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Measuring Consumer Resistance to Innovation in Meat Packaging
- Evidence from Choice Experiments

by

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Abstract

In this thesis, consumers' perceptions and willingness-to-pay for a new packaging technology for beef steaks, vacuum packaging, are measured using real choice experiments and different information scenarios. The findings suggest that information plays an important role in consumers' attitudes towards vacuum packaged beef steaks: beneficial information affects consumers' behaviour in a positive way and is more dominant after negative information has been provided. There was no significant evidence to support that consumers are willing to pay more for beef steak with a long shelf-life or beef ageing. The Food Technology Neophobia Scale (FTNS) was used to measure differences in consumers' perceptions of food innovation. The findings show that there were no significant relationships between socio-demographic characteristics with FTNS. Using mixed logit models, a consumer's willingness to purchase vacuum packaged beef steak increased with the education level, the income level, the presence of children in the household, and decreased with FTNS scores.

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1 Introduction

In order to maintain long-term growth and firm success, innovation and economic health have been identified as core drivers. A survey conducted by McKinsey and Co. showed that innovation is considered one of the top three drivers of company growth in the next three to five years by more than 70 percent of top executives (Barsh *et al.*, 2008). Although spending on innovation as compared to sales in the agricultural and food sector is conspicuously lower than in the high-technology industry, new food-product innovations never stop springing up in the food market. Several waves of innovation in the agricultural sector in conjunction with machinery, chemistry and biological developments have occurred over the last 150 years (Craff *et al.*, 2003). Over the past decade alone, an increasing number of new food products emerged in different food markets (Sloan, 2002).

The market success of new food product innovations hinges on consumers behavioural responses to the innovation. Hence, not all innovations are accepted by the market and consumers without resistance. From the perspective of consumer attitudes, innovations may be categorized as either receptive or resistant (Garcia *et al.*, 2007). Receptive innovations are those that are readily adopted by the market. Resistant innovations may face psychological and economic switching costs in the consumer market, despite a seemingly clear competitive advantage over existing products. Consumer resistance to innovations may be caused by a number of factors that can pose a conflict with consumers' established behaviour and beliefs, requiring individuals to abandon their ingrained or adopt unfamiliar routines. Resistance factors and barrier to the adoption of innovations can range from consumer habits and traditions to norms and risk perceptions. As a result, negative attitudes towards the innovation may prevent widespread adoption and market penetration, innovation success and a high return on investment (Garcia *et al.*, 2007; Kleijnen *et al.*, 2009; Aoki *et al.*, 2010).

Methods were developed to measure consumer behaviour toward innovation and technology acceptance, such as Diffusion of Innovations (Rogers, 1983), Technology Acceptance Model (Davis *et al.*, 1989), Trust in Science Scale

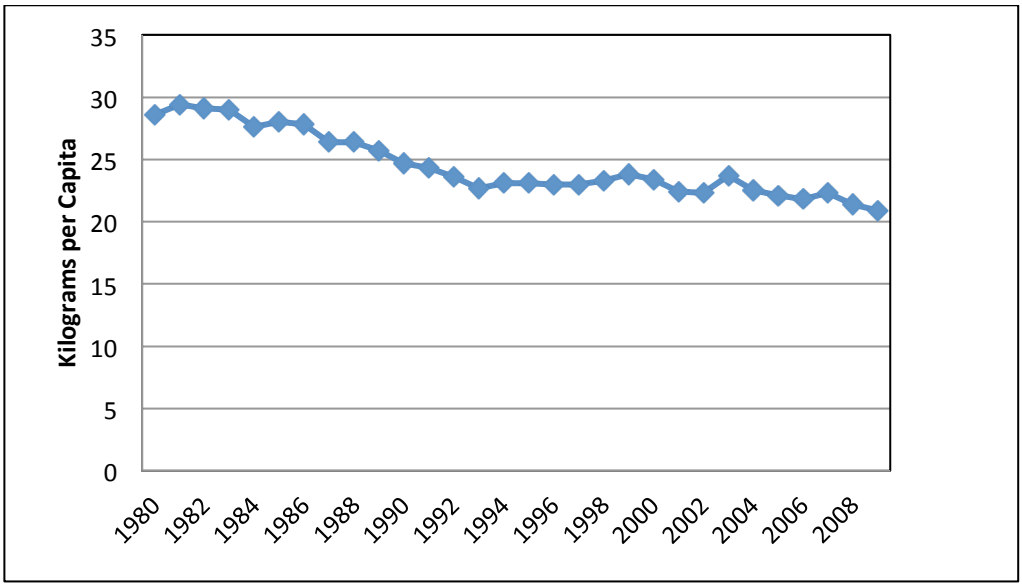
(Bak, 2001), and the Unified Theory of Acceptance and Use of Technology (Venkatesh *et al.*, 2003). Existing research has also developed several different tools to measure consumers' acceptance or rejection of new food technologies: the Food Neophobia Scale (Pliner and Hobden, 1992), the General Neophobia Scale (Pliner and Hobden, 1992), the Food Attitude Scale (Frank and van der Klaauw, 1994; Raudenbush *et al.*, 1998), the Food Situations Questionnaire (Loewen and Pliner, 2000) and the Food Technology Neophobia Scale (Cox and Evans, 2008).

1.1 Problem Statement

Consumer demand keeps changing over time due to growing population, rising incomes, and changing lifestyles. These changes cause consumers to look for and demand high quality, convenient, nutritious and safety new food products (Winger and Wall, 2006). Therefore, demand drives firm level innovation to maintain competitiveness and attractive products to meet consumer needs. For example, high pressure processing (fruit juice) and modified atmosphere packaging (salads) are applied to achieve food safety and genetic modification (oilseeds) and bio-active ingredients (yoghurt) are introduced to enhance health benefits (Cox and Evans, 2008).

In the meat sector, consumers' need for safe, high quality and convenient new product is more obvious. Producers have struggled with product innovations as a means for fighting declining demand. The beef industry, for instance, faced declining per capita beef demand from the early 1980's to the late 2000's (Figure 1.1). Per capita beef consumption decreased by more than one-fourth, or approximately 8.6 kilograms per capita between 1981 and 2009. This decline is attributed to several factors: the relative high price of beef compared to pork and poultry meats; changing consumer demographic characteristics, leading to a greater interested in and demand for convenient and easy-to-prepare meat products (Schroeder *et al*. 2000); growing food-health concerns, which have contributed to negative perceptions of beef in terms of its level of fat and cholesterol (National Institute of Nutrition report on Tracking Nutrition Trends, 2002; Schroeder, 2002).

Figure 1.1 Per Capita Consumption of beef in Canada, 1980-2009



Source: Agriculture and Agri-Food Canada, http://www.agr.gc.ca.

To date, significant amounts of time and money have been invested by researchers and the beef industry to identify the reasons behind the decline in beef consumption across North America. Schroeder (2002) revealed that if the beef industry had succeeded in meeting consumers' needs and demands earlier, demand for beef in all likelihood would not have declined as much as it did and would probably be at higher levels today. Consumers place ever more emphasis on how convenient meat products are, and especially how quickly such products can be prepared for consumption (Schroeder *et al.*, 2000; Buckley *et al.*, 2007). Changing lifestyles and the dissatisfaction with fresh beef's largely inconvenient packaging also potentially affect the decline in beef consumption in North America (Mintert *et al.*, 2009). Changing lifestyles and demographics are behind the growth in time-saving convenience products that are steadily increasing in consumers demand. According to Brunner *et al.* (2010), there is no doubt that convenience is one of the big trends in the meat business, especially for meat packaging method.

Due to its biological composition, fresh meat is a highly perishable product. Lomeli (2005) claimed that food safety issues and health concerns played an important role in determining the demand for beef products. Nowadays, consumer demand for safe production methods motivates food companies to explore new ways to improve their production practices in terms to

maintaining food safety (Cheruvu *et al.*, 2008). In the meat sector, alternative packaging technologies such as natural bio-preservatives and active packaging have been developed to coalesce consumer demands for high quality, convenience, safety, and fresh appearance with extended shelf-life in fresh meat products.

Advanced packaging technologies can protect meat products from discolouration, off-flavour, off-odour, nutrient loss and texture changes (Linssen *et al.*, 2003; Gill, 2003). Meat packaging technology has undergone significant changes over the past few decades. However, many such innovations have not been available to supermarket shoppers for long and conventional packaged meat products still dominate the Canadian retail meat shelf.

Regarding food technology market success, out of 539 new technological innovations tracked by Ernst & Young and AC Nielsen, only 33 achieved sustainable market successes (Watzke and Saguy, 2001). Other sources indicate that innovation failure rates range between 40% – 50% (Lafley, 2008), 67% – 88% (Buisson, 1995; Rudolph, 1995; Prime Consulting Group, 1997; Lord, 1999; Theodore, 2000), and 99% (Morries, 1993; Sloan, 1994). Given such high innovation failure rates, it is important for producers to find out how a technological innovation will perform in the place market in order to avoid introduction failure. Stewart-Knox and Mitchell (2003) stated that understanding consumer needs and expectations was closely associated with product success. Knowing consumer needs and expectations may reduce the risk of product failure and enhance product market success. As a result, there is a need to measure the level of consumer acceptance of innovations.

A new product produced with the help of a novel packaging technology, vacuum sealed beef steak, was introduced in the Western Canadian market in 2010. Whether this technological innovation meets consumer's needs or satisfies consumers the way that the innovation fulfills different needs will be crucial to its market acceptance and hence success.

Compared to beef steak packaged using vacuum meat packaging technology, conventional foam tray and film packaging is more difficult to open, has a shorter shelf-life and is often bedeviled by leakage issue. Meat-science research has shown conventionally packaged meat to be less tender, and hence,

of lower eating quality (Filgueras *et al.*, 2010). However, conventional packaging may be more convenient to some consumers and a less costly option for meat producers.

Ultimately, consumers are the judges of the success of new food product innovations and related technologies. In other words, consumers are in control of the final decision whether a new product is successful or not. As a result, in order to develop successful new food and meat products, firms need to gain a broader understanding of how consumers evaluate new products and information about product characteristics when confronted with alternative product and/or technology choices.

1.2 Thesis Objectives

The main objective of this thesis is to identify factors which affect Canadian consumers' perceptions, acceptance, and willingness-to-pay (WTP) for alternative food packaging technologies. In particular, this thesis investigates differences in consumer's responses to a novel vacuum-packaging technology for beef steak. The Food Technology Neophobia Scale (FTNS), originally proposed by Cox and Evans (2008), is used to assess consumers' attitudes towards food innovations and specifically acceptance or rejection of the vacuum packaging technology. A focus of this research is to extend the application of the FTNS. The empirical analysis applies real choice experiments to estimate how this new food technology, vacuum packaging of beef meat, affects consumer perceptions and evaluation of different quality and food safety attributes. In doing so, the analysis aims at estimating consumer's resistance to technological innovation in food products under different information scenarios.

This thesis has three specific objectives:

1) To estimate consumers' WTP for beef steak products differentiated by packaging method (vacuum seal and foam tray packaging), meat ageing and shelf-life.
2) To measure the impact of different information scenarios regarding the

properties of the vacuum packaging technology on consumer's choice decisions.

3) To measure consumers' overall attitudes towards new food technologies by means of the FTNS.

1.3 Organization of This Study

This thesis is organized into five chapters. The purpose of the first three chapters is to provide the reader with an overview of the thesis' research objectives and to create a foundation for the fourth and fifth chapters in which empirical results are reported. Chapter 1 has stated the research problem, outlined the general research objectives and provided a study overview. Chapter 2 presents a review of previous studies related to consumer's WTP for new food technologies, including studies that have focused on the issue of consumer resistance to innovation, the FTNS, experimental economics and choice experiments. Chapter 3 provides an overview of the theoretical framework for measuring consumer's WTP and specifics of the data collection and experimental design procedures. Details of the theoretical and empirical models applied in the analysis are also presented. Chapter 4 then summarizes the data structure and descriptive statistics. Chapter 5 discusses the results of different specifications of multinomial logit and mixed logit choice models. Chapter 6 discusses major findings in light of Canadian consumers' resistance to food technology innovation and WTP for vacuum-packaged beef steak. The thesis concludes with implications for Canadian agribusinesses and policy makers.

2 Literature Review

2.1 Introduction

This chapter presents a review of existing literature concerning consumer resistance to innovations, the Food Technology Neophobia Scale (FTNS), vacuum packaging, as well as an overview of consumers' willingness-to-pay (WTP) studies on food. Section 2.2 discusses different barriers preventing consumers from accepting innovations. In section 2.3 an overview of the FTNS is given. Section 2.4 discusses the advantages and disadvantages of vacuum packaging technology in the context of fresh meat packaging. Section 2.5 presents relevant selected choice-based conjoint studies and WTP studies on food and meat. Section 2.6 ends this chapter with a brief summary.

2.2 Consumer Resistance to Innovations

Why are consumers resisting some products produced by new technologies even when these products have clear competitive advantages over existing products? This and related questions have been asked by a number of studies that investigate consumer resistance to innovation. According to Ram and Sheth (1989, p. 6), "innovation resistance is the resistance offered by consumers to an innovation, either because it poses potential changes from a satisfactory status quo or because it conflicts with their belief structure". In order to adopt innovations, consumers may need to change their established traditions or modify long-term beliefs. As a result, consumers may hold negative attitudes towards new technologies or products containing them and resist adopting new innovations.

In their 1989 article, Ram and Sheth distinguished five categories of barriers that may cause consumer resistance to innovation (Table 2.1). The first barrier, *usage barrier*, describes the fact that some consumers are happy with the existing status if an innovation requires a relatively long process to learn new skills or develop routines. An example of a food product facing a usage barrier by North American consumers is tofu. Tofu requires largely unfamiliar

cooking skills to be properly prepared. However, tofu in the form of ready-to-eat frozen desserts, which were also invented by tofu manufacturers, has been partially accepted among North Americans. The second barrier, *value barrier*, exists when consumers do not see a strong performance-to-price relation or value offered by an innovation when compared with existing substitutes. The Automatic Teller Machine (ATM) is a good example of an innovation that successfully dealt with the value barrier. Although it cannot provide complex banking transactions and has a withdrawal limit (e.g. $500), ATMs provide value to the consumer when it is impossible to access a bank branch directly. The third resistance factor, *risk barrier*, summarizes four risk factors: physical risk, economic risk, functional risk, and social risk. Physical risk exists when consumers are afraid that an innovation may pose a threat to health or property. For instance, sugar substitutes may face a physical risk barrier is sugar substitutes (e.g. saccharin). Saccharin has been shown to cause adverse effects on human health. Economic risk exists when the cost of an innovation is higher than expected or exceeds the general public's consumption capacity. For example, electronic products, such as personal computers and cameras, may be susceptible to this barrier. Purchases would be postponed by interested consumers because a better product with a lower price will soon be provided. Functional risk refers to the probability that an innovation may not perform properly because of incomplete testing prior to its market introduction. New car models may carry functional risks. Although they have been tested before release, no performance record exists and it is possible that they may not function properly (as expected). Social risk is connected with consumers' concerns that adopting an innovation will cause "social ostracism or peer ridicule" (Ram and Sheth, 1989, p. 8). Genetically modified (GM) foods, which have been shown to generate social risks, are still rejected by most consumers. The fourth barrier, *tradition barrier*, describes the fact that an innovation may force some consumers to deviate from their present cultural traditions or long term habits. For instance, screw caps on wine bottles are not acceptable to consumers who prefer the tradition associated with opening a cork-bottled wine. The fifth barrier category is *image barrier*. An image barrier can arise from an innovation's country of origin, including the product class or industry.

Table 2.1 summarizes scholarly research on consumer resistance to innovation in the food industry categorized by the above five innovation barriers. The table also illustrates that the empirical evidence on risk factors associated with food product innovations, and especially consumer resistance to food innovations, is growing but still scarce.

Table 2.1 Literature overview: drivers of consumer resistance in food

Driver	Description	Source	Nature of the study	Relevant findings
Usage barrier	An innovation requires a lengthy learning process, or skills or routines	Foxall (1993)	Quantitative -survey	Food innovations were more likely to be rejected by the people, who held a high level of commitment to a coherent behaviour pattern.
Physical risk	An innovation could cause harm to people or property	Marette *et al.* (2008)	Quantitative – experiment and survey	When more information was provided, consumers were concerned more about health risk of the technological innovation of fish (methylmercury) than other benefits (omega-3 fatty acids).
		Ganiere *et al.* (2004)	Quantitative - experiment and survey	Most consumers in Taiwan were not opposed to purchasing GM food although they might experience health related effects.
		Bredahl (2001)	Quantitative – survey	The quality and trustworthiness of the food products played an important role in consumers' choices. GM food negatively affected consumer evaluations of these food innovations.
		Saba *et al.* (2000)	Quantitative – survey	With high uncertainty of the health effects, most consumers were opposed to accept GM food.
Economic risk	An innovation will be a waste of economic resources	Noussair *et al.* (2004)	Quantitative – experiment	Consumers predominantly opposed GM food. Their reluctance to buy these foods decreased when price decreased.

Several papers discuss consumers' fears and concerns related to novel food

technologies (von Alvensleben, 2001; Ronteltap *et al.*, 2007; Siegrist, 2007). Consumers are becoming more conscious of food production methods and prefer organic food and free range livestock products to GM foods (von Alvensleben, 2001). There is considerable evidence that some new technologies are relatively easily accepted in the market, while others encounter resistance and consumers are doubtful about them (e.g., Cardello, 2003; Evans and Cox, 2006; Cardello *et al.*, 2007; Cox *et al.*, 2007; Siegrist *et al*., 2007). Cardello (2003) found that novel food technologies, such as genetic engineering, the use of bacteria, and irradiation, were viewed with concerns by more than 60% of consumers. In the paper by Cardello *et al.* (2007), consumers also showed the greatest negative attitude towards these two new food technologies, irradiation and genetic modification.

Consumer's awareness of food technologies is an important influencing factor in their perception of food technologies (Cox *et al.*, 2007). Moreover, consumer's reaction to many food technologies is influenced by whether they are provided with certain information about the technology or not. Marette *et al.* (2008) and Cardello (2003) found information to have a positive effect and mitigated consumer's concern levels, while Wilson *et al.* (2004), Hansen *et al.* (2003) and Scholderer and Frewer (2003) found a negative reinforcement from the provision of information. Food preservation technologies and irradiation, for instance, are generally rejected by consumers, even when they know that these technologies are considered safe and effective by the scientific community (Henson, 1995; Ronteltap *et al.*, 2007). Preservation and food irradiation novel technologies encounter risk barrier: physical risk and functional risk, as consumers are concerned about the safety of these technologies and may be afraid of the potential threat to their healthy. Image barrier, as consumer may link food irradiation with cancer risks, also plays an important part in consumer's resistance to food irradiation technology and application. However, research by Hansen *et al.* (2003) found that consumers would react positively if positive information about food innovations was provided by a trusted source. As a result, it may be a wise choice for producers and marketers to provide accurate information about novelties before potentially misleading information is being released to consumers largely unfamiliar with new food products (Backstrom *et al.*, 2004).

The literature has shown that the success of food innovations hinges on the understanding of how consumer characteristics and perceptions affect the acceptance of or resistance to an innovation. Consumer perceptions of product quality do not only rely on intrinsic quality attributes, but also on other factors: such as health, social, cultural, environmental attributes, and cognitive processes during the time of purchase (Cardello *et al.*, 2007). Strong consumer demand for food safety, without sacrificing quality or convenience, forces food companies to innovate while maintaining safety standards. Fresh meat, for example, is a highly perishable product whose quality hinges on proper handling and storage conditions. Alternative packaging technologies such as natural bio-preservatives and active packaging have received attention in the meat industry to meet consumer's demand. However, the impact of these novel technologies on the physical product attributes can greatly affect its acceptance and has not been sufficiently investigated to date.

2.3 Food Technology Neophobia Scale

Evans and Cox (2006) suggested that firms need to gauge the acceptance of foods produced using novel technologies to ensure their acceptance, rather than risk market failure when consumers form negative perceptions in the market place. Pliner and Salvy (2007) pointed out that it is to be expected that individuals have different attitudes towards different novel food technologies. Several methods have been developed in the literature to measure differences in consumer's perceptions of and attitudes towards innovation.

Pliner and Hobden (1992) developed a 10-item questionnaire, the Food Neophobia Scale (FNS), to measure consumer's willingness to try, in an effort to predict consumer's choice of new foods. Another scale, the revised Food Attitude Scale (FAS-R), has been used to rate consumer's willingness to eat foods they had never tried (Frank and van der Klauuw, 1994; Raudenbush *et al.*, 1998). Loewen and Pliner (2000) developed the Food Situations Questionnaire (FSQ) to capture children's attitudes towards novel foods considering specific situational factors.

More recently Cox and Evans (2008) developed a systematic questionnaire

tool, the FTNS, to measure consumers' acceptance or rejection of novel food technologies. As part of the development process, the original FTNS containing 81 statements was reduced to a final list of 13 items (see table 2.2) using a three stage validation exercise. In stage 1, 193 students from two Universities in Adelaide completed the questionnaire containing 81 questions which resulted in the exclusion of 50 questions. In stage 2, 459 people were recruited from four major Australian cities to complete a computer-based questionnaire based on the remaining 31 questions from stage 1, which resulted in the final 13 questions that make up the FTNS tool. In stage 3 of the research, 294 residents of South Australia completed the 13 item FTNS to test the performance of the tool compared to other scales, such as FNS. According to Cox and Evans (2008), the FTNS can be considered more suitable for measuring receptivity to food products using new technologies than the older FNS (confirmed by Tuorila *et al.*, 2001; Flight *et al.*, 2003; Pliner and Salvy, 2007), which was found to be more suitable for assessing trait anxiety and 'sensation seeking' (Pliner and Hobden, 1992; Pliner and Melo, 1997).

The FTNS ranks consumers' responses to novel food technologies based on seven-point bi-polar scales anchored 'totally disagree' to 'totally agree', with a labeled mid-point of 'neither agree nor disagree'. The first 6 questions measure the respondent's level of perceived necessity of new food technologies. The following 4 questions obtain consumer's perceptions of the potential risk of novel food technologies. Questions 11 and 12 aim at uncovering whether consumers consider new food technologies to be healthier or not. Finally, question 13 measures consumer's attitudes towards the media. Evans *et al.* (2010) tested the consistency and stability of the FTNS in the context of two different case studies. Their results indicated that the FTNS is stable over time and a reliable tool for measuring consumers' reactions to new food technologies. All of the above scales were developed to identify differences in individual's reactions towards novel food technologies.

Table 2.2 Food Technology Neophobia Scale

		Totally disagree			Neither agree nor disagree			Totally agree
		1	2	3	4	5	6	7
1	There are plenty of tasty foods around so we don't need to use new food technologies to produce more.							
2	The benefits of new food technologies are often grossly overstated.							
3	New food technologies decrease the natural quality of food.							
4	There is no sense trying out high-tech food products because the ones I already eat are good enough.							
5	New foods are not healthier than traditional foods.							
6	New food technologies are something I am uncertain about.							
7	Society should not depend heavily on technology to solve its food problems.							
8	New food technologies may have long term negative environmental effects.							
9	It can be risky to switch to new food technologies too quickly.							
10	New food technologies are unlikely to have long term negative health effects.							
11	New products produced using new food technologies can help people have a balanced diet.							
12	New food technologies can give people more control over their food choices.							
13	The media usually provides a balanced and unbiased view of new food technologies.							

Source: www.csiro.au/resources/Food-Technology-Neophobia-Scale.html.

For gender differences, using the FTNS, the FNS, and the FSQ, research was unable to detect differences between men and women (Pliner and Hobden, 1992; McFarlane and Pliner, 1997; Tuorila *et al.*, 1998; Loewen and Pliner, 2000; Flight *et al.*, 2003; Cox and Evans, 2008; Evans *et al.*, 2010). However, using the FAS-R, women were reported to be more neophobic than men (Alley and Burroughs, 1991; Frank and van der Klauuw, 1994).

Regarding differences in attitudes towards food technology based on age studies differ widely in how age was categorized, making it difficult to compare or summarize previous findings. In general the majority of studies using the FNS and FSQ scales found that neophobia declines with age

(McFarlane and Pliner, 1997; Lowen and Pliner, 2000). The exception is Tuorila *et al.* (2001) who tested the FNS on a group of consumers in Finnland aged 16 to 80 years. The authors found that neophobia increased with age. Studies using the newer FTNS reported no difference in technology perceptions across age categories (Cox and Evans, 2008; Evans *et al.*, 2010).

However, significant differences have been found in FTNS studies when participant's educational level was considered. Studies showed that with less educated consumers tend to be more neophobia than their higher educated peers (Cox and Evans, 2008; Evans *et al.*, 2010). Using the FNS, neophobia increased with education in only one study by Tuorila *et al.* (2001), while food neophobia scores did not differ by education in the study by Flight *et al.* (2003).

2.4 Vacuum Packaging Technology

Vacuum packaging is a method of storing food and presenting it for sale in oxygen impermeable bags under vacuum (Seideman and Durland, 1983; Ibrahim *et al.*, 2008). This food packaging method, marketed successfully for years in many countries, has been used to prolong the shelf-life and tenderness of fresh meat during extended periods of shipment and storage (Seideman and Durland, 1983; Cornforth and Hunt, 2008).

Price, packaging and freshness have a major impact on consumer's meat expenditure patterns (Barr, 1992). The colour of meat has been found to be a primary indicator of freshness determining consumer purchase decisions (Warner *et al.*, 1993; Viana *et al.*, 2005). Adams and Huffman (1972) confirmed that consumers related freshness to the colour of lean meat. After the removal of oxygen from the package, vacuum packaged meat typically is purple-brown coloured, which is distinctly different from bright red colour of conventionally tray-packaged meat[1].

The literature discusses several advantages of vacuum packaging of fresh

[1] In conventionally packaged meats deoxymyoglobin is rapidly transformed into oxymyoglobin. This form of myoglobin is responsible for the bright red colour of conventionally tray-packaged meats. Under vacuum packaging deoxymyoglobin is stable and causes the distinct purple colour of quintessential for freshly cut meat stored in the absence of oxygen (Seideman and Durland, 1983).

meat. The advantages of vacuum packaging are increased shelf-life, stabilized-colour, reduction of weight loss, and mitigated spoilage (Seideman and Durland, 1983). Research has demonstrated that shelf-life can be greatly increased when fresh beef is vacuum packaged in plastic films of low gas permeability, compared to commercial packaging in a pure air atmosphere (Dainty *et al.*, 1979; Egan and Shay, 1982; Brewer *et al.*, 1992; Church and Parsons, 1995; Filgueras *et al.*, 2010;). Additional advantages of vacuumized storage include the preservation of colour, increased hygienic control and enhanced palatability due to controlled ageing of meat (Filgueras *et al.*, 2010). Meat colour remains relatively stable under vacuum packaging over a range of 35 days under conditions of 2-3°C (Jeong and Claus, 2011). Vacuum packaging also reduces weight-loss from evaporation and trimming. The use of impermeable film prevents the dehydration of beef (meat) that is exposed to an open refrigeration system (Seideman, 1975). Furthermore, the use of films which are essentially impermeable to oxygen transmission provides a means for controlling the growth and metabolism of undesirable aerobic microorganisms that are associated with the spoilage of fresh meat (Dainty *et al.*, 1979; Newton and Rigg, 1979). In addition, vacuum packaging beef has been found to be a very effective method for ageing beef. Lindahl *et al.* (2010) reported that tenderness was attained after approximately 15-25 days under vacuumized storage.

Previous research has also discussed several potential disadvantages of vacuum packaging of fresh meat products. The greatest drawback of is that the use of impermeable films and related machine leads to much higher costs for vacuum packaging compared with conventional packaging. Because the film used in vacuum packaging is a crucial factor in preserving meat quality, the physical properties of the packaging film should be puncture resistance, ability to produce a good seal, low moisture-vapor transmission rate and low oxygen permeability (Johnson, 1974). As vacuum packaging creats an anaerobic environment, an increase in the number of anaerobic microorganisms, such as Clostridium, may pose a threat to human health hazard if no attention is paid to continuous temperature monitoring and food safety procedures during meat cutting, chilling and storage (Seideman and Durland, 1983). The growth of anaerobic bacteria under suboptimal storage conditions is another potential

risk of vacuum packaging. Egan and Shay (1982) suggested that vacuum packaged fresh beef developed significantly off-putting flavours after 13-28 days of vacuumized storage. Pierson *et al.* (1970) also reported a slightly sour flavour after 10 days of vacuum-packaged storage in saran, which they attributed to the activity of lactic-acid bacteria. Overall, the advantages of vacuum packaging hinge on the existence of a complete vacuum in the package. If the vacuum is broken, spoilage will occur (Seideman and Durland, 1983).

Previous research has investigated consumers' attitudes toward different meat attributes, especially beef, of relevance to the properties of vacuum packaging. Lynch *et al.* (1986) determined that panelists preferred 3-day shelf-life of polyvinyl-packaged ground beef over a 12-day shelf-life of vacuum packaged ground beef. Regarding colour, Carpenter *et al.* (2001) stated that meat colour and packaging type influenced consumer's rated appearance scores and subsequent likelihood to purchase. The authors reported that consumers' appearance scores were rated red > purple > brown and overwrap with polyvinyl chloride (PVC) > vacuum skin pack (VSP) > modified atmosphere packing (MAP). Other studies reported similar results regarding consumer's preference for meat of light and cherry red colour (e.g., Warner *et al.*, 1993; Viana *et al.*, 2005; Alfnes *et al.*, 2006; Grebitus *et al.*, 2009). Lynch *et al.* (1986) found that the odour of vacuum packaged beef was preferred by many consumers. For ageing, Filgueras *et al.* (2010) stated that longer ageing enhanced the palatability of meat and Kukowski *et al.* (2005) found that consumers were willing to pay more for more tender and flavourful steaks. Economic studies commonly found that higher prices have a negative impact on consumer choice decisions for meat products (Chen and Chern, 2004; Chern and Richertsen, 2004; Tonsor *et al.*, 2005). Whether Canadian consumers accept and are willing to pay for novel vacuum sealed beef steak products, a new product introduced in the Western Canadian market in 2010 will be further investigated in this thesis.

2.5 Choice Experiment and Willingness to Pay Studies

In everyday life, consumers reveal their preferences for decision alternatives (goods, services, etc.), through choices. Especially for marketing economists it is important to understand how changes in the characteristics of choice alternatives affect individuals' preferences. Over the last forty years a large number of studies have advanced our understanding and ability to predict the choice behaviour of decision makers among discrete goods (Louviere *et al.*, 2000). Several different methods, including conjoint analysis, contingent valuation, and experimental auction methods, have been used to investigate consumer's preferences and WTP for food quality attributes. Conjoint analysis have been a very popular technique to analyze the structure of consumer's preferences. A number of case studies have shown that choice experiments are another popular and effective method to measure the retail value of product and particularly food attributes. Moreover, choice experiments are consistent with random utility theory and Lancaster's theory of utility maximization (e.g., Gao and Schroedor, 2009; Zakrys *et al.*, 2009; Aoki *et al.*, 2010). The following section provides an overview of choice experiments that estimate consumer's WTP for different foods and their attributes.

2.5.1 Consumer's Willingness to Pay for Food

This section reviews studies using conjoint analysis that have measured estimated consumer's WTP for meat. Aoki *et al.* (2010) employed two choice experiments, real (laboratory experiment) and hypothetical (field survey) choice experiments, to investigate consumer's attitude towards a food additive (sodium nitrite) to ham sandwiches. The study investigated whether information about sodium nitrite affected consumer's choice decisions. Two information treatments (no information and information) with regard to sodium nitrite were conducted. Both benefits and risks of sodium nitrite were provided to consumers during the information treatment. A conditional logit model was used to analyze the data. Aoki and colleagues found that consumers did not prefer the use of sodium nitrite under both information treatments. In the real choice experiments, flavour related information affected consumer's WTP for ham sandwiches more, while health risk related information played a

greater role in consumer's choice behaviour in the hypothetical field study.

Carlsson et al. (2007) used a choice experiment framework to estimate consumer benefit of labeling and bans on GM food. Data from a mail survey of 710 participants in 2003 was analyzed using a mixed logit model. The results suggested that Swedish consumers were willing to pay premium prices to ensure that GM contents were banned from food production.

Peterson and Yoshida (2004) surveyed Japanese consumers to evaluate consumer perceptions and WTP for imported rice. Consumers were given three choices of rice with different attributes being price and country-of-origin. A nested logit model was applied to analyze the data. The authors found that households with children were more likely to choose domestically produced rice, and the effect of gender and age on choice decisions differed across regions.

Hossain and Onyango (2004) used a choice experiment to analyze consumer's acceptance of nutritionally enhanced GM foods in the United States (U.S.). A phone survey was conducted and the authors used an ordered probit model to estimate the participant's WTP for GM foods. The results showed that consumer's trust in government regulation and in scientists' expertise on biotechnology had a significant effect on consumer's acceptance of GM foods with enhanced nutrient profiles. The authors concluded that the main drivers of market success for bioengineered foods, such as GM foods, were the public's perception of risk and benefits, and food safety.

2.5.2 Consumer's Willingness to Pay for Meat

This section reviews studies that have used experimental economics techniques to estimate consumer's WTP for different meat products. Gao and Schroeder (2009) used choice experiments to investigate consumer's WTP for beef steaks with additional attribute information related to U.S. product certification. An online survey was conducted resulting in 550 responses. Attributes in the choice experiment were price, certified U.S. product, tenderness, leanness, and freshness. A random parameter logit model was applied in the analysis to test whether the additional beef steak labeling

information affected consumers' preferences for other food quality attributes. The study concluded that changes in participant's WTP for different attributes depended on the number of product attributes considered and their relationship to newly added certified label attribute.

Zakrys *et al.* (2009) used choice experiments to investigate the relationship between consumer's acceptance of beef steak package with MAP technology and their perception of product flavour. The authors conducted a 4-testing-session sensory analysis among 134 participants. Consumers were asked to describe beef steaks by the following measures: liking of flavour, juiciness, toughness, oxidized flavour, and overall acceptability. An ANOVA-partial-least-squares regression revealed that beef steaks which were more tender and juicier were most preferred by consumers. The study also found that MAP beef steaks were preferred by consumers because of better tenderness and juiciness compared to a standard beef steak product. Other consumer studies have confirmed that taste factors are a crucial driver of consumer perceptions of food and meat quality and acceptance (e.g., Tuorila and Cardello, 2002; Cardello and Schutz, 2003; Kukowski *et al.*, 2005).

Loureiro and Umberger (2007) used choice experiments to estimate consumers' preferences for different attributes of labeled ribeye steaks in the U.S. beef market. A mail survey was conducted resulting in 632 completed returns. Participants were asked to select between two ribeye steaks with different sets of attributes: traceability, country-of-origin, food safety inspection, and tenderness. Results from a multinomial conditional logit model showed that ribeye-beef steaks being certified for USDA food safety inspection were preferred and received higher levels of consumer trust than other available choices.

Kukowski *et al.* (2005) conducted an experimental auction to evaluate consumer's acceptability and WTP for beef steaks. Consumers were asked to evaluate the appearance of uncooked beef steak, their cooked palatability and then were randomly selected to participate in a subsequent auction session. The attributes evaluated by consumers during the auction were: steak shape, size, leanness, colour, tenderness, juiciness, and flavour. The study's results indicated that consumers were willing to pay more for more tender and flavourful steaks.

One of the first studies to use laboratory auctions to estimate consumer's WTP for selected beef steak attributes differentiated by tray or vacuum packaging method is the study by Schmitz *et al.* (1993). The study used three information treatments (no information, verbal information, and information plus a demonstration) to convey information about vacuum packaging technology to participants. The benefits and characteristics of VSP were also provided to participants. Beef steak attributes were categorized into: health, convenience, appeal and merchandising. Results indicated that regardless of packaging method health related attributes reduced consumer's WTP for beef steaks. Positive information about VSP and related consistency in product quality were found necessary conditions to successfully market vacuum sealed beef steak.

Carpenter *et al.* (2001) used choice experiments to investigate differences in the demand for beef differentiated by colour and packaging method. Consumers were given choices of beef steaks with different attributes: colour (red, purple, and brown) and fresh beef packaging method (MAP, VSP, or PVC). Carpenter *et al.* (2001) found that colour and packaging influenced product appearance scores and subsequent likelihood of consumer purchase. The authors reported that consumers were willing to pay more for beef steaks with an attractive red colour. Consumer's preference ranking for packaging method was PVC > VSP > MAP. Other studies have confirmed the finding that beef consumers prefer meat of light and cherry red colour which has been shown to act as a strong indicator of freshness (e.g., Warner *et al.*, 1993; Viana *et al.*, 2005; Alfnes *et al.*, 2006; Grebitus *et al.*, 2009).

Table 2.3 provides an overview of literature conducted on consumers' WTP for meat attributes. When both survey and experimental methods are applied, the most widely used analytical model is the mixed logit approach. Colour, shelf-life, food safety concerns, and different types of information and labeling signals have been commonly found to affect consumer's acceptance and WTP for meat products.

Table 2.3 Literature overview: consumer reactions to meat products using choice experiments method

Empirical approach	Source	Nature of the study	Relevant findings
Heteroscedastic extreme-value model	Kallas and Gil (2011)	Quantitative – survey	Most consumers in Spain preferred local origin of rabbit meat and products with quality certification. Also, consumers showed high preference for convenience and "ready to eat" meat products.
Mixed logit model	Grebitus *et al.* (2009)	Quantitative – experiment and survey	Different types of information and labeling affected consumers' choice behaviour. Consumers preferred ground beef with brighter red colour and longer shelf-life. Consumer's WTP decreased when beef products were labeled as MAP.
Mixed logit model	Alfnes *et al.* (2006)	Quantitative – experiment and survey	Normal or above normal red salmon was preferred by consumers and positive WTP exists. Colour-added labeling had a positive effect on the demand for above normal red salmon.
Mixed logit model	Tonsor *et al.* (2005)	Quantitative – survey	In general, European consumers were more willing to pay a premium for a labeled steak than for country-of-origin steak. French and German consumers were concerned more about GM feed usage, while German and British consumers would pay more to avoid the use of growth hormones.
Multiple correspondence analysis	Ganiere *et al.* (2004)	Quantitative – survey	Most consumers in Taiwan were not opposed to purchasing GM soybean fed salmon, although they anticipated potential health effects.

2.5.3 Factors Explaining Consumer Opposition to Food Innovation

Food innovation and emerging food technologies may encounter consumer resistance. Optimizing the quality of novel foods or those produced with novel technologies is crucial to their market success but might not guarantee their success (Cardello *et al.*, 2007). Various factors, food safety concerns, risks and benefits associated with novel food technologies, and mistrust, help to explain consumer's opposition to some foods produced by new technologies (Bonny,

2004; Hossain and Onyango, 2004; Peterson and Yoshida, 2004; Cardello *et al.*, 2007).

Over the past few years, food safety issues specifically related to novel food technologies, such as genetic modification, food irradiation, and laser-light processing, have been studied by researchers (e.g., Henson, 1995; Iposos-Reid, 2002; Cardello, 2003; Ronteltap *et al.*, 2007). Many preservation techniques and irradiation of foods tend to be generally rejected by many consumers because of widespread concerns about the safety of these procedures and their potentially harmful effects to human health (Henson, 1995; Chen and Chern, 2004; Ronteltap *et al.*, 2007;). A 12-country survey conducted by Ipsos-Reid (2002) showed that an average of 76% of consumers claimed that they were concerned about the safety of GM foods. Women, especially, tended to be more concerned about GM foods than men in North America, Europe, and the Asia-Pacific region (Ipsos-Reid, 2002). The European Commission (2001) conducted a survey in 15 European countries and found that more than half of respondents stated concerns about GM foods and considered them to be dangerous. The feeling of "danger" was particularly distinct among the self-employed, housewives, people residing in rural areas, and women (European Commission, 2001).

One other major factor that can inhibit the successful adoption of novel food technologies is a lack of knowledge and understanding among consumers (Cardello *et al.*, 2007). Thus, reliable, trustworthy and effective provision of information about the risks and benefits of food technologies plays an important role in consumer acceptance and WTP, and hence market success. Several studies have examined the role of U.S. consumers' perceptions of risks and benefits associated with food biotechnology on their attitudes towards foods produced with biotechnology, showing that product acceptance is driven primarily by consumer's risk-benefit perceptions (Baker and Burnham, 2001; Lusk *et al.*, 2001; Moon and Balasubramanian, 2001). Bredahl (2001) reported similar results for European consumers. A number of studies further have shown that consumers' perceptions are unbalanced and tilted towards the risks associated with GM foods (Frewer *et al.*, 1997; Boccaletti and Moro, 2000; Grunert *et al.*, 2000; Burton *et al*., 2001;). Consumers generally tend to show negative attitudes towards GM foods, where GM risks are considered to be

substantial and cannot be compensated by potential GM benefits, such as improved taste or functionality.

The consumer economic literature widely acknowledged that trust plays an important role in consumer's reaction to new food product innovations, such as GM foods (Siegrist, 2000; Costa-Font *et al.*, 2008; Govindasamy *et al.*, 2008). Several authors have analyzed consumer's trust in scientific knowledge and different institutions (e.g., Baker and Burnham, 2001; Lusk *et al.*, 2001; Moon and Balasubramanian, 2001; Hossain and Onyango, 2004; Christoph *et al.*, 2006). Hossain and Onyango (2004) found that consumers' acceptance of nutritionally enhanced GM foods in the U.S. was highly dependent on their level of trust in the scientists' expertise on biotechnology in both private and public institutions, and in the government's ability to regulate GM foods effectively. Other studies on the same issue have also pointed out that the less trust a consumer has in the scientific community, food companies, and their government, the less likely they are to purchase GM foods (Soregaroli *et al.*, 2003; Onyango, 2003).

2.6 Summary

Chapter two reviewed five main barriers causing consumer's resistance to innovation: usage, value, risk, tradition, and image barriers. The FTNS, together with earlier scale measures, is frequently used by researchers to assess consumer's acceptance or rejection of novel food stuffs and/or technologies. The FTNS was found to provide a more reliable tool to measure the degree of Canadian consumer's resistance to innovation in meat packaging. Therefore, the FTNS measure is added to this study's analysis of Canadian consumers' attitudes and WTP for vacuum packaging technology. Section 2.4 summarized literature that discussed selected advantages and disadvantages of vacuum packaging of food and meat products in particular and provides the background to designing relevant attribute combinations in this study's consumer choice experiments. Regarding the choice of model framework the economic literature clearly favours the use of choice-based conjoint experiments as a superior method for analyzing consumer's WTP for and

potential resistance to innovation in meat packaging; supported by current findings discussed in this chapter. Most prior research focused on consumers' WTP and acceptance of agricultural products, such as GM foods. Few studies paid close attention to food packaging technologies and particularly vacuum packaging of beef, which constitutes a recent food innovation in the Western Canadian retail market. Hence, it is worthwhile investigating how Canadian consumers' choice behaviour, and their receptiveness to beef steak packaged with vacuum-seal technology. The next chapter presents the empirical model, choice-based conjoint experimental framework, including the experimental set-up and survey design.

3 Methodology and experimental design

3.1 Introduction

Laboratory experiments have become an important research methodology for economists since the approach was first developed by Chamberlin (1948). According to Zwerina (1997), one of the most important advantages of choice experiments is their capacity to allow for the collection of data involving simulated purchase decisions that can be used to predict consumer behaviour. Choice experiments provide a more realistic and simpler environment for the participants of consumer behavioural research studies. Another important advantage of choice experiments is their ability to differentiate "alternative- or brand- specific attributes and levels, such as unique price effects for Coke versus Pepsi, can easily be accommodated" (Zwerina, 1997, p. 6). Zwerina also pointed out that incorporating a no-choice option for estimating market shares is an important advantage of discrete choice experiments over traditional analytical methods. Friedman and Sunder (1994) provided a description of the process involved in conducting economic experiments. The authors explained that induced-value theory (Smith, 1976) can allow an experimenter to observe participants' characteristics for experimental control. "Laboratory" experimental research methods have become increasingly widespread in studies aimed at testing whether the assumptions economic theory makes about rational behaviour are in fact descriptive of the actual behaviour of humans.

More recently, the field of experimental economics has become increasingly popular in economics studies modeling the impacts of real world incentive systems on behaviour in order to gain a better understanding of why consumers' are willingness-to-pay (WTP) for specific food attributes. For example, Grebitus *et al.* (2009) tested the impact of different types of consumer information and labeling signals on consumer's meat product choice behaviour in a study of beef packaged in conventional tray packaging and modified atmosphere packaging. The attributes evaluated by participants were price, shelf-life, colour, and packaging method. Kukowski *et al.* (2005) used

choice experiments to analyze U.S. consumers' preferences for beef steak attributes. The experimental attributes were: steak shape, size, leanness, colour, tenderness, juiciness, and flavour. Schmitz *et al.* (1993) used an experimental auction method to investigate how selected beef steak attributes affected consumer's WTP for ribeye steaks in regular packaging and vacuum packaging under three information treatments. The steak attributes were categorized into health, convenience, appeal and merchandising. In order to investigate consumer resistance to innovation in foods and meat products in particular, this thesis was conducted in a choice-experimental case study of vacuum packaging of beef steaks.

The remainder of this chapter discusses the theoretical framework of this thesis, the choice-based conjoint analysis (CBC) model applied in the empirical analysis of consumer acceptance of vacuum packaging of beef, and the experimental design. The underlying economic model of consumer demand for quality attributes is the well-established model by Lancaster (1966), which is introduced in the following section. A discussion of the mixed logit model applied in the analysis is given in section 3.3. Section 3.4 provides a general explanation of experimental design in CBC studies, including a discussion of the importance of a no-choice option in experimental economic analyses and specific details of experimental and survey designs in this study: survey questionnaires, experimental and data collection procedures, information provided to participants, and overview of variables used in the estimation of the mixed logit model. The hypotheses tested in the empirical analysis are listed in section 3.5.

3.2 Economic Model

Lancaster's (1966) theory of demand provides researchers with a foundation of studying consumer behaviour in the context of food attributes, differences and changes in food product attributes and the introduction of product innovations. According to Lancaster, consumers obtain utility directly from the characteristics of a good rather than the good itself. One assumption of this model is that multiple characteristics inherent in goods are objective and the

same for all consumers (Hendler, 1975). However, utility is a subjective concept and depends on a consumer's preferences between bundles of characteristics. As a result, each individual product can be viewed as the sum of its multiple product quality attributes. Assuming that the relationship between the good and its embodied attributes is linear and objective, this relationship can be expressed as:

$$x_j = \sum_k a_{jk} y_k \tag{3.1}$$

where x_j is the j^{th} commodity, a_{jk} represents the k^{th} quality attribute incorporated in x_j, and y_k is the level of attribute k.

The main objective of this thesis is to estimate Canadian consumers' demand for beef steak differentiated by products attributes such as price, packaging method, ageing and shelf-life. Following Lancaster's framework, two assumptions must be made: (1) consumer utility is derived from the consumption of beef steak; and (2) beef steak products vary in the above quality attributes. Other possible influencing factors are the consumer's demographic characteristics (e.g., income levels, gender, and education levels), the price of beef steak, and consumers' risk attitudes towards the new food packaging technology under consideration. For the purpose of this analysis the otherwise observable attribute, beef steak colour is not considered, because it was not possible to objectively distinguish small variations in steak colour across the beef steaks used in the experimental economic analysis. Therefore, the consumer's utility function for differentiated beef steak can be written as:

$$U = f(P, PM, A, S, D, RA) \tag{3.2}$$

where U is consumer utility obtained from consumption of beef steak products, P is the price of beef steak, PM is the packaging method, A is beef ageing , S is shelf-life, D is consumer socio-demographic characteristics, and RA is consumer risk attitudes towards new food technologies.

3.3 The Multinomial Logit Model and Mixed Logit Model

To investigate questions surrounding consumer preferences and individual choice behaviour, choice based research methods and logistic regression models have been widely applied in the economics profession (e.g., Carlsson

et al. 2004; Loureiro and Umberger, 2007; Zakrys *et al.*, 2009). Regarding the econometric estimation of experimental economic models different logit models have been used in the experimental choice literature. The multinomial logit (MNL) model is one of the most widely applied discrete choice models (McFadden and Train, 2000; Train, 2009). The utility function for decision maker *n*, choosing alternative *j* in choice situation *t* is:

$$U_{njt} = \boldsymbol{\beta}_n' \boldsymbol{x}_{njt} + \varepsilon_{njt} \tag{3.3}$$

where $\boldsymbol{x}_{njt}$ is a vector of explanatory variables relating to alternative *j*, $\boldsymbol{\beta}_n$ is a vector of unobserved coefficients, and the error term ε_{njt} has zero mean and is identically and independently distributed (IID) over alternatives and over *n*, *j*, and *t*.

The choice probabilities P_{njt} is defined as:

$$P_{njt} = \frac{exp\,(\boldsymbol{\beta}_n' \boldsymbol{x}_{njt})}{\sum_j exp\,(\boldsymbol{\beta}_n' \boldsymbol{x}_{njt})} \tag{3.4}$$

One of the problems of MNL models frequently discussed in the experimental economics literature is the assumption that all characteristics of choice probabilities are independent from irrelevant alternatives (IIA). The IIA assumption, however, is not realistic in the case of MNL applications with similar choice alternatives. Also, the MNL model framework can only capture variations in consumers' taste preferences with respect to observed variables. Preferences that vary with unobserved variables (brand preference in this case) or those that are purely random cannot be incorporated in the MNL model. A further development of the logit model approach that overcomes the problem of the MNL model is the mixed logit (ML) model (Train, 2009).

The ML model, also known as a random-parameters logit model, presents a generalization of the standard logit model which allows individual model parameters to vary randomly across consumers (Revelt and Train, 1998; McFadden and Train, 2000). The ML model has become a popular tool for studying data generated from discrete choice experiments (Revelt and Train, 1998; Train, 2009). The ML model approach has also been applied to analyze consumer attitudes toward beef and consumer risk perceptions to new food technologies, such as GM (West *et al.*, 2002; Alfnes, 2004; Lusk and Schroeder, 2004; Tonsor *et al.*, 2005; Carlsson *et al.*, 2007; Grebitus *et al.*, 2009). In situations where individuals engage in repeated choices the ML

approach has proven to produce more efficient estimates compared to the MNL model and does exhibit the above mentioned problems related to IIA (Revelt and Train, 1998). By obviating three major limits of the standard logit model, the ML approach explicitly allows for random taste variation among individuals, unrestricted substitution patterns between choices, and correlation in unobserved factors over time (Train, 2009). Also, its error term structure is not restricted to normal distributions as compared to the probit model, resulting in efficient estimates in situations when individuals make repeated choices in an experimental setting.

The random-parameters logit model can be summarized as follows: each decision maker *n* (*n*=1,…, *N*) faces a choice amongst *J* alternatives in each of *T* choice situations. The choice set can vary over decision makers and choice situations. The decision maker is assumed to consider the full set of alternatives in choice situation *t* and to choose the alternative that provides the highest level of utility. The utility that decision maker *n* obtains from alternative *j* in choice situation *t* can be expressed as:

$$U_{njt} = \boldsymbol{\beta}_n^{'} \boldsymbol{x}_{njt} + \varepsilon_{njt} \tag{3.5}$$

where $\boldsymbol{x}_{njt}$ is a vector of explanatory variables relating to alternative *j*, $\boldsymbol{\beta}_n$ is a vector of unobserved coefficients for each *n* and varies with the density $f(\boldsymbol{\beta}_n|\theta^*)$ where θ^* are the fixed parameters of the distribution, and ε_{njt} is a random term with zero mean that is IID over alternatives and independent of underlying parameters and observable variables.

In general $\boldsymbol{\beta}_n$ can be expressed as $\boldsymbol{\beta}_n = \boldsymbol{b} + \eta_n$, where $\boldsymbol{b}$ is the mean coefficient and η_n is a random term with zero mean whose distribution over individuals and alternatives depends on a set of underlying parameters and observable variables. The distribution of η_n can be assumed to be normal, lognormal, triangular, or any other feasible distribution. Under these assumptions the utility function can be re-written as:
$U_{njt} = \mathbf{b}'\boldsymbol{x}_{njt} + \eta_n{}'\boldsymbol{x}_{njt} + \varepsilon_{njt}$. The stochastic part, $\eta_n{}'\boldsymbol{x}_{njt} + \varepsilon_{njt}$, is correlated with alternatives and time. In contrast to MNL models, each β_n in an ML model has a mean and a standard deviation, and the ML model treats the unobserved information as a separate error component. According to Hensher and Greene (2003), the existence of preference heterogeneity is

captured by the presence of a significant coefficient for the standard deviation of the parameter $\boldsymbol{\beta}_n$.

The conditional probability ($\boldsymbol{\beta}_n$) that decision maker *n* chooses alternative *i* in period *t* is the standard logit (Revelt and Train, 1997):

$$L_{nit}(\boldsymbol{\beta}_n) = \frac{exp\,(\boldsymbol{\beta}_n' \boldsymbol{x}_{nit})}{\sum_j exp\,(\boldsymbol{\beta}_n' \boldsymbol{x}_{njt})} \tag{3.6}$$

The unconditional choice probability is integrated over all possible values of $\boldsymbol{\beta}_n$ weighted by the density of $\boldsymbol{\beta}_n$:

$$Q_{nit}(\theta^*) = \int L_{nit}(\boldsymbol{\beta}_n)\, f(\boldsymbol{\beta}_n|\theta^*) d\boldsymbol{\beta}_n \tag{3.7}$$

In order to obtain maximum likelihood estimates, the probability of each decision maker's sequence of observed choices is needed. Conditional on $\boldsymbol{\beta}_n$, the probability of decision maker *n*'s observed sequence of choices can be represented by the standard logit:

$$S_n(\boldsymbol{\beta}_n) = \prod_t L_{ni(n,t)t}(\boldsymbol{\beta}_n) \tag{3.8}$$

where $i(n,t)$ is the alternative that decision maker *n* chose in period *t*. In comparison, the unconditional choice probability is:

$$P_n(\theta^*) = \int S_n(\boldsymbol{\beta}_n)\, f(\boldsymbol{\beta}_n|\theta^*) d\boldsymbol{\beta}_n \tag{3.9}$$

where $\boldsymbol{\beta}_n$ represents decision maker's tastes which vary over people. The density of this distribution contains the parameters θ^* denoting the mean and covariance of $\boldsymbol{\beta}_n$. "This shows how one can estimate the person specific choice probabilities as a function of the underlying parameters of the distribution of the random parameters" (Hensher and Greene, 2003, p. 136).

The estimation of choice probabilities based on equation (3.5) or (3.7) cannot be calculated analytically. However, choice probabilities can be approximated through simulation. For a given value of θ, a value of $\boldsymbol{\beta}_n$ is drawn from its distribution. $S_n(\boldsymbol{\beta}_n)$ is calculated using this draw of $\boldsymbol{\beta}_n$. This process is repeated for many draws, and the mean of the resulting $S_n(\boldsymbol{\beta}_n)$ is taken as the approximate choice probability given by equation (3.10):

$$SP_n(\theta) = (1/R) \sum_{r=1,\ldots,R} S_n(\boldsymbol{\beta}_n^{r|\theta}) \tag{3.10}$$

where R is the number of replications, $\boldsymbol{\beta}_n^{r|\theta}$ is the r^{th} draw from $f(\boldsymbol{\beta}_n|\theta)$, and $SP_n(\theta)$ is the simulated probability of the individual's sequence of choices.

In summary, the ML model provides us with an important method to

investigate a number of empirical issues relevant to consumer behaviour. According to Hensher and Greene (2003, p. 138) these can be categorized into seven key issues:

1. Selecting the random parameters;
2. Selecting the distribution of the random parameters;
3. Selecting the number of points on the distributions;
4. Preference heterogeneity around the mean of a random parameter;
5. Accounting for observations drawn from the same individual: correlated choice situations;
6. Accounting for correlation between parameters;
7. Obtaining consumers' WTP for certain attributes.

3.4 The Choice-Based Conjoint Experiment Mechanisms

Conjoint analysis (CA) and discrete choice experimentation (DCE), also known as CBC, were integrated together for the first time to develop a new approach to analyze consumer preferences for multi-attribute goods (Louviere and Woodworth, 1983). According to Louviere *et al.* (2000) and Raghavarao *et al.* (2011), the CBC approach offers several advantages. First, CBC provides researchers with an approach to estimate consumers' demand for new products containing new attributes or process features. Second, appropriate experimental designs ensure that new relevant data required for estimation of partworths are observable, and, at the same time, solve the problems that existing variables have little variability and are highly collinear in the market. Third, the implementation of the CBC approach is straight forward and less expensive than other methods for eliciting consumers' preferences. Last but not least, the CBC can provide insights into products that have not been in the market.

CA and DCE are the most widely applied methodologies in the diverse field of marketing, and measuring and analyzing preferences and choices of consumers, households, and organizations (Carroll and Green, 1995). A commonly used set of designs has been developed and applied to economic experiments over the years. The analysis in this thesis employs the dominance

measures design (Louviere *et al.*, 2000) to obtain the most preferred option relative to all other available choices. In the description of a choice experimental design, choice sets composed of several attributes, each defined as combinations of different attribute levels are developed. Respondents are typically shown sets of two or more explicitly defined competitive alternatives and asked to make a series of most preferred choices among several scenarios presented during the experiment.

3.4.1 The Reason for including a No-choice Option

Because of the high cost of delay, urgent need, or limited brands, consumers sometimes face circumstances that force them to choose one of the available options when purchasing in a real world context. The traditional choice design in the decision-making literature often forces respondents to choose among a given set of alternatives. However, in most actual purchase situations, buyers are not forced to choose from any particular set of products available to them. Consumers have the option not to purchase at all or purchase elsewhere.

Greenleaf and Lehmann (1995) examined the reasons for delaying purchase decisions, and found that one of the most important causes is the difficulty of selecting an alternative. In some cases, none of the alternatives are considered attractive enough. Tversky and Shafir (1992) suggested that the potential reason for "choosing a no-choice option" may be to avoid making difficult trade-offs altogether. Several studies show that the tendency to defer choice is increased when they choose from two equally attractive alternatives than when one of the alternatives is clearly superior (Tversky and Shafir, 1992; Dhar, 1997).

As mentioned in Haaijer *et al.* (2001), the major advantage of including a no-choice option in a CBC analysis is that it could yield more realistic experimental results. Participants are not forced to choose the products when they are not willing to, which will avoid unwanted biases in the analytical results. Estimates of the model parameters will be more precise and prediction of the market reaction will be more realistic. In situations where buyers tend to not select any option, for instance when uncertain about their preferences, not

including a no-choice option might lead to biased results during subsequent choice analysis (Dhar, 1997; Dhar and Simonson, 2003; Vermeulen *et al.*, 2008). One of the disadvantages of including a no-choice alternative into a choice set is that no information is collected about consumers' preferences and choices of attributes of alternatives from a no-choice option, which, after all, is the main purpose of conducting choice experiments. In addition, using a no-choice design to estimate demand volume would be less valid if respondents choose no-choice options in order to avoid difficult choices. However, the advantage still overweighs the disadvantages, and this study uses no-choice alternatives in the experimental design.

3.4.2 Experimental Design and Survey Questionnaire

Experimental Design

This study conducted a laboratory choice experiment involving 108 participants recruited from the general public in the Edmonton metropolitan area[2]. Nine sessions were held in April 2011 with 99 participants who finally completed the survey and experiments. The participants expressed interest in participating in this experiment and had shopped for beef products in the past 6 months. Participants were screened out if they were less than 18 years of age, did no grocery shopping for their household, or had participated in any focus groups related to meat purchase. They were given instructions on the purpose and plan for the study. Each participant was only allowed to participate in one experimental session and each session lasted approximately 50 min. Participants were grouped into groups of 10 to 15 individuals.

At the beginning of the experiments, participants received a $30 endowment as compensation for their involvement. This money was available for their use during the experiment for buying one of multiple packages of fresh beef displayed during several rounds of the experiment. Participants were not asked to eat any beef in the experiment. At the end of the real choice experiments, participants purchased one randomly selected beef product that they chose during the experiment. This approach has been successfully used in previous

[2] Ethics approval was obtained at the University of Alberta, Pro00019312.

studies to elicit a consumer's real purchase choice decisions (e.g., Grebitus *et al.*, 2009; Aoki *et al.*, 2010). The total value of the purchased beef product and remaining cash endowment (of initial $30) equaled $30 for all participants.

Central to the analysis is the laboratory choice experiment to collect data on Canadian consumers' preferences for packaged beef steaks (10oz). Real beef steak products were provided to consumers during the choice experiment. A total of nine scenarios containing two different versions of packaged beef steak products, one vacuum packaged and one conventional tray-packaged (see figure 3.1) were presented to participants.

Figure 3.1 Experimental set up

Each pair of product alternatives in each scenario was referred to as Alternative A and Alternative B. The experimental design included three attributes, price, ageing, and shelf life, with three levels each (table 3.1).

Table 3.1 Attributes of the beef steak

Attribute	Price	Ageing	Shelf-life
Level	$ 5.5	7 days	3 days
	$ 6.5	14 days	5 days
	$ 7.5	28 days	14 days

Table 3.2 presents an exemplary choice set as presented to participants.

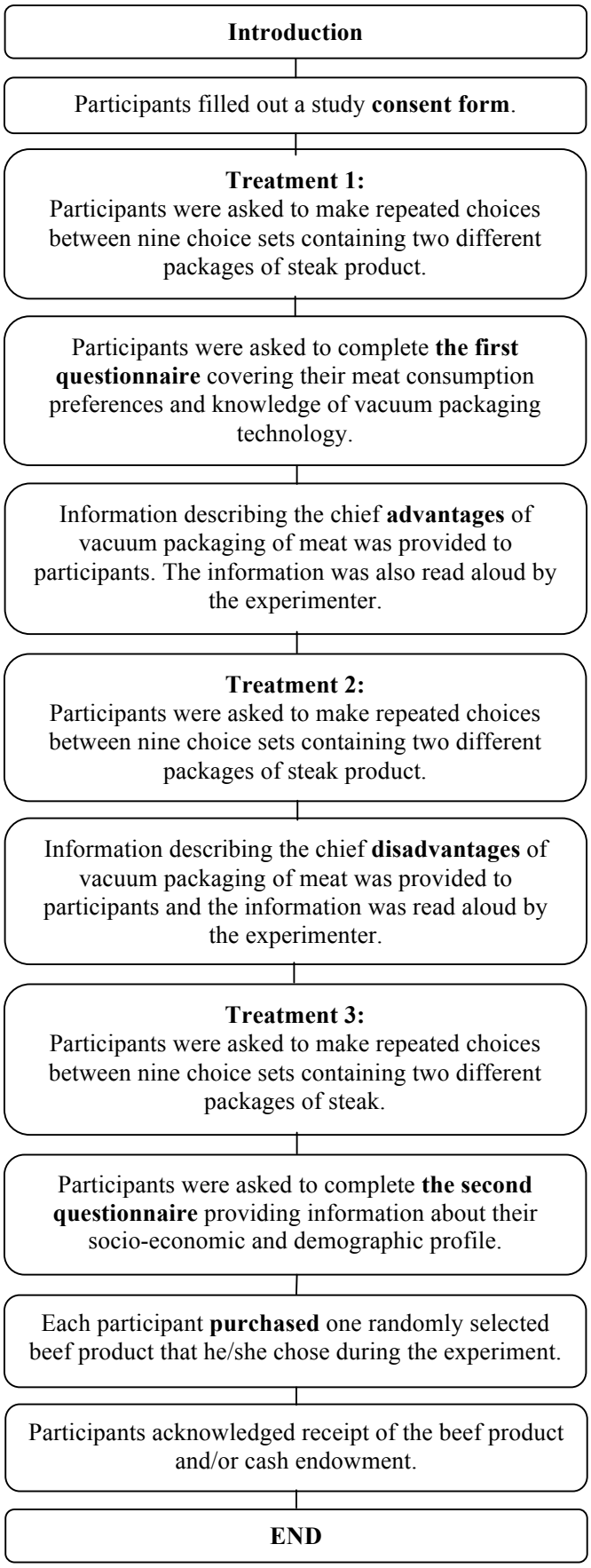
Table 3.2 Exemplary choice set

Scenario 1 I would choose (check X one)	10 oz. Strip loin		No purchase
	Alternative A	Alternative B	
	$7.5	$6.5	
Ageing	14 days	7 days	
Shelf-life	5 days	3 days	

Participants were asked to make repeated choices between pairs of differentiated packaged beef steak products under three information treatments which focused on the properties of vacuum packaged beef steak products. During the experimental sessions, participant's meat consumption preferences, knowledge of vacuum packaging, and acceptance of food technologies were assessed using a survey tool that follows Cox and Evans' (2008) Food Technology Neophobia Scale (FTNS). Figure 3.2 is a flow chart that shows the detailed experimental procedure.

Three information treatments focused on the properties of vacuum packaging of meat were included in the experimental design. Participants received different information in three treatments during the experiments. In treatment 1, participants had no information about vacuum packaging method. In treatment 2, the slides about the advantages of vacuum packaging were presented to participants and the information was read aloud by an experimenter. In treatment 3, the slides about the disadvantages of vacuum packaging were presented to participants and the information was read aloud by an experimenter. The PowerPoint slides are attached in Appendix B.

Figure 3.2 Experimental procedure



The information about the benefits and potential disadvantages of vacuum packaging of meat products used in the experiment and the survey is summarized. Points 1-7 are regarded as positive. Information points 8-9 are considered negative types of information.

Point 1: Fresh meat maintains its freshness and flavour longer compared to conventional packaging methods (foam tray packaging).

Point 2: Fresh meat maintains its texture and will not dry out because vacuum packaged food does not become dehydrated from contact with cold or dry air, and does not lose moisture.

Point 3: Vacuum packaged fresh meat that is high in fat and oils won't become rancid.

Point 4: No additional preservatives are necessary in vacuum packaging.

Point 5: Vacuum packaged meat is easier to open and eliminates leakage that frequently occurs with conventional fresh meat packaging.

Point 6: Vacuum packaging of meat uses less packaging material and therefore reduces waste.

Point 7: Vacuum packaged meat is freezer ready and conveniently portion ready sized.

Point 8: The main risk of using vacuum packaging for meat products is the potential risk of faster spoilage if the packaging gets damaged and the meat is exposed to oxygen. Furthermore, bacterial mold and yeast can grow under this environment.

Point 9: The other disadvantage is that vacuum packaging involves more expensive packaging material and machinery. Therefore, vacuum packaging could lead to higher meat prices for consumers at the retail level.

Survey Questionnaire

Following previous literature (e.g., Schmitz *et al.*, 1993; Grebitus *et al.*, 2009; Aoki *et al.*, 2010), a field survey and a laboratory choice experiment are applied in this thesis to investigate how consumers evaluate vacuum packaging of beef products and whether the provision of information about the underlying vacuum packaging technology affects their choice behaviour. Table 3.3 provides an overview of the survey, while the full survey can be found in Appendix A.

Table 3.3 Survey Overview

		# of questions	Description of research
Questionnaire I: Food purchasing and consumption			
	Section 1	7	Meat consumption patterns and attitudes regarding meat
	Section 2	3	Perception and usage of food labeling
	Section 3	3	Perception of novel technologies and novel food technologies
	Section 4	6	Knowledge of different meat packaging technologies
Questionnaire II: Social demographics		9	Socio-demographic information on the household

Survey questionnaire part I was intended to obtain information about participant's food purchasing and consumption behaviour. The first section was designed to collect information on meat consumption patterns and attitudes regarding meat. The second section elicited information about perceptions and usage of food labeling. The third section focused on consumers' perceptions of novel technologies; especially novel food technologies. The fourth section asked consumers about their knowledge of different meat packaging technologies. Data from sections 3 and 4 will be used later to measure consumer resistance to innovation in meat packaging, especially vacuum packaging. Survey questionnaire part II was designed to gather socio-demographic information that will be included as control variables in the empirical analysis.

3.4.3 Relevant Variables from Choice Experiments

Each participant (n = 1,…,99) faced T = 9 choice situations (t = 1,…,T). In each choice situation, the participant was presented with a set of alternatives. Each set contained 3 elements: 2 beef steak alternatives and the 'no purchase' alternative. In total, there were J = 19 alternatives, indexed by j, (j = 1,…,19), including 18 beef steak packages and the 'no purchase'. Each decision

maker's utility function can be represented as:

$U_{njt} = \beta_{0n}NC_{njt} + \beta_{1n}X_{njt} + \beta_{2n}R_{nt} + \beta_{3n}ID_{nt} + \beta_{4n}FP_{nt} + \varepsilon_{njt}$, for n = 1,…,99, j = 1,…,19, t = 1,…,9

where $\boldsymbol{\beta}$ is a vector of unobserved coefficients that vary over individuals, and ε_{njt} is the random component of the indirect utility. Table 3.4 lists variables that will be used in the ML model.

Table 3.4 Definition of variables used in the empirical analysis and their source

Variable	Definition	Source
U_{njt}	The indirect utility of an individual *n* for an alternative *j* at a choice occasion *t*.	----
NC_{njt}	A vector of no-choice constant.	Experiment
X_{njt}	A vector of observed variables (price, ageing, Shelf-life, and package method) relating to alternative *j*.	Experiment
R_{nt}	A vector of risk index (food technology neophobia scale) interaction terms.	Survey
ID_{nt}	A vector of individual demographic characteristics (e.g., gender, age, income, education) interaction terms.	Survey
FP_{nt}	A vector of individual food purchasing and consumption preferences interaction terms.	Survey

According to Louviere *et al.* (2000, p.63), "a characteristic of an individual, or any other variable that is not an attribute of an alternative in a choice set, cannot be included as a separate variable in all utility expressions since it does not vary across alternatives. To enable a non-modal attribute to be included in all utility expressions, it must be interacted with an alternative-specific attribute". As a result, R_{nt}, ID_{nt}, and FP_{nt} are interaction terms with other attributes. The index constructed from consumers' attitudes toward food safety will be calculated using data obtained from question 7 in survey questionnaire I. And the first two parts in question 11 will be used to calculate the index constructed from consumers' attitudes toward innovation. Table 3.5 provides a summary of observed variables which will be used in the analysis. This table also contains summary statistics of relevant variables obtained from both survey questionnaires. Details of each participant's profile and other analysis of the survey questionnaire information will be discussed in the next chapter.

Table 3.5 Summary of observed variables used in the analysis

Variable	Definition	Mean	Std. Dev.
Attribute:			
NC=No-choice constant	Dummy variable equal to 1 if no-choice option	-	-
P=Price	Variable indicating price of $5.5, $6.5, $7.5	-	-
SL3=Shelf-life of 3 days	Dummy variable equal to 1 if beef steak alternative has a 3 day shelf-life.	-	-
SL14=Shelf-life of 14 days	Dummy variable equal to 1 if beef steak alternative has a 14 day shelf-life. 5 day shelf-life is excluded because of multicollinearity.	-	-
A7=Aged for 7 days	Dummy variable equal to 1 if beef steak alternative has been aged for 7 day.	-	-
A28=Aged for 28 days	Dummy variable equal to 1 if beef steak alternative has been aged for 28 day. Aged for 14 day is excluded because of multicollinearity.	-	-
PM=Packaging Method	1 if beef steak is vacuum packaged.	-	-
Socio-demographic:			
Age	1=18- 25 years, 2=25-34 years, 3=35-44years, 4=45-54 years, 5=55-64 years, 6= 65 plus years	2.99	1.699
Gender	Dummy variable equal to 1 if the participant is male.	0.54	0.501
Income	1=Less than $20 000, 2=$20 000 to $49 999, 3=$50 000 to $79 999, 4=$80 000 to $109 999, 5=$110 000 to 150 000, 6=More than $150 000	2.62	1.307
Child	Dummy variable equal to 1 if the household has children.	0. 28	0. 450
Education	1=Some high school, 2=High school diploma, 3=Some college or technical, 4=Associate's degree, 5=Bachelor's degree, 6=Master's degree, 7=Doctorate, 8=Other	3.73	1.862
Attitude:			
FTNS=Food Technology Neophobia Scale	Index constructed from consumers' attitudes towards new technologies of food.	38. 97	7. 807
FS=Food safety	Index constructed from consumers' attitudes towards food safety.	36. 17	8. 664
Innovation	Index constructed from consumers' attitudes towards innovation.	6. 74	1. 502
Ageing	Consumer's attitude toward ageing of beef steak.	4. 06	1. 072
SL=Shelf-life	Consumer's attitude toward shelf-life of beef steak.	3. 65	1. 131

3.5 Study Hypotheses

The main objective of this study is to identify factors that affect consumers' purchase decisions and WTP for beef steak products differentiated by packaging method. A specific focus is on assessing consumers' acceptance or rejection of the vacuum meat-packaging technology, vacuum seal packaging. Furthermore, consumers' receptivity to new food technologies is quantified by means of the FTNS. Specific null hypotheses to be tested in the empirical analysis are listed in table 3.6.

Table 3.6 Null hypotheses of the empirical analysis

	Hypotheses
H_1	The FTNS scores have no effect on people's acceptance of vacuum packaging.
H_2	Perception of food safety has no effect on people's acceptance of vacuum packaging.
H_3	Level of openness to innovation has no effect on people's acceptance of vacuum packaging.
H_4	Positive information of vacuum packaging technology has no effect on people's acceptance of vacuum packaging.
H_5	Extended shelf-life and longer ageing have no effect on people's acceptance of vacuum packaging.

Evans *et al.* (2010) stated that individuals were expected to be more willing to try novel food products produced by novel technologies if the individual had a lower FTNS score. Therefore, people who have lower FTNS scores are expected to be more likely to accept vacuum-packaged beef steak. For hypothesis 2 and 3, people who are more concerned about food safety and are less open to food innovations are expected to be more likely to reject the vacuum packaging technology.

Hansen *et al.* (2003) found that consumers react more positively to the food innovation if positive information about food innovations was provided by a trusted source. Therefore, people are expected to be more likely to choose vacuum-packaged beef steak if the advantages of vacuum packaging

technology are clearly communicated to them before a purchase decision is made.

Previous research directly relevant to this analysis has also shown that consumers prefer meat (beef) of light and cherry red colour and are willing to pay more for an extended product shelf-life (e.g., Warner *et al.*,1993; Carpenter *et al.*, 2000; Viana *et al.*, 2005; Alfnes *et al.*, 2006; Grebitus *et al.*, 2009;). Therefore, the shelf-life extension from vacuum-packaging is hypothesized to positively affect consumer's WTP for vacuum-packaged beef steak. Filgueras *et al.* (2010) stated that longer ageing enhanced the palatability of beef and Kukowski et al. (2005) found that consumers were willing to pay more for tender and flavourful beef steak. Following these previous findings, participants are expected to be willing to pay more for beef steak that has been aged longer. Considering the impact of positive and negative information about vacuum packaging discussed above, participants' WTP for vacuum-packaged beef steak are expected to decrease relative to the risk information. On the other hand, participants trust in the vacuum packaging technology may have improved over the course of the experiment, which may also influence their choice decision process.

4 Survey results

4.1 Introduction

This chapter presents the results obtained from the analysis of Canadian consumers' responses to the survey questions. These survey questions were used to analyze consumer attitudes and perceptions for different product attributes, labeling, and vacuum packaging. Section 4.2 provides a breakdown of the sample demographics. The next two sections describe the results of Canadian consumers' opinions toward beef steak, food labeling, and new technologies. Section 4.5 presents the results of the Food Technology Neophobia scale (FTNS). The last section provides a brief summary of the chapter.

4.2 Demographic Characteristics and Summary Statistics

Table 4.1 presents the definitions and summary statistics of the demographic characteristics of the sample group. A total of 99 Canadian consumers participated in the choice experiment and completed the survey, with 54% of the participants being male and 46% female. Therefore, the sample was skewed toward a higher percentage of males when compared with national representative data collected by the Census of Canada (2006). The average age of the participants was 39.6 years, and ranged from 18 to 83 years. On average, each participant came from 2 person-households. 30.8% of the respondents had children who were high school-aged or younger. 83% of the participants were born in Canada. In terms of education levels, 36.4% of the participants had a college or technical degree, 22.2% of the participants had a bachelor's degree, 22.2% of participants studied in high school or had high school diploma, and 6.1% of the participants had a postgraduate degree. The average annual household income level fell within the $20,000 to $79,999 category. More specifically, 21.2% of respondents' annual household income was less than $20,000; 31.3% of the respondents selected the $20,000 to $49,999 category; 24.2% of participants reported an annual household income between

$50,000 and $79,999; and 15.2% of participants' annual household income lay between $80,000 and $109,999. The sample population consisted of a larger percentage of males, higher average age, greater than average number of children in the household, and lower annual household income than the Albertan average as reported by the Census of Canada (2006). Therefore, the results may not be representative of Alberta.

Summary statistics on shopping behaviour are presented in table 4.2. Few participants, on average, purchased beef daily (6.1 percent). More than 73.8% of the sample claimed to have purchased beef at least once a week, 19.2% at least once a month, and 4.0% less than once a month. Regarding steak specifically, very few participants purchased steak daily (1 percent). 72.7% of the participants purchased steak weekly, 15.2% monthly, and 10.1% less than once a month.

Descriptive statistics on where participants received their information and their level of trust regarding information on foods and food safety are presented in table 4.3. Internet sources and television were the two most popular forms of media that consumers used to obtain food related information (44.4% and 26.3%, respectively), while radio and magazines were the two least popular forms (8.1% and 22.2%, respectively). Internet sources had the highest level of trust among participants (46.5%). The second highest level of trust (41.4%) was for magazines, while radio and television were the two least trust worthy sources of information with 30.4% and 37.4%, respectively.

Table 4.1 Demographic summary statistics

Variable	Description	Mean	Std. Dev.	Min.	Max.	Alberta Census (2006)[3]
Gender	The subject's gender: 1=Male 0=Female	0.54	0.501	0	1	0.50
Age	Age of individual	39.60	17.338	18	83	36.0
		Survey percentage				
	1=18-24 years	20.2				
	2=25-34 years	32.3				
	3=35-44 years	13.1				
	4=45-54 years	10.1				
	5=55-64 years	11.1				
	6=65 plus years	13.1				
People	Number of individuals in the household	2.36	1.388	1	6	3.0
Children	Number of individuals of high school age or younger	0.59	1.001	0	3	0.30
		Survey percentage				
	There are children who are high school-aged or younger in the household.	30.8				
	There is no child who is high school-aged or younger in the household.	69.2				
Elder	Number of individuals 65 or older	0.18	0.460	0	2	-
		Survey percentage				
	There are individuals older than 64 in the household.	15.2				
	There is no individual older than 64 in the household in the household.	84.8				
Ethnic	Where were you born: 1=Canada 0=Other	0.83	0.379	0	1	0.83

[3]Data source is Statistics Canada, www.statcan.gc.ca.

Table 4.1 Continued

Variable	Description	Mean	Std. Dev.	Min.	Max.	Canada Census (2006)[4]
Education	Education level:	3.73	1.862	1	8	-
		Survey percentage				
	1=Some high school	11.1				
	2=High school diploma	11.1				
	3=Some college or technical	36.4				
	4=Associate's degree	6.1				
	5=Bachelor's degree	22.2				
	6=Master's degree	4.0				
	7=Doctorate	2.0				
	8=Other	7.1				
Income	The annual household income before taxes:	53599.5	-	-	-	84368
		Survey percentage				
	1=Less than $20,000	21.2				
	2=$20,000 to $49,999	31.3				
	3=$50,000 to $79,999	24.2				
	4=$80,000 to $109,999	15.2				
	5=$110,000 to 150,000	4.0				
	6=More than $150,000	4.0				

[4]Data source is Statistics Canada, www.statcan.gc.ca.

Table 4.2 Summary statistics of shopping behaviour

Variable	Description	Percentage
	How often on average do you eat beef:	
Beef	Daily	6.1
	5-6 times a week	3.0
	3-4 times a week	27.3
	1-2 times a week	37.4
	1-3 times a month	19.2
	Less than once a month	4.0
	Rarely	3.0
	Never	0
	How often on average do you eat steak:	
Steak	Daily	1.0
	5-6 times a week	11.1
	3-4 times a week	22.2
	1-2 times a week	38.4
	1-3 times a month	15.2
	Less than once a month	10.1
	Rarely	2.0
	Never	0

Table 4.3 Source of information and level of trust

Variable	Never	Rarely	Sometimes	Often	Always
How often do you use the following forms of media to acquire food related information:					
Radio	43.3%	27.3%	21.2%	7.1%	1.0%
Television	16.2%	20.2%	37.4%	19.2%	7.1%
Newspaper	20.2%	17.2%	36.4%	22.2%	4.0%
Magazines	25.3%	21.2%	31.3%	14.1%	8.1%
Internet sources	19.2%	11.1%	25.3%	30.3%	14.1%
	No trust	**A little trust**	**Neutral**	**Some trust**	**Complete trust**
Level of trust regarding information on foods and food safety:					
Radio	15.2%	13.1%	41.4%	25.3%	5.1%
Television	15.2%	20.2%	27.2%	29.3%	8.1%
Newspaper	11.1%	17.2%	31.3%	34.3%	6.1%
Magazines	13.1%	14.1%	31.3%	34.3%	7.1%
Internet sources	16.2%	11.1%	26.3%	40.4%	6.1%

4.3 Opinions toward Beef Steak and Food Labeling

For firms in the market to make informed investment decisions it is important for them to understand current attitudes of Canadian consumers regarding meat labeling. Table 4.4 presents descriptive statistics of consumers' opinions about beef steak attributes and food labeling. Table 4.5 presents the consumers' perceptions and levels of trust in food labeling.

In this survey, participants were asked to evaluate the following statement:

> "How important is each of the following attributes to you when you purchase beef steak?"

Respondents reported colour, price, shelf-life, date of packaging, type of cut, and marbling as the 6 most important attributes when choosing beef steak. 52.5% of participants in the sample stated that colour played a very important role in their decision making. 48.5% of respondents considered price to be a very important attribute when purchasing beef steak. Shelf-life was considered very important by 43.4%. Date of packaging was rated by 41.4% of the sample population to be very important. The type of cut and marbling were both considered to be very important by more than 30% of respondents. On the other hand, brand and packaged by producer were considered less important attributes. Over half of the survey respondents (56.6%) said that they usually did not read the product label information on "safe handling procedures".

In this survey, respondents were also asked to evaluate the following statement:

> "How would you rate steak relative to beef in general with regards to each of the following attributes?"

The majority of respondents (70.7%) appeared to be satisfied with the consistency of beef steak quality compared with the quality of beef in general, while 5.1% of respondents claimed that they were dissatisfied with beef steak quality consistency. 31.3% of respondents thought that the safety of beef steak was superior to that of beef in general. Over half of respondents (55.6%) stated

that beef steak was easier to prepare, while 12.1% thought that beef steak was inferior or slightly inferior to beef in general when it came to ease of preparation. Half of the sample population considered beef steak to be a healthier choice than other beef products.

Over 45% of respondents agreed with the statement: "steak is my favourite meat", while 22.2% had no opinion, 24.2% disagreed with this statement, and 7.1% of respondents strongly disagreed.

Respondents were also asked:

> "How often do you check the label for each of the following pieces of information".

65.7% stated that they always checked the expiration date. Ingredients received the second highest rating for this question, with 23.2% of respondents saying that they always checked the label. 21.2% of respondents claimed to always check the nutritional content of their food, which was a little higher than the percentage of respondents who claimed to always check the country of origin (18.2%).

In this survey, respondents were asked about their the level of trust:

> "Please indicate your level of trust regarding the accuracy of the labeling for each of the following pieces of information on meat products".

For nutritional content, 74.7% of participants selected at least "some trust". Nutritional content received the second highest rating for this question, while 84.8% of respondents reported trusting the accuracy of the expiration date.

Fresh beef steak is a highly perishable product whose quality hinges on proper handling and storage conditions. Demand for high quality, safety, and fresh appearance at the store level makes shelf-life in beef steak a critical variable. Without sacrificing quality or convenience, strong consumer demand for food safety forces food companies to innovate while maintaining safety standards. Consumer concerned about food safety, diet, and health provide opportunities and risks to food product and process innovations and product development (Cheruve *et al.*, 2008). However, innovation success hinges on an understanding of how consumer characteristics and perceptions affect the acceptance or resistance of an innovation.

Table 4.4 Consumers' opinions toward beef steak

Variable	Not important	A little important	Neutral	Somewhat important	Very important
How important each of the following attributes is to you when you purchase beef steak:					
Price	1.0%	14.1%	9.1%	27.3%	48.5%
Colour	1.0%	3.0%	12.1%	31.3%	52.5%
Marbling	2.0%	8.1%	24.2%	31.3%	34.3%
Brand	29.3%	13.1%	35.4%	16.2%	6.1%
Shelf life, best before date	3.0%	8.1%	12.1%	33.3%	43.4%
Date of packaging	2.0%	13.1%	11.1%	32.3%	41.4%
Ageing of beef	6.1%	6.1%	33.3%	26.3%	28.3%
Safe handling instructions	14.1%	13.1%	25.3%	16.2%	31.3%
Type of cut (e.g., rib, sirloin)	5.1%	9.1%	14.1%	32.3%	39.4%
Weight/size of packaging	3.0%	7.1%	17.2%	43.4%	29.3%
Nutrition	11.1%	8.1%	29.3%	23.2%	28.3%
Packaged in store	11.1%	14.1%	38.4%	20.2%	16.2%
Packaged by producer (pre-packaged)	19.2%	14.1%	39.4%	15.2%	12.1%

Table 4.4 Continued

Variable	Inferior	Slightly inferior	About the same	Slightly Superior	Superior
How would you rate steak relative to beef in general with regard to each of the following attributes:					
Overall value	0	13.1%	26.3%	38.4%	22.2%
Consistency of quality	0	5.1%	24.2%	44.4%	26.3%
Safe to eat	0	1.0%	33.3%	34.3%	31.3%
Nutritious	1.0%	2.0%	48.5%	30.3%	18.2%
Easy to prepare	2.0%	10.1%	32.3%	25.3%	30.3%
Healthy choice	1.0%	5.1%	43.4%	32.3%	18.2%
Availability in store	1.0%	8.1%	46.5%	22.2%	22.2%
	Strongly disagree	**Disagree**	**No opinion**	**Agree**	**Strongly agree**
Steak is my favourite meat.	7.1%	24.2%	22.2%	30.3%	16.2%

Table 4.5 Consumers' opinions toward food labeling

Variable	Never	Rarely	Sometimes	Often	Always
How often do you check the label for each of the following pieces of information:					
Expiration date	0	3.0%	11.1%	20.2%	65.7%
Nutritional content	4.0%	19.2%	28.3%	27.3%	21.2%
Country of origin	12.1%	25.3%	20.2%	24.2%	18.2%
Ingredients	7.1%	8.1%	23.2%	38.4%	23.2%
	No trust	**A little trust**	**Neutral**	**Some trust**	**Complete trust**
Level of trust regarding the accuracy of the labeling for each of the following pieces of information on meat products:					
Expiration date	1.0%	5.1%	9.1%	50.5%	34.3%
Nutritional content	0	6.1%	19.2%	42.4%	32.3%
Country of origin	2.0%	7.1%	21.2%	33.3%	36.4%
Ingredients	3.0%	5.1%	20.2%	42.4%	29.3%
	Yes	**No**			
Do you usually read the product label information on "safe handling procedures"?	43.4%	56.6%			

4.4 Opinions toward New Technologies and New Food Technologies

Although new products produced using new technologies often had advantages compared with existing products, many of them still met resistance, and many firms were faced with high rates of innovation failures (Garcia and Atkin, 2002; Molesworth and Suortti, 2002; Moor, 2002). In food technology, out of 539 new technological innovations of Ernst & Young and AC Nielsen, only 33 received real market successes (Watzke and Saguy, 2001). From other sources, estimated failure rates range were 40 – 50% (Lafley, 2008), 67 – 88% (Buisson, 1995; Rudolph, 1995; Prime Consulting Group, 1997; Lord, 1999; Theodore, 2000), and 99% (Morries, 1993; Sloan, 1994). Facing such high innovation failure rates, it is important for producers to find out how a technology innovation will perform in the market in order to avoid introduction failure. The purpose of this section is to identify the opinions consumers have regarding novel technologies; specifically, novel food technologies.

Table 4.6 presents data on how participants in this study viewed new technologies and new food technologies. Even though 80% of respondents claimed that they were likely to try new things, 52.6% also stated they were likely to buy new things only after these items had been established. Half of respondents thought new food technologies were something they felt uncertain about, and 58.6% claimed it was too risky to switch to new food technologies too quickly. The data suggest that consumers concerned about novel food technologies could be one of the factors leading to food technology resistance, which is consistent with findings obtained by previous studies (Hossain and Onyango, 2004; Peterson and Yoshida, 2004).

Over 50% of respondents disagreed with the statements “We don’t need to use new food technologies to produce more” and “There is no sense trying out high-tech food products”. More than half of all participants believed that new food technologies can give people more control over their food choices, and new products can help people have a balanced diet. Although some consumers were not willing to try novel food technologies, most of them still thought that

these technologies had some advantages. In summary, consumer concerns about food safety, diet, and health provide at least some opportunities to food product and process innovations and product development (Cheruve *et al.*, 2008).

Table 4.7 clearly shows that vacuum packaging was the most well-known meat packaging method; only 1% of participants did not know it. Animal cloning was known by most consumers as one of five meat production methods. In table 4.8, animal cloning and genetic modification were selected as the two meat production methods that concerned participants most (45.5% and 30.3%). These summary statistics suggest that most respondents were concerned about food biotechnology. This is consistent with previous research results showing that consumers are becoming more conscious of how food is produced (von Alvensleben, 2001). Respondents held a generally negative view towards preservation technique and food irradiation, even though the scientific community consideres these technologies to be safe and effective (Henson, 1995; Ronteltap *et al.*, 2007).

The results obtained from these questions enable us to better understand consumers' perceptions of new technologies. They also function as an indicator of people's awareness and level of convern about specific new food technologies. Since many consumers are not familiar with new food products, more information might be required before they are widely accepted (Backstrom *et al.*, 2004). In the next chapter empirical models are employed to analyze consumers' attitudes towards different attributes under different information scenarios.

Table 4.6 Consumers' opinions toward new technologies and new food technologies

Variable	Strongly disagree	Disagree	No opinion	Agree	Strongly agree
I am likely to try new things.	1.0%	3.0%	14.1%	52.5%	29.3%
I am likely to buy new things only after they have been established.	3.0%	29.3%	15.2%	37.4%	15.2%
I am likely to adopt a new technology only when the price is reasonable.	3.0%	9.1%	9.1%	52.5%	26.3%
There are plenty of tasty foods around so we don't need to use new food technologies to produce more.	24.2%	37.4%	18.2%	13.1%	7.1%
The benefits of new food technologies are often grossly *overstated*.	6.1%	20.2%	36.4%	26.3%	11.1%
New food technologies *decrease* the natural quality of food.	7.1%	35.4%	29.3%	20.2%	8.1%
There is no sense trying out high-tech food products because the ones I already eat are good enough.	10.1%	45.5%	17.2%	22.2%	5.1%
New foods are *not* healthier than traditional foods.	10.1%	33.3%	27.3%	20.2%	9.1%
New food technologies are something I am *uncertain* about.	4.0%	21.2%	24.2%	41.4%	9.1%
Society should *not* depend heavily on technology to solve its food problems.	10.1%	26.3%	18.2%	26.3%	19.2%
New food technologies may have long term *negative* environmental effects.	5.1%	19.2%	43.4%	16.2%	16.2%
It can be *risky* to switch to new food technologies too quickly.	2.0%	19.2%	20.2%	42.4%	16.2%
New food technologies are *unlikely* to have long term negative health effects.	6.1%	25.3%	46.5%	16.2%	6.1%
New products produced using new food technologies can help people have a balanced diet.	2.0%	10.1%	36.4%	44.4%	7.1%
New food technologies can give people *more* control over their food choices.	3.0%	12.1%	25.3%	52.5%	7.1%
The media usually provides a balanced and *unbiased* view of new food technologies.	25.3%	33.3%	25.3%	14.1%	2.0%

Table 4.6 Continued

Variable	Not important	A little important	Neutral	Somewhat important	Very important
How important is each of the factors to you when you purchase new products:					
Functionality	0	1.0%	13.1%	29.3%	56.6%
Quality	0	0	2.0%	20.2%	77.8%
Nutritional value	3.0%	3.0%	17.2%	37.4%	39.4%
Healthfulness	2.0%	4.0%	9.1%	44.4%	40.4%
Environmental impact	4.0%	7.1%	23.2%	35.4%	30.3%
Perceived value	2.0%	6.1%	12.1%	41.4%	38.4%
Uncertainty about the innovation	7.1%	8.1%	49.5%	20.2%	15.2%

Table 4.7 Knowledge of meat products and packaging technologies

Variable	Don't know it	Have heard of it	Have heard of it and have limited knowledge of its purpose	Have heard of it and know its purpose	Know its purpose and understand how it works
Level of knowledge about each of the following meat production and packaging technologies:					
Modified Atmosphere Packaging	65.7%	11.1%	15.2%	2.0%	6.1%
Sodium Nitrite	35.4%	25.3%	16.2%	19.2%	4.0%
Low Oxygen Packaging	54.5%	15.2%	17.2%	6.1%	7.1%
Genetic Modification	24.2%	22.2%	20.2%	18.2%	15.2%
Vacuum Packaging	1.0%	12.1%	11.1%	38.4%	37.4%
Nanotechnology	42.4%	19.2%	24.2%	9.1%	5.1%
High Oxygen Packaging	59.6%	21.2%	11.1%	3.0%	5.1%
Irradiation (X-rays)	45.5%	18.2%	20.2%	7.1%	9.1%
Animal Cloning	13.1%	21.2%	28.3%	20.2%	17.2%
	Yes	**No**			
Have you recently heard something about **vacuum packaged beef** in the mass media?	19.2%	80.8%			
Have you recently bought **vacuum packaged beef**?	36.4%	63.6%			

Table 4.8 Level of concerns of meat products and packaging technologies

Variable	Not at all concerned	A little concerned	Neutral	Somewhat concerned	Very concerned
Level of concerns regarding the use of the following meat production and packaging technologies:					
Modified Atmosphere Packaging	19.2%	14.1%	55.6%	6.1%	5.1%
Sodium Nitrite	12.1%	18.2%	38.4%	17.2%	14.1%
Low Oxygen Packaging	22.2%	11.1%	54.5%	8.1%	4.0%
Genetic Modification	4.0%	22.2%	15.2%	28.3%	30.3%
Vacuum Packaging	55.6%	10.1%	23.2%	5.1%	6.1%
Nanotechnology	17.2%	19.2%	49.5%	6.1%	8.1%
High Oxygen Packaging	20.2%	13.1%	54.5%	7.1%	5.1%
Irradiation (X-rays)	7.1%	16.2%	26.3%	28.3%	22.2%
Animal Cloning	4.0%	10.1%	13.1%	27.3%	45.5%

4.5 Results of the Food Technology Neophobia Scale

Individual FTNS scores were computed as the sum of ratings given to the 13 statements rated on 5-point scales rated from “strongly disagree” to “strongly agree”. The 4 negative FTNS items were rated in reversed order. The FTNS scores have a theoretical range of 13 to 65.

Participants’ FTNS scores were factor analyzed by examining how interrelated individual item were in order to measure the consistency of participants’ FTNS respondents. The scale items loaded mainly on two factors, summarized in table 4.9. The first factor (Factor 1) was related to consumers’ perception of new food technologies and their risk. Factor 1 summarized FTNS scale items describing negative attitudes towards new food technologies or new foods. In contrast, the second factor (Factor 2) appeared to reflect consumers’ attitudes towards new food technologies as healthier choices. As such factor 2 summarized positive perceptions towards new food technologies or new foods. The results of the factor analysis confirm that participants’ FTNS responses are consistent.

Table 4.9 Food Technology Neophobia scale: factor descriptions and item means, standard deviation and loadings. Loading that are higher on either factor have been marked bold.

Factor	Description	Item	Mean	Std. Dev.	Factor1	Factor2
1	New food technologies are unnecessary	There are plenty of tasty foods around so we don't need to use new food technologies to produce more.	2.41	1.195	**0.762**	0.047
		The benefits of new food technologies are often grossly *overstated*.	3.16	1.066	**0.720**	0.171
		New food technologies *decrease* the natural quality of food.	2.87	1.075	**0.774**	0.144
		There is no sense trying out high-tech food products because the ones I already eat are good enough.	2.67	1.088	**0.718**	0.107
		New foods are *not* healthier than traditional foods.	2.85	1.137	**0.677**	0.064
		New food technologies are something I am *uncertain* about.	3.30	1.035	**0.646**	0.093
2	Perception of risks	Society should *not* depend heavily on technology to solve its food problems.	3.18	1.296	**0.678**	-0.222
		New food technologies may have long term *negative* environmental effects.	3.19	1.085	**0.805**	-0.035
		It can be *risky* to switch to new food technologies too quickly.	3.52	1.044	**0.645**	0.107
		New food technologies are *unlikely* to have long term negative health effects. (R).	2.91	0.949	0.147	**0.574**
3	Healthy choice	New products produced using new food technologies can help people have a balanced diet. (R).	3.44	0.848	-0.246	**0.811**
		New food technologies can give people *more* control over their food choices. (R).	3.48	0.908	-0.327	**0.706**
4	Information/ media	The media usually provides a balanced and *unbiased* view of new food technologies. (R).	2.34	1.071	0.010	**0.466**

(R) indicates reverse scored items.

The mean FTNS scores for the entire participant sample was 38.97 (std. dev. = 7.81) (table 4.10). According to Evans *et al.* (2010), individuals were less willing to try or more likely to refuse to taste novel food products produced by novel technologies if they had higher scores on the FTNS; that is, higher FTNS scores represented people who were 'more food technology' neophobic. FTNS scores did not increase with gender, age, education, or income. There were no significant relationships between gender, age, education, or income, with FTNS. These findings are similar to other studies using FTNS (Cox and Evans, 2008; Evans *et al.*, 2010). However, there were some significant differences within sub-categories of key socio-demographic variables. People aged 35 to 44 had lower FTNS scores compared with people aged 18 to 24 ($p < 0.05$) and 25-34 ($p < 0.05$). People with an associate's degree were more likely to try new things compared with people with only some high school education ($p < 0.1$).

Table 4.10 Food Technology Neophobia scale by gender, age, education, and income

Scale		**Range**		**Min**	**Max**	**Mean**	**Std. Dev.**
Food Technology Neophobia scale (FTNS)		13	75	19	58	38.97	7.807
Variable	**Categories**		**Min.**	**Max.**	**Mean**	**Std. Dev.**	**N**
Gender	Male		26	54	38.09	6.825	53
	Female		19	58	39.98	8.772	46
Age	18-24 years		26	58	41.00	8.669	20
	25-34 years		19	55	40.19	8.070	32
	35-44 years		27	51	34.62	7.741	13
	45-54 years		28	47	37.70	6.255	10
	55-64 years		27	52	38.27	6.813	11
	65 plus years		32	54	38.77	7.026	13
Education	Some high school		26	50	41.27	6.769	14
	High school diploma		28	52	37.00	7.335	11
	Some college or technical		19	58	39.39	8.466	36
	Associate's degree		27	44	34.33	7.737	6
	Bachelor's degree		27	54	38.86	6.742	22
	Master's degree		29	45	35.25	6.850	4
	Doctorate		34	52	43.00	12.728	2
	Other		27	55	41.57	9.484	7

Table 4.10 Continued

Variable	Categories	Min.	Max.	Mean	Std. Dev.	N
Income	Less than $20 000	26	50	38.76	7.389	21
	$20 000 to $49 999	27	54	40.16	7.823	31
	$50 000 to $79 999	19	52	38.00	7.945	24
	$80 000 to $109 999	26	58	38.73	9.067	15
	$110 000 to $150 000	33	52	42.75	8.139	4
	More than $150 000	32	36	33.75	1.708	4

Pearson's correlations (see table 4.11) of FTNS score data indicats that participants' FTNS scores were significantly correlated with their food safety concern levels ($p < 0.01$) and attitudes towards food innovation ($p < 0.01$). The positive correlation between FTNS and food safety implies that higher participants' FTNS scores were matched by higher food safety scores indicating that those critical of food technologies also tended to be more concerned about food safety. The negative correlation between FTNS and innovation also fits the theory well.

Table 4.11 Pearson's correlations

	Food safety	Innovation
FTNS	0.156***	-0.298***
Food safety	1.000	-0.375***
Innovation		1.000

Notes: *** indicates significance at the 1% level (2-tailed).

4.6 Summary

This chapter provided a discussion of the results from a descriptive analysis of the survey data. As shown in this chapter, the statistics of the demographic characteristics of my sample, percentage of males, average age, and number of children in the household, were higher than the Canada Census results for Alberta (2006). When viewing the attributes of beef steak, colour, price, shelf-life, date of packaging, type of cut, and marbling were considered as the 6 most important attributes when purchasing beef steak. The survey also elicited consumer opinions regarding novel technologies and novel food technologies. Over half of the participants were willing to try new food

products produced using new technologies while some of them worried about novel food technologies and their overall value. Vacuum packaging was the most well-known meat packaging method in my survey. However, much smaller percentage of the participants had heard of vacuum packaged beef steak in the mass media and had recently bought it. This chapter also presented an analysis of the FTNS scores. The FTNS scores ranged from 19 to 58. The findings suggest that there were no significant correlations between socio-demographic characteristics and FTNS.

Major findings obtained from participant surveys:

- This sample population had a much lower average annual household income compared to the average for Albertan reported by the Census of Canada (2006).
- Internet sources were the most popular form of media that consumers used to receive food-related information, and enjoyed the highest level of trust among participants.
- Although almost half of all participants stated that they considered safe handling instructions to be an important attribute when purchasing beef steak, the majority said they usually did not read the product label information on "safe handling procedures".
- Compared with beef in general, the majority of participants considered beef steaks to be safe to eat, easier to prepared, a healthy meat option, and superior in overall value and quality consistency.
- Summary statistics suggest that most participants were unfamiliar with new food biotechnologies and concerned about them.
- Participants' FTNS scores and their food safety percewtions were correlated indicating that higher FTNS resistance scores went along with higher food safety concerns.

5 Model Results and Analysis

5.1 Introduction

The objectives of this study are to construct a willingness-to-pay (WTP) measure for several attributes of beef steaks, and to assess consumer's acceptance of a novel food product – vacuum packaged beef steak. This study focuses on three attributes represent the key differences between vacuum sealed beef steaks and conventionally packaged steaks: packaging method, beef ageing, and shelf-life. As each respondent made multiple choices, it was necessary to use multi-response models. To test whether preference heterogeneity among participants had a significant impact on WTP outcomes, both multinomial logit (MNL) models and mixed logit (ML) models were estimated. If preference heterogeneity existes, the ML model is considered to be the more suitable choice model (Revelt and Train, 1998; McFadden and Train, 2000; Nahuelhal *et al.*, 2004; Train, 2009).

This chapter presents the results of the econometric analysis using the data obtained from the choice experiments and responses from the participant survey. Four models were specified and estimated, which will be discussed in separate subsections. The section on each model begins with regression results followed by WTP estimates based on the full sample. All models were estimated using the software package *Nlogit 4.0*, which is part of *Limdep 9.0*[5]. The last section concludes with a brief summary.

5.2 Model 1: Choice-Specific Attributes

5.2.1 Regression Results

The results from the ML and MNL models in which only choice-specific attributes were considered are reported in table 5.1. In the ML models, the estimates for the no-choice constant (NC) were relatively big and negative.

[5] Source: www.limdep.com/.

Not choosing either option resulted in a lower overall utility. All parameters of price (P) were statistically significant in all three treatments at the 1%, 5%, and 1% levels, respectively. Price had a negative effect on product choice, as predicted by economic theory. The coefficients on all choice-specific attributes were not statistically significant in any of the three treatments. The standard deviations were also not statistically significant, implying that no significant heterogeneity existed among consumers, and that preferences did not vary in the population for these choice-specific attributes. As a result, the ML models did not provide more efficient estimation when compared with the MNL, although the ML models had a better fit to the data than the MNL models.

In the MNL models, the estimated coefficients for NC and P were significant at the 1% level, and had the expected signs in all three treatments, while the coefficients on aged for 7 days (A7), aged for 28 days (A28), and shelf-life of 14 days (SL14) were not significant. The coefficient on shelf-life of 3 days (SL3) was negative and statistically significant at the 10% level in treatment 3. Compared to beef steak with a shelf-life of 5 days, consumers were less likely to buy the one with SL3. Not all the parameters of packaging method (PM) were statistically significant, and some coefficients were negative. The reasons that vacuum packaging might have a negative effect on product choice are: (1) the colour of vacuum packaged beef steak was an unappealing brown, and (2) the package appeared difficult to open.

Table 5.1 MNL and ML Model 1 Estimates (sample size = 2673)

Variable	Parameter	Treatment 1		Treatment 2		Treatment 3	
		MNL	**ML**	**MNL**	**ML**	**MNL**	**ML**
NC	Mean of Fixed Coefficient	-1.5617***	-2.2884***	-1.5382***	-3.0689***	-1.5775***	-1.8762***
		(0.3613)	(0.7570)	(0.3587)	(0.8903)	(0.3593)	(0.5885)
P	Mean of Fixed Coefficient	-0.1566***	-0.2643**	-0.1603***	-0.3904***	-0.1614***	-0.2035**
		(0.0562)	(0.1180)	(0.0560)	(0.1419)	(0.0559)	(0.0888)
A7	Mean of Normal Coefficient	0.0353	0.0602	-0.0428	-0.0330	-0.1334	-0.1570
		(0.1074)	(0.1705)	(0.1080)	(0.2202)	(0.1089)	(0.1385)
	Standard Deviation of Normal Coefficient	----	0.4523	----	0.0269	----	0.1308
			(0.9237)		(1.2591)		(0.9495)
A28	Mean of Normal Coefficient	-0.1708	-0.4728	-0.0887	-0.1643	0.0245	-0.0780
		(0.1075)	(0.4198)	(0.1051)	(0.3438)	(0.1046)	(0.2703)
	Standard Deviation of Normal Coefficient	----	1.6785	----	1.9972	----	1.2439
			(1.6247)		(1.4736)		(1.4582)
SL3	Mean of Normal Coefficient	-0.0105	-0.0137	-0.1923	-0.6504	-0.2265*	-0.2839
		(0.1305)	(0.2163)	(0.1344)	(0.7798)	(0.1334)	(0.2049)
	Standard Deviation of Normal Coefficient	----	1.2753	----	2.4837	----	0.4966
			(1.1644)		(2.5053)		(1.0639)
SL14	Mean of Normal Coefficient	0.0353	-0.0267	0.0853	-0.4693	0.0245	-0.0412
		(0.1441)	(0.2959)	(0.1360)	(1.3597)	(0.1383)	(0.2460)
	Standard Deviation of Normal Coefficient	----	1.0430	----	8.3357	----	1.0855
			(1.2875)		(12.6564)		(1.3417)
PM	Mean of Normal Coefficient	-0.2667*	-0.6294	0.1894	0.2860	-0.0483	-0.1071
		(0.1484)	(0.4062)	(0.1458)	(0.2350)	(0.1470)	(0.2258)
	Standard Deviation of Normal Coefficient	----	1.8549	----	0.2296	----	0.7189
			(1.1886)		(2.0749)		(1.1352)
LL		-950.2583	-937.7000	-937.7000	-932.3946	-954.9241	-954.2389

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses are standard errors. LL denotes the Log likelihood value. Variable definitions can be found in table 3.5, p. 40.

5.2.2 Willingness-to-pay: Model 1

With the price coefficient fixed, WTP was estimated as the ratio between the mean of the random parameter of the attribute and the negative coefficient of price (Nahuelhual *et al.*, 2004). Consumer *i*'s WTP for attribute *j* can be computed using the following formula: $WTP_{ij} = -(\beta_j/\beta_p)$.

Table 5.2 WTP for different attributes in Model 1

Variable	Treatment 1		Treatment 2		Treatment 3	
	MNL	**ML**	**MNL**	**ML**	**MNL**	**ML**
A7	0.2254	0.2278	-0.2670	-0.0845	-0.8265	-0.7715
A28	-1.0907	-1.7889	-0.5533	-0.4209	0.1518	-0.3833
SL3	-0.0670	-0.0518	-1.1996	-1.6660	**-1.4033**	-1.3951
SL14	0.2254	-0.1010	0.5321	-1.2021	0.1518	-0.2025
PM	**-1.7031**	-2.3814	1.1815	0.7326	-0.2993	-0.5263

Note: Bold fonts indicate statistical significance of the attribute mean WTP. Variable definitions can be found in table 3.5, p. 40.

The calculation of the mean WTP is shown in table 5.2. The WTP for vacuum packaging was higher under treatments 2 and 3 compared with treatment 1. That showed that positive information about vacuum packaging increased consumers' WTP by about $2.89 in the MNL and by $3.11in the ML model from treatment 1 to treatment 2. In general, vacuum packaging had a positive effect on WTP as participants were willing to pay $1.40 more for vacuum packaging under the MNL model and $1.86 more under the ML model as we moved from treatment 1 to treatment 3. However, overall WTP for vacuum packaging remained negative in treatment 3.

Consumers' WTP for A7 decreased after being given information about vacuum packaging in both MNL and ML models, and their WTP for A28 increased in the case of the MNL model. For MNL, the WTP for SL3 were negative compared to a shelf-life of 5 days, indicating that consumers were willing to pay more for a longer shelf-life after receiving the positive and negative informational treatments about vacuum packaging.

5.3 Model 2: Choice-Specific Attributes and Demographic Interaction Terms

5.3.1 Regression Results

Table 5.3 presents the results of the ML and MNL models including choice-specific attributes and demographic interaction terms in three treatments. In the ML models, the estimates for the NC and P were statistically significant and had the expected sign in all three treatments. Price, once again, had the expected negative effect on product choice. The coefficients on all the choice-specific attributes were not statistically significant in any of the three treatments. The only exception to this was for PM in treatment 1, where the estimated parameter was negative and statistically significant at the 5% level. This suggested that consumers were not willing to buy vacuum packaged beef steak before they were provided with additional information about the technology. For SL3, the coefficients of the standard deviations were statistically significant in treatments 2 and 3, implying that significant heterogeneity existed among consumers and preferences varied in the population for these choice-specific attributes. As a result, the ML models provided more efficient estimation when compared with MNL, although the differences between the LL were not large.

In the MNL models, the estimated coefficients on NC and P were significant at conventional levels and had the expected signs in all three treatments, while the coefficients on A7, A28, and SL14 were not significant. The coefficient on SL3 was negative and statistically significant at the 10% level in treatment 2. Compared to beef steak with a shelf-life of 5 days, consumers were less likely to buy the one with 3-day shelf life. The parameter of PM was statistically significant at the 10% level and negative in treatment 1. Together, these results suggest that prior to receiving positive information about vacuum packaging, consumers lacked confidence on this new technology and were less willing to choose it over the conventionally packaged steaks.

Table 5.3 MNL and ML Model 2 Estimates (sample size = 2673)

Variable	Parameter	Treatment 1		Treatment 2		Treatment 3	
		MNL	**ML**	**MNL**	**ML**	**MNL**	**ML**
NC	Mean of Fixed Coefficient	-1.5974***	-2.2598***	-1.5897***	-2.9032***	-1.6232***	-2.4799***
		(0.3678)	(0.6612)	(0.3667)	(0.9813)	(0.3676)	(0.7160)
P	Mean of Fixed Coefficient	-0.1616***	-0.2632***	-0.1644***	-0.3633**	-0.1666***	-0.2942***
		(0.0573)	(0.1020)	(0.0573)	(0.1545)	(0.0573)	(0.1126)
A7	Mean of Normal Coefficient	0.0371	0.0600	-0.0444	-0.0312	-0.1401	-0.2693
		(0.1093)	(0.1604)	(0.1106)	(0.2120)	(0.1115)	(0.2582)
	Standard Deviation of Normal Coefficient	----	0.3323	----	0.5742	----	1.4805
			(1.0724)		(1.2765)		(1.3433)
A28	Mean of Normal Coefficient	-0.1780	-0.2282	-0.0931	-0.3681	0.0261	0.0279
		(0.1095)	(0.2519)	(0.1076)	(0.3931)	(0.1072)	(0.2357)
	Standard Deviation of Normal Coefficient	----	0.7713	----	2.2107	----	1.3741
			(1.1828)		(1.8282)		(1.2923)
SL3	Mean of Normal Coefficient	-0.0140	-0.5227	-0.2290*	-1.4026	-0.2432	-1.0571
		(0.1319)	(0.5555)	(0.1360)	(0.9229)	(0.1350)	(0.6730)
	Standard Deviation of Normal Coefficient	----	3.6812	----	4.1930*	----	3.3193*
			(2.3507)		(2.2455)		(1.7766)
SL14	Mean of Normal Coefficient	0.0316	-0.0121	0.0702	-0.0875	0.0133	-0.0255
		(0.1477)	(0.2318)	(0.1399)	(0.2815)	(0.1427)	(0.2546)
	Standard Deviation of Normal Coefficient	----	0.8921	----	1.8568	----	0.9459
			(0.9989)		(1.2490)		(1.6576)
PM	Mean of Normal Coefficient	-0.9691*	-1.4478**	-0.3506	-0.6208	0.4857	0.7836
		(0.5053)	(0.7129)	(0.4738)	(0.9594)	(0.4819)	(0.7808)
	Standard Deviation of Normal Coefficient	----	0.1516	----	1.2745	----	0.3937
			(0.8565)		(1.6182)		(0.8444)

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses are standard errors. LL denotes the Log likelihood value. Variable definitions can be found in table 3.5, p. 40.

Table 5.3 Continued

Variable	Parameter	Treatment 1		Treatment 2		Treatment 3	
		MNL	**ML**	**MNL**	**ML**	**MNL**	**ML**
PM*FTNS	Mean of Fixed Coefficient	-0.0187*	-0.0253*	-0.0224**	-0.0479*	-0.0460***	-0.0750***
		(0.0099)	(0.0136)	(0.0093)	(0.0249)	(0.0097)	(0.0217)
PM*Education	Mean of Fixed Coefficient	0.0699	0.1225*	0.2487***	0.4922***	0.1067**	0.1867**
		(0.0432)	(0.0642)	(0.0425)	(0.1849)	(0.0421)	(0.0756)
PM*Age	Mean of Fixed Coefficient	0.0396	0.0396	-0.0162	-0.0137	-0.0217	-0.0109
		(0.0480)	(0.0645)	(0.0456)	(0.0901)	(0.0469)	(0.0721)
PM*Gender	Mean of Fixed Coefficient	0.5580***	0.8671***	0.4024***	0.9547**	0.5010***	0.9077***
		(0.1575)	(0.2685)	(0.1488)	(0.4163)	(0.1511)	(0.3018)
PM* Income	Mean of Fixed Coefficient	0.2478***	0.3667***	0.1029*	0.2141	0.1836***	0.2610**
		(0.0579)	(0.1056)	(0.0558)	(0.1341)	(0.0567)	(0.1025)
PM*Child	Mean of Fixed Coefficient	0.2510	0.4036	0.1039	0.2878	0.5169***	0.7979***
		(0.1760)	(0.2461)	(0.1668)	(0.3369)	(0.1704)	(0.3039)
LL		-931.6040	-927.1603	-911.1212	-906.4766	-927.1648	-923.1315

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses are standard errors. LL denotes the Log likelihood value. Variable definitions can be found in table 3.5, p. 40.

5.3.2 Food Technology Neophobia Scale

The estimated coefficients for the interaction term PM*FTNS were negative and statistically significant for both MNL and ML models in all three treatments. This suggests that people with higher FTNS scores were less likely to accept vacuum packaged beef steak. That is, people who were more neophobic generally disliked vacuum packaged beef steak more, ceteris paribus. This is consistent with my prior expectation. A more detailed explanation will be given for Model 3B in section 5.5, which has similar results.

5.3.3 Demographic Interactions

The estimated coefficient on education was positive and significant when interacted with vacuum packaging. It suggest that people with higher education levels were more likely to choose vacuum packaged beef steak. In addition, men, and respondents with higher incomes were more likely to accept vacuum packaged beef steak. People with children in the household tended to dislike vacuum packaged beef steak. The results are similar to those obtained in Model 3B and greater explanation will be provided in section 5.5.

5.3.4 Willingness-to-pay: Model 2

When interaction terms are present, consumer *n*'s WTP for attribute *j* is computed by adding the coefficient of the attribute and the coefficients of interaction terms multiplied by either their mean or actual value together, all divided by the negative of the price coefficient. The utility function with interaction terms is:

$$U_{njt} = \beta_1 \mathrm{NC} + \beta_2 \mathrm{P} + \beta_3 \mathrm{A7} + \beta_4 \mathrm{A28} + \beta_5 \mathrm{SL3} + \beta_6 \mathrm{SL14} + \beta_7 \mathrm{PM} + \beta_8 \mathrm{PM} * \mathrm{FTNS} + \beta_9 \mathrm{PM} * \mathrm{Education} + \beta_{10} \mathrm{PM} * \mathrm{Age} + \beta_{11} \mathrm{PM} * \mathrm{Gender} + \beta_{12} \mathrm{PM} * \mathrm{Income} + \beta_{13} \mathrm{PM} * \mathrm{Child} + \mathcal{E}_{njt} \quad (5.1)$$

Mean WTP was calculated using the following formula:

$$\text{Mean WTP}_{PM} = -\frac{\left[\frac{\sum_n \beta_8 \text{FTNS}_n + \sum_n \beta_9 \text{Education}_n + \sum_n \beta_{10} \text{Age}_n + \sum_n \beta_{11} \text{Gender}_n + \sum_n \beta_{12} \text{Income}_n}{N}\right]}{\beta_2} - \frac{\left[\frac{\sum_n \beta_{13} \text{Child}_n}{N}\right]}{\beta_2} - \frac{\beta_7}{\beta_2}.$$

where *n* indicates each individual, and *N* is the sample size.

Table 5.4 WTP for different attributes in Model 2

Variable	Treatment 1		Treatment 2		Treatment 3	
	MNL	**ML**	**MNL**	**ML**	**MNL**	**ML**
A7	0.2296	0.2280	-0.2701	-0.0859	-0.8409	-0.9154
A28	-1.1015	-0.8670	-0.5663	-1.0132	0.1567	0.0948
SL3	-0.0866	-1.9859	**-1.3929**	-3.8607	-1.4598	-3.5931
SL14	0.1955	-0.0460	0.4270	-0.2408	0.0798	-0.0867
PM	**-1.8433**	**-1.2022**	1.0442	1.2787	-0.4652	-0.2650

Note: Bold fonts indicate statistical significance of the attribute mean WTP. Variable definitions can be found in table 3.5, p. 40.

The calculation of the mean WTP value is reported in table 5.4. For both MNL and ML, the WTP for vacuum packaging was higher under treatments 2 and 3 compared with treatment 1. The results show that positive information about vacuum packaging increased consumers' WTP by about $2.89 in the MNL and by $2.48 in the ML, as you moved from treatment 1 to treatment 2. In general, vacuum packaging had a positive effect on participants' WTP, as the results indicate that respondents increased their WTP for vacuum packaging by $1.38 in the MNL and by $0.94 in the ML from treatment 1 to treatment 3, although the WTP were still negative in treatment 3.

Consumers' WTP for A7 decreased after being given information about vacuum packaging in both the MNL and ML models, and their WTP for A28 increased for MNL.

For MNL and ML, the WTP for SL3 were negative compared to a shelf-life of 5 days indicating that consumers were willing to pay more for a longer shelf-life. The estimated coefficients on SL14 show that the WTP increased after introducing the positive information that vacuum packaging method leaded to shelf-life extension for MNL. One reason for this result may be that consumers were suspicious of a longer shelf-life but they trusted the vacuum packaging method in prolonging shelf-life. However, WTP decreased from

treatment 2 to treatment 3 after consumers were given the negative information about vacuum packaging.

5.4 Model 3A: Choice-Specific Attributes and Demographic and Attitude Interaction Terms

5.4.1 Regression Results

Table 5.6 lists the results of the ML as compared to the MNL including choice-specific attributes and demographic and attitude interaction terms in three treatments. The coefficients of the standard deviations were statistically significant for SL3 in treatments 2 and 3 at the 5% and 10% levels, respectively, and it was significant for SL14 in treatment 2 at the 5% level, implying that significant heterogeneity existed among consumers and preferences varied in the population for these choice-specific attributes. As a result, the ML models provided more efficient estimation when compared with MNL, although the differences between the LL values were not large. The results of ML models will be discussed.

In the ML models, the estimates for NC and P were statistically significant and had the expected sign in all three treatments. The results suggest a significantly positive effect of ageing for 7 days compared with ageing for 14 days in treatments 1 and 2 at the 5% and 10% levels, respectively. These results confirm Model 3B in section 5.5 and explaination will be provided there. The coefficient on PM in treatment 1 was negative and statistically significant at the 5% level, showing that consumers were not willing to buy vacuum packaged beef steak before being given any information about it. The estimated coefficient on SL3 was positive and significant at the 10% level compared to a shelf-life of 5 days in treatment 2, showing that participants were willing to pay more for a shorter shelf-life. That may be because respondents did not trust the positive information and had some doubts about this new technology's ability to prolong shelf-life.

The sign on the coefficient for SL3 changed from negative in model 2 (model with attributes and demographic interaction terms) to positive in model

3A (individual attitude variables were interacted with steak attributes) in MNL models in treatment 2. The reason may be that consumers' attitudes towards shelf-life in model 3A were controlled and the interaction term SL3*SL captured the negative value for a short shelf-life (SL3); that is, the WTP for SL3 decreased with the level of importance of shelf-life. But the negative attitude towards SL3 was not for the entire sample in respect that the positive coefficient for SL3 suggest that some consumers would like to buy beef steaks with a 3-day shelf life. As a result, preference heterogeneity for beef steak existed and the ML model was a more appropriate model specification. Information on consumer tastes variation and difference in perceptions of shelf-life and other product characteristics should be relevant to grocery retailers and food manufacturers when making product development decisions. In the ML models, similar results were obtained for SL3 in model 3A treatment 2 and A7 in model 3A treatments 1 and 2.

Table 5.5 MNL and ML Model 3A Estimates (sample size = 2673)

Variable	Parameter	Treatment 1		Treatment 2		Treatment 3	
		MNL	**ML**	**MNL**	**ML**	**MNL**	**ML**
NC	Mean of Fixed Coefficient	-1.6013***	-2.3541***	-1.5852***	-2.7836***	-1.6193***	-2.5787***
		(0.3687)	(0.7474)	(0.3693)	(0.9364)	(0.3687)	(0.7638)
P	Mean of Fixed Coefficient	-0.1628***	-0.2838**	-0.1650***	-0.3471**	-0.1664***	-0.3126***
		(0.0574)	(0.1142)	(0.0578)	(0.1465)	(0.0574)	(0.1204)
A7	Mean of Normal Coefficient	0.5323*	1.1200**	0.7350**	1.1930*	0.1494	0.4176
		(0.3103)	(0.5477)	(0.3220)	(0.6322)	(0.3184)	(0.5858)
	Standard Deviation of Normal Coefficient	----	0.4875	----	0.9956	----	1.2770
			(1.1529)		(0.8557)		(0.9383)
A28	Mean of Normal Coefficient	-0.3295	-0.5126	0.0960	-0.1430	0.1369	0.0533
		(0.3327)	(0.5525)	(0.3232)	(0.6633)	(0.3153)	(0.6082)
	Standard Deviation of Normal Coefficient	----	0.4731	----	1.5894	----	1.7445
			(1.1672)		(1.1819)		(1.0664)
SL3	Mean of Normal Coefficient	0.3063	-0.0803	0.9799***	1.9200*	0.3443	0.3119
		(0.3617)	(1.6303)	(0.3748)	(1.1560)	(0.3703)	(1.0622)
	Standard Deviation of Normal Coefficient	----	7.4006	----	3.7658**	----	4.5022*
			(6.5688)		(1.7731)		(2.6017)
SL14	Mean of Normal Coefficient	-0.1237	-0.1741	0.1289	-0.1335	-0.4457	-0.8629
		(0.3961)	(0.5515)	(0.3782)	(0.7324)	(0.3911)	(0.6567)
	Standard Deviation of Normal Coefficient	----	0.9954	----	2.0971**	----	0.9700
			(0.9869)		(1.0176)		(1.0249)
PM	Mean of Normal Coefficient	-0.9154*	-1.4178**	-0.2515	-0.5208	0.5845	1.0524
		(0.5078)	(0.7098)	(0.4781)	(0.8808)	(0.4849)	(0.8254)
	Standard Deviation of Normal Coefficient	----	0.1454	----	0.7470	----	0.5083
			(0.9720)		(1.5463)		(1.0039)

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses are standard errors. LL denotes the Log likelihood value. Variable definitions can be found in table 3.5, p. 40.

Table 5.5 Continued

Variable	Parameter	Treatment 1		Treatment 2		Treatment 3	
		MNL	**ML**	**MNL**	**ML**	**MNL**	**ML**
PM*FTNS	Mean of Fixed Coefficient	-0.0200**	-0.0286**	-0.0245***	-0.0452**	-0.0491***	-0.0842***
		(0.0101)	(0.0151)	(0.0094)	(0.0215)	(0.0099)	(0.0250)
PM*Education	Mean of Fixed Coefficient	0.0664	0.1380**	0.2455***	0.4529***	0.1000**	0.1973**
		(0.0434)	(0.0673)	(0.0428)	(0.1507)	(0.0422)	(0.0846)
PM*Age	Mean of Fixed Coefficient	0.0447	0.0383	-0.0078	-0.0150	-0.0090	0.0024
		(0.0485)	(0.0677)	(0.0464)	(0.0854)	(0.0475)	(0.0756)
PM*Gender	Mean of Fixed Coefficient	0.5784***	0.9502***	0.4377***	0.9528**	0.5532***	1.0061***
		(0.1595)	(0.2844)	(0.1513)	(0.3788)	(0.1538)	(0.3344)
PM* Income	Mean of Fixed Coefficient	0.2473***	0.3869***	0.0974*	0.1936	0.1789***	0.2596**
		(0.0582)	(0.1121)	(0.0561)	(0.1185)	(0.0567)	(0.1105)
PM*Child	Mean of Fixed Coefficient	0.2506	0.4276*	0.0999	0.2659	0.5279***	0.8193**
		(0.1764)	(0.2558)	(0.1675)	(0.3121)	(0.1711)	(0.3223)
A7*Ageing	Mean of Fixed Coefficient	-0.1364*	-0.2852**	-0.2139**	-0.3378**	-0.0793	-0.1732
		(0.0803)	(0.1416)	(0.0840)	(0.1619)	(0.0825)	(0.1478)
A28*Ageing	Mean of Fixed Coefficient	0.0406	0.0920	-0.0536	-0.0365	-0.0310	-0.0099
		(0.0851)	(0.1333)	(0.0834)	(0.1640)	(0.0811)	(0.1558)
SL3*SL	Mean of Fixed Coefficient	-0.0775	-0.3148	-0.2987***	-0.7924**	-0.1444*	-0.4498
		(0.0828)	(0.4526)	(0.0872)	(0.3764)	(0.0853)	(0.3475)
SL14*SL	Mean of Fixed Coefficient	0.0357	0.0312	-0.0194	0.0070	0.1113	0.1968
		(0.0910)	(0.1218)	(0.0869)	(0.1657)	(0.0897)	(0.1443)
LL		-929.0257	-921.5308	-901.4109	-896.5202	-923.7034	-920.1249

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses are standard errors. LL denotes the Log likelihood value. Variable definitions can be found in table 3.5, p. 40.

5.4.2 Food Technology Neophobia Scale and Demographic Interactions

The estimated coefficient for PM*FTNS was negative and statistically significant, while the estimate coefficient for PM*Gender was positive and significant for both MNL and ML in all three treatments. Together, these results suggest that men and people with lower FTNS scores were more likely to accept vacuum packaged beef steak. In addition, WTP for vacuum packaged beef steaks increased with the level of education, level of income, presence of children in the household, and decreased with the FTNS score. These results will be discussed in section 5.5.

5.4.3 Attitudinal Interactions

Ageing was negative and significant when interacted with A7 in the first two treatments for MNL and ML. This suggests that people who thought ageing was important when purchasing beef steak were less likely to choose beef steak with a shorter ageing time. This is an expected result. Shelf-life was negative and statistically significant when interacted with SL3, indicating that respondents who were more concerned about shelf-life were also more likely to choose beef steaks with longer shelf-life. Explanation will be given in section 5.5.

Another model was estimated which results can be found in Appendix C table C.1. After adding the interaction term PM*Colour to model 3A, the coefficients of it were negative and significant. Participants who considered the colour of the beef steak to be important were more likely to refuse to try vacuum packaged beef steak. Further explanation will be given in section 5.5.

5.4.4 Willingness-to-pay: Model 3A

The calculation of the mean WTP is shown in table 5.6. Consumers' WTP for A7 decreased after being given both positive and negative information about vacuum packaging and their WTP for A28 increased for both the MNL and

ML models.

For both MNL and ML, the WTP for vacuum packaging was higher under treatments 2 and 3 compared with treatment 1. Positive information (treatment 2) about vacuum packaging increased consumers' WTP by about $2.98 in the MNL and by $2.22 in the ML. In general, vacuum packaging had a positive effect on WTP as participants were willing to pay $1.33 more for vacuum packaging in the MNL and $0.80 more in the ML, as you moved from treatment 1 to treatment 3. However, after all the information treatments, WTP was still negative (treatment 3).

For MNL and ML, the WTP for 3-day shelf life was negative compared to a shelf-life of 5 days, indicating that consumers were willing to pay more for a longer shelf-life.

Table 5.6 WTP for different attributes in Model 3A

Variable	Treatment 1		Treatment 2		Treatment 3	
	MNL	ML	MNL	ML	MNL	ML
A7	**0.2115**	**0.2784**	**-0.2772**	**-0.1152**	-0.8416	-0.6864
A28	-0.1813	-0.6230	-0.6039	-0.7958	0.1427	0.0549
SL3	-0.0513	-4.7864	**-1.4110**	**-3.7371**	-1.4541	-4.8442
SL14	0.1305	-0.1671	0.3039	-0.3027	0.0371	-0.2044
PM	**-1.7386**	**-0.9041**	1.2463	1.3207	-0.4061	-0.1053

Note: Bold fonts indicate statistical significance of the attribute mean WTP. Variable definitions can be found in table 3.5, p. 40.

5.5 Model 3B: Choice-Specific Attributes, Demographic and Attitude Interaction Terms, and Food Safety

5.5.1 Regression Results

Table 5.8 lists the results of model 3B for the ML and MNL. The difference between model 3A and model 3B is the inclusion of an interaction term to account for an individual's attitude toward food safety. The coefficients of the standard deviations were statistically significant at the 10%, 5%, and 5% levels for SL3 in treatments 1, 2, and 3, respectively. The standard deviation coefficients were also significant at the 5% level for A7 and SL14 in treatment 3, implying that significant heterogeneity existed among consumers and

preferences varied in the population for these choice-specific attributes. As a result, the ML models provided more efficient estimation when compared with MNL, although the difference between the LL was not large. Therefore, only the results of the ML models will be dicussed.

The coefficients of P had a negative sign and were significant. Other studies found similar qualitative results concerning price, but with different point estimates (Chen and Chern, 2004; Chern and Richertsen, 2004; Tonsor *et al.*, 2005).

The NC was the 'starting point' of utility gained from the non-purchase alternative, and it was negative and statistically significant. Many studies added a no-choice constant in their models and obtained a negative sign (e.g., Brazell *et al.*, 2006; Gao and Schroeder, 2009).

For ageing, results showed a significantly positive effect for A7 compared with aged for 14 days at the 10% level in treatments 1 and 2. Previous studies have not added ageing to their model to analyze consumer's perception of it. The reason that consumers did not choose steaks with longer ageing may be due to the fact that most beef steaks sold in Canadian supermarkets do not carry ageing labels. Therefore, respondents may not have been familiar with this type of information and associated longer ageing with "older beef steaks" instead of more tender ones. Retailers should not only label the beef steaks for ageing, but also introduce this concept and information to consumers through different media or scientific institutions. This way ageing related information may not be ignored or misunderstood by Canadian beef consumers in the future.

For shelf-life, the coefficient on 14-day shelf life was negative and significant at the 10% level compared with a shelf-life of 5 days in treatment 3, showing that consumers were unlikely to purchase beef steaks with a longer shelf-life after being provided with both positive and negative information about vacuum packaging. Lynch *et al.* (1986) obtained a similar result and showed that people preferred conventionally packaged ground beef with a shelf-life of 3 days versus vacuum packaged beef with a shelf-life of 12 days. The reason may be that consumers were suspicious of and concerned about very long shelf lives and worried about food safety. Safety assurances of very long shelf lives may be needed from scientific institutions in order to reduce

consumers' risk perception of longer shelf lives. Also, government regulation for vacuum packaging method should be provided to ensure the safety of the products.

For packaging method, the coefficient on PM in treatment 3 was positive and statistically significant at the 5% level, showing that respondents were more likely to buy vacuum packaged beef steak after being given positive and negative information about it. This finding confirms results obtained by Marette *et al.* (2008) and Cardello (2003) that information has a mitigating effect on consumer's concern levels about technology. This may be due to the fact that consumers trusted the information about vacuum packaging technology provided during the experiment and placed more weight on positive information. In this context, it may be important for retailers to provide full information disclosure, especially of positive information, to consumers to change their risk perception of vacuum packaging of food stuffs.

In model 3B treatments 1 and 2, the sign on the coefficients for A7 was positive while the sign on the coefficients for A7*Ageing was negative in ML models. The reason may be that consumers' perception towards ageing were taken into account and the interaction term A7*Ageing captured the negative value for a short ageing time (A7); that is the WTP for A7 decreased with the level of importance of ageing. But the negative attitude towards A7 was not for the entire sample as the positive coefficient for A7 showed that some consumers would like to purchase beef steaks with 7-day ageing. These results further show the existence of heterogeneous preferences for beef steak. The valuation variation is important for retailers and manufacturers to balance the welfare of diverse consumers, rather than manage for the average preferences. At the same time, the sign on the coefficient for SL14 in model 3B treatment 3 was negative while the sign on the coefficients for SL14*SL was positive in ML model. The reason is similar with the above explanation for A7.

Table 5.7 MNL and ML Model 3B Estimates (sample size = 2673)

Variable	Parameter	Treatment 1		Treatment 2		Treatment 3	
		MNL	**ML**	**MNL**	**ML**	**MNL**	**ML**
NC	Mean of Fixed Coefficient	-1.6188***	-2.5779***	-1.5873***	-2.8195***	-1.6285***	-2.6375***
		(0.3705)	(0.7940)	(0.3694)	(0.9707)	(0.3692)	(0.7305)
P	Mean of Fixed Coefficient	-0.1645***	-0.3150**	-0.1651***	-0.3529**	-0.1672**	-0.3203***
		(0.0577)	(0.1231)	(0.0578)	(0.1542)	(0.0575)	(0.1150)
A7	Mean of Normal Coefficient	0.4892	1.0169*	0.7245**	1.1205*	0.1200	0.3084
		(0.3109)	(0.5898)	(0.3227)	(0.6319)	(0.3198)	(0.5996)
	Standard Deviation of Normal Coefficient	----	0.6959	----	0.7514	----	1.7260**
			(1.2018)		(1.1561)		(0.8173)
A28	Mean of Normal Coefficient	-0.3799	-0.8878	0.0827	-0.2997	0.0990	-0.0584
		(0.3331)	(0.6969)	(0.3242)	(0.7715)	(0.3165)	(0.5895)
	Standard Deviation of Normal Coefficient	----	0.9745	----	2.2625*	----	1.7483
			(1.3652)		(1.2675)		(1.1284)
SL3	Mean of Normal Coefficient	0.3515	0.1239	0.9865***	2.2360	0.3712	0.2694
		(0.3624)	(1.4455)	(0.3750)	(1.3826)	(0.3704)	(0.9697)
	Standard Deviation of Normal Coefficient	----	6.3883*	----	4.3109**	----	3.9071**
			(3.5734)		(2.1644)		(1.8362)
SL14	Mean of Normal Coefficient	-0.2988	-0.6459	0.1035	-0.2089	-0.5386	-1.0753*
		(0.4026)	(0.6787)	(0.3812)	(0.7664)	(0.3950)	(0.6431)
	Standard Deviation of Normal Coefficient	----	1.1317	----	1.9878*	----	0.3877
			(1.2600)		(1.0342)		(0.9700)
PM	Mean of Normal Coefficient	0.0597	0.2404	-0.0982	-0.1339	1.1065**	1.9838**
		(0.5803)	(0.8981)	(0.5521)	(1.0895)	(0.5601)	(0.9616)
	Standard Deviation of Normal Coefficient	----	0.5910	----	1.0517	----	0.5853
			(1.1656)		(1.2257)		(0.8194)

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses are standard errors. LL denotes the Log likelihood value. Variable definitions can be found in table 3.5, p. 40.

Table 5.7 Continued

Variable	Parameter	Treatment 1		Treatment 2		Treatment 3	
		MNL	**ML**	**MNL**	**ML**	**MNL**	**ML**
PM*FTNS	Mean of Fixed Coefficient	-0.0163	-0.0238	-0.0238**	-0.0461**	-0.0470***	-0.0773***
		(0.0101)	(0.0163)	(0.0095)	(0.0223)	(0.0100)	(0.0211)
PM*FS	Mean of Fixed Coefficient	-0.0295***	-0.0563***	-0.0047	-0.0126	-0.0160*	-0.0326**
		(0.0089)	(0.0205)	(0.0086)	(0.0177)	(0.0087)	(0.0152)
PM*Education	Mean of Fixed Coefficient	0.0503	0.1118	0.2431***	0.4780***	0.0911**	0.1748**
		(0.0440)	(0.0743)	(0.0431)	(0.1637)	(0.0426)	(0.0760)
PM*Age	Mean of Fixed Coefficient	0.0696	0.0999	-0.0039	-0.0056	0.0041	0.0344
		(0.0493)	(0.0803)	(0.0469)	(0.0924)	(0.0481)	(0.0764)
PM*Gender	Mean of Fixed Coefficient	0.5654***	1.0258***	0.4351***	0.9867**	0.5472***	1.0134***
		(0.1609)	(0.3366)	(0.1515)	(0.4245)	(0.1544)	(0.3072)
PM* Income	Mean of Fixed Coefficient	0.2152***	0.3889***	0.0921	0.2040	0.1628***	0.2356**
		(0.0594)	(0.1306)	(0.0569)	(0.1307)	(0.0576)	(0.1008)
PM*Child	Mean of Fixed Coefficient	0.2917	0.6149*	0.1072	0.2441	0.5566***	0.9158***
		(0.1790)	(0.3138)	(0.1681)	(0.3315)	(0.1724)	(0.3156)
A7*Ageing	Mean of Fixed Coefficient	-0.1245	-0.2545*	-0.2110**	-0.3121*	-0.0713	-0.1562
		(0.0808)	(0.1508)	(0.0843)	(0.1601)	(0.0830)	(0.1543)
A28*Ageing	Mean of Fixed Coefficient	0.0538	0.1715	-0.0500	-0.0285	-0.0208	0.0191
		(0.0856)	(0.1590)	(0.0837)	(0.1917)	(0.0815)	(0.1542)
SL3*SL	Mean of Fixed Coefficient	-0.0908	-0.2826	-0.3007***	-0.9008*	-0.1524*	-0.3758
		(0.0830)	(0.3498)	(0.0873)	(0.4643)	(0.0854)	(0.2653)
SL14*SL	Mean of Fixed Coefficient	0.0788	0.1354	-0.0131	0.0245	0.1341	0.2548**
		(0.0927)	(0.1435)	(0.0877)	(0.1736)	(0.0907)	(0.1437)
LL		-923.4868	-915.1778	-901.2574	-896.3148	-921.9896	-915.8874

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses are standard errors. LL denotes the Log likelihood value. Variable definitions can be found in table 3.5, p. 40.

5.5.2 Food Technology Neophobia Scale and Demographic Interactions

The coefficients on the interaction terms PM*FTNS and PM*FS were negative and statistically significant, while PM*Gender was positive and significant for both MNL and ML. The coefficients on the interaction terms PM*Education, PM*Income, and PM*Child were statistically significant in some treatments for both MNL and ML. The interaction terms suggest that men, and persons with lower FTNS and FS scores were more likely to accept vacuum packaged beef steak. A consumer's willingness to purchase vacuum packaged beef steak increased with the level of education, the income level, the presence of children in the household, and decreased with FTNS scores and the level of concern regarding food safety. The interaction terms PM*FTNS and PM*FS are new and the results were expected and obvious.

For demographic interaction terms, other studies have found similar results, except for the presence of children in the household. For example, Moerbeek and Casimir (2005) found that women were less likely to consume genetically modified (GM) foods. Chern and Rickertsen (2004) found that a higher level of education was positively correlated with consumer WTP for GM foods. Chen and Chern (2004) found that wealthier people tended to consume more foods produced using new technology, and that consumers' WTP was influenced by their perception of the risk to human health posed by the new technology. Ipsos-Reid (2002) found that women were more concerned than men about GM food in North America. Chen and Chern (2004) also showed that the number of children within the household negatively affected consumer's willingness to purchase GM foods.

The reason that women were less likely to buy vacuum packaged beef steaks may be that women's role of nurturer and care provider of the family caused them to be more concerned about food safety and health. The reason that people with higher education were more likely to buy vacuum packaged beef steaks may be that education was correlated with knowledge and better educated people can more easily understand the information about new technologies. The consumers with higher incomes tended to purchase more

vacuum packaged beef steaks, implying that wealthy people were more likely to try this new product produced with novel technology and would not consider it as a risk. This may be that wealthy people had relatively higher education, and they were more likely to have accessed to and learned this new technology before. The household with children tended to consume more vacuum packaged beef steaks, and this result is somewhat surprising, as the concern for the health of younger children in the household might decrease the consumption of this kind of food. The reason might be that consumers with children in the household may place more weight on the advantages of vacuum packaging, and did not consider the potential chance of packaging damage as a risk. These findings are useful for government and food industries for educating the consumers about vacuum packaged foods targeted to different demographic groups. In addition, it is important for food industries to explain the concepts related to vacuum packaging that consumers may not be familiar with (e.g., ageing time) and introduce the benefits of this kind of packaging method to consumers through internet, television, and newspaper. Communicating effective information can influence consumers' behaviour and change their risk perception of vacuum packaging. Moreover, the safety confidence in vacuum packaged beef steaks could be increased by reassuring consumers that these new products are safe, and retailers and manufacturers are reliable. Thus, government can set down regulations to ensure the safety of the vacuum packaged beef steaks and restrictions on food industries to avoid information asymmetries of potential risks.

5.5.3 Attitudinal Interactions

Ageing was negative and significant when interacted with A7 in the first two treatments for ML and in treatment 2 for MNL. It suggests that respondents who thought ageing was important when purchasing beef steak were less likely to choose beef steak with shorter ageing times. The interaction term SL3*SL was negative and statistically significant in treatments 2 and 3, while the interaction term SL14*SL was positive and significant in treatment 3. This indicates that consumers who considered shelf-life to be an important attribute

prefer a longer shelf-life, which is obvious and expected.

The results of another model that was estimated can be found in Appendix C table C.3. After adding PM*Colour to model 3B, the coefficients of it were negative and significant in treatment 3 for the ML. Participants who considered the colour of beef steak to be important were less likely to choose vacuum packaged beef steak. Since the colour of vacuum packaged beef steak was darker and browner than conventional tray packaged steaks, this indicates that these consumers preferred a redder colour when choosing fresh meat. This finding is in line with previous studies on consumer WTP for the colour of salmon (Alfnes *et al.*, 2006). Previous research also showed that consumers preferred meat with a light cherry-red colour (Warner *et al.*, 1993; Carpenter *et al.*, 2000; Viana *et al.*, 2005; Alfnes *et al.*, 2006; Grebitus *et al.*, 2009).

Two other models were estimated, the results of which can be found in Appendix C table C.2 and C.3. After changing PM*FTNS to PM*Innovation, the coefficient was positive and significant in treatment 2 indicating that participants who were more open to novel innovations were more likely to accept vacuum packaging method.

5.5.4 Willingness-to-pay: Model 3B

The calculation of the mean WTP is shown in table 5.8. For both MNL and ML, the WTP for vacuum packaging was higher under treatments 2 and 3 compared with treatment 1. This shows that positive information about vacuum packaging increased consumers' WTP by about $3.05 in the MNL and by $2.30 in the ML. In general, information about vacuum packaging had a positive effect on WTP as participants were willing to pay $1.36 more for vacuum packaging in the MNL and $0.73 more in the ML from treatment 1 to treatment 3. However, WTP was still negative after participants received both the positive and negative information treatment. Aoki *et al.* (2010) found similar results from their laboratory experiments dealing with ham sandwiches with a food additive (sodium nitrite).

Consumers' WTP for A7 decreased after being given positive and negative about vacuum packaging for both MNL and ML compared with aged for 14

days. For MNL, the WTP for SL3 was negative compared to a shelf-life of 5 days in treatment 2 indicating that consumers were not willing to pay more for a shorter shelf-life when provided with positive information about vacuum packaging. After obtaining all the information about vacuum packaging, the WTP for SL14 was negative compared with a shelf-life of 5 days in treatment 3 for ML. This suggests that consumers might have been suspicious of and concerned about a shelf-life of 14 days.

Table 5.8 WTP for different attributes in Model 3B

Variable	Treatment 1		Treatment 2		Treatment 3	
	MNL	ML	MNL	ML	MNL	ML
A7	0.2114	**0.2793**	**-0.2765**	**-0.0529**	-0.8388	-0.8171
A28	-1.1157	-0.8312	-0.6045	-1.1440	0.1380	0.0353
SL3	-0.1042	-3.2490	**-1.4194**	-4.0273	-1.4805	-3.9224
SL14	0.1284	-0.3053	0.3047	-0.3101	0.0350	**-0.1274**
PM	-1.7993	-0.8340	1.2458	1.4613	**-0.4418**	**-0.0997**

Note: Bold fonts indicate statistical significance of the attribute mean WTP. Variable definitions can be found in table 3.5, p. 40.

5.6 Conclusions

MNL and ML models were constructed to analyze the data generated from the survey and experiments. Four different models were developed. In the base model, which only contained choice-specific attributes, all the coefficients of the standard deviations in the ML model were statistically insignificant, implying that no significant heterogeneity existed among consumers and preferences did not vary in the population for those choice-specific attributes. As a result, the ML models did not provide efficient estimation when compared with MNL, although the ML models had a better fit to the data than the MNL models. For the remaining three models, which included choice-specific attributes and interaction terms, some standard deviations were statistically significant, implying that significant heterogeneity existed among consumers and preferences varied in the population for those choice-specific attributes. Thus, the ML models provided more efficient estimation when compared with MNL, although the difference between the LL values were not large. Nahuelhual *et al.* (2004) had the same finding that ML is a more

appropriate approach when the standard deviations of the variables are significant and span the positive and negative portions of the real number line.

Results from the ML models revealed that WTP for A7 was $0.40 less than aged for 14 days after introducing positive information about vacuum packaging to consumers. My findings show that there was no significant WTP for 28-day ageing and 3-day shelf life. The WTP for SL14 was negative compared to shelf-life of 5 days in treatment 3 after receiving all the information about vacuum packaging.

The WTP for vacuum packaging was higher under treatments 2 and 3 compared with treatment 1. This shows that positive information about vacuum packaging increased consumers' WTP. In general, vacuum packaging had a positive effect on participants' WTP. However, participants' WTP for vacuum packaging in treatment 3 (i.e., after receiving all information treatments) was negative.

The results for the demographic characteristics and attitudes interacted with PM indicates that WTP for additional vacuum packaged beef steak increased with the level of education, income level, presence of children in the household, and decreased with FTNS scores, and concerns with food safety. People who thought ageing and shelf-life were important were less likely to choose beef steak with shorter ageing time and shelf-life. Participants who considered colour to be important were less likely to choose vacuum packaged beef steak.

To conclude:

1. Ageing time affects consumer's WTP for beef steak. Beef steak aged for 7 days is the most preferred.
2. Consumers generally do not prefer steaks with very long shelf lives (e.g., 14 days). This result rejects hypothesis 5 and implies that people are not willing to pay more for beef steak with extended shelf-life.
3. In general, after negative information was provided, information about vacuum packaging, positive and negative information as a whole, increased participants' WTP.
4. The ML model is more likely to be a proper approach for modeling in this study.

6 Summary and Conclusions

6.1 Study Summary

Novel food technologies appear unceasingly. Sometimes even when these products have clear competitive advantages over existing products, they face innovation resistance. As a result, firms in food industries face significant risks of product introduction failures. This thesis focused on consumer resistance to innovation. The main purpose of this thesis was to:

1) Estimate consumers' WTP for beef steak products differentiated by packaging method (vacuum seal and foam tray packaging), meat ageing and shelf-life.
2) Measure the impact of different information scenarios regarding the properties of the vacuum packaging technology on consumer's choice decisions.
3) Measure consumers' overall attitudes towards new food technologies by means of the Food Technology Neophobia Scale.

A survey and real choice experiments were conducted to study how new food technologies affect consumers' perceptions and evaluation of vacuum packaged beef steaks. Consumer's acceptance and willingness-to-pay (WTP) for a new meat packaging technology, vacuum packaging, was investigated. Three information treatments focused on the properties of vacuum packaging method were applied in order to examine the knowledge effect on consumers' choice behaviour and their resistance to technological innovation under different information scenarios. The Food Technology Neophobia Scale (FTNS), a questionnaire tool developed by Evans and Cox (2006), was calculated to measure consumers' reactions to new food technologies. The findings are as following.

Finding 1:

After introducing positive information about vacuum packaging to consumers, results from ML models revealed that the WTP for aged for 7 days (A7) was lower compared to aged for 14 days. My findings show that there

was no significant WTP for beef steak aged for 28 days (A28) and a 3-day shelf-life (SL3). The WTP for a shelf-life of 14 days (SL14) was negative compared to a shelf-life of 5 days in treatment 3 after receiving all the information. These results partially reject hypothesis 5 and support that people were not willing to pay more for beef steak with extended shelf-life. Also, there is no significant evidence showing that people were willing to pay more for beef steak with longer ageing. However, interaction terms show that people who thought ageing and shelf-life were important when purchasing beef steak were less likely to choose beef steak with shorter ageing and shelf-life.

Finding 2:

The WTP for vacuum packaging was higher under treatment 2 compared to treatment 1, showing that positive information about vacuum packaging affects consumers' behaviour in a positive way. WTP for vacuum packaging after all the information was provided was higher than none of the information was received. This implies that positive information about vacuum packaging was still absorbed and more dominant, which is in line with the findings of Marette *et al.* (2008) that beneficial information also impacted WTP if they were mentioned before risk. These findings rejecte the hypothesis 4 and support that people were more willing to purchase vacuum packaged beef steak if the advantages of vacuum packaging technology were introduced to them.

Finding 3:

The interaction variables that were constructed using demographic characteristics and attitudes with packaging method (PM) show that consumers were more willing to buy vacuum packaged beef steaks when they had higher education, when they had higher level of income, and when they had children in the household. Participants who considered colour to be important were less likely to choose vacuum packaged beef steak. People with lower FTNS were more likely to accept vacuum packaging. At the same time, people who were more concerned about food safety were more likely to reject vacuum packaging. People who were more open to innovation were more willing to accept vacuum packaging. These results rejecte the first three hypotheses listed in chapter 3.

Finding 4:

There were no significant main effects of gender, age, education, or income, for FTNS. However, there were some significant differences within sub-categories of key socio-demographic variables. People aged 35 to 44 had lower FTNS scores compared with people aged 18 to 24 ($p < 0.05$) and 25-34 ($p < 0.05$). People with an associate degree were more likely to try new things compared with people with some high school education ($P < 0.1$).

6.2 Implications

In this study, empirical models were developed to estimate Canadian consumers' preferences for different food quality and safety attributes with respect to vacuum packaged beef steak. The results of this analysis contributed to a better understanding of different perceptions of food technology innovations among Canadian consumers. Such knowledge should be valuable in developing merchandising strategies for new retail meat products based on vacuum packaging technologies.

As this study has shown, information about vacuum packaging method did affect consumers' choice decisions and in general had a positive effect in consumers' acceptance of vacuum packaged beef steak. It is important to change their risk perception of vacuum packaging and to alleviate their concerns. Food industries that produce retail meat products using vacuum packaging method need to introduce these new products, especially their advantages, to consumers by media that consumers trust. As only 19.2% of participants had recently heard about vacuum packaged beef in the mass media, the majority of consumers were not well informed about vacuum packaged foods. The survey results indicated that the internet, television, and newspapers were the top 3 forms of media to acquire food related information and internet, magazines, and newspaper were the top 3 sources that consumers trusted most to obtain information on foods and food safety. The food industry needs to provide unbiased information to consumers to let this kind of food be known by more people, before they obtain negative information from other outlets. If information can change consumers' attitude toward new technologies, then it is possible that the willingness to buy vacuum packaged

foods would increase. As a result, the success of vacuum packaged fresh beef products relies highly on the effectiveness of the information. As well, longer beef ageing that ensures premium taste, tenderness and quality may be mentioned as the first advantage because of its significance in the empirical analysis.

In addition, the results show that there may be a niche market for vacuum packaged meat in Canada. For the consumer, longer shelf-life compared to 3-5 days for tray overwraps, leak-proof packaged, freezer-ready, and prolonged ageing time is attractive. For retailers, the advancement of extended retail display life leads to significant cost savings from reduced markdowns, spoilage, waste and labour costs for repackaging. One attribute that retailers could improve to increase acceptance of vacuum packaging is the colour of the vacuum packaged meat. Over half of the participants claimed that colour was very important when purchasing beef steak. However, the colour of vacuum packaged beef steaks sold in Canada is purple brown. It is not the "fresh" red colour of conventional tray packaged steaks. If the cost is reasonable, FDA- and USDA-approved technology engineered to maintain a fresh red colour in a vacuum package should be applied. This "FreshCase packaging"[6] has already been introduced in the United States.

Government, responsible for the public safety and regulation of the food sector, needs to implement regulations for food producers and manufactuerers to ensure the safety and proper use of novel food technologies, such as vacuum packaging of meat products. Strict rules on safety procedures during processing and especially continuous temperature control may be crucial to avoide growth conditions for anaerobic bacteria in vacuum packaging (e.g., Clostridium species) if temperature abuse occurs. In addition, public education programs and information campaigns should also educate the public about proper storage and cooking precedures for vacuum-packaged meat (beef steak) products to avoid potential health threats from unsafe foods.

The econometric results also showed that the price of vacuum packaged beef steak had a fairly significant effect, suggesting that reducing the price for vacuum packaged foods as compared to conventional tray packaged ones is

[6] Source: www.canadianmanufacturing.com/packaging/products-and-equipment/curwood-intros-freshcase-packaging-27451.

critical in increasing consumers' willingness to buy these new foods. In addition, my results indicate that consumers' attitude toward these new foods vary across demographic characteristics. The willingness to buy increased with the level of education, level of income, and presence of children. This finding is useful for government and food industries for educating the consumers about vacuum packaged foods targeted to different demographic groups.

The results of this thesis indicate that this new food technology may be successful in the Canadian retail market. Geiven the very high market failure rates of food product innovation, the value of this study lies in its contribution to the efficiency of the innovation process. More detailed knowledge of consumer preferences (and heterogeneity) towards food technology innovations can help to minimise resources waste and innovation failure rates.

6.3 Limitations and Future Research

There are some limitations to this study. Since the experiments were done using the real products of vacuum packaged beef steak, it was impossible to control the colour as an attribute like other studies (Alfnes *et al.*, 2006; Grebitus *et al.*, 2009) in order to find out consumers' attitudes towards colour. However, previous findings showed that colour was the primary factor of fresh meat determining consumer purchase decisions and influencing their likelihood to purchase (Carpenter *et al.*, 2001; Roosen *et al.*, 2003; Viana *et al.*, 2005). Colour was the attribute not included to the experiments or considered in the estimation of the structural equation model. Further study could be done to look into how different colours may affect consumer behaviour. The attribute colour can be measured by sensory experiemnts and considered in the estimation of the structural equation model.

In addition, this study measured the effect of risk and benefit information by conducting three treatments with different information provided in each treatment. Instead of investigating the effects of information specified by choice reasons, this study examined them as a whole. Aoki *et al.* (2010) let participants choose the two most important reasons that determined their

choice in each information round and added their choice reasons into the model in order to find out which kind of information would have the largest marginal effect on the choice. In that case, future experiments could add this part to look into different information's individual effect.

In this study all participants were provided positive information first. Hence, it was not possiable to identify the potential negative effect of negative information on participant's choice decisions. In order to measure the impact of negative information on consumers choice decisions, future experimental designs would need to randomaize the delivery of positive and negative information between participant subsamples. In this way, the influence of either negative or positive information could be revealed.

Due to the cost and time limitation, the sample size of this study is relatively small and the survey and experiments were only held in Edmonton. In addition, mean values of key socio-economic indicators suggest that my sample may not have been perfectly representative of the overall Albertan population (Census of Canada, 2006). This may lead to some biases and care should be taken when interpreting the results of this study. The results may also suffer some potential biases from the no choice problem if non-respondents differ from participants in demographic characteristics. Therefore, future studies could be conducted by recruiting more people from a wider range of the society.

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Appendix A

Survey Questionnaire

Questionnaire 1

Are you in charge of your family's everyday food shopping?

Yes_____ No_____

If yes, approximately what proportion of your household's weekly food shopping do you do?

_____%

Food Purchasing and Consumption **ID # _____**

To get started, we would like to ask you a few questions about your meat consumption patterns and your attitudes regarding meat. There are no 'right' or 'wrong' answers and your responses will be kept confidential. Please think carefully about each question before answering. Your completion of the survey is extremely important for the results of this study.

1. How often on average do you eat the following (including at home and away from home)? (For each item, place an X in the space that best describes your consumption habits.)

	Daily	5 to 6 times a week	3 to 4 times a week	1 to 2 times a week	1 to 3 times a month	Less than once a month	Rarely	Never
Beef								
Chicken								
Pork								
Lamb								
Fish								
Steak								

2. Several attributes may be important to you when you purchase beef steak. Please indicate how important each of the following attributes is to you when you purchase beef steak. (Please circle the answer where 1 = not important and 5 = very important)

Attributes	Not important	A little important	Neutral	Somewhat important	Very important
Price	1	2	3	4	5
Colour	1	2	3	4	5
Marbling	1	2	3	4	5
Brand	1	2	3	4	5
Shelf life, best before date	1	2	3	4	5
Date of packaging	1	2	3	4	5
Ageing of beef	1	2	3	4	5
Safe handling instructions	1	2	3	4	5
Type of cut (e.g., rib, sirloin)	1	2	3	4	5
Weight/size of packaging	1	2	3	4	5
Nutrition	1	2	3	4	5
Packaged in store	1	2	3	4	5
Packaged by producer (pre-packaged)	1	2	3	4	5

3. What is the price range of one kilogram (kg) of steak you normally purchase at large grocery stores (e.g., Safeway, Superstore) in Edmonton? Please indicate a price range:

   $_____ to $_____.

4. Please specify the type of steak cut you purchase most often. (e.g., T-bone, ribeye, sirloin, etc.)

   _____

5. Please indicate your level of agreement with the following statement.

Issue	Strongly disagree	Disagree	No opinion	Agree	Strongly agree
Steak is my favourite meat.	1	2	3	4	5

6. Please indicate how you would rate steak relative to beef in general with regard to each of the following attributes.

Attribute	Inferior	Slightly inferior	About the same	Slightly Superior	Superior
Overall value	1	2	3	4	5
Consistency of quality	1	2	3	4	5
Safe to eat	1	2	3	4	5
Nutritious	1	2	3	4	5
Easy to prepare	1	2	3	4	5
Healthy choice	1	2	3	4	5
Availability in store	1	2	3	4	5

7. Please indicate how important the following issues are in your meat purchase decisions.

Issue	Not important	A little important	Neutral	Somewhat important	Very important
Food safety in general	1	2	3	4	5
Mad Cow Disease (BSE)	1	2	3	4	5
Foot and Mouth Disease	1	2	3	4	5
Listeria monocytogenes	1	2	3	4	5
Salmonella	1	2	3	4	5
Escherichia coli O157:H7 (E.Coli)	1	2	3	4	5
Growth Hormones	1	2	3	4	5
Antibiotics	1	2	3	4	5
Meat prices are too high	1	2	3	4	5

For this section, we would like to ask you a series of questions regarding your perception and usage of food labeling. Please think carefully about each question before answering.

8. Do you usually read the product label information on "safe handling procedures"?

   YES _____ NO _____

9. When you are purchasing food, how often do you check the label for each of the following pieces of information?

Issue	Never	Rarely	Sometimes	Often	Always
Expiration date	1	2	3	4	5
Nutritional content	1	2	3	4	5
Country of origin	1	2	3	4	5
Ingredients	1	2	3	4	5

10. Please indicate your level of trust regarding the accuracy of the labeling for each of the following pieces of information on meat products.

Issue	No trust	A little trust	Neutral	Some trust	Complete trust
Expiration date	1	2	3	4	5
Nutritional content	1	2	3	4	5
Country of origin	1	2	3	4	5
Ingredients	1	2	3	4	5

We would like to ask your perceptions of novel technologies and novel food technologies.

11. Please indicate your level of agreement to the following statements.

Issue	Strongly disagree	Disagree	No opinion	Agree	Strongly agree
I am likely to try new things.	1	2	3	4	5
I am likely to buy new things only after they have been established.	1	2	3	4	5
I am likely to adopt a new technology only when the price is reasonable.	1	2	3	4	5

12. Please indicate how important each of the following factors is to you when you purchase new products.

Factors	Not important	A little important	Neutral	Somewhat important	Very important
Functionality	1	2	3	4	5
Quality	1	2	3	4	5
Nutritional value	1	2	3	4	5
Healthfulness	1	2	3	4	5
Environmental impact	1	2	3	4	5
Perceived value	1	2	3	4	5
Uncertainty about the innovation	1	2	3	4	5

13. Please indicate your level of agreement of the following statements regarding technology innovation in food.

Issue	Strongly disagree	Disagree	No opinion	Agree	Strongly agree
There are plenty of tasty foods around so we don't need to use new food technologies to produce more.	1	2	3	4	5
The benefits of new food technologies are often grossly *overstated*.	1	2	3	4	5
New food technologies *decrease* the natural quality of food.	1	2	3	4	5
There is no sense trying out high-tech food products because the ones I already eat are good enough.	1	2	3	4	5
New foods are *not* healthier than traditional foods.	1	2	3	4	5
New food technologies are something I am *uncertain* about.	1	2	3	4	5
Society should *not* depend heavily on technology to solve its food problems.	1	2	3	4	5
New food technologies may have long term *negative* environmental effects.	1	2	3	4	5
It can be *risky* to switch to new food technologies too quickly.	1	2	3	4	5
New food technologies are *unlikely* to have long term negative health effects.	1	2	3	4	5
New products produced using new food technologies can help people have a balanced diet.	1	2	3	4	5
New food technologies can give people *more* control over their food choices.	1	2	3	4	5
The media usually provides a balanced and *unbiased* view of new food technologies.	1	2	3	4	5

In the final set of questions, we would like to ask you several questions regarding your knowledge of different meat packaging technologies.

14. Please indicate your level of knowledge about each of the following production packaging technologies.

Technology	Don't know it	Have heard of it	Have heard of it and have limited knowledge of its purpose	Have heard of it and know its purpose	Know its purpose and understand how it works
Modified Atmosphere Packaging	1	2	3	4	5
Sodium Nitrite	1	2	3	4	5
Low Oxygen Packaging	1	2	3	4	5
Genetic Modification	1	2	3	4	5
Vacuum Packaging	1	2	3	4	5
Nanotechnology	1	2	3	4	5
High Oxygen Packaging	1	2	3	4	5
Irradiation (X-rays)	1	2	3	4	5
Animal Cloning	1	2	3	4	5

15. Please indicate your level of concerns regarding the use of the following meat production and packaging technologies.

Issue	Not at all concerned	A little concerned	Neutral	Somewhat concerned	Very concerned
Modified Atmosphere Packaging	1	2	3	4	5
Sodium Nitrite	1	2	3	4	5
Low Oxygen Packaging	1	2	3	4	5
Genetic Modification	1	2	3	4	5
Vacuum Packaging	1	2	3	4	5
Nanotechnology	1	2	3	4	5
High Oxygen Packaging	1	2	3	4	5
Irradiation (X-rays)	1	2	3	4	5
Animal Cloning	1	2	3	4	5

16. Have you recently heard something about **vacuum packaged beef** in the mass media?

YES _____ NO _____

17. Have you recently bought **vacuum packaged beef**?

YES _____ NO _____

18. Please indicate how often you use the following forms of media to acquire food related information.

Media	Never	Rarely	Sometimes	Often	Always
Radio	1	2	3	4	5
Television	1	2	3	4	5
Newspaper	1	2	3	4	5
Magazines	1	2	3	4	5
Internet sources	1	2	3	4	5

19. Please indicate your level of trust regarding information on foods and food safety.

Media	No trust	A little trust	Neutral	Some trust	Complete trust
Radio	1	2	3	4	5
Television	1	2	3	4	5
Newspaper	1	2	3	4	5
Magazines	1	2	3	4	5
Internet sources	1	2	3	4	5

Questionnaire 2

About you **ID # _____**

This is the last part of the survey. We would like some background information about you, as it is a critical part of our analysis. This is an anonymous survey and your name is in no way linked to the responses. In addition, all of this information will be treated as confidential. Results of the survey will only be used in aggregate form and only for research purposes.

1. Indicate your gender. Male _____ Female _____
2. What is your age? _____ years
3. How many individuals live in your household, including yourself? If you are a student, do not include your parents or roommates: # _____
4. Of your household, how many are of high school age or younger? # _____
5. Of your household, how many are 65 or older? # _____
6. Were you born in Canada? Yes_____ No_____
7. What is your educational background? (Mark the box next to the highest level of education you have completed.)

   Some High School _____

   High School Diploma _____

   Some College or Technical _____

   Associate's Degree _____

   Bachelor's Degree _____

   Master's Degree _____

   Doctorate _____

   Other _____

8. What is your association with the University of Alberta?

   There is no association _____ Student _____

   Faculty/staff _____ Other_____

9. Please indicate your approximate annual household income before taxes:

   Less than $20,000 _____ $80,000 to $109,999 _____

   $20,000 to $49,999 _____ $110,000 to $150,000 _____

   $50,000 to $79,999 _____ More than $150,000 _____

Appendix B

The PowerPoint Slides

Welcome to an experiment on market decision making

University of Alberta
Department of Resource Economics and Environmental Sociology
Dr. Sven Anders; Dr. Henry An; Qing Chen

1

- Now you may read the consent form in your package.
- If you consent to participate in the experiment, please sign the consent form and hand it back to the interviewer.

2

- It is important that you answer the questions individually so please do not consult with others.

3

Round 1

- Please take choice sheet 1 and walk along all of the product pairs.
- If you have completed the choice sheet please hand it back to the interviewer.
- Next, please take a seat and fill in questionnaire I. Please make sure you finish filling in questionnaire I.
- If you have completed questionnaire I, please hand it back to the interviewer and take a seat.

4

Round 2

- Fresh meat maintains its freshness and flavour longer compared to conventional packaging methods (foam tray packaging).
- Fresh meat maintains its texture and will not dry out because vacuum packaged food does not become dehydrated from contact with cold or dry air, and does not lose moisture.
- Vacuum packaged fresh meat that is high in fat and oils won't become rancid.
- No additional preservatives are necessary in vacuum packaging.
- Vacuum packaged meat is easier to open and eliminates leakage that frequently occurs with conventional fresh meat packaging.
- Vacuum packaging of meat uses less packaging material and therefore reduces waste.
- Vacuum packaged meat is freezer ready and conveniently portioned .

5

Round 2

- Please take choice sheet 2 and walk along all of the product pairs to repeat the same procedure as round 1.
- If you have completed the choice sheet, please hand it back to the interviewer and take a seat.

6

Round 3

- If the meat spoils even faster, the advantages of vacuum packaging no longer exist.
- The cost of vacuum packaged meat may increase because of higher machine and material cost for vacuum packaging.

7

Round 3

- Please take choice sheet 3 and walk along all of the product pairs to repeat the same procedure as round 2.
- If you have completed the choice sheet, please hand it back to the interviewer and take a seat.

8

- Now, please fill in questionnaire II.
- After you finish it, please hand questionnaire II to the interviewer.
- Please go to the cashier and pay for the beef steak.
- In the mean time, please sign the research participant receipt form and hand it to the interviewer.

9

Thank you!

10

Appendix C

Model Results and Relevant Statistical Summary

Table C.1 MNL and ML Model Estimates (sample size = 2673)

Variable	Parameter	Treatment 1		Treatment 2		Treatment 3	
		MNL	ML	MNL	ML	MNL	ML
NC	Mean of Fixed Coefficient	-1.6012***	-2.5861***	-1.5860***	-3.0134***	-1.6214***	-2.7938***
		(0.3692)	(0.7904)	(0.3696)	(1.0756)	(0.3693)	(0.8589)
P	Mean of Fixed Coefficient	-0.1633***	-0.3191**	-0.1654***	-0.3816**	-0.1672***	-0.3477**
		(0.0575)	(0.1241)	(0.0578)	(0.1702)	(0.0575)	(0.1353)
A7	Mean of Normal Coefficient	0.5335*	1.2047**	0.7333**	1.3622*	0.1494	0.5766
		(0.3103)	(0.5773)	(0.3217)	(0.7864)	(0.3185)	(0.6025)
	Standard Deviation of Normal Coefficient	----	0.6238	----	1.4367	----	0.9709
			(0.9430)		(1.0174)		(1.0058)
A28	Mean of Normal Coefficient	-0.3325	-0.7327	0.0925	-0.2954	0.1344	0.0609
		(0.3334)	(0.7183)	(0.3232)	(0.8007)	(0.3157)	(0.6953)
	Standard Deviation of Normal Coefficient	----	1.3402	----	2.2032*	----	2.0039*
			(0.9389)		(1.2447)		(1.1127)
SL3	Mean of Normal Coefficient	0.3485	0.1302	1.0169***	2.5032	0.3942	0.3571
		(0.3631)	(2.2349)	(0.3759)	(1.5717)	(0.3716)	(1.3326)
	Standard Deviation of Normal Coefficient	----	11.0102	----	4.8621*	----	5.9285*
			(9.0407)		(2.7848)		(3.3010)
SL14	Mean of Normal Coefficient	-0.2649	-0.5902	0.0252	-0.4498	-0.6002	-1.4699*
		(0.4052)	(0.6540)	(0.3858)	(0.8731)	(0.3994)	(0.8116)
	Standard Deviation of Normal Coefficient	----	0.4038	----	2.0030*	----	0.5593
			(1.3847)		(1.2031)		(1.1794)
PM	Mean of Normal Coefficient	-0.2693	-0.1268	0.2607	0.4685	1.3158**	3.1258**
		(0.6315)	(1.0047)	(0.6028)	(1.3054)	(0.6100)	(1.4134)
	Standard Deviation of Normal Coefficient	----	1.0526	----	1.4670	----	1.3248
			(0.7764)		(1.3958)		(0.9065)
PM*FTNS	Mean of Fixed Coefficient	-0.0175*	-0.0263	-0.0224**	-0.0501*	-0.0463***	-0.0863***
		(0.0102)	(0.0171)	(0.0096)	(0.0267)	(0.0100)	(0.0278)
PM*Education	Mean of Fixed Coefficient	0.0632	0.1416*	0.2423***	0.5305***	0.0955**	0.2109**
		(0.0435)	(0.0789)	(0.0428)	(0.2037)	(0.0423)	(0.0948)
PM*Age	Mean of Fixed Coefficient	0.0334	0.0188	-0.0166	-0.0298	-0.0216	-0.0219
		(0.0489)	(0.0776)	(0.0467)	(0.1020)	(0.0479)	(0.0862)

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses are standard errors. LLF denotes the Log likelihood value. Variable definitions can be found in table 3.5, p. 39.

Table C.1 Continued

Variable	Parameter	Treatment 1		Treatment 2		Treatment 3	
		MNL	ML	MNL	ML	MNL	ML
PM*Gender	Mean of Fixed Coefficient	0.5575***	1.0287***	0.4169***	1.1232**	0.5267***	1.0434***
		(0.1605)	(0.3406)	(0.1523)	(0.5234)	(0.1549)	(0.3779)
PM*Income	Mean of Fixed Coefficient	0.2388***	0.4335***	0.0904	0.2120	0.1698***	0.2517**
		(0.0585)	(0.1373)	(0.0564)	(0.1465)	(0.0571)	(0.1221)
PM*Child	Mean of Fixed Coefficient	0.2333	0.4683	0.0840	0.2841	0.5074***	0.8977**
		(0.1769)	(0.2983)	(0.1683)	(0.3757)	(0.1717)	(0.3738)
A7*Ageing	Mean of Fixed Coefficient	-0.1368*	-0.3029**	-0.2136**	-0.3773*	-0.0796	-0.2096
		(0.0803)	(0.1448)	(0.0840)	(0.1975)	(0.0825)	(0.1539)
A28*Ageing	Mean of Fixed Coefficient	0.0413	0.1193	-0.0527	-0.0218	-0.0304	-0.0161
		(0.0853)	(0.1684)	(0.0834)	(0.1990)	(0.0812)	(0.1791)
SL3*SL	Mean of Fixed Coefficient	-0.0866	-0.5095	-0.3067***	-1.0255*	-0.1553*	-0.5669
		(0.0831)	(0.6317)	(0.0874)	(0.5685)	(0.0856)	(0.4167)
SL14*SL	Mean of Fixed Coefficient	0.0710	0.1309	0.0065	0.0732	0.1501	0.3341*
		(0.0935)	(0.1439)	(0.0890)	(0.1940)	(0.0919)	(0.1765)
PM*Colour	Mean of Fixed Coefficient	-0.1537*	-0.4030**	-0.1210	-0.2467	-0.1732**	-0.4474**
		(0.0895)	(0.1769)	(0.0867)	(0.2018)	(0.0872)	(0.1998)
LLF		-927.5631	-917.9170	-900.4379	-894.6431	-921.7349	-914.4187

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses are standard errors. LLF denotes the Log likelihood value. Variable definitions can be found in table 3.5, p. 39.

Table C.2 MNL and ML Model Estimates (sample size = 2673)

Variable	Parameter	Treatment 1		Treatment 2		Treatment 3	
		MNL	ML	MNL	ML	MNL	ML
NC	Mean of Fixed Coefficient	-1.6226***	-2.6069***	-1.5974***	-2.7627***	-1.6232***	-2.6154***
		(0.3701)	(0.7927)	(0.3695)	(0.9616)	(0.3660)	(0.7305)
P	Mean of Fixed Coefficient	-0.1652***	-0.3179***	-0.1667***	-0.3415**	-0.1670***	-0.3154***
		(0.0576)	(0.1227)	(0.0578)	(0.1514)	(0.0570)	(0.1147)
A7	Mean of Normal Coefficient	0.4866	0.9694*	0.7175**	1.0729*	0.1150	0.1471
		(0.3107)	(0.5565)	(0.3228)	(0.5631)	(0.3179)	(0.6505)
	Standard Deviation of Normal Coefficient	----	0.5535	----	0.2090	----	1.9427
			(1.5306)		(1.6776)		(1.0251)
A28	Mean of Normal Coefficient	-0.3832	-0.8479	0.0609	-0.2317	0.0884	-0.0697
		(0.3331)	(0.6075)	(0.3244)	(0.6593)	(0.3146)	(0.4953)
	Standard Deviation of Normal Coefficient	----	0.6913	----	1.4812	----	0.4531
			(1.0068)		(1.3610)		(1.0095)
SL3	Mean of Normal Coefficient	0.3439	0.3123	1.0169***	1.7851*	0.3309	0.2662
		(0.3624)	(1.2620)	(0.3759)	(1.0165)	(0.3679)	(0.9442)
	Standard Deviation of Normal Coefficient	----	5.7118*	----	2.5655*	----	3.8943
			(2.9738)		(1.5277)		(2.1265)
SL14	Mean of Normal Coefficient	-0.2583	-0.6047	0.0814	-0.3063	-0.3828	-0.9806
		(0.4014)	(0.6629)	(0.3801)	(0.7719)	(0.3885)	(0.6637)
	Standard Deviation of Normal Coefficient	----	1.4384	----	2.0153*	----	1.2243
			(0.8814)		(1.1869)		(1.2137)
PM	Mean of Normal Coefficient	-0.8413	-0.8585	-2.2278	-4.1247**	1.0338	-1.5365
		(0.6777)	(0.9990)	(0.6529)	(1.9051)	(0.6492)	(1.0454)
	Standard Deviation of Normal Coefficient	----	0.3126	----	1.4932	----	0.3812
			(0.7768)		(1.4074)		(0.9839)
PM* Innovation	Mean of Fixed Coefficient	0.0347	0.0283	0.1440***	0.2626*	0.0530	0.0904
		(0.0561)	(0.0831)	(0.0537)	(0.1362)	(0.0538)	(0.0834)
PM*FS	Mean of Fixed Coefficient	-0.0293***	-0.0566***	-0.0001	-0.0053	-0.0182**	-0.0363**
		(0.0093)	(0.0202)	(0.0089)	(0.0175)	(0.0090)	(0.0156)

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses are standard errors. LLF denotes the Log likelihood value. Variable definitions can be found in table 3.5, p. 39.

Table C.2 Continued

Variable	Parameter	Treatment 1		Treatment 2		Treatment 3	
		MNL	ML	MNL	ML	MNL	ML
PM*Education	Mean of Fixed Coefficient	0.0456	0.1045	0.2297***	0.4315**	0.0795*	0.1427*
		(0.0442)	(0.0742)	(0.0429)	(0.1708)	(0.0424)	(0.0733)
PM*Age	Mean of Fixed Coefficient	0.0836	0.1159	0.0410	0.0837	0.0320	0.0890
		(0.0508)	(0.0811)	(0.0484)	(0.0972)	(0.0489)	(0.0775)
PM*Gender	Mean of Fixed Coefficient	0.5716***	1.0113***	0.4124***	0.8771**	0.5684***	1.0424***
		(0.1618)	(0.3255)	(0.1524)	(0.4312)	(0.1540)	(0.3270)
PM*Income	Mean of Fixed Coefficient	0.2170***	0.3863***	0.0856	0.1794	0.1688***	0.2380**
		(0.0595)	(0.1194)	(0.0571)	(0.1261)	(0.0574)	(0.1085)
PM*Child	Mean of Fixed Coefficient	0.2724	0.5499*	0.1370	0.3385	0.4715***	0.7433**
		(0.1798)	(0.2937)	(0.1698)	(0.3424)	(0.1708)	(0.3005)
A7*Ageing	Mean of Fixed Coefficient	-0.1236	-0.2449*	-0.2088**	-0.2993**	-0.0686	-0.1282
		(0.0807)	(0.1421)	(0.0843)	(0.1429)	(0.0826)	(0.1627)
A28*Ageing	Mean of Fixed Coefficient	0.0546	0.1706	-0.0444	-0.0144	-0.0186	0.0449
		(0.0856)	(0.1498)	(0.0839)	(0.1615)	(0.0811)	(0.1266)
SL3*SL	Mean of Fixed Coefficient	-0.0889	-0.2897	-0.3079***	-0.6326**	-0.1415*	-0.3799
		(0.0830)	(0.3195)	(0.0875)	(0.3118)	(0.0848)	(0.2765)
SL14*SL	Mean of Fixed Coefficient	0.0696	0.1181	-0.0068	0.0567	0.0982	0.2262
		(0.0925)	(0.1432)	(0.0876)	(0.1743)	(0.0893)	(0.1449)
LLF		-924.5972	-916.3353	-900.7865	-896.9958	-933.0616	-927.0342

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses are standard errors. LLF denotes the Log likelihood value. Variable definitions can be found in table 3.5, p. 39.

Table C.3 MNL and ML Model Estimates (sample size = 2673)

Variable	Parameter	Treatment 1		Treatment 2		Treatment 3	
		MNL	ML	MNL	ML	MNL	ML
NC	Mean of Fixed Coefficient	-1.6207***	-2.6044***	-1.5957***	-2.8849***	-1.6219***	-2.3950***
		(0.3703)	(0.8001)	(0.3698)	(0.9793)	(0.3667)	(0.6689)
P	Mean of Fixed Coefficient	-0.1652***	-0.3175**	-0.1668***	-0.3594**	-0.1674***	-0.2848***
		(0.0576)	(0.1243)	(0.0578)	(0.1548)	(0.0571)	(0.1031)
A7	Mean of Normal Coefficient	0.4907	1.0024*	0.7219**	1.1808*	0.0376	0.1798
		(0.3107)	(0.5763)	(0.3223)	(0.6168)	(0.0544)	(0.5878)
	Standard Deviation of Normal Coefficient	----	0.7532	----	0.6160	----	1.7112
			(1.1306)		(1.1072)		(1.1897)
A28	Mean of Normal Coefficient	-0.3794	-1.0539	0.0673	-0.2715	0.0998	-0.0330
		(0.3334)	(0.7538)	(0.3242)	(0.7334)	(0.3148)	(0.4839)
	Standard Deviation of Normal Coefficient	----	1.5138	----	1.9636	----	0.9281
			(0.9715)		(1.2754)		(0.8624)
SL3	Mean of Normal Coefficient	0.3667	0.1178	1.0462***	1.9454*	0.3752	0.3504
		(0.3635)	(1.6640)	(0.3767)	(0.9999)	(0.3694)	(0.9038)
	Standard Deviation of Normal Coefficient	----	7.3343	----	2.6484	----	3.5308
			(4.7732)		(1.8617)		(3.1897)
SL14	Mean of Normal Coefficient	-0.3338	-0.7293	0.0002	-0.4958	-0.5228	-1.0165*
		(0.4085)	(0.6809)	(0.3856)	(0.8606)	(0.3961)	(0.5905)
	Standard Deviation of Normal Coefficient	----	1.0364	----	1.6636	----	0.3765
			(0.9619)		(1.4222)		(2.3796)
PM	Mean of Normal Coefficient	-0.4024	-0.4205	-1.6938**	-3.5829*	-0.1704	-0.0080
		(0.7981)	(1.2903)	(0.7737)	(2.0757)	(0.7735)	(1.1771)
	Standard Deviation of Normal Coefficient	----	0.4377	----	2.0485	----	0.0257
			(0.7643)		(1.4458)		(1.2825)
PM* Innovation	Mean of Fixed Coefficient	0.0276	0.0023	0.1349**	0.2716*	0.0376	0.0629
		(0.0565)	(0.0875)	(0.0541)	(0.1453)	(0.0544)	(0.0763)
PM*FS	Mean of Fixed Coefficient	-0.0271***	-0.0518***	0.0023	0.0013	-0.0141	-0.0265*
		(0.0095)	(0.0196)	(0.0091)	(0.0199)	(0.0092)	(0.0139)

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses are standard errors. LLF denotes the Log likelihood value. Variable definitions can be found in table 3.5, p. 39.

Table C.3 Continued

Variable	Parameter	Treatment 1		Treatment 2		Treatment 3	
		MNL	ML	MNL	ML	MNL	ML
PM*Education	Mean of Fixed Coefficient	0.0456	0.1062	0.2292***	0.4797***	0.0790*	0.1319**
		(0.0442)	(0.0752)	(0.0428)	(0.1742)	(0.0424)	(0.0664)
PM*Age	Mean of Fixed Coefficient	0.0722	0.0783	0.0273	0.0635	0.0093	0.0497
		(0.0520)	(0.0842)	(0.0495)	(0.1068)	(0.0501)	(0.0719)
PM*Gender	Mean of Fixed Coefficient	0.5594***	1.0204***	0.3954***	0.9069**	0.5439***	0.8926***
		(0.1623)	(0.3267)	(0.1532)	(0.4265)	(0.1549)	(0.2873)
PM*Income	Mean of Fixed Coefficient	0.2147***	0.4069***	0.0826	0.1974	0.1647***	0.1982**
		(0.0596)	(0.1278)	(0.0573)	(0.1392)	(0.0576)	(0.0996)
PM*Child	Mean of Fixed Coefficient	0.2572	0.5438*	0.1161	0.2804	0.4381**	0.6414**
		(0.1801)	(0.3005)	(0.1709)	(0.3693)	(0.1716)	(0.2746)
A7*Ageing	Mean of Fixed Coefficient	-0.1248	-0.2514*	-0.2103**	-0.3252**	-0.0717	-0.1277
		(0.0807)	(0.1463)	(0.0842)	(0.1581)	(0.0825)	(0.1450)
A28*Ageing	Mean of Fixed Coefficient	0.0536	0.1936	-0.0461	-0.0221	-0.0216	0.0232
		(0.0857)	(0.1759)	(0.0838)	(0.1816)	(0.0812)	(0.1237)
SL3*SL	Mean of Fixed Coefficient	-0.0935	-0.3219	-0.3139***	-0.6696**	-0.1506*	-0.3690
		(0.0833)	(0.4075)	(0.0877)	(0.3169)	(0.0851)	(0.3061)
SL14*SL	Mean of Fixed Coefficient	0.0884	0.1644	0.0135	0.1043	0.1331	0.2466*
		(0.0943)	(0.1483)	(0.0891)	(0.1918)	(0.0912)	(0.1302)
PM*Colour	Mean of Fixed Coefficient	-0.0972	-0.2829*	-0.1145	-0.2273	-0.1866**	-0.3027**
		(0.0927)	(0.1683)	(0.0894)	(0.2015)	(0.0900)	(0.1472)
LLF		-924.0498	-915.1933	-899.9665	-897.0648	-930.9101	-926.5245

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses are standard errors. LLF denotes the Log likelihood value. Variable definitions can be found in table 3.5, p. 39.