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Consumers' Preferences Regarding Agricultural Biotechnology

By

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled *Consumers' Preferences Regarding Agricultural Biotechnology* submitted by *Diane Lynne McCann* in partial fulfillment of the requirements for the degree of *Master of Science* in Agricultural and Resource Economics.

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ABSTRACT

This study is motivated by an increased prevalence of agricultural biotechnology. It focuses on peoples' preferences for two food policies, increased labeling or increased food inspection, directed at providing a higher level of food quality assurance. The data for this study were collected through a 1999 telephone survey of Alberta residents.

Conditional logit models were developed to examine the socio-economic characteristics of consumers and their preferences for particular policy options. Consumers' median willingness to pay for the policy options were calculated based on the results of the conditional logit estimations.

The results suggest that consumers tend to prefer and are willing to pay for a policy for developing a labeling system that gives more information about agricultural biotechnology for food; there is a preference for a labeling policy over a policy of more restrictive regulation. Similarly, a policy that will increase food inspection tends to be preferred to more restrictive regulation. Overall, more people preferred to pay for a food labeling policy than for increased food inspection. It appears that females are willing to pay more than males for both the food policy options of labeling and inspection in the case of agricultural biotechnology.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Background

Food safety is a concern for many Canadian consumers. A survey by Environics (1999) found that 35 percent of respondents identified food safety as the food issue of most concern. The nutritional value of food was identified by 26 percent of respondents as the food issue of most concern, and 18 percent identified quality, taste, and appearance as the greatest concern. Almost half (47 percent) of respondents are "very concerned" about food safety (Environics, 1999). When queried about specific food safety issues, 63 percent of respondents indicated they were "very concerned" about chemical pesticides, 45 percent were "very concerned" about antibiotic use in livestock and 37 percent of respondents indicated they are "very concerned" about genetically engineered foods or biotechnology (Environics, 1999).

Over the last ten years, consumers have become more aware of agricultural biotechnology. National surveys indicated an increase from 54 percent in 1997 to 68 percent in 2000 in the number of Canadians who had seen or read anything on biotechnology in the previous three years (Einsiedel, 2000). Increased consumer awareness can at least be partly attributed to the growth in the scope of biotechnological procedures and products during the past decade. Biotechnology-derived crops were planted on an appreciable scale in 1996 and the level of their planting has increased rapidly since then (OECD, 2000a). The largest area of genetically modified crop plantings, by far, has been in the United States. Plantings of genetically modified crop varieties in Argentina, Canada, China, and Australia have also been significant (OECD, 2000a,b; Europa, 2000). Most of the products that have been approved in Canada are crop plants--corn, canola, potatoes, and soybean--that have been genetically modified to improve agronomic characteristics such as crop yield, hardiness and uniformity, insect and virus resistance and herbicide tolerance (Health Canada, 2000).

Although research is being conducted on genetically modified wheat, currently, no genetically modified varieties of wheat or barley have been registered for commercial production. "The earliest any transgenic wheat variety could be considered for registration in Canada is 2003 or later" (Canadian Wheat Board, 2001). The reported results of focus groups conducted by the Canadian Wheat Board (CWB) across Western Canada in 2000 and 2001 indicate that there is a lack of enthusiasm among farmers about genetically modified wheat, mainly because of concerns over increased costs (Ewins, 2001). Lack of domestic consumer acceptance and export markets for genetically modified wheat as well as the lack of an effective segmentation system in Canada are some of the other concerns expressed by industry spokespeople about the potential commercial production of genetically modified wheat (Ewins, 2001).

Despite the proposed benefits of agricultural biotechnology, such as reduced pesticide and herbicide use, together with prospects for improved crop quality and increased productivity, numbers of people are doubtful about the new technology. Those opposed to agricultural biotechnology maintain that neither the long-term human health effects from consuming genetically engineered products nor the long-term environmental effects of growing genetically modified crops are known. Ethical and social questions that have been raised include the right of companies to own and alter the genetics of plants or animals and consumer's right to be informed about what they are consuming.

A number of economic research studies have been undertaken, mainly in the United States, on consumers' attitudes towards agricultural biotechnology. For example, Hoban and Katic (1998) surveyed American consumers and found men to be more aware of biotechnology, excluding cloning, than women. Men were found to be more likely to perceive benefits from biotechnology. Hoban and Katic (1998) also found that men were more likely to express support for the food labelling policy of the United States agency, the Food and Drug Administration (FDA). Hoban and Katic (1998) concluded that respondents with more years of education were more aware of the general process of biotechnology and cloning as well as the benefits of biotechnology. Men and younger respondents appear to be more willing to buy foods developed through biotechnology (Hoban and Katic, 1998).

Numbers of polls have also focused on Canadian consumers' attitudes toward biotechnology. An example of this type of poll is the survey of Canadians' attitudes towards biotechnology by Environics (1999) noted above. Surveys were undertaken by Einsiedel in 1997 and 2000 to determine if Canadian consumers' attitudes and knowledge of biotechnology had changed during that period. Einsiedel (2000) found that people under 34 years of age, university graduates, and males are most likely to agree with the statement that applications of biotechnology should be encouraged. These studies, patterned on European assessments of consumer attitudes undertaken through Eurobarometer surveys, also shed light on how some attitudes vary internationally. An example is the level of trust in government and related organisations, which seems to be much lower in some European countries than in Canada. Another example of an assessment of Canadians' attitudes to agricultural biotechnology is the National Institute of Nutrition's qualitative study that was completed in 1999 to assess consumers' understanding and interpretation of label messages for the voluntary labelling of foods that have been developed with the aid of biotechnology. This study found that: 1) the wording of labelling messages considerably affects the level of consumer understanding; 2) consumers want to be informed through labelling messages that are simple; 3) consumers want to be informed through labelling messages that are linked to government regulatory approval (National Institute of Nutrition, 1999).

In March 1999, a panel convened in Calgary with the objective of isolating the concerns and benefits of biotechnology perceived by the average Canadian citizen. The citizens panel was charged with recommending ways to address the issues they identified. Overall, the panel concluded that biotechnology could be a safe and beneficial technology (Citizens Conference on Food Biotechnology, 1999). Some of the concerns that the panel felt should be addressed were genetic modification of animals, unresolved labelling issues and the separation of government regulatory agencies and promotional agencies (Citizens Conference on Food Biotechnology, 1999).

A relatively small number of studies have attempted to analyze directly the effect of the presence of genetically engineered products on consumption decisions. Most of these studies focused specifically on consumers' attitudes towards recombinant Bovine Somatotropin (rBST). This is a genetically engineered version of bovine somatotropin, a naturally occurring hormone, which stimulates milk production in cows. Kuperis et al (1999) found that the probability of a Canadian consumer purchasing milk decreased if the milk is identified to be from cows that have been treated with rBST.

A study of labelling of rBST milk by Burrell (1999) in the Netherlands found that women are less likely than men to purchase milk if the milk was labelled as rBST milk. Burrell also found that when non-rBST milk is labelled, and thus perceived as less risky than rBST milk, women were more likely than men to prefer the nonrBST milk. Burrell concluded that high levels of education were not a relevant factor in predicting who will not buy labelled rBST milk. However, in a study of American consumers, Wang et al (1997) found that: 1) individuals with a lower education level tended to be willing to pay less for rBST-free milk; 2) consumers in one urban county of the United States were willing to pay more for rBST milk than people in more rural counties; 3) income tended to have a positive impact on willingness to pay for rBST-free milk.

1.2 Objectives of the Study

The objective of this study is to gain more information on consumers' attitudes and reactions to agricultural biotechnology. Given the increasing importance of the issue of food biotechnology as a food safety or food quality issue, and the lack of knowledge about consumers' preferences for different policy options, this thesis research is particularly timely. The study provides information on consumers' attitudes about agricultural biotechnology and consumers' preferences for policies that will provide a higher level of food quality assurance. From a policy makers' perspective, the results of this study provides information on consumers' attitudes and preferences to the specified policy options. The specific objectives of the study are to:

1. Determine if there have been shifts in attitudes towards biotechnology over time given limited data;

2. Understand consumers' attitudes and preferences for different policy options. These policy options could:

   - place restrictions on the production, processing or marketing of food that contains products of biotechnology
   - increase food inspection
   - provide information on food labels about the effects of agricultural biotechnology.

1.3 Thesis Organization

The next chapter presents a literature review. In this review, the current regulatory system for biotechnology in Canada is described, as are some previous studies on food safety issues and biotechnology. A brief explanation of labelling theory and labelling issues is also presented. The design of the survey used to gather the data for this study, and the information used to examine the individual socio-economic characteristics that affect consumer preference and willingness to pay for three policy options are then discussed in Chapter 3. A comparison of food quality concerns between data obtained in an earlier survey conducted in 1995 and the data set obtained in 1999 is made in Chapter 4. The theory underlying the model development and estimation is explained in the next chapter. The estimation results and analysis are presented in the sixth chapter. In the final chapter, conclusions and policy implications of the research are put forward and future research possibilities in the area are outlined.

2 LITERATURE REVIEW

2.1 Regulation of Biotechnology in Canada

The Canadian policy response to biotechnology is focused on regulating the product rather than the process used to make the product. That is, the safety of food derived from a new crop plant is assessed, rather than the focus being on the method used to develop the plant. The Canadian Food Inspection Agency (CFIA) and Health Canada are responsible for assessing the safety of foods derived from biotechnology.

The CFIA is responsible for the regulation of products derived from biotechnology, including plants, animal feeds and animal feed ingredients, fertilizers, and veterinary biologics (Canadian Food Inspection Agency, 2001). Health Canada is responsible for assessing the safety of products for human health derived through biotechnology including foods, drugs, cosmetics, medical devices and pest control products (Canadian Food Inspection Agency, 2001). In assessing the safety of genetically modified products, Health Canada has the responsibility to undertake scientific assessments. Health Canada examines how the food was developed, including a full description of the genes involved in the modification and their integration into the modified product (Health Canada, 2001). Health Canada also assesses the composition of the product and its nutritional quality and the potential for the production of toxic or allergenic products (Health Canada, 2001).

Two Canadian polls suggest that strong support for the current Canadian regulatory system is limited. In 1995 and 1999, only eight percent of respondents stated that they "strongly agree" that biotechnology was being properly regulated (Environics, 1999). These reported percentages are slightly higher than Einsiedel found for a somewhat stronger statement relating to regulation. Einsiedel (2000) found that almost four percent of Canadians "strongly agree" that the current regulations are sufficient to protect people from any risks linked to genetically modified food. The design of the Canadian regulatory system has prompted groups, like the Royal Society of Canada, to ask for changes to the system to be made (Wilson, 2001). The increased interest in issues of food safety and quality, and the increased recognition of the widespread nature of biotechnology and concerns about consumer confidence in the current regulatory system, are underlying reasons to investigate consumers' preferences for policies that may provide higher levels of confidence in the regulatory system.

2.2 Socio-economic Factors that Influence Consumers' Attitudes

Economic theory related to product quality, together with information from previous studies and literature on consumers' perceptions of food safety, biotechnology, labelling, and *a priori* reasoning, indicated the importance of several socio-economic factors that may influence respondents' attitudes, suggesting the possible importance of age, household income, gender, marital status, years of schooling, number of children in the household, and location of residence. The importance of these socio-economic influences is supported by the studies of consumers' perceptions of biotechnology conducted by Hoban and Katic (1998), Burrell (1999), Einsiedel (2000) and Wang et al (1997).

A study of consumers' attitudes towards food safety in the United States by Lin (1995) found that individuals' age and gender may have a significant effect on their attitudes towards food safety. Older consumers are generally expected to be more concerned about food safety than younger consumers. Women are generally observed to be more concerned about food safety than are men. Lin (1995) also found that households with young children are more concerned about food safety.

Kuperis et al (1999) completed a study on consumers' perceptions of milk containing rBST. The results of this study indicated that age, gender, number of years of education completed by the respondent, and the number of children in the household who are under the age of six have a significant effect on consumers' perceptions of rBST milk.

2.3 Some Issues Related To Food Labelling

Economic analysis of consumer choice in the absence of full information has included the development of the concepts of experience, search and credence characteristics of goods. Experience attributes are those features that a consumer can determine only after using the product; an example could be the flavor of a particular formulation of a food. In contrast, search attributes are features, like price, that can be determined before buying the product; thus a major issue facing consumers for such products are to locate or search for their chosen product. Credence attributes are attributes that can not be measured (Nelson, 1970).

Food safety and nutritional characteristics of foods can be referred to as credence attributes because consumers cannot measure these qualities of foods (Caswell and Mojduszka, 1996). For example, looking at an apple or eating an apple does not provide any information to the consumer about the conditions in which the apple was grown; although these conditions may affect quality characteristics that can be valued by some consumers. However, if the apple was labelled "pesticide free" or "organic", the consumer would know that the apple was grown without pesticides or under the protocols that apply for organic labelling. By providing information to consumers through labelling, credence attributes (attributes that can not be measured) can be turned into experience attributes (attributes that a consumer can determine only after using the product) or search attributes (attributes that can be determined before buying the product) (Nelson, 1970).

Several approaches to labelling policies have been discussed in the context of public policy. One set of issues relates to the use of label messages that contain positive statements about ingredients such as "this product contains genetically modified organisms," versus negative claims such as "this product does not contain genetically modified organisms". One variant of positive label statements is the message that "this product may contain genetically engineered organisms", but there is evidence that such indefinite statements are opposed by many consumers as uninformative statements (Veeman, 2001). Another major set of issues relates to voluntary labelling of content or process versus the mandatory labelling requirements for foods derived from agricultural biotechnology that are being adopted in numbers of countries.

Some commentators have stressed the prevalence of crop biotechnology and the difficulty of providing an absolute guarantee of food that does not contain ingredients derived from genetically modified organisms. Some "estimate that about 70 percent of processed foods in Canada now contain genetically engineered products" (Anonymous, 1999). Therefore, in North America it has been argued that, given the extent to which genetically engineered ingredients are in foods, mandatory label statements would convey little information (Runge and Jackson, 1999).

Negative labels like "this product contains no genetically modified organisms" or "this product has not been genetically modified" requires that "no" be defined in terms of a minimum threshold. In circumstances where labelling is not mandatory, as in North America, where process labelling is only mandated if there are compositional changes or potential allergenic characteristics of modified food, voluntary negative rather than positive labelling is expected to be pursued by food processors and/or retailers.

Voluntary labelling of food containing genetically modified products is permitted in Canada if the claims are factual and are not misleading or deceptive. Negative labelling claims require the labeled crops to be segregated from genetically modified crops during production, marketing and processing. Such labelling claims will involve costs of segregating the genetically modified product from conventionally produced products and the resulting verification and monitoring. The costs associated with this will necessarily have some influence on the cost of food marketing. Because food products are marketed internationally, differences in definitions and labelling requirements associated with this issue can also be expected to add to the costs of trading.

Previous studies tend to indicate a high level of public support for labelling. For example, in the 1999 Environics poll, 61 percent of respondents stated that they "strongly disagree" that special labelling of genetically modified foods is NOT necessary (Environics, 1999). The need for more information on attitudes towards labelling and the recognition that a labelling policy may involve costs and tradeoffs underlies this research.

3 THE DATA

3.1 Introduction

The survey questions for this study were developed by Dr. Michele Veeman and Dr. Victor Adamowicz in the Department of Rural Economy at the University of Alberta. The Population Research Laboratory at the University of Alberta was commissioned to include these questions as part of their annual survey of Albertans. The entire survey was conducted by means of telephone interviews between January 5, 2000 and February 8, 2000. Initial contact was made with 2,235 Albertans. Call backs were made to reluctant householders to increase the response rate. The final sample of individual information from 1,203 interviews was obtained, for a response rate of 53.8 percent.

Socio-economic data that includes the age, gender, years of education, marital status, household income, location of residence and number of children in the household were collected from each respondent. The reported descriptive statistics are based on the final sample of 1,203 respondents. In the sample, there were 603 males and 600 females. The average age of the respondents was 42. The average household income of respondents in the survey was between $50,000 and $54,999. Respondents had completed an average of 14.5 years of school. This sample was representative of Alberta's population. The indexes of dissimilarity for the total sample demonstrate that the sample adequately reflects the population from which it is drawn (Dennis, 2000).

The interviews conducted for this study covered a range of related issues, including questions focusing on health risks and biotechnology. Each respondent was provided with the following definition of agricultural biotechnology:

> *"Agricultural biotechnology refers to biological methods that use living organisms, like cells, or parts of them (genes), to make changes in plants or animals so that crop and livestock production can be increased"*
> (1999 Alberta Survey Questionnaire/Codebook 2000, 4).

3.2 Health Risk Questions

Data on views of health risks were collected through several questions conducted near the beginning of the interview. First, respondents were asked whether six possible health risks pose: almost no health risk, slight health risk, moderate health risk or high health risk. The six possible health risks that respondents were asked about were pesticides, bacteria, food additives, agricultural biotechnology for plants or crops that are used for food, agricultural biotechnology with farm animals that are used for food, and dietary fat and cholesterol intake. In another set of questions for this study, respondents were asked to rank, in order of the importance of their concern, six possible health risks to the Alberta public. The specified concerns were pesticides, bacteria, food additives, agricultural biotechnology for plants or crops that are used for food, agricultural biotechnology with farm animals that are used for food, and dietary fat and cholesterol intake. The responses to the health risk questions are presented in Chapter 4.

3.3 The Policy Preference Questions

During the telephone interviews, respondents were presented with two hypothetical situations. In scenario one, respondents were asked questions about their preferences for a policy that would place restrictions on the production, processing or marketing of food, versus a policy that would increase food inspection. In scenario two, respondents were asked questions about their preference for a policy that would place restrictions on the production, processing or marketing of food, versus a policy for developing a labelling system for food that gives information on the effects of agricultural biotechnology. The purpose of asking these questions was to determine whether respondents would choose a particular policy option as a means to achieve higher levels of food safety assurance and to assess which policy option they would prefer.

In the first hypothetical situation, respondents were told that food costs are expected to increase if food inspection was increased or if the use of agricultural biotechnology that increases crop or livestock production was limited. Specific questions related to this scenario were then given. The wording of the questions was as follows;

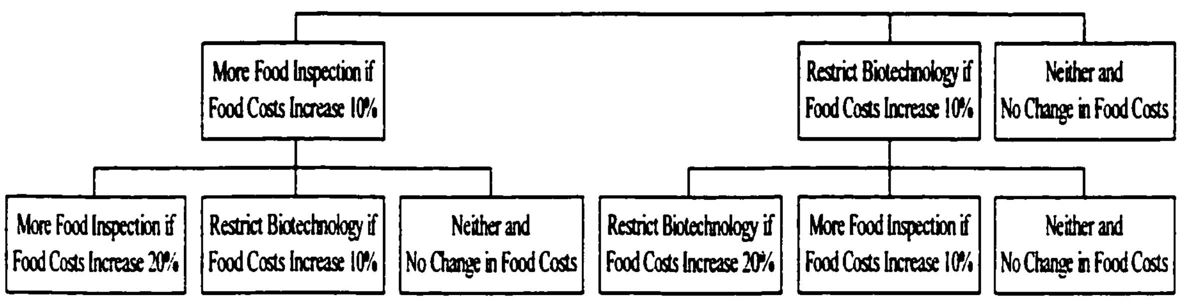
1. "Now suppose each of these (increasing food inspection and limiting the use of agricultural biotechnology) will lead to a 10 % increase in food prices. If you HAD to choose, would you choose more food inspection, limiting the use of agricultural biotechnology or not restricting either and keeping food prices at current levels?

2. Suppose that increasing food inspection leads to a 20% increase in food costs and restricting agricultural biotechnology leads to a 10% increase in food costs. Which would you choose, more food inspection, limiting agricultural biotechnology or no change and keeping food prices at current levels?

3. Suppose that restricting agricultural biotechnology leads to a 20% increase in food costs and more food inspection leads to a 10% increase in food costs. Which would you choose, increased food inspection, limiting agricultural biotechnology or no change and keeping food prices at current levels?" (1999 Alberta Survey Questionnaire/Codebook 1999, p.5)

All respondents were asked question one. Respondents choosing more food inspection were then asked question two. Respondents choosing to limit agricultural biotechnology in response to question one were then asked question three. Respondents who chose neither more food inspection nor limiting agricultural biotechnology in response to question one were not asked the second or third questions. This format elicited responses involving choices of the two policy options of inspection and regulation identified in question one, in situations where increasing food costs would result if there was more inspection or if biotechnology were restricted. A summary of the possible responses to the questions are presented in Figure 3-1. The responses to these three questions composed one set of the discrete choice data used to develop an econometric choice model.

Figure 3-1 Possible Responses to the Policy Preference Questions in Scenario One



In the second hypothetical situation presented to respondents, respondents were told that food costs are expected to increase if a labelling system for food was developed that gives information on the effects of agricultural biotechnology or if the use of agricultural biotechnology that increases crop or livestock production was limited. The wording of these questions was as follows;

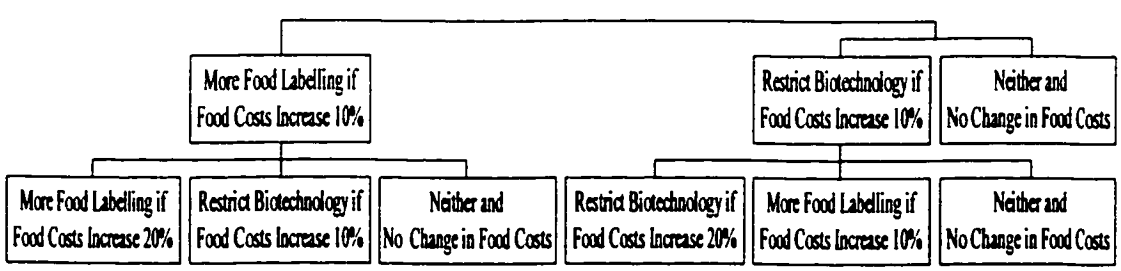
1. "Now suppose each of these (developing labelling systems and limiting agricultural biotechnology) will lead to a 10 percent increase in food prices. If you <u>HAD</u> to choose, would you choose more food labelling, limiting the use of agricultural biotechnology or not restricting either and keeping food prices at current levels?

2. Suppose that the labelling requirements lead to a 20 percent in food costs and restricting agricultural biotechnology leads to a 10 percent increase in food costs. Which would you choose, labelling requirements, limiting agricultural biotechnology or no change and keeping food prices at current levels?

3. Suppose that restricting agricultural biotechnology leads to a 20 percent increase in food costs while labelling requirements lead to a 10 percent increase in food costs. Which would you choose, increased food inspection, limiting agricultural biotechnology or no change and keeping food prices at current levels?" (1999 Alberta Survey Questionnaire/ Codebook 1999, p. 6)

Again, all respondents were asked question one. Respondents choosing more food labelling were asked question two. Respondents choosing to limit agricultural biotechnology were asked question three. Respondents who chose neither more labelling nor limiting agricultural biotechnology in response to question one were not asked the second or third question. This format elicited responses involving choices of the two policy options of food labelling and regulation identified in question one, in situations where increasing food costs would result if there was food labelling or if biotechnology were restricted. A summary of the possible responses to the policy preference questions are presented in Figure 3-2. The responses to these questions compose the second set of the data used to develop an econometric choice model.

Figure 3-2 Possible Responses to the Policy Preference Questions in Scenario Two



In both sets of questions, the responses indicate the respondents' willingness to make a trade-off between paying increased food costs for a higher level of food safety assurance through specified policy options. The respondent's preference for a particular policy option and their willingness to pay for this policy in terms of higher food costs are reflected in their choices.

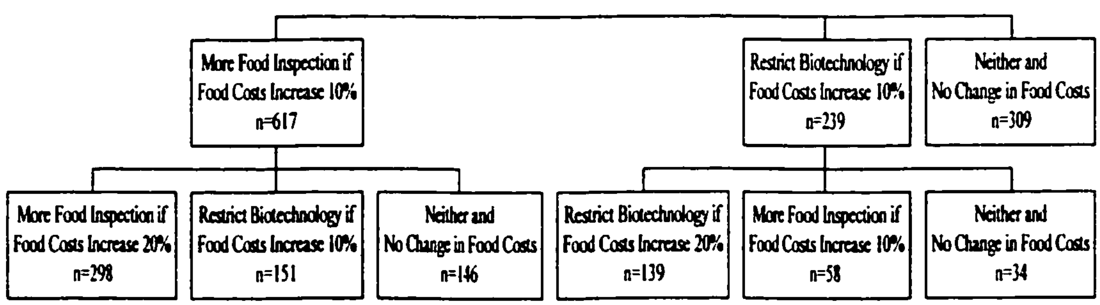
The policy preference questions were designed in a format that lies between a double-bound dichotomous choice framework and a single-bound dichotomous choice framework. In a typical double-bound framework, respondents are involved in two rounds of bidding. Respondents respond to the first dollar amount presented in the first question and then face a second question involving another dollar amount, higher or lower depending on the response to the first question (Hanemann et al, 1991). In this set of policy preference questions, in the second round of bidding, respondents were only given an opportunity to pay a higher amount for the policy option. For example, respondents who are willing to pay an additional 10 percent for food if biotechnology is restricted, are then asked if they are willing to make a bigger tradeoff, in terms of even higher food costs, if they chose the same policy. If respondents are not willing to pay an additional 20 percent for food to restrict biotechnology, these respondents can chose to increase food inspection if food costs increase 10 percent. Unlike a double-bound framework, respondents were not provided with an opportunity to pay a lower amount for the same policy option. In single-bound dichotomous choice format, respondents are asked only one question. The respondent either indicates "yes" they choose the policy or good at or above a specified payment amount, or "no" they do not choose the policy at the specified amount. This type of question does not allow the respondent to indicate to what extent, above the specified amount, they value the policy. Hanemann et al (1991) concluded that the double-bounded dichotomous approach is asymptotically more efficient than a single-bounded approach.

3.4 Description of Responses to Policy Preference Questions

The numbers of responses to the policy preference questions in scenario one and scenario two are presented in Figure 3.3 and Figure 3.4, respectively. Respondents who answered either "don't know" or gave no response to the questions are excluded from the tables, from the data set and from the econometric estimation.

Figure 3.3 illustrates that a higher percentage of respondents chose food inspection rather than restricting biotech or neither. When food inspection increased food costs by 20 percent, almost 50 percent of those respondents who initially choose more food inspection continued to choose inspection over the other two options. When limiting agricultural biotechnology increased food costs by 20 percent, the majority of those respondents who initially chose limit agricultural biotechnology continued to choose this policy option over the other two policy options.

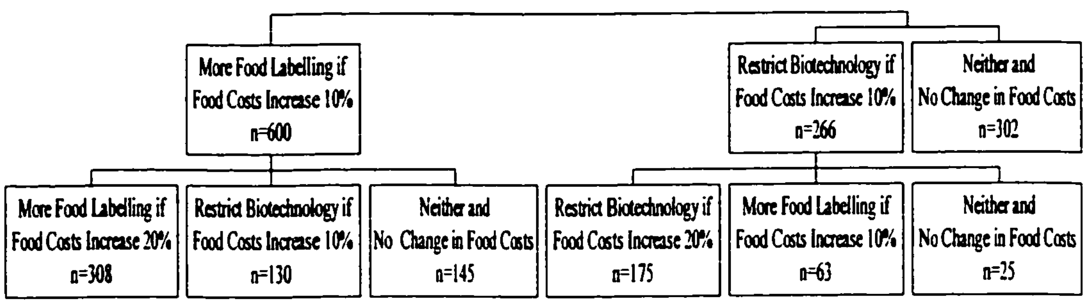
Figure 3-3 Respondents' Choice to Increase Food Inspection, Limit Use of Agricultural Biotechnology or Neither Policy Option[1]



[1] The number of responses to the first question are presented in the first row of Figure 3-3 The number of responses to the second question are presented in the first three boxes in the second row of Figure 3-3 and the number of responses to the third question are presented in the last three boxes in the second row.

Fig 3.4 illustrates that a higher percentage of respondents chose more food labelling rather than restricting biotech or neither. When more food labelling increased food costs by 20 percent, the majority of those respondents who initially choose more food labelling continued to choose labelling over the other two options. When limiting agricultural biotechnology increased food costs by 20 percent, almost half of the respondent who initially chose limits agricultural biotechnology continued to choose this policy option over the other two policy options.

Figure 3-4 Respondents' Choice to Develop a Labelling System, Limit Use of Agricultural of Biotechnology or No Change in Either[2]



3.5 Sources of Health Risk and Food Benefit Information

During the telephone surveys, respondents were told "people get information about health risks and benefits of food from different sources" (Alberta Survey Questionnaire 1999, p7). The respondent was asked the question "In what ways do you get MOST of your information about such health risk?" (Alberta Survey Questionnaire 1999, p7). The ten sources of information that were most frequently stated by

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[2] The number of responses to the first question are presented in the first row of Figure 3-4. The number of responses to the second question are presented in the first three boxes in the second row of Figure 3-4 and the number of responses to the third question are presented in the last three boxes in the second row.

respondents and the number of respondents who stated each source of information are presented in Table 3-1. The source of information most frequently stated by respondents was magazines/ newspapers and television/radio. Some 104 respondents stated food labels as a source of information and only seven respondents stated government/ government publications as a source of information.

Table 3-1 Sources of Health Risk and Food Benefit Information

Source of Information	**Frequency**
Magazines/Newspapers	780
Television/Radio	649
Books	145
Friends, neighbors, relatives	124
Food labels	104
Leaflets	75
Internet	64
Doctor	59
Other health care professionals (excluding nurses)	52
Government/Government publications	7

4 COMPARISON OF FOOD SAFETY CONCERNS

A useful context to assess consumer's perceptions of biotechnology may be gained from comparing the perceptions of biotechnology with other food safety issues. In 1996, a previous study by Kuperis et al, of Alberta consumers' attitudes towards genetically engineered hormones and other food safety issues in 1995 applied similar questions to the questions that were asked in this study. A comparison between consumers' attitudes towards food safety concerns in 1999 and 1995 will be made to determine if consumers' attitudes have changed over the four intervening years.

In 1995, respondents were asked to state if five food safety concerns posed a health risk. These health risks were pesticides in food, bacteria in food, food additives, genetically engineered growth hormones that increase livestock productivity and dietary fat and cholesterol intake. The respondents could state that the food safety concern poses "almost no health risk", "slight health risk", "moderate health risk", or "high health risk" (The Alberta Survey Codebook 1995, p.13).

In the 1999 survey, respondents were asked to state if six food safety concerns presented a health risk. The six food safety concerns presented to the respondent were: pesticides in food, bacteria in food, food additives such as preservatives and colouring agents, agricultural biotechnology for plants for plants or animals that are used for food, agricultural biotechnology with farm animals that are used for food, and dietary fat and cholesterol. The respondent was queried about each food safety concern individually. For example, the respondent was asked, "how much of a health risk are pesticides in food to the Alberta public?"(1999 Alberta Survey Questionnaire/ Codebook 1999, p. 3).

The respondent could chose between "almost no health risk", a "slight health risk", a "moderate health risk", or a "high health risk".

A comparison of health risk perceptions between 1999 and 1995 suggests that Albertans' perceptions of food safety concerns have not changed much over four years. The ratings are provided in more detail in Table 4-1. In 1999, dietary fat/ cholesterol and pesticides were rated as moderate or high health risks by 87.2 percent and 74.7 percent of respondents, respectively. These findings are very similar to 1995, where dietary fat and cholesterol and pesticides and were rated as moderate or high health risks by 86.8 percent and 77.4 percent of respondents, respectively.

The 1999 data also suggest that agricultural biotechnology for animals is perceived to be a slightly higher food safety concern than is agricultural biotechnology for plants and crops. In 1999, agricultural biotechnology "for plants or crops used as human foods to increase plant or crop productivity" was rated as a moderate or high health risk by 56.1 percent of respondents. Agricultural biotechnology "for farm animals used to increase livestock productivity" was rated as either a moderate health risk or a high health risk by 62.2 percent of respondents. In 1995, growth hormones were rated as a moderate or high health risk by 66.6 percent of respondents.

The respondents' ratings in 1995 and 1999 were assessed using the Kolomogorov-Smirnov two-sample test to determine if the two independent samples were from populations with the same distribution (Siegel, 1956). The ratings for agricultural biotechnology used in plants were excluded from this analysis because this health concern was not included in the 1995 survey. Respondents were queried about genetically engineered growth hormones in 1995 and agricultural biotechnology for animals in 1999. Thus these ratings were included in the analysis. The results of this test suggest that the respondents' ratings in 1995 and 1999 are from the same population. The differences between the ratings reported in 1995 and 1999 are not statistically significant.

Table 4-1 Respondents Ratings of a Specified Food Safety Concern[1]

	Percentage of respondents that rated the food safety concern as:							
	High Health Risk		Moderate Health Risk		Slight Health Risk		Almost No Health Risk	
	1999	1995	1999	1995	1999	1995	1999	1995
Dietary Fat and Cholesterol	45.8	49.5	41.4	37.3	11.1	9.5	1.7	3.6
Pesticides in Food	35.8	37.4	38.9	40.0	20.8	18.3	4.5	4.4
Growth Hormones	N/A	29.5	N/A	37.1	N/A	23.3	N/A	10.0
Agricultural Biotechnology: Animals	28.3	N/A	33.9	N/A	24.8	N/A	12.9	N/A
Bacteria in Food	26.7	23.6	38.7	39.1	28.5	28.1	6.0	9.2
Agricultural Biotechnology: Plants and Crops	23.8	N/A	32.3	N/A	26.7	N/A	17.2	N/A
Food Additives	21.9	23.1	36.0	39.3	30.4	29.6	11.9	7.9

[1] percentages may not add to 100 because of rounding

In both 1995 and 1999, a second set of questions on food safety asked respondents to rank several food safety concerns. In 1995, the food safety concerns that were queried were pesticides, bacteria, food additives, growth hormones, and dietary fat and cholesterol. Respondents were asked which of the five food safety concerns was viewed to be the most significant. Respondents were then asked which of the remaining four food safety concerns was viewed to be the most significant and then which of the remaining was the most significant and so on until the respondent had ranked the five food safety concerns.

In 1999, respondents were asked a similar set of questions. They were asked to rank the importance for health risks of pesticides, bacteria, food additives, and agricultural biotechnology for plants or crops that are used for food, agricultural biotechnology with farm animals that are used for food, and dietary fat and cholesterol intake. Respondents were asked which of the six was viewed to be the most significant food safety concern. Then they were asked which of the remaining five food safety concerns was viewed as the most significant food safety concern and so on until the respondent had ranked the six food safety concerns. The most significant food safety concern identified by various respondents from this process is presented in Table 4-2.

Table 4-2 The Most Significant Food Safety Concern Reported by Respondents

	Number		Percentage	
Food Safety Concern	1999	1995	1999	1995
Dietary Fat and Cholesterol	388	491	33.5	41.1
Pesticides in Food	339	362	29.3	30.3
Bacteria in Food	195	127	16.8	10.6
Agricultural Biotechnology: Animals	108	N/A	9.3	N/A
Growth Hormones	N/A	111	N/A	9.3
Food Additives	94	104	8.1	8.7
Agricultural Biotechnology: Plants and Crops	34	N/A	2.9	N/A

In each of the two surveys (1995 and 1999), dietary fat and cholesterol was stated most frequently by respondents as the most significant food safety concern. Pesticides in food were the second most frequently stated significant food safety concern. According to the responses presented in Table 4-2, concern about dietary fat and cholesterol appears to have declined slightly since 1995, whereas concern about bacteria in food appears to have increased since 1995. The same percentage of respondents that expressed concern about growth hormones in 1995 expressed concern about agricultural biotechnology in farm animals in 1999. Compared to other health risks, agricultural biotechnology for animal and plant use does not appear to be viewed as a significant health risk. About nine percent of respondents stated that they viewed agricultural biotechnology for animal use to be the most significant health risk and almost three percent stated that they viewed agricultural biotechnology for plant and crop use as the most significant health risk.

5 THEORETICAL FRAMEWORK

5.1 Introduction

The economic theory guiding this research study will be outlined in this section. This discussion will include a description of the elements of choice behavior, discrete choice theory, probabilities and maximum likelihood estimation. The description of the theory of individual choice behavior closely follows Ben-Akiva and Lerman (1985) and Train (1986).

5.2 Individual Consumer Choice Behavior

Ben-Akiva and Lerman state that a "specific theory of choice is a collection of procedures that defines the following elements:

1. decision maker;
2. alternatives;
3. attributes of alternatives; and
4. decision rule" (1985, 32).

The decision maker can be a household, an individual or an organization. The decision maker faces a set of alternatives that compromise the individual's choice set. To be included in the choice set, these alternatives must be feasible for the decision makers and known to them. For example, an alternative that is not within the individual's budget is not a feasible alternative and would not be included in that person's choice set. Therefore, only affordable alternatives would be in the decision maker's choice set.

The choice set can be one of two kinds: continuous or discontinuous. A question such as "How much of product A, B and C can you afford to purchase?" would elicit a continuous response. However, a question such as "Would you purchase product A, B or C?" would elicit a discontinuous response. Discontinuous or discrete choices are analyzed in this study because they simulate a market or policy choice better than continuous responses.

Each alternative in the choice set has attributes that are either known with certainty or expected by the individual. A decision maker will consider the attributes of an alternative in absolute terms and the attributes of the alternative relative to the attributes of other alternatives. Once the attributes of each alternative are compared and weighed by the individual then a decision rule is assumed to be applied. According to Lancaster (1966), consumers typically value goods for the attributes embodied in them, rather than purchasing goods for their own sake. It is from these attributes that utility is derived, allowing the utility function to be defined in terms of attributes. Lancaster's theory is useful in examining issues of food quality and food safety. For example, a person who supports chemical-free horticultural practices might prefer to consume organic products. Rather than simply gaining utility from the purchase of a particular product such as an apple, such a consumer will gain utility from the attributes of this good. These might include attributes like color, taste, and texture of the apple as well as knowing it was produced without chemicals.

A decision rule "describes the internal mechanism used by the decision maker to process the information available and arrive at a unique solution" (Ben-Akiva and Lerman 1985, 35). Four classifications of decision rules are outlined in Ben-Akiva and Lerman (1985, 35-36). These are dominance, satisfaction, lexicographic rules and utility maximization. Utility maximization, the decision rule assumed to be applicable to respondents in this study, will be explained. Utility is a measure of satisfaction that provides economists with a way to describe consumer's preferences (Varian, 1987). For example, it is concluded that individual n facing a choice between alternative i and alternative j will choose the alternative that provides the highest utility. The individual will choose alternative i if, and only if, $U_{in} > U_{jn}$, $i \neq j$. According to consumer theory, consumers are rational. They purchase goods and services to maximize their utility, subject to their budget constraint.

5.3 Random Utility Theory

A discrete choice is defined as one in which a decision maker faces a choice among a set of alternatives meeting the following criteria:

1. "the number of alternatives in the set is finite;
2. the alternatives are mutually exclusive: that is, a person's choice of one alternative in the set necessarily implies that the person does not choose another alternative;
3. the set of alternatives is exhaustive: that is, all possible alternatives are included, and so the person necessarily chooses one alternative from the set" (Train 1986, 4).

The utility function of an individual is believed to be a function of the attributes of the alternative as well as the attributes of the individual. This concept can be illustrated by the function $U_{in}=U(\mathbf{X}_{in}, \mathbf{W}_n)$ where $\mathbf{X}_{in}$ is a vector of the attributes of alternative i as viewed by individual n and $\mathbf{W}_n$ is a vector of attributes of individual n such as income and age. This utility function would be considered a precise description of utility or a true measure of utility if every element of **X** and **W** were known and measurable by the researcher but this is unlikely to be the case. Consequently, an individual's utility function can be illustrated by the function, $U_{in}=V(\mathbf{X}_{in}, \mathbf{W}_n, \boldsymbol{\beta}) + e_{in}$, where $\mathbf{X}_{in}$ is a vector of the attributes of alternative i as viewed by individual n, $\mathbf{W}_n$ is a vector of attributes of individual n such as income and age, and $\boldsymbol{\beta}$ is a vector of parameters to be estimated. The deterministic component $V(\mathbf{X}_{in}, \mathbf{W}_n, \boldsymbol{\beta})$ is observed by the researcher and reflects the utility associated with attributes of the choice and characteristics of the individual that are observed by the researcher. The random component, e_{in}, consists of errors of observation and measurement. The random variable e_{in} is the difference between the individuals' true utility $U(\mathbf{X}_{in}, \mathbf{W}_n)$ and the individual's observed utility $V(\mathbf{X}_{in}, \mathbf{W}_n, \boldsymbol{\beta})$ so that:

$$U_{in} = U(\mathbf{X}_{in}, \mathbf{W}_n) = V(\mathbf{X}_{in}, \mathbf{W}_n, \boldsymbol{\beta}) + e_{in}. \quad (5.1)$$

The right hand side of equation 5.1 is the postulated indirect utility function of the individual.

5.4 Probabilities

Because the true utility of an individual, $U(\mathbf{X}_{in}, \mathbf{W}_n)$, is not observable, it is impossible to predict with certainty the alternative an individual will choose. However, using the part of the individual's utility function that is measurable, $V(\mathbf{X}_{in}, \mathbf{W}_n, \boldsymbol{\beta})$, it is possible to predict an individual's choice.

$$P_{in} = \text{Prob}\ (U_{in} > U_{jn}, \text{ for all j in } J_n, j \neq i) \quad (5.2)$$

By substituting equation 5.1 into 5.2 and denoting $V(\mathbf{X}_{in}, \mathbf{W}_n, \boldsymbol{\beta})$ as V_{in}, we obtain:

$$P_{in} = \text{Prob}\ (V_{in} + e_{in} > V_{jn} + e_{jn}, \text{ for all j in } J_n, j \neq i). \quad (5.3)$$

Rearranging, $P_{in} = \text{Prob}\ (e_{jn} - e_{in} < V_{in} - V_{jn}, \text{ for all j in } J_n, j \neq i)$. (5.4)

The indirect utility associated with individual n's choice of alternative i or alternative j is represented by V_{in} and V_{jn}. The probability that individual n chooses alternative i depends on the probability that the difference between the unobserved components of utility for alternative j and i is less than the difference between the observed components of utility for alternative i and j. The difference between V_{in} - V_{jn} is observable, but the difference between e_{jn} and e_{in} is a random variable and not observable. Consequently, the right hand side of 5.4 is a "joint cumulative distribution, namely, the probability that each random variable $e_{jn} - e_{in}$ is below $V_{in} - V_{jn}$, respectively, for all j in J_n, $j \neq i$)" (Train 1986, 12). By assuming a particular distribution of the random variables, it is possible to derive the distribution of each difference $e_{jn} - e_{in}$ for all j in J_n, $j \neq i$). Using equation 5.4, the probability that the decision maker will choose alternative i as a function of $V_{in} - V_{jn}$ for all j in J_n, $j \neq i$, can be calculated. It is assumed that the error terms are identically and independently distributed (IID Gumbel) (Ben-Akiva and Lerman, 1985).

In some choice situations, utility depends on attributes that vary across alternatives. When the data consist of a choice with alternative-specific attributes the conditional logit is the appropriate model (Greene, 1993). In the conditional logit model, utility depends on $V(\mathbf{X}_{in}, \mathbf{W}_n, \boldsymbol{\beta})$ as in equation 5.1, which includes characteristics specific to the individual and an attribute specific to the choice. Following Greene (1993), let $V_{nj} = [X_{nj}, W_n]$, where X_{nj} is a vector of the attributes of alternative j as experienced by individual n and W_n is a vector of the characteristics of individual n interacted with attributes of the alternative. That is, the individual's characteristics multiplied by the alternative specific attributes are used in the model, not the individual's characteristics alone. The probability of individual n choosing alternative j is:

$$\text{Prob}\left[Y_n = j\right] = e^{\beta' X_{nj} + \gamma'_j W_n} / \sum_j e^{\beta' X_{nj} + \gamma'_j W_n} \qquad (5.5)$$

where β and γ are parameters to be estimated

5.5 Application of Consumer Choice Theory

Discrete choice theory recognizes that consumers often choose among discrete alternatives in their consumption decisions. The questions presented to respondents in this study are posed in a discrete choice framework and satisfy the criteria outlined by Train (1986). The decision maker is asked to make a choice among a set of three alternatives, satisfying the criteria that the number of alternatives in the set is finite. The alternatives are mutually exclusive because the respondent can only choose one alternative and all possible alternatives are included because one of the alternatives is "neither". For example, in the first set of choice questions, respondents were given the following choices: 1) increase food inspection; 2) limit use of agricultural biotechnology; 3) neither (the current policy). The deterministic component of the indirect utility function for each of the choices can be represented by V_{1n}, V_{2n}, and V_{3n}.

From equation 5.4, the probability of respondent n choosing increased food inspection, as opposed to the current policy, is:

$$\text{Pr [U(increasing food inspection)} > \text{U (neither)]} = \text{Pr } (e_{1n} - e_{3n} \leq V_{3n} - V_{1n}). \qquad (5.6)$$

Estimating these probabilities involves specifying a functional form for the deterministic utility. From equation 5.1 the deterministic component of the respondent's indirect utility function can be specified as:

$$V_{in} = \beta' \mathbf{X}_{in} + \gamma \mathbf{W}'_n, \tag{5.7}$$

where $\mathbf{X}_{in}$ is a vector of the attributes of alternative i, which is the increase in food costs associated with the particular policy option, and $\mathbf{W}_n$ is a vector of attributes of individual n, such as income and age, interacted with the alternative-specific constants while β and γ are vectors of unknown parameters.

The conditional indirect utility is a function of the alternative-specific constants and β(Income – cost). If a linear functional form is used, income drops out of the utility difference calculation and is not used in the estimation. Therefore, the hypothesized indirect utility function of individual n choosing "more food inspection" is:

$$V_{1n} = \alpha_1[\text{INSPECT=1}] + \alpha_2[\text{RESTRICT BIOTECH=0}] + \alpha_3[\text{NEITHER=0}] + \beta\text{COST} + \gamma\mathbf{W} \tag{5.8}$$

The hypothesized indirect utility function of individual n choosing to "restrict biotechnology" is:

$$V_{2n} = \alpha_1[\text{INSPECT=0}] + \alpha_2[\text{RESTRICT BIOTECH=1}] + \alpha_3[\text{NEITHER=0}] + \beta\text{COST} + \gamma\mathbf{W} \tag{5.9}$$

COST represents the food costs associated with a particular choice. In conditional logit models, it is necessary to interact the individual's characteristics with the choice specific variables to introduce variation across the choices. These interaction terms are represented in **W** in equations 5.8 and 5.9.

5.6 Maximum Likelihood Function

In this study conditional logit models are estimated using maximum likelihood procedures provided by the program Limdep. Ben-Akiva and Lerman note that "a maximum likelihood estimator is the value of the parameters for which the observed sample is most likely to have occurred" (1985, 20). The likelihood function for a multinomial choice model is:

$$L^* = \prod_{n=1}^{N} \prod_{i \in C_n} P_n(i)^{y_{in}}. \tag{5.10}$$

where N is the sample size, and C_n is the choice set facing individual n. (Ben-Akiva and Lerman, 1985).

6 MODEL DEVELOPMENT, ESTIMATION, AND RESULTS

6.1 Introduction

As outlined in Chapter 3, respondents were asked to specify choices in two hypothetical scenarios in which food costs were expected to increase if a certain policy option is chosen. In the first hypothetical situation presented to the respondents, food costs were expected to increase by 10 percent if "more food inspection" was chosen or food costs were expected to increase by 10 percent if "restrict agricultural biotechnology" was chosen while food costs would remain at their current level if "neither policy option" was chosen. If the respondent chose "more food inspection", then the respondent was presented with a situation in which it was expected that food costs would increase by 20 percent if there was more food inspection while food costs would increase by 10 percent if agricultural biotechnology was restricted and food costs would remain the same if neither policy option was chosen. However, if the respondent chose "limit agricultural biotechnology" to the first question, then the respondent was presented with a situation in which it was expected that food costs would increase by 20 percent if agricultural biotechnology was restricted or food costs would increase by 10 percent if food inspection was increased while food costs would remain the same if neither policy option was chosen.

Respondents who chose "more food inspection" when food costs would increase by 10 percent are willing to make a trade-off between this policy option and placing some restrictions on the production, processing or marketing of food to ensure a higher level of food safety. In the second round of questions, respondents who continued to choose "more food inspection" were queried whether they were willing to make an even bigger trade-off in the form of higher food costs for the specified means of increased food safety assurance.

In the second set of policy choices considered, the respondent was presented with another hypothetical scenario similar to the first scenario. In the second scenario the policy options presented to the respondent are "increase labelling requirements" and "limit agricultural biotechnology" whereas in the previous situation the policy options were "more food inspection" and "limit agricultural biotechnology". Thus, in the second scenario, the willingness of respondents to make trade-offs between more labelling and limiting agricultural biotechnology are assessed.

6.2 Model Development

Model I is the base model for estimating the data from the responses to scenario one presented in Figure 3-3. This model includes the alternative-specific constants, RESTRICT BIOTECH and INSPECT, and the alternative-specific attribute, COST. Similarly, Model II is the base model for estimating the data from the responses to scenario two presented in Figure 3-4. Model II includes the alternative-specific constants RESTRICT BIOTECH, and LABEL, and COST. Both Model I and Model II were then modified to include respondents' socio-economic characteristics and sources of information about health risk and benefits of food, identified by the respondent.

Interacting the socio-economic variables with alternative specific constants is one way to express the effect of the socio-economic variables. Thus, in Model I and Model II, the variables denoting the age of respondent, gender, household income, marital status, children in the household, years of schooling, and location of respondent's residence are included as interactions with the alternative-specific constants.

In scenario one, each socio-economic variable is expressed as a constant that is specific to the alternative of increasing food inspection or restricting biotechnology. Consequently, in estimating versions of Model I, there are two gender variables in the model. The coefficient on MALE interacted with the alternative-specific constant RESTRICT BIOTECH expresses the effect of gender on the probability of choosing to "restrict agricultural biotechnology" relative to the base case of choosing "no change in either". MALE interacted with the alternative-specific constant INSPECT expresses the effect of gender on the probability of choosing "more food inspection" relative to the base case of choosing "no change in either". Similarly, the coefficients on AGE, CHILD, EDUC, INCOME, MARR, URBAN interacted with RESTRICT BIOTECH, express the effect of age, children in household, years of schooling completed, household income, marital status, and location of residence, respectively, on the probability of choosing to "restrict agricultural biotechnology". Similarly, the coefficients AGE, CHILD, EDUC, INCOME, MARR, URBAN interacted with INSPECT express the effect of age, children in the household, years of schooling completed, household income, marital status, and place of residence, respectively, on the probability of "choosing more food inspection". The COST coefficient expresses the effect that increasing food cost will have on the choice of policy option. COST is an alternative-specific attribute that varies over the alternatives. RESTRICT BIOTECH and INSPECT are expressed as alternative-specific constants because these constants are always related to a specific alternative.

Similarly, in estimating versions of Model II, each socio-economic variable is expressed as a constant that is specific to the alternatives of more food labelling, restricting biotechnology and no change in either. The estimated coefficient on MALE interacted with LABEL expresses the effect of gender on the probability of choosing "more food labelling" relative to the base case of choosing "no change in either". The estimated coefficients on the variables AGE, CHILD, EDUC, INCOME, MARR, and URBAN interacted with the alternative-specific constant LABEL, express the effect of age, children in the household, years of schooling completed, household income, marital status, and place of residence, respectively, on the probability of choosing "more food labelling". As in Model I, the COST coefficient in Model II expresses the effect that increasing food costs has on each choice. The variables RESTRICT BIOTECH and LABEL are expressed as alternative-specific constants. Table 6-1 provides a description of the socio-economic variables included in estimating several versions of Model I and Model II.

Table 6-1 Description of Socio-economic Variables Used in Estimating Models

Variable Name	Variable Description
RESTRICT BIOTECH	Alternative-specific constant representing the utility associated with the respondent's choice to restrict agricultural biotechnology.
INSPECT	Alternative-specific constant representing the utility associated with the respondent's choice of more food inspection.
LABEL	Alternative-specific constant representing the utility associated with the respondent's choice to have more food labelling.
COST	Alternative-specific attribute representing the postulated increase in food costs associated with a particular policy option.
AGE	A continuous variable representing the reported age of the respondent.
AGESQR	A continuous variable representing the reported age of the respondent, squared.
CHILD	A dummy variable indicating children under the age of 18 in the household, where 1 is indicates that at least one child, 0 with no children in the household.
EDUC	A continuous variable representing the number of years of education completed by the respondent.
INCOME	A continuous variable representing the total household income before taxes.
MALE	A dummy variable reflecting the respondent's gender, where 1 is indicates that male, O with female.
MARR	A dummy variable reflecting the respondent's marital status, where 1 is indicates that married or common-law, 0 with single, divorced, separated or widowed.
URBAN	A dummy variable classifying the respondent's place of residence, where 1 is indicates that city or town, 0 with village or rural area.

Model I and Model II were also modified to include sources of information cited by individuals about health risk and benefits of food. The dummy variables outlined in Table 6-2 represent whether the respondent indicated a particular information medium as a source of information. For example, INT is a dummy variable that indicates whether or not the respondent indicated the internet as a source of health risk information. The coding of 1 for this indicates that the respondent noted the internet as a source of health risk information while the coding of 0 applies if the respondent did not indicate the internet as a source of health risk information.

Table 6-2 Dummy Variable Names and Descriptions

Variable Name	Variable Description
INT	This indicates whether respondents stated that they use the internet as a source of health risk information, 1 indicates that the respondent stated the "internet" and 0 that the internet was not stated.
LAB	This indicates whether respondents mentioned "food labels" as a source of health risk information, where 1 indicates that they mentioned it and 0 indicates that they did not mention it
LEAF	This indicates whether respondents mentioned "brochures or leaflets" as a source of health risk information, where 1 indicates that they mentioned it and 0 indicates that they did not mention it.
MED	This indicates whether respondents mentioned "doctors, nurses, or other health care professionals" as a source of health risk information, where 1 indicates that they mentioned it and 0 indicates that they did not mention it.
PER	This indicates whether respondents mentioned "teachers or other people (i.e. friends, neighbors, relatives)" as a source of health risk information, where 1 indicates that they mentioned it and 0 indicates that they did not mention it.
PUB	This indicates whether respondents mentioned "television, radio, magazines, newspapers, books, or professional journal" as a source of health risk information, where 1 indicates that they mentioned it and 0 indicates that they did not mention it.
STORE	This indicates whether respondents mentioned "health food store" as a source of health risk information, where 1 indicates that they mentioned it and 0 indicates that they did not mention it
WORK	This indicates whether respondents mentioned "work in a related industry or work in a health or science field" as a source of health risk information, where 1 indicates that they mentioned it and 0 indicates that they did not mention it.

Prior to the model estimations, non-responses to questions of income (295 instances), age (15 instances), years of schooling (2 instances), and number of children in household (3 instances) were replaced with the respective median of the reported values. The median of the reported value for income is $57,500. The median of reported age is 40 years, the median years of schooling is 14 years, and the median number of children in the household is zero children. Non-responses to questions about marital status (8 incidences) and location of residence (2 incidences), were omitted from the data set as were "don't know" and non-responses to the policy preference questions presented in scenario one and scenario two.

Statistically significant correlation between socio-economic variables was expected and this was assessed. The tables of correlation coefficients for the socio-economic variables used in Model I and Model II can be found in Appendix A. In this data set, statistically significant relationships were found between CHILD and AGE, MARR and CHILD, INCOME and MARR, and MARR and AGE. Consequently, several versions of Model I and Model II were identified and tested to assess the effect that correlation between some of the socio-economic variables might have on the estimated results.

6.3 Model Estimation

A conditional logit model was estimated to define the relationship between the socio-economic variables and the choice of policy options presented to the respondent in hypothetical scenario one and two. The software LIMDEP Version 7.0 (Greene, 1998) was used to estimate several versions of Model I and Model II.

6.3.1 Results of Model I Estimation

The results from estimating several versions of Model I are presented in Table 6-3. Most of the estimated coefficients display the expected signs in the three versions of the estimated model. The chi-squared statistic shows that all models are statistically significant. The value of the adjusted ρ^2 statistic ranges from 0.07980 to 0.08924. It appears that Model I.1 fits this data set the best because it has the largest log-likelihood and adjusted ρ^2 statistic.

INCOME was excluded from Model I.2 because of the statistically significant correlation between INCOME and EDUC, and INCOME and MARR. The exclusion of income does not appear to appreciably affect the coefficients on EDUC or MARR compared to the estimated coefficients on the same variables in Model I.1.

Because of the statistically significant correlation between MARR and CHILD, INCOME and MARR, and MARR and AGE, MARR was excluded from Model I.3. The exclusion of marital status from Model I.3 does not appear to have an appreciable effect on the estimated coefficients on CHILD in Model I.3. However, excluding marital status from Model I.3 does have an effect on the coefficients on AGE and INCOME. In Model I.3, AGE interacted with RESTRICT BIOTECH and age interacted with INSPECT is significant in Model I.3. INCOME interacted with INSPECT is significant. The alternative-specific constants cannot be interpreted separately from the other coefficients in the model because of the interactions with the demographic variables.

The estimated coefficient on COST is negative and significant, indicating that the increased food costs that are associated with choosing to "increase food inspection" or "restrict biotechnology" decreases the probability of consumers choosing more food inspection or restricting food biotechnology. The size of the estimated coefficient on COST and the associated t statistic does not change much across the four models. That is, the effect of cost does not appear to change with the model specification.

The effect of the variable MALE is significant and negative in all models. Male consumers are less likely to choose either "more food inspection" or "restricting biotechnology" than are female consumers. The coefficient on MARR is significant and positive in the choice to increase food inspection in Model I.1 and Model I.2. In these models, it appears that married consumers are more likely to choose "more food inspection" than are single consumers. URBAN is significant and positive in the choice "more food inspection" in Model I.1, Model I.2, and Model I.3. Consumers living in urban areas are more likely to choose "more food inspection" than are consumers living in rural areas. INCOME interacted with more food inspection is significant and positive in Model I.3. That is, the probability of consumers choosing "more food inspection" increases as the income of the respondent increases.

AGE interacted with INSPECT and RESTRICT BIOTECH are significant and positive in Model I.3. This indicates that the probability of consumers choosing either "restrict agricultural biotechnology" or "more food inspection" increases as the age of the consumer increases.

Some estimated coefficients did not display the signs that were expected. The estimated coefficient on CHILD was expected to be significant and positive in all models. However, CHILD interacted with RESTRICT BIOTECH in Model I.1, I.2 and I.3 and interacted with INSPECT in Model I.2 was insignificant and negative. CHILD interacted with INSPECT was positive but insignificant in Model I.2 and Model I.3. It appears that the probability of consumers choosing to restrict agricultural biotechnology or increase food inspection is not affected by the presence of children in the household. However, it should be noted that correlation between the demographic variables may be influencing these results.

Table 6-3 Results of Model I Estimation

Variable	Model I Coefficient (t statistic)	Model I.1 Coefficient (t statistic)	Model I.2 Coefficient (t statistic)	Model I.3 Coefficient (t statistic)
RESTRICT BIOTECH	0.821922** (10.0664)	0.489030 (1.52183)	0.533132 (1.69185)	0.478322 (1.48872)
AGE		0.005925 (1.78946)	0.005733 (1.73663)	0.006309* (1.96632)
INCOME		0.001425 (0.74050)		0.001496 (0.79911)
MALE		-0.62012** (-6.34191)	-0.61286** (-6.30030)	-0.61800** (-6.33416)
MARR		0.035656 (0.32536)	0.052062 (0.48863)	
EDUC		0.021171 (1.36949)	0.023641 (1.55809)	0.021638 (1.39831)
CHILD		-0.01825 (-0.16698)	-0.01649 (-0.15088)	-0.003260 (-0.03183)
URBAN		0.010245 (0.07382)	0.007078 (0.05101)	0.005518 (0.04014)
INSPECT	1.61055** (19.3111)	0.815588** (2.96188)	0.908733** (3.35876)	0.79542** (2.89159)
AGE		0.004768 (1.70136)	0.004352 (1.55741)	0.00634* (2.34957)
INCOME		0.002941 (1.82482)		0.003684* (2.34269)
MALE		-0.45342** (-5.51069)	-0.43932** (-5.36732)	-0.44413** (-5.41140)
MARR		0.191488* (2.06770)	0.228773* (2.53142)	
EDUC		0.009209 (0.70352)	0.014121 (1.10151)	0.01045 (0.79917)
CHILD		-0.002720 (-0.02962)	0.000802 (0.00875)	0.063883 (0.74528)
URBAN		0.489997** (3.97387)	0.48545** (3.93880)	0.458498** (3.75101)
COST	-9.67296** (-16.5741)	-9.73187** (-16.6115)	-9.72723** (-16.6091)	-9.72123** (-16.6045)
Log – Likelihood	-3482.20	-3439.47	-3441.15	-3441.88
Restricted (slopes=0) Log-L	-3638.97	-3638.97	-3638.97	-3638.97
Chi-Squared (χ^2)	313.54	398.99	395.64	394.18
Adjusted ρ^2 Statistic	.07980	0.08924	.08906	.08887

* denotes significance at the $\alpha = 0.05$ level   ** denotes significance at the $\alpha = .01$ level

In estimating Model I.4, the alternative-specific constants were interacted with the sources of health risk and food benefit information to assess if any source of information was associated with a significant effect on the probability of the respondent choosing one of the alternatives. From the results presented in Table 6-4, it appears that using the internet is a source of food benefit/health risk information is a significant explanatory variable on policy choice. Respondents who get information from the internet are more likely to choose either to restrict biotechnology or more food labelling than neither policy option. Consumers who get their health risk and food benefit information from food labels, leaflets, other people or publications are more likely to choose more food inspection than neither policy option.

Table 6-4 Results of Model I.4 Estimation

Variable	Coefficient (t statistic)	Variable	Coefficient (t statistic)
RESTRICT BIOTECH	0.232157 (0.66342)	**MORE FOOD INSPECTION**	0.489546 (1.64668)
INT	0.648955** (3.03008)	INT	0.406268* (2.10428)
LAB	0.202566 (1.08723)	LAB	0.431938** (2.82046)
LEAF	0.324602 (1.50249)	LEAF	0.410242* (2.18909)
MED	-0.162620 (-0.88372)	MED	0.093463 (0.62770)
PER	0.049147 (0.29372)	PER	0.552069** (4.16127)
PUB	0.308828 (1.92005)	PUB	0.261817* (2.02367)
STORE	-0.29430 (-0.33205)	STORE	0.579271 (0.90515)
WORK	0.883777* (2.27610)	WORK	0.524938 (1.46356)
AGE	0.006204 (1.84198)	AGE	0.004996 (1.75077)
INCOME	0.001567 (0.80723)	INCOME	0.003649 (2.24246)
MALE	-0.60701** (-6.13938)	MALE	-0.43883** (-5.25808)
MARR	0.010795 (0.09780)	MARR	0.198985 (2.12980)
EDUC	0.013536 (0.86317)	EDUC	0.000981 (0.07387)
CHILD	0.001374 (0.01241)	CHILD	-0.01923 (-0.20782)
URBAN	0.025890 (0.18568)	URBAN	0.499681** (4.02766)
COST	-9.81189** (-16.66090)		
Log – Likelihood			- 3412.295
Restricted (slopes=0) Log-Likelihood			- 3638.967
Chi-Squared (χ^2)			453.344
Adjusted ρ^2 Statistic			.09433
*denotes significance at the α=0.05 level		** denotes significance at the α = .01	

In estimating the next two models, Model I.5 and I.6, the variable COST was interacted with the socio-economic variables to determine the effect of the respondent's characteristics on the probability that they will be willing to pay higher food costs as a consequence of policy choice.

In Model I.5, the vector of socio-economic variables includes AGE, INCOME, MALE, MARR, EDUC, CHILD, and URBAN. To assess whether a non-linear relationship exists between the probability of choosing "more food inspection" or the probability of choosing to "restrict biotechnology and the age of the respondent, a quadratic term, age squared, was included in Model I.6. Consequently, in Model I.6, the vector of socio-economic includes AGE, INCOME, MALE, MARR, EDUC, CHILD, and URBAN and AGESQR. The results of the model estimations are given in Table 6.5. The chi-squared statistics show that both models are significant. The values of the adjusted ρ^2 statistics are 0.08643 and 0.08690.

The estimated coefficients display the expected signs in Model I.5 and I.6. COST is significant and negative in Model I.5 and Model I.6, indicating that increasing the cost of food decreases the probability of consumers choosing either "restrict biotechnology" or "more food inspection". AGE, INCOME, and URBAN are significant and positive in both models. The probability of paying higher food costs for one of the policy options increases as age increases or as income increases. Urban residents are more likely to pay higher food costs for one of the policy options than are urban residents. MALE is significant and negative in both models, indicating that male consumers are less willing to pay higher food costs for more food inspection or restricting biotechnology than are female consumers.

Table 6-5 Results of Model I.5 and Model I.6 Estimation

Variable	Model I.5 Coefficient (t statistic)	Model I.6 Coefficient (t statistic)
RESTRICT BIOTECH	0.85892** (10.4215)	0.86192** (10.4502)
INSPECT	1.64791** (19.5965)	1.65093** (19.6197)
COST	-14.7675** (-7.8010)	-17.8817** (-7.4502)
AGE	0.04158* (2.2092)	0.24441* (2.5191)
AGESQR		-0.00222* (-2.1325)
CHILD	0.111428 (0.1811)	-0.11320 (-0.1811)
EDUC	0.083279 (0.9517)	0.042565 (0.4752)
INCOME	0.02401* (2.2112)	0.020978 (1.9142)
MALE	-3.3319** (-6.0311)	-3.32014** (-6.0051)
MARR	0.890914 (1.4349)	0.613228 (0.9661)
URBAN	1.83159* (2.2034)	1.91479* (2.2995)
Log - Likelihood	-3453.594	-3451.316
Restricted (slopes=0) Log-L	-3638.967	-3638.967
Chi-Squared (χ^2)	370.746	375.302
Adjusted ρ^2 Statistic	.08643	.08690
* denotes significance at the $\alpha = 0.05$ level ** denotes significance at the $\alpha = .01$ level		

6.3.2 Results of Model II Estimation

In this section, the results of estimating several versions of Model II are presented. Four versions of Model II (Model II to Model II.3) were estimated to determine whether respondent's choice of "more food labelling" or "restrict agricultural biotechnology" can be explained by the postulated explanatory variables. Model II.4

includes the respondent's socio-economic characteristics interacted with the alternative-specific constants as well as sources of health risk information interacted with the socio-economic characteristics. To determine the effect of the respondents' characteristics on the probability they will be willing to pay the higher food costs, in Model II.5 and Model II.6, COST is interacted with the socio-economic characteristics of the respondent.

Similar to the sequence of Model I estimations, INCOME and MARR were consequently omitted from Model II.2 and Model II.3, respectively, to assess the effect that the statistically significant correlation between the variables may have on the other estimated coefficients. The chi-squared statistics show that all models are significant. The value of the adjusted ρ^2 statistic ranges from 0.06314 to 0.07177. Model II.1 appears to fit this data set the best because it has the largest log-likelihood and adjusted ρ^2 statistic.

The estimated coefficients display the expected signs. COST is negative and highly significant, indicating that increasing food costs decreases the probability of consumers choosing more food labelling or restricting food biotechnology. The size of the estimated coefficient and the t statistic does not change much across the four models, suggesting a stable relationship. That is, the effect of cost does not appear to change with model specification.

In Models II.1, II.2, and II.3, the effect of the variable MALE is negative and highly significant. Male consumers are less likely to choose either more labelling or restricting biotechnology than are female consumers. INCOME is positive and highly significant in the choice to restrict biotechnology, indicating that the probability of consumers choosing to restrict biotechnology increases as the income of the respondent increases. INCOME does not appear to be a significant explanatory variable in the choice of more food labelling. CHILD is highly significant and positive in Model II.1, Model II.2 and Model II.3. Children in the household increases the probability of choosing to restrict agricultural biotechnology or more food labelling. The alternative-specific constants cannot be interpreted separately from the other coefficients in the model.

Statistically significant correlation can affect the estimated results. It was determined that the correlation between INCOME and MARR and INCOME and EDUC is statistically significant. The estimated results in Model II.2 are similar to Model II.3. The estimated coefficients on MALE continue to be highly significant and negative. The estimated coefficients on CHILD also continue to be highly significant and positive. When INCOME is omitted from Model II.2, EDUC interacted with RESTRICT BIOTECH becomes significant. Omitting MARR from the estimation does not appear to affect the results appreciably.

Table 6-6 Results of Model II Estimation

Variable	Model II Coefficient (t statistic)	Model II.1 Coefficient (t statistic)	Model II.2 Coefficient (t statistic)	Model II.3 Coefficient (t statistic)
RESTRICT BIOTECH	0.7831** (9.7935)	-0.2030 (-0.63756)	-0.01401 (-0.04486)	-0.20614 (-0.64791)
AGE		0.00365 (1.11647)	0.002902 (0.89265)	0.004039 (1.28391)
INCOME		0.006079** (3.21237)		0.006339** (3.43819)
MALE		-0.51143** (-5.33354)	-0.48329** (-5.07197)	-.50972** (-5.3171)
MARR		0.053968 (0.49650)	0.131118 (1.23889)	
EDUC		0.023163 (1.50245)	0.033314* (2.21071)	0.023397 (1.52326)
CHILD		0.362966** (3.38429)	0.36879** (3.44491)	0.3798** (3.78278)
URBAN		0.258892 (1.81543)	0.253375 (1.77806)	0.249028 (1.75979)
LABEL	1.4533** (17.9683)	0.719854** (2.61321)	0.80057** (2.95847)	0.733630** (2.66612)
AGE		0.003819 (1.38737)	0.00349 (1.26976)	0.002818 (1.06236)
INCOME		0.002598 (1.59879)		0.002093 (1.31895)
MALE		-0.38153** (-4.62357)	-0.37002** (-4.50578)	-0.387480** (-4.70321)
MARR		-0.12878 (-1.39195)	-0.10021 (-1.10724)	
EDUC		0.031618* (2.38956)	0.03616** (2.78372)	0.030521* (2.31236)
CHILD		0.252397** (2.70552)	0.25556** (2.73977)	0.207159* (2.37561)
URBAN		0.171926 (1.43002)	0.16613 (1.38262)	0.192769 (1.61545)
COST	-8.3466** (-14.977)	-8.37478** (-15.0056)	-8.37005** (-15.0003)	-8.3634** (-14.9950)
Log – Likelihood	-3557.57	-3517.67	-3522.84	-3519.54
Restricted (slopes=0) Log-L	-3682.24	-3682.24	-3682.24	-3682.24
Chi-Squared (χ^2)	249.33	329.14	318.79	325.40
Adjusted ρ^2 Statistic	.06314	.07177	.07068	.07155

* denotes significance at the $\alpha = 0.05$ level ** denotes significance at the $\alpha = .01$ level

In Table 6-7, the results of Model II.4 are presented. As with Model I.4, Model II.4 assesses the influence of sources of health risk/food benefit information on the probability of the respondent choosing a one of the policy alternatives. The variable MED is negative and significant indicating that consumers who obtain health risk information from the people in the medical field are less likely to choose restrict agricultural biotechnology and more food labelling. That is, consumers who get information from doctors, nurses, or other health care professionals are more likely to choose neither policy option than restrict agricultural biotechnology or more food labelling. LABELPER and LABELPUB are positive and significant. Consumers who get health information from other people such as friend and neighbors or publications such as television, radio or magazines are more likely to choose more labelling. Interestingly, LABEL is not a significant explanatory variable in the choice of more food labeling. Consumers who get information from food labels are not more likely to choose more food labeling.

Table 6-7 Results of Model II.4 Estimation

Variable	Coefficient (t statistic)	Variable	Coefficient (t statistic)
RESTRICT BIOTECH	-0.019030 (-0.05574)	**MORE FOOD LABELLING**	0.347869 (1.16654)
INT	0.218384 (1.00873)	INT	0.311209 (1.64518)
LAB	-0.294140 (-1.61316)	LAB	0.182008 (1.23455)
LEAF	0.193141 (0.98370)	LEAF	-0.036630 (-0.20557)
MED	-0.37973* (-2.23172)	MED	-0.31854* (-2.20539)
PER	0.010307 (0.06195)	PER	0.677375** (5.03713)
PUB	-0.168300 (-1.12905)	PUB	0.339618* (2.57384)
STORE	1.742970 (1.59711)	STORE	2.031300 (1.91587)
WORK	-0.02181 (-0.05299)	WORK	0.537847 (1.62261)
AGE	0.004166 (1.25318)	AGE	0.004863 (1.73477)
INCOME	0.005903** (3.09841)	INCOME	0.003002 (1.82814)
MALE	-0.51205** (-5.27839)	MALE	-0.38985** (-4.65080)
MARR	0.053825 (0.49296)	MARR	-0.121240 (-1.29978)
EDUC	0.021957 (1.41163)	EDUC	0.026925* (2.00303)
CHILD	0.376871** (3.49560)	CHILD	0.255169** (2.70853)
URBAN	0.265024 (1.85047)	URBAN	0.164111 (1.35643)
COST	-8.48654* (-15.09180)		
Log – Likelihood			-3485.833
Restricted (slopes=0) Log-Likelihood			-3682.236
Chi-Squared (χ^2)			392.806
Adjusted ρ^2 Statistic			.07804
*denotes significance at the α=0.05 level		** denotes significance at the α = .01 level	

In Table 6-8, the results of Model II.5 and Model II.6 are presented. In these models the COST variable is interacted with the socio-economic variables to determine the effect of the respondent's characteristics on the probability that they will be willing to pay higher food costs. COST is significant and negative in Model II.5 and Model II .6, indicating that increasing the cost of food decreases the probability of consumers choosing either restrict biotechnology or more food labelling. The probability of a respondent paying higher food costs for either policy option increases as age or the years of education completed by the respondent increases. The presence of children in the household increases the willingness to pay for higher food costs. MALE is significant and negative, indicating that male consumers are less willing to pay higher food costs for labelling or restricting biotechnology than are female consumers.

Table 6-8 Results of Model II.5 and Model II.6 Estimation

Variable	Model II.5 Coefficient (t statistic)	Model II.6 Coefficient (t statistic)
RESTRICT BIOTECH	0.81795** (10.1382)	0.822382* (10.182)
LABEL	1.48881** (18.2616)	1.49329* (18.2982)
COST	-15.37440** (-8.2304)	-19.1565* (-8.08575)
AGE	0.039060* (2.1222)	0.282896* (2.99049)
AGESQR		-0.00266* (-2.62831)
CHILD	1.78246** (2.9231)	1.51073* (2.43947)
EDUC	0.239116** (2.7513)	0.192142* (2.16568)
INCOME	0.019956 (1.8614)	0.016393 (1.5152)
MALE	-2.78755** (-5.1190)	-2.77726* (-5.09462)
MARR	-0.22384 (-0.3651)	-0.5722 (-0.91105)
URBAN	1.54070 (1.8939)	1.63453* (2.00516)
Log – Likelihood	-3529.561	-3526.095
Restricted (slopes=0) Log-L	-3682.236	-3682.236
Chi-Squared (χ^2)	305.35	312.282
Adjusted ρ^2 Statistic	0.06958	0.07036
*denotes significance at the $\alpha = 0.05$ level **denotes significance at the $\alpha = .01$ level		

6.4 Comparison of the Responses to the Policy Preference Questions in Scenario One and Scenario Two

A comparison of the significant explanatory variables in Model I.1 and Model II.1, and Model I.6 and Model II.6, the models with highest log-likelihoods for this data set, will be made in this section. In comparing Model I.1 and Model II.1, the variable indicating the respondent's gender is the only variable that is statistically significant in both models. Men are less likely than women to choose one of the policy options that will provide a higher level of food quality assurance. Marital status and urban are significant explanatory variables in the choice of more food inspection but not in the choice to restrict biotechnology. The presence of children in the household is a significant explanatory variable in the choice between restricting biotechnology and food labelling. Household income is significant explanatory variable in the choice to restrict biotechnology while the respondent's education level is a significant explanatory variable in the choice of more food labelling.

In Model I.6 and Model II.6, the variables indicating the respondent's gender, age, and location of residence are significant explanatory variables. These variables have a significant effect on the probability that the respondent will pay more, in the form of higher food costs, for one of the policy options. The presence of children in the household and the education level of the respondent are significant explanatory variables in Model II.6 but not in Model I.6.

6.5 Consumer's Median Willingness to Pay (WTP) for Particular Policy Options

In this section, the median willingness of consumers' to pay higher food costs for a particular policy option is calculated. Compensating variation (CV) is one method that can be used to calculate changes in consumer's welfare. CV is the maximum amount of money a consumer would be willing to give up in the new situation to leave him or hers-self as well off as in the old situation (Broadway and Bruce, 1984). In the context of this thesis, CV is the maximum amount of money that consumers would be willing to pay for one of the policy options so that their utility is the same as before agricultural biotechnology was introduced. For the purpose of this calculation, a female and male consumer were created. The female consumer is assumed to be a married woman with children. She has 14 years of education, a household income of $57,500 and lives in an urban area. The second consumer (M) is a single male without children. He has 14 years of education, an annual income of $40,000 and lives in an urban area.

If the respondent chose to "restrict biotechnology" or if the respondent chose "no change in either" the respondent's indirect utility functions, respectively, would be:

$V_{RESTRICT} = \alpha_{RESTRICT} + \beta(M\text{-}CV)$

$V_{NEITHER} = 0 + B(M)$

where M = income and CV = willingness to pay for the policy option.

Thus, equation 6.1 stated below, expresses the utility difference between having the particular policy and not having it. Finding the amount of CV that sets the utility difference to zero is one way of calculating the welfare measure.

$$\Delta V = \alpha - \beta\,(CV) \qquad (6.1)$$

By rearranging equation 6.1, CV is equally to α/β.

Following Hanemann (1984), the median willingness to pay for the particular policy options is calculated in section 6.5.1 and section 6.5.2.

6.5.1 Median WTP Assuming Constant Marginal Utility of Food Costs

The estimated coefficients from Model I.1 and Model II.1, the models with the largest log-likelihoods, are used in this calculation. Only the statistically significant explanatory variables are used in the median WTP calculation. The estimated coefficient on COST is assumed to be the marginal utility of food costs. Thus, the marginal utility of food costs is the same for both consumers in this model. Following Hanemann (1984) each of consumer F's and consumer M's median WTP can be calculated according to the following formula:

Median WTP = $(\alpha_{ASC} + \gamma X)/-\beta_{COST}$,

where:

α = the estimated coefficient on the statistically significant alternative-specific constant

γ = the estimated coefficients for the statistically significant socio-economic characteristics interacted with the appropriate ASC

X = the value of the socio-economic characteristics of consumer F and consumer M

β = the estimated coefficient on the variable COST

The median WTP estimates, expressed in percentage terms, for both consumers are presented in Table 6-9. It appears that both consumers are willing to pay less, in the form of higher food costs, for a policy that will restrict biotechnology. Each of the consumers are willing to pay most for a labelling policy that will provide information about agricultural biotechnology. Consumer F is willing to pay 16.9 percent more for food if food is labeled and consumer M is willing to pay just over nine percent more for food if foods are labelled. Consumer M is not willing to pay more for food in either scenario if agricultural biotechnology is restricted. Consumer F is not willing to pay, in the form of higher food costs, if biotechnology is restricted in scenario one.

Table 6-9 Derivation of Consumer's Median WTP (as a percentage of food costs) for Policies: Assuming Constant Marginal Utility of Food Costs

	Coefficient Estimation $[\alpha_{ASC} + \gamma X]$		Coefficient Estimation $[\beta]$		Median WTP $[(\alpha_{ASC}+\gamma X)/ -\beta_{COST}]$	
	F	M	F	M	F	M
Scenario One						
Restrict Biotech	0	-0.620	-9.732	-9.732	0.0	-0.064
More Food Inspection	1.497	0.852	-9.732	-9.732	0.154	0.088
Scenario Two						
Restrict Biotech	0.713	0.268	-8.375	-8.375	0.085	-0.032
More Food Labelling	1.415	0.781	-8.375	-8.375	0.169	0.093

6.5.2 Median WTP Assuming Changing Marginal Utility of Food Costs

Model I.1 and Model II.1 were revised to allow the marginal utility of food costs to change depending on the characteristics of the consumer. These revised models, Model I.A and II.A are presented in Appendix B and Appendix C, respectively and contain the socio-economic variables interacted with the alternative-specific constants, RESTRICT BIOTECH and INSPECT in scenario one and RESTRICT BIOTECH and LABEL in scenario two. These interaction terms assume the marginal utility of food costs is constant for all consumers. The socio-economic characteristics interacted with COST are also included in these models. These interaction terms assume that the marginal utility of food costs changes between consumers. The coefficients estimated in these models are then used to determine consumer F's and consumer M's median WTP for a particular policy option. Following Hanemann (1984), the WTP estimate is calculated according to the equation:

Median WTP= $(\alpha_{ASC} + \gamma X)/-(\beta_{COST} + \delta X)$

where:

α = the estimated coefficient on the statistically significant alternative-specific constants

γ = the statistically significant estimated coefficients on the interaction terms between the socio-economic characteristics and the appropriate ASC

X = the value of the socio-economic characteristics of consumer F and consumer M

β = the estimated coefficient on the variable COST

δ = the statistically significant estimated coefficients for the interaction terms between the socio-economic characteristics and COST

The results of the estimated WTP are presented in Table 6-10. Both consumers are willing to pay the least amount, in terms of higher food costs, for a policy that will restrict biotechnology. Consumer F is willing to pay the most for a food labeling policy. Compared to the median WTP estimates in section 6.5.1, where it was assumed the marginal utility of food costs were constant, allowing the marginal utility of food costs to vary according to the socio-economic characteristics of the respondent, results in a lower estimate of the median willingness to pay for the particular policy options.

Table 6-10 Derivation of Consumer's Median WTP (as a percentage of food costs) for Policies: Assuming Changing Marginal Utility of Food Costs

	Coefficient Estimation $[\alpha_{ASC} + \gamma X]$		Coefficient Estimation $[\beta_{COST} + \delta X]$		Median WTP $(\alpha_{ASC}+\gamma X)/-(\beta_{COST}+\delta X)$	
	F	M	F	M	F	M
Scenario One						
Restrict Biotech	0.0	-0.567	-11.644	-11.644	0.0	-0.049
More Food Inspection	0.736	0.341	-11.644	-11.644	0.063	0.029
Scenario Two						
Restrict Biotech	0.450	-0.149	-15.695	-15.695	0.029	-0.009
More Food Labelling	1.798	1.467	-15.695	-15.695	0.114	0.093

The consumers' median willingness to pay that was calculated in this study is supported by other studies. Huffman et al (2001) used laboratory auction experiments for three food items to determine American consumers' willingness pay for foods with and without genetically modified labels. They found that respondents were willing to a premium of 14 percent for foods they perceived as nonbiotechnology.

Moon and Balasubramanian (2001) used a stated preference approach to measure American consumers' willingness to pay a premium for breakfast cereals made of nonbiotechnology ingredients. Consumers' mean willingness to pay a premium for cereal made from nonbiotechnology ingredients was between ten and twelve percent.

7 CONCLUSIONS AND DISCUSSION

7.1 Conclusions and Discussion

Biotechnology raises complex questions and issues of ethics, environment and law. One challenge facing government is to design public policy that will maximize biotechnology's proposed benefits to society while taking into account the concerns of consumers. One possible option is to develop a policy that will place restrictions on the production, processing or marketing of foods that contain products of agricultural biotechnology. Another possible option is to increase food inspection. Yet another policy option is to develop a labelling policy that will provide consumers with information on the effects of agricultural biotechnology.

This study examined Alberta consumers' attitudes towards agricultural biotechnology. Consumers' perceptions of agricultural biotechnology were compared with their perceptions of other food safety issues. Consumers' preferences for various policy options were examined.

Compared to other food safety issues, many Alberta consumers view agricultural biotechnology for plants and animals to be less of a food safety concern than dietary fat and cholesterol and pesticides in food. However, there are still an appreciable number of respondents who stated that agricultural biotechnology, whether used for plants or animals, presents a high or moderate risk. The results of this survey also indicate that Alberta consumers are more concerned about animal biotechnology than about plant or crop biotechnology. Animal biotechnology could be seen as being less ethical and more unnatural than plant biotechnology.

In the first hypothetical situation presented to consumers, respondents could choose between two options, placing restrictions on the production, processing or marketing of food or increasing food inspection. In the second hypothetical situation, consumers could choose between a developing a labelling system for food that gives information on the agricultural biotechnology through labelling or restricting agricultural biotechnology. Food costs were expected to increase if either policy option was chosen. The effects of selected socio-economic variables on the choice of policy option were examined. The effects of socio-economic variables on the willingness to pay higher food costs were also examined. The median willingness to pay, of two different representative consumers, for each policy option, was calculated to determine the tradeoff between higher food costs and choice of policy that a consumer would be willing to make.

In this study, in both hypothetical situations presented to respondents, more respondents chose either the food inspection or food labelling policy option as opposed to limiting agricultural biotechnology. This could indicate that Alberta consumers would prefer to have either more food inspection or labels on food to provide them with information about biotechnology, as opposed to a policy that would place restrictions on production, processing or marketing of food. That is, although it appears that consumers would prefer not to restrict the scope of biotechnology, they still want a policy that will provide them with information and a higher level of safety assurance. People are willing to pay for things that affect then directly and thus they want to make sure that food is inspected or labeled.

The results from estimating several versions of Model I, suggest that gender, marital status and location of residence are significant explanatory variables in the choice between more food inspection and restricting biotechnology. The results from estimating Model II suggest that income, gender, households with children, and years of education are significant explanatory variables in choosing between more food labelling and restricting biotechnology.

Respondents with higher incomes may be able to afford the higher food costs associated with each policy option whereas respondents with lower incomes may not be able to afford the higher food costs. The significant correlations between some of the variables could provide an explanation for urban being a significant explanatory variable in Model I.

Typically, women appear to express more concern about food safety issues. Therefore, it is not surprising that compared to women, men are more likely to choose neither policy option and keep food costs at their current level. Households with children are more likely than households without children to choose one of the policy options. Respondents with children are willing to pay higher food costs to mitigate the perceived risks associated with biotechnology.

It also appears that both male and female consumers are willing to pay higher food costs for greater food assurance. The representative female and male consumers in this study were willing to pay the highest amount, in terms of higher food costs, either for a policy that would increase food inspection or for a policy that would require foods to be labelled. Both consumers were willing to pay the least amount for a policy that would place some restrictions on agricultural biotechnology.

The results of this study also provided information on the sources of heath risk and food benefit information that consumers use most frequently. Magazines, newspapers, television and radio were the most frequently indicated sources of information. These sources of information present important means to distributing information about the effects of agricultural biotechnology.

7.2 Possible Limitations and Extensions of the Study

Whenever respondents are asked to respond to a hypothetical situation, strategic and hypothetical biases are a concern (Bishop and Heberlein, 1979). Hypothetical bias occurs when respondents perceive the situation to be hypothetical and as a result they may not give an accurate response. If this is the case, the respondent's actual behavior is not captured by responses to the survey questions. Strategic bias occurs when respondents' responses reflect what policy they would like to see implemented, rather than giving a response that accurately reflects their behavior in the actual market.

Strategic behavior could be a significant issue in this survey because people may view their responses as consequential. That is, strategic behaviour could occur because the conditions imposed by the hypothetical scenario are sufficient to motivate respondents to understate or overstate their willingness to pay. The more confident respondents are that the policy will be provided regardless of the amount they choose, and the more the respondents believe that they will actually have to pay the amount they have chosen, the greater is the tendency to underbid in a CV survey (Mitchell and Carson, 1989). Conversely, the more respondents believe that the amount they reveal will influence the provision of the policy and the less they believe their payment obligation will determine the amounts they will actually have to pay, the greater is their tendency to overbid (Mitchell and Carson, 1989).

By responding "no change in either and keep food costs at their current level" some respondents could be indicating that the current regulatory system provides a sufficient level of food safety. It is also possible that these respondents are not willing to pay higher food costs for increased food safety because of budget constraints. This response could also be an indication of "protest bids by respondents who refuse to play the game" (Mitchell and Carson 1989, 166). Protest bids can also be an indication that the respondent does not agree with the payment vehicle (Munro and Hanley, 1999).

Due to lengthiness of the telephone survey and time constraints, a general definition of agricultural biotechnology was given to respondents. An explanation of biotechnology that included some of the proposed advantages and disadvantages of the technology might have given respondents a fuller understanding of the technology. However, in view of the time constraints involved, the definition given was chosen to be as neutral as possible, in an effort not to bias responses.

A lack of comparison with actual purchases is a further limitation. There are food products, such as soy milk, that are labeled as "not made from genetically modified soy beans, for which actual purchases are made. The tradeoffs that consumers are willing to make when they purchase such goods could be compared with the results from presenting consumers with hypothetical situations. Comparing actual purchase decisions with the results presented in this study is a potential extension of this work.

Further research could focus on data collected from focus groups and individuals to determine consumers' willingness to pay for greater food assurances and for specific labeling policies. In these focus groups, and in subsequent experiments, the tradeoffs that consumers are willing to make for different messages on the labels (positive versus negative) or different labelling policies (voluntary and mandatory) could be assessed.

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APPENDIX A: CORRELATION COEFFICIENTS

Correlation Coefficients for Model I

	AGE	CHILD	EDUC	INCOME	MALE	MARR	URBAN
AGE	1	-0.25749	-0.15944	-0.09261	-0.07202	0.14462	-0.0737
CHILD	-0.25749	1	0.0396	0.12013	-0.04416	0.30356	-0.02556
EDUC	-0.15944	0.0396	1	0.22935	0.06972	0.05098	0.1189
INCOME	-0.09261	0.12013	0.22935	1	0.11763	0.25588	-0.02339
MALE	-0.07202	-0.04416	0.06972	0.11763	1	0.04549	-0.04648
MARR	0.14462	0.30356	0.05098	0.25588	0.04549	1	-0.14192
URBAN	-0.0737	-0.02556	0.1189	-0.02339	-0.04648	-0.14192	1

Correlation Coefficients for Model II

	AGE	CHILD	EDUC	INCOME	MALE	MARR	URBAN
AGE	1	-0.25950	-0.15348	-0.08389	-0.07554	0.13846	-0.07798
CHILD	-0.25950	1	0.03393	0.11430	-0.04960	0.30850	-0.02711
EDUC	-0.15348	0.03393	1	0.23007	0.07176	0.06631	0.12126
INCOME	-0.08389	0.11430	0.23007	1	0.11563	0.25374	-0.01911
MALE	-0.07554	-0.04960	0.07176	0.11563	1	0.04310	-0.04407
MARR	0.13846	0.30850	0.06631	0.25374	0.04310	1	-0.13913
URBAN	-0.07798	-0.02711	0.12126	-0.01911	-0.04407	-0.13913	1

APPENDIX B: RESULTS OF MODEL I.A ESTIMATION

Variable	Coefficient (t statistic)	Variable	Coefficient (t statistic)
RESTRICT BIOTECH	0.69811 (1.27972)	**COST**	-11.6438** (-2.98909)
AGE	0.00171 (0.30038)	AGE	0.03707 (0.90700)
CHILD	-0.09626 (-0.51558)	CHILD	0.69314 (0.52011)
EDUC	0.02141 (0.80908)	EDUC	-0.00196 (-0.01041)
INCOME	-0.00282 (-0.85463)	INCOME	0.03737 (1.58446)
MALE	-0.56705** (-3.39196)	MALE	-0.46907 (-0.39312)
MARR	0.07127 (0.37879)	MARR	-0.31317 (-0.23260)
URBAN	0.24413 (0.97781)	URBAN	-1.99835 (-1.13399)
INSPECT	1.05842 (1.91157)		
AGE	0.00015 (0.02525)	Log - Likelihood	-3436.973
CHILD	-0.08987 (-0.47092)	Restricted (slopes=0) Log-L	-3638.9668
EDUC	0.00943 (0.34992)	Chi-Squared (χ^2)	403.9876
INCOME	-0.00174 (-0.51737)	Adjusted ρ^2 Statistic	.08897
MALE	-0.39493** (-2.31208)		
MARR	0.23094 (1.20093)		
URBAN	0.73564** (2.93130)		
*denotes significance at the α = 0.05 level	**denotes significance at the α = .01 level		

APPENDIX C: RESULTS OF MODEL II.A ESTIMATION

Variable	Coefficient (t statistic)	Variable	Coefficient (t statistic)
RESTRICT BIOTECHNOLOGY	0.756519 (1.41855)	**COST**	-15.6954** (-4.21914)
AGE	-0.00619 (-1.12094)	AGE	0.070378 (1.83436)
CHILD	0.070143 (0.87971)	CHILD	0.195881 (0.356115)
EDUC	-0.00594 (-0.22799)	EDUC	0.248097 (1.39465)
INCOME	0.007819** (2.42005)	INCOME	-0.01434 (-0.63735)
MALE	-0.46143** (-2.82239)	MALE	-0.57002 (-0.50172)
MARR	-0.00358 (-0.01935)	MARR	0.966423 (0.749419)
URBAN	0.117562 (0.470959)	URBAN	1.26209 (0.709182)
MORE FOOD LABELLING	1.79706** (3.34766)		
AGE	-0.00723 (-1.30105)	Log - Likelihood	-3518.219
CHILD	-0.01341 (-0.16748)	Restricted (slopes=0) Log-L	-3682.2358
EDUC	-0.00084 (-0.03217)	Chi-Squared (χ^2)	328.0336
INCOME	0.004483 (1.37468)	Adjusted ρ^2 Statistic	.07068
MALE	-0.32978* (-1.99977)		
MARR	-0.16951 (-0.90736)		
URBAN	0.012011 (0.04748)		