.458	(1.672)
Brand*PoC			1.441	(1.008)	3.761**	(1.816)
CanG*PoC			-1.671*	(0.902)	-2.451	(1.623)

*,**,*** *denote significance at the 10 percent, 5 percent, and 1 percent levels respectively.*

Starting with the unadjusted data models 1 and 2, the significance levels of the individual estimates have not changed when compared to those of the regression coefficients. Willingness-to-pay for 'Internal Tags' is about $3 per bottle. Willingness-to-pay for 'Product of Canada' is about twice as high as that for the new technology. Still higher is the willingness-to-pay for 'Canadian Guaranteed,' $8.21 in model 1 and $9.52 per bottle in model 2. Respondents valued the brand option "National Manufacturer Brand" negatively, which has to be interpreted as positive willingness-to-pay for the "Ontario Regional Producer Brand," valued at $1.50 in model 1 and at $2.34 in model 2. The ranking of willingness-to-pay estimates is in line with the ranking of similar factors affecting the purchase decision reported by Ginseng users in Figure 2. Finally, the negative interaction term for the simultaneous use of the 'Canadian Guaranteed' and 'Product of Canada' labels can now be assigned a negative willingness-to-pay estimate of about $1.67 that needs to be subtracted from the sum of the main effects when they are used jointly on the product.

When comparing results for model 2 with unadjusted data to those with weighted data, it can be noted that significance levels and direction of willingness-to-pay for significant estimates have not changed much. However, a clear pattern of change is that standard errors and absolute values of the estimates have increased for the model with weighted data. Since the willingness-to-pay estimates of model two with the original data are relatively high already, a further increase in estimates may be questioned. Two important further changes should be noted that are relevant for the assessment of the regional branding option. First, although the significance level of the main effect deteriorated from 5% to 10%, its willingness-to-pay estimate increased. Second, the interaction term between ’Brand’ and ‘Product of Canada’ has become highly significant. Its positive sign suggests that the joint use of the ‘National Manufacturer Brand’ label and the ‘Product of Canada’ label is valued positively by consumers, in addition to the main effects.

Discussion

The primary objective of this study was to assess whether a new technology for enhanced quality assurance and traceability would be accepted by consumers when introduced to the marketplace. Secondary objectives were to determine whether a) consumers were willing to pay a premium for a regional producer brand, and b) the value of a regional brand could be impacted by existing signals of country of origin that are familiar to consumers. Answers to these questions would inform strategy development of a producer association, as the ‘internal tagging technology’ can potentially contribute to safeguarding future investment in branding and processing. But it can also be rejected by consumers, such as genetically modified foods in Europe.

The results of the choice experiment point to consumer acceptance and no interference with established signals of product origin. Willingness-to-pay for ‘internal tags’ being added to the ginseng capsules was positive. Between the two branding options investigated, participants favored the regional brand. In addition, the established quality signals ‘Canadian Guaranteed’ and ‘Product of Canada’ were valued positively by the respondents, leading to an increase in willingness-to-pay. This suggests that they should be considered for use in marketing strategy for strengthening quality reputation and assured product origin.

Signaling domestic origin of raw materials, the “Canadian Guaranteed” label was clearly valued most among the three traceability/quality assurance signals. This result is a bit surprising, because this label was clearly described as self-endorsed claim by a manufacturer. A recent study on the acceptance of functional foods in Canada shows that such self-endorsed claims typically are not highly valued by Canadian consumers (Hailu et al. 2009: 260f). The promised Canadian origin of raw materials may have over compensated the possibility of little trust in self-endorsed claims.

The applicability of the discrete choice approach to agribusiness management decisions has been demonstrated by Gallardo (2011). Although this case involves decisions that are possibly more strategic in nature than the one presented by Gallardo (2011), the mechanisms behind implementing a discrete choice study and interpreting the results, basically remain the same. However, an in-depth discussion of the limitations of (any) choice experiment study design and sample representativeness and validity of results are warranted, before conclusions for managerial decision making can finally be drawn.

Critical Assessment of the Limitations of the Experimental Study Design

The experimental design included only those features that were directly relevant to the research objectives. The design, however, can be quickly adapted to address specific questions in management decision making. More specifically, we did not differentiate between types of ginseng, e.g. Siberian/Asian vs. North American, which are used for different purposes or indications. Similarly, a number of salient attributes, such as package size, dosage, or type of application – pill, powder, or tea – were not included, although they will likely impact choices. However, at the time of data collection, while a pilot study for a new extraction method for ginseng was underway, plans for applying 'internal tags' to ginseng extract did not exist, nor an outline of a marketing strategy for products based on the new extraction method. Therefore, investing in a more specific study was not justified.

While Enneking (2004) had used actually existing brands in his study, the branding options in our study were deliberately not based on existing brand options. Although the concept of a 'National Manufacturer Brand" may be less accurate in measuring the value of a brand than using a known brand name, there are two strong reasons for not doing so. First, it is obviously problematic to imply that real brands are associated with the use of a new, not yet approved technology. Second, there are a number of established national brands in the ginseng market segment. Not including all may have introduced a bias, while including all would have complicated data collection and analysis. Hence, respondents were provided with examples of national brands in the introduction to the choice experiment. Further, a regional producer brand, as portrayed in the choice experiment, did not exist and thus could not be known to respondents. However, consumers are generally aware of collaborative marketing efforts of Ontario farmers in other sectors and would thus likely perceive the described branding effort as credible.

Conclusion

Recommendations for Marketing and Agribusiness Management

To the best of the authors' knowledge, only Chrysochou, Chyssochoidis and Kehagia (2009) have yet studied consumers' perceptions of traceability technologies but included only well established information carriers. The present study thus provides additional insights for a current topic in managerial decision making that has received little attention in academic reaserch so far. Scienitific advances will continue to hold potential benefits for enhanced traceability and quality assurance in the food and natural health product industries. Consumer concerns, however, may act as barriers to technology takeup. In light of the preceding discusison, the results of the study will be assessed along the three study objectives to arrive at recommendations for management decisions.

The positive and significant willingness to pay for the presence of 'internal tags' has to be interpreted as a signal of consumer acceptance. However, this does not mean that the producers should expect to be able to charge a premium for the presence of 'internal tags.' First, the new technology is a means to an end, i.e. assurance of a certain quality. For that quality promise a premium can then be charged. Second, it would require effectively communicating the benefits and use of the technology, which would be costly and risky.

The positive and significant willingness to pay for the regional ginseng producer brand points to a favorable consumer valuation. It likely also reflects within-province support and additional trust in the producers and their direct control over production methods and qualities supplied.

Whether this result can actually be translated into an actual premium will depend on their effective investment in quality assurance and branding. At the time of the study no branding strategy had been developed so that we could not make the branding options more specific. However, as strategy development and implementation planning progress, material to present the branding options more vividly and realistically, such as logos and vision statements would be available. These should be used jointly with existing brand names in a follow-up discrete choice experiment to assess how specific regional branding options would be valued relative to established brands.

The fact that the quality signals ‘Canadian Guaranteed’ and ‘Product of Canada’ received the largest willingness-to-pay estimates indicates that consumers value Canadian origin of a product. The fact, however, that these estimates are considerably larger than those for the regional brand does not mean that a national, i.e. Canadian branding strategy should be preferred over the regional branding strategy. With significant interaction effects between brand and the other two signals being largely absent, it is likely that it would be beneficial to establish a brand with a strong association with Ontario that also signals the Canadian origin to its customers. In that regard, the results of our study do not deviate from the empirical regularity that main effects typically account for most of the variation in a data set (Louviere, Hensher and Swait 2000). For future studies that should be taken as a recommendation to focus on the main effects of the estimation. In our study, they were found to be fairly robust across models and between weighted and non-weighted data.

The issue of using survey weights or not for adjusting sample data is not necessarily of concern to a growers’ association or an agribusiness company that faces a branding decision. But it should not be neglected, as the choice of one over the other may impact the outcome of the decision. In this particular study, the difference in outcomes was rather marginal from a marketing management perspective, given that main effects clearly dominated the results and were only little affected. However, the only compelling or acceptable reason to include results from both weighted and unadjusted data for interpretation was that one data set could not be clearly preferred over the other. In cases where non-response error and/or non-coverage error with respect to the key variables of interest can be clearly grasped and accounted for, the weighted data is preferable.

Finally, while we hope to have illustrated the practical value of our study, a disclaimer is in order that the insights from the choice experiment only have limited value in the preparation for impacts from negative publicity about or campaigning against the new technology.

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