The Political Economy of Animal Testing and Traceability in Response to Transmissible Spongiform Encephalopathies (TSEs)

by

Aye Chan Myae

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Abstract

Transmissible Spongifrom Encephalopathies (TSEs), which include bovine spongiform encephalopathy (BSE) in cattle and chronic wasting disease (CWD) in cervids, are associated with three possible risks. The risks of food safety outbreaks, the risks to economic benefits, and the risks to society's perceptions, attitudes and behaviour have been identified. In situations in which there appear to be no possible satisfactory market adjustments through individual choices and market chain interactions, governments mitigate risk by imposing appropriate regulations, particular standards, trade barriers or other risk management strategies. In this thesis, the impacts of CWD on consumer behaviour, the rationale for government decisions about the appropriate level of animal testing for CWD and the public interest in animal testing and traceability for cervid meats are considered, representing part but not all of the government regulatory responses to the existence of CWD.

In the first paper of this dissertation, the underlying factors determining CWD-testing requirements in wild and farmed cervids (compared to BSE-testing regulations in cattle) in the context of economics, politics and society are determined across regions in Canada and the US. Political economy models for the level of animal testing are specified and estimated using time series data from 1991 to 2012. The results provided broaden stakeholders' and consumers'/ society's knowledge about the important factors considered in TSE-management policy, and how these differ by region. In the second paper, society's preferences for CWD-testing and traceability systems in venison consumption are determined. The analysis is conducted with surveys of Canadian and US household shoppers of whom at least 50% having eaten venison in their life. The results of the mixed logit models on the stated choice data sets across respondent segments with different risk perceptions and risk attitudes towards venison provide the link between society's perceived risks about CWD and preferences for these food-safety attributes. In the third paper, Canadian household's meat consumption behaviour is determined using Homescan™ panel data from 2003 to 2009 and survey data in 2011 from the Nielsen Company. The comparisons of results from

two-stage demand models across consumer segments with different preferences for obtaining venison provide some indications of the variations in public responses to TSEs risks in daily purchasing.

In summary, this dissertation conducts a comprehensive analysis, from both a policy maker's perspective and a consumer's perspective, across sectors (cattle, farmed cervids and wild cervids) and across countries, Canada and the US. Using two regulatory policies – animal-testing and traceability – two important questions related to TSEs risks are investigated empirically: Why do governments undertake specific regulatory policies? and How does society perceive the regulatory policies and risks in their lives? The results provided background rich in enhancing risk management and trade development strategies in the face of animal disease induced food safety issues in the future.

Preface

This dissertation is an original work by Aye Chan Myae under the supervision of Dr. Ellen Goddard. No part of this dissertation has been previously published.

Dedication

This dissertation is dedicated to my parents, brother, sister and my family. This endeavor would not have been possible without unconditional love, endless support and wise guidance throughout my life from my late dad, Than Win, my mom, Htwe Kyi, my brother and my late sister. I do not get to this point in my life without my husband, Aung Kyaw Moe. Aung is a source of great inspiration for me. His love, support, strength and confidence catalyze me in my way to get a good shape of spiritual, mental and physical well-being. Our daughter Cherry Moe blessed me, a stressful grad student, with her lovely hugs, cheerful kisses and joyful plays. This dissertation is dedicated to them.

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1. INTRODUCTION

1.1. MOTIVATION AND STUDY OBJECTIVES

In general, risk is related to "personal circumstances such as health, pensions, insurance, and investments; societal issues such as terrorism, economic performance, and food safety; and business structures such as corporate governance, strategy, and business continuity" (Hillson and Murray-Webster, 1955, p.4). From a political perspective, risks can be thought of as possible losses and other adverse consequences causing hazards affecting people, animal life or the environment (Government Accounting Section, Department of Finance, 2004; House of Lords, 2006). In situations in which there appears to be no possible satisfactory adjustment through individual choices and market interactions, governments mitigate risks by imposing appropriate regulations – for example, by enforcing laws like the "Safe Food for Canadians Act" or a particular standard. Governments may also impose interventions such as taxes, supports, and subsidies (House of Lords, 2006). In any kind of risk management situation, there is a challenge due to the human behaviour, which means possible differences between public attitudes and societal reactions to risks, and between actual government intervention in risk management and society's expectations (Hillson and Murray-Webster, 1955). Therefore, in a risk management situation, there are at least two important questions: (1) why do governments undertake specific risk management policies?; and (2) how does society perceive the regulatory policies and risks in their lives?

These two questions highlight how three agents – government, industry, and consumers – likely have different objectives and selection of responses to risks within countries. Since, in general, the objective of government (public policy) is to maximize social welfare across society, how governments undertake specific risk management policies subject to maximize social welfare, can be a great interest for societies. How society perceives the regulatory policies and risks in their lives can be essential in making informed decisions by regulatory agencies. Knowledge of what policies are implemented by particular countries, why those policies are different, and how the public views different potential interventions across countries can facilitate decision making in the future. In this study, the emphasis is on Transmissible Spongifrom Encephalopathies (TSEs), which include bovine spongiform encephalopathy (BSE) in cattle, chronic wasting disease (CWD) in cervids – mule deer, white-tailed deer, and elk – and scrapie in sheep. The risks associated with TSEs include risks to economic livelihoods, trade barriers or markets, food safety, public health or tourism/ wilderness enjoyment.

Considering the risks of CWD, from an economic point of view, the impacts include: i) costs to governments for research and disease related-risk management; ii) a decline in economic activities due to trade restrictions, limits imposed on animal movement, depopulation of farmed herds, and herd reduction programs in wild cervids; iii) a reduction in consumer demand in terms of hunting participation or meat consumption; and iv) loss of earnings from wildlife-related recreational activities (Seidl and Koontz, 2004). CWD, which is spreading in Canadian and American wild animals, who do not recognize borders, differences in policies, in public attitudes towards appropriate interventions and in behavioural responses, can make risk management more difficult. For example if people who eat venison from hunted animals prefer to have all animals tested for CWD they may change hunting locations (stop travelling to one country or the other) if testing is available in only one of the two countries. Venison in this study refers solely to deer and elk in both farms and wildlife. Therefore, as an animal disease outbreak (TSEs in this case) occurs, consumers, government, and industry – producers, processors and retailers – are all affected in different ways.

Given a potential negative link between animal health risks and human health implications – for example, the link between BSE and variant Creutzfeldt-Jakob disease (vCJD) – and given that markets alone have limitations in resolving risks, governments have great interest in enacting public policies related to TSEs risk management (Sato, 2010). Risk management has been defined as “the process of weighing policy alternatives in the light of the results of a risk assessment through the process of identification of risk levels and other relevant evaluations” (Cope et al. 2010, p.349). In the case of BSE, the World Organization for Animal

Health (OIE) sets guidelines for BSE surveillance and provides minimum surveillance levels for different risk assessment standards. Based on OIE standards, governments can undertake higher levels of testing should they wish. Due to limited North American geographic distribution, CWD is not among the diseases monitored by the OIE. There are no international standards, guidelines, recommendations or support for CWD control and eradication.

In dealing with both BSE and CWD, two of the possible responses that governments can undertake include adjusting the level of animal disease surveillance programs – such as the level of animal testing and animal identification and/or traceability systems. The main objectives of surveillance programs are to maintain and enhance market access by providing necessary information about the level of animal disease outbreaks in a region and the effectiveness of disease control measures. Animal testing is required, but variable regulation is important in verifying as age, health and clinical signs of the disease. And so questions remain open as to how governments make the decision of the appropriate level of testing to mandate – even across species facing similar diseases in the same country.

Voluntary or mandatory traceability systems, which may extend from farm to slaughter, slaughter to retail or farm to fork, have also been commonly used in other countries post BSE. The main objective of traceability programs is to track a product batch and its history through the whole or part of a production chain – for example, from harvest through transport, storage, processing, distribution and sales – (Moe, 1998). Given that traceability systems could help to minimize the potential of unsafe product production/distribution, bad publicity, liability and recalls (Golan et al., 2004), governments and industries have a great interest in it. Governments could choose traceability systems from farm to slaughter versus farm to folk, within adjustable cost structures.

For economists, there are important factors to be considered in the face of TSEs outbreaks. The factors include:

(i) How a particular regulatory policy or a risk management strategy affects market behaviour;

(ii) Whose economic welfare, concerns and what kind of economic factors are considered in regulatory policies;

(iii) What society's perceptions are towards regulatory policies and their safety; and

(iv) How society's behaviour with respect to meat consumption has been changed in the presence of TSEs concerns.

Animal diseases influence a number of critical elements of society – many of which have public good aspects – such as food safety and the health of wild animals. Governments face international constraints on behaviour associated with major animal diseases, but have more flexibility with localised diseases such as CWD. Risk management for animal diseases, particularly in the context of disease in wild animals, must be done in the context of multiple countries, often multiple agencies within government due to imperfect knowledge of public risk perception, preferences for different polices and industry interests in maintaining and expanding markets domestically and internationally. Analysis of the influences on policy decisions which have been made (and differ across country borders) and of public preferences for policies which could be made (such as different levels of animal testing and/or traceability from farm to final consumer as opposed to point of slaughter) can inform future policy making. In addition private decision making – industry, trade association, for example – might also be improved if there is a better understanding of why historical policy decisions have been made, what preferences are for potential decisions in the future, and public behavioural responses. In this dissertation the two questions of why governments make specific policy decisions and how society responds will be dealt with empirically in the context of CWD. Specifically, the questions addressed are: ***(1)*** why do governments undertake a specific level of animal testing for CWD (given the options available); and ***(2)*** how does society perceives CWD risks in their lives influencing their meat consumption behaviour and/or preferences for the implementation of animal testing and traceability systems for venison.

Results from the thesis will inform future decisions about maintaining and/or changing the level of animal testing in deer and elk from both a political economy and a public preference perspective. Given differences in actions taken in Canada and the US, are these justified by different political pressures and or public preferences? The focus is also on risk perceptions about CWD from a human health perspective and how that influences preferences for animal testing and traceability systems in Canada and the US and specifically for Canada how venison consumption patterns have been affected. These specific research areas have been understudied.

1.2. Structure of Dissertation

The structures of the three papers are as follows and are conducted across countries (Canada, the US).

1st Paper: The political economy of CWD-testing in farmed and wild cervids in Canada and the US (briefly compared to BSE-testing in Cattle in Canada, the US and Japan) – this addresses the issue of the determinants of the current level of animal testing for this disease selected in each country.

2nd Paper: Public preferences for traceability and animal testing in response to TSE outbreaks in Canada and the US – in the context of risk perceptions about CWD, does the public prefer to see CWD animal testing (for all meat) and traceability to final consumer in projected purchases.

3rd Paper: Household behavior with respect to meat consumption in the presence of CWD (and BSE) concerns in Canada – do Canadians' risk perceptions about CWD influence their behaviour in terms of meat consumption.

In the first paper, an emphasis is placed on CWD-testing in the farmed and wild populations, using political economy models. Alesina (2007) highlighted that the term political economy was developed by economists, when the influence of political forces on public policy formation became obvious, and it was increasingly difficult to explain through traditional economic models. The term political economy is a complex term, which has been defined in different ways, and has been used in different areas of study. One definition, which is most relevant to this study, is "the social science that deals with political science and economics as a unified subject" (American Heritage Dictionary, accessed January 2011). In other words, it could be defined as the determination of underlying factors in how a public policy was created and implemented in the context of economics, politics and society. The political economy for this particular study means the determination of underlying factors in animal-testing regulations for TSEs. Given significant differences (see Section 1.3) between wild and farmed cervids – such as different environments and different impacts, different regulatory authorities (management of wild animals differs from management of domesticated animals) who have been taking responsibilities for CWD surveillance in the farmed and wild cervid sectors separately – and given the lack of knowledge about the exact path of disease spread between farmed and wild populations, the analysis of *CWD-testing* levels are conducted separately for wild and farmed cervids.

Time series data was used in the analysis. The level of *CWD-testing* was used as a policy outcome which is created and implemented by multiple government agencies. It has been chosen as a dependent policy variable as a proxy for government regulation, related to CWD disease spread in the farmed and wild cervid sectors. It has been chosen as a measurable policy based on the actual number of animals tested for CWD in farmed and wild population, over a certain period of time, and across provinces/states in Canada and the US. The level of *CWD-testing* was derived as the number of CWD-tested animals in the farmed and wild sector. Four types of explanatory variables such as variables that reflect political market effects, variables that reflect economic factors, variables that reflect society's concerns about food safety and variables that reflect CWD prevalence have been defined for farmed cervid models. Since the farmed cervid industry (currently largely in Alberta, Manitoba and Saskatchewan in Canada) could have effects on consumers nationally, national level data is used in the farmed cervid models. Similar strategy is used in the US. The results are examined in comparison to previous studies of *BSE-testing* in cattle, in which same models are used as in the farmed cervid models.

In the wild cervid sector, CWD management strategies have been implemented in different ways in different provinces/states, and CWD incidents in one province/state can affect domesticated and wild animals in other provinces/states economically. Therefore, provincial level data is used in the wild cervid models in Alberta and Saskatchewan (where positive CWD cases had been found) in Canada and in Colorado and Wyoming (where CWD had started) in the US. Three types of explanatory variables such as variables that reflect economic factors, variables that reflect interest groups' responses or society's concerns about health risk to human and wild animals, and CWD prevalence and updated management strategies have been defined for the wild cervid sector. In traditional commodity modelling, political market effects are often calculated as the wedges between prices at different market levels (Sarker et al. 1993) – in the case of wild animals those market effects are much more diffuse and represent demands for tourism activities, for hunting licenses rather than for a specific meat. These variables are included directly in the model rather than using the political preference function approach, which is more common to conventional political economy models in agriculture policy.

In the second paper, society's preferences for traceability and CWD-testing in venison consumption are examined. The data from stated preference surveys conducted in Canada (n = 1464) in 2009 by Leger Marketing and the US (n = 999) in 2010 by TNS Global is used. Survey respondents were regular household food shoppers, with the requirement that at least 50% of the respondents in each country had eaten venison at least once in their life. Survey questions include individual demographic characteristics, risk perceptions and attitudes towards venison, frequency of venison consumption from different sources such as hunted meat and in a restaurant, regular place of venison purchases, their knowledge about CWD and traceability, and various psychological constructs. A choice experiment with 15 choice sets is included in the final part of the survey giving three options to respondents to choose between two venison steaks with different prices (ranging from CN$ 5.50/500gms to CN$ 16.00/500gms) with different food safety attributes (CWD-tested, traceable, CWD tested and traceable or none), and not choosing either option in their retail purchase decisions. A mixed logit model is applied, incorporating heterogeneity in consumers' preferences for traceability and animal testing for CWD. Willingness to pay (WTP) values, as a proxy for society's perceptions about CWD-management strategies, are calculated and determined in comparison across consumer segments with different risk perceptions/attitudes towards venison. Risk perceptions and risk attitudes are two important distinct dimensions and represent "a person's view about riskiness of a particular situation", and "a person's overriding tendency towards risk in a consistent way across different risky situations" respectively (Schroeder et al. 2006, p.26). The results are compared across consumer segments in Canada and the US. Understanding the link between risk perceptions and preferences for interventions can assist both industry and policy makers in decisions about future innovations for these two interventions.

In the third paper, Canadian household meat consumption behaviour including exotic meats (venison – deer and elk meat) and traditional meats (beef, pork, chicken, turkey, bison and seafood) is examined. A total of 2393 households from the Homescan™ panel data (July 2003 – June 2009, n=9300 each year, Nielsen Company), and who also responded to a 2011 survey – in which venison risk perceptions and attitudes are identified (n=7000, Nielsen Company) is used. In Canada, only 0.7 % of the households in the Homescan™ panel data (July 2002- June 2009) and 1.3% of the households in the sample for this study purchased venison from commercial outlets. Although there have not been frequent venison purchases from stores in Canada, many more households (about 35.9% in this sample) consumed venison from their own or someone else's hunting activities. There are three reasons to study consumers' consumption behaviour about venison:

- There is still some uncertainty about whether there will ever be a link between human health and eating CWD infected deer/elk meats, and the real possibility that consumers are concerned about animal diseases without knowing whether or not there is a link to human health;

- Raising exotic meat species – such as deer, elk, bison, and wild boar – has been encouraged as a method of diversification of livestock enterprises, and as a way of conserving specialized animals (Hobbs and Kerr, 2000; Hobbs et al., 2006; and Statistics Canada, 2008); and
- Demand for venison has been increasing due to better health benefits and different qualities of venison, as compared to other meats (Statistics Canada, 2008).

In this paper, it is assumed that understanding differences among consumers, in terms of their behaviour with respect to venison, could be useful in developing efficient communication with the public, if there ever are food-safety issues, associated with CWD. Given that, the analysis is conducted for four consumer segments (Table 5.1) – those that purchase traditional meats but do not eat venison, those that purchase traditional meats and venison from stores, those that purchase traditional meats from stores and obtain venison from hunting, and those that purchase traditional meats from stores and venison from other outlets. Due to zero expenditure problems in the sample data, especially for venison purchases, a two-step estimation procedure with a probit model in the first step and Doublelog-Translog two stage demand system in the second step is used. Demand shifters such as prices, households' socio-demographics, consumers' risk perceptions/attitudes and media coverage, particularly of CWD and BSE are incorporated into the model. The results are compared across consumer segments.

Ultimately, the information from all the three studies could reveal why the governments used a particular regulatory policy, and how societies react to risks and regulatory policies in the face of TSEs. Policy implications could be useful for governments in developing risk management strategies for similar disease outbreaks in the future, and for industries in their market development. A summary, conclusions, policy implications and suggestions for future research are discussed in the last Chapter of the thesis.

1.3. THE CONTRIBUTION OF THE DISSERTATION

A comprehensive analysis about the level of animal-testing and traceability in response to TSEs from both a policy maker's perspective and a consumer's perspective is conducted across sectors (farmed/wild cervid sector with some comparisons to BSE in the cattle sector) and across countries (Canada and the US) in this dissertation. There are no other studies, which emphasized the determination of specific regulatory policies – animal-testing and traceability – using actual data and empirical estimations. Moreover, contributions from this study to the literature include a new theoretical formula measuring political weights governments focus on producers' welfare relative to consumers' welfare in determining the level of TSE-testing in the cattle and farmed-cervid sectors, comparisons of public preferences for food-safety attributes across segments with different risk perceptions/attitudes, and consumers' behaviour in response to food safety risks among consumer segments with different use of venison supplies. Ultimately, the main purpose of the dissertation is to broaden knowledge about the development of regulatory policies and societal perceptions of risks in the face of TSEs.

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2. BACKGROUND ON TSES, RESPONSES AND IMPACTS

The aim of this chapter is to provide background information on TSEs, responses by governments – particularly about disease surveillance programs – animal identification and traceability systems, impacts on the industry, and impacts on and responses by consumers/society.

2.1. TSEs (BSE, CWD)

During the last forty years, various TSEs have grown in significance. Prion diseases may have raised concerns in consumers' minds about food safety associated with meat, world-wide. BSE and CWD both exist in Canada and the US, and markets for beef, bison, elk and deer have been affected by the diseases, partially through trade bans in export markets. In 1993, the first Canadian BSE case was diagnosed in an imported cow in Canada. Since 2003, there have been 19 indigenous BSE cases confirmed in Canada. CWD was first recognized in wild mule deer in Northern Colorado in 1967 and was identified as a TSE in 1978. The spread of CWD in Canadian cervids is believed to have begun with the importation of farmed cervids from a South Dakota farm in 1989 (Office of the Auditor General of Canada, 2003). In 1996, CWD was discovered on a Canadian elk farm (CFIA, 2012), and it since has been found on deer and elk farms and in the wild in Saskatchewan and Alberta. There have been 777 CWD cases (Alberta: 4 farmed cervids and 220 wild cervids; Saskatchewan: 142 farmed cervids and 411 wild cervids) confirmed in Canada as of the end of 2014.

2.2. Government and Public Policy Response to TSE Outbreaks

The first step that a government takes in the management of a (health) risk is protecting against potential hazards in a variety of ways, including "protection against severe risks by preventing problems from occurring or limiting the damage", "erring on the side of caution by protecting against potential catastrophe", and "advance testing, priority setting, and learning from error" for reducing uncertainty by testing whenever possible (Sato, 2010, p.22). Governments may use different strategies at different times based on a particular country's risk situation and its society's demands. In the case of TSE outbreaks, governments undertake action plans (in order to work towards better control and to generate more effective policies) partially based on recommendations of multinational organizations (for example, OIE), professional experts, and the industry (CFIA, 2010). Governments in different countries have tried to intervene in many ways to help cattle, elk and deer farmers, to protect the health of wild animals and humans, and to regain public confidence in their food consumption.

Given the lack of information and research evidence about the causes of TSE diseases, and given the lack of precise methods on how to prevent associated risks, various regulations and risk management strategies have been adopted by government (Coulthart and Cashman, 2001; Will, 1999; and Sato, 2010). However, as discussed in Section 1.1, animal testing and traceability among other TSE management strategies are popular. In terms of animal testing regulations, only the minimum level of testing requirements is determined by the OIE based on a countries' risk status (for example, the OIE sets guidelines for BSE surveillance), and countries can choose higher testing levels as appropriate. The OIE provides a risk-assessment standard to determine the BSE risk status of the cattle population of a country, zone or compartment. Risk assessment here means the process of identification of risk level associated with BSE.

In article 11.6.22 of the OIE-Terrestrial Animal Health Code 2009, the OIE defined the criteria in terms of the number of cattle to be tested for BSE. The two criterions – Type A and Type B – has been identified for testing adult cattle at age two to younger than nine years. ***Type A surveillance*** is defined that the sample must represent 20 to 27 percent of adult cattle population**,** which allows the detection of BSE at a design prevalence of at least one case per 100,000 in the adult cattle population. ***Type B surveillance*** is defined that the sample must represent 10 to 14 percent of adult cattle population for**,** which allow the detection of BSE around a design prevalence of at least one case per 50,000 in the adult cattle population. ***Type B surveillance*** is carried out by countries which face negligible BSE-risk-status or controlled BSE risk status. There is no surveillance point value for clinical signs of cattle younger than two years of age (OIE 2009). The OIE has established BSE-related official recognition about the sanitary status of countries and zones, science-based standards, guidelines, and recommendations as per the international standards. It provides political advice, strategic design and technical assistance for the control and eradication of BSE (OIE, 2010). CWD is not in the OIE-listed diseases and there is no support for CWD control. However, experiences in strategic BSE-management under OIE guidance would be to CWD-affected countries advantage (Canada and the US). There are no international standards, guidelines, recommendations or support for CWD control, surveillance and eradication.

Whatever strategies a government pursues in managing animal-disease-induced risks, significant costs can be generated, especially in countries which have large livestock sectors (Rich and Winter-Nelson, 2007). These costs arise from mandatory/voluntary surveillance programs imposed by governments, or the need for special protection to agricultural related industries for food security (for example, in industrialized countries). Bearing different levels of costs at different times, governments undertake specific risk management strategies within the allowed category for their risk status. Understanding factors which determine the level of government regulations (for example, animal testing levels) can increase public understanding of how seriously governments take social welfare into consideration.

2.3. GOVERNMENTS' BSE AND CWD SURVEILLANCE PROGRAMS

As a shared responsibility among producers, industry, veterinarians and provincial governments, the Canadian government has developed a BSE-surveillance strategy to achieve two types of benefits: i) to maintain consumers' confidence; and ii) to secure access to international markets (CFIA, 2010). Canada sets the surveillance level in accordance with the OIE guidelines (Type A surveillance) to maintain its status as a "controlled BSE risk" country. The Canadian BSE-surveillance program targets animals at high risk of developing BSE disease – such as cattle over 30 months old which are dead, down, dying or diseased and cattle exhibiting strong clinical signs (nervous or aggressive behaviour, abnormal posture, lack of co-ordination, difficulty rising from a lying position, etc.) – (CFIA, 2010). In order to maintain a BSE-free status in national herd, a ban on the use of SRMs in all animal feed has been brought into effect since 1997. The feed ban was enhanced in July 12, 2007 by prohibiting the use of SRMs in all animal feeds, pet foods and fertilizers (CFIA, 2010). In order to control BSE-related food-safety problems, the removal of specified risk materials (SRMs) – including skull, brain, trigeminal ganglia, eyes, tonsils, vertebral column, spinal cord, and dorsal root ganglia – from cattle older than 30 months of age and the removal of the small intestine from cattle of all ages has been mandated for human consumption since July 2003 (CFIA, 2010).

Although CWD was first found in Canada in 1989 in an imported farmed cervid, the provincial governments of Canada enhanced their CWD surveillance testing from 2000 onward as a result of subsequent cases of domestic CWD. Since CWD infection occurs in both wild and farmed animals, control-strategies for CWD seem to be more complicated than that for BSE. Surveillance of CWD in wild cervids is conducted by different regulatory authorities such as natural resource management agencies, environment ministries, and Parks Canada. Surveillance in farmed cervids is conducted by agriculture and rural development departments (for example, Manitoba Agriculture, Food and Rural Initiatives, Alberta Agriculture and Rural Development, and Saskatchewan's Ministry of Agriculture). However, CWD is a reportable disease in Canada under the federal Health of Animal Act, such that all suspect cases must be reported to the Canadian Food Inspection Agency (Wright and Tapscott, 2007).

In terms of CWD surveillance programs for captive (farmed) cervids, Alberta (August, 2002), Saskatchewan (December, 2002), Yukon (November, 2002) and Manitoba (2002) currently have mandatory surveillance programs – testing all deaths, slaughter of animals greater than 12 months of age. Quebec, British Columbia, Ontario and North-west Territories have voluntary surveillance programs (CWD Alliance website: Regulations). Quebec has more recently moved to a mandatory traceability system of all farmed cervids as the first phase of a mandatory farmed surveillance strategy. The level of CWD-testing in the cervid industry is dramatically higher than the level of BSE-testing in the beef industry, although only 7 farmed cervids – in Alberta (2 in 2002, 1 in 2003) and in Saskatchewan (1 in 1996, 3 in 2008) – have been found to have the disease. Being found with CWD positive cases, 66 farms in Canada have been depopulated (CFIA, 2012). The main difference may lie in the fact that the disease may spread throughout the wild cervid population and may be transmitted to farmed cervids. Although CFIA sets policy, it does not mandate particular level of testing regulations and leaves to provincial concern. Testing nears but does not quite approach 100% across the country as a whole for farmed cervids that are slaughtered. In provinces with mandatory surveillance programs, all animals that die or are slaughtered after they are 12 months of age are tested for CWD.

Provincial CWD surveillance programs of wild cervids are more diversified than those of farmed cervids due to the complexity of organizations involved in disease-management programs. Since different surveillance programs are practiced in different provinces, the following CWD-management strategies, which are adopted from the CWD Alliance website across provinces, are discussed in Canada.

Alberta: Since fall 1996, there has been ongoing surveillance – primarily hunter-kills plus clinical cases and road kills – of wild-cervids. The first positive wild deer was found in September 2005, and the first positive hunter-kill was found in December 2005. Therefore, surveillance was intensified as a more active program from 2005 to 2008. During this period, the Fish and Wildlife Division used increased fall hunting opportunities in designated CWD-risk areas to monitor the occurrence and spread of CWD, and called for mandatory submission of deer heads in the designated high risk areas. The surveillance has since been changed to a passive program to collect heads from animals that are killed by hunters voluntarily, killed on roads, and found in clinical cases. Mandatory submission of deer heads is required in designated high risk areas. In 2008, the Fish and Wildlife

Division initiated voluntary carcass handling and transportation guidelines in CWD-risk areas, and for carcasses which might be brought into Alberta from CWD-risk areas outside the province.

Saskatchewan: Saskatchewan operated CWD surveillance program from 1997 - 2013. Since then samples include passive samples collected by conservation officers and collar-marked research animals. To date 48,878 wild cervids have been tested and 327 mule deer, 77 white-tailed deer and 7 elk have been found positive. There are currently 22 wildlife management zones showing occurrence of infection, the latest cases detected along the South Saskatchewan River near Dundurn, along the northern fringe of the Great Sandhills and northeast of North Battleford. Eradication of CWD from wild cervid populations is no longer a realistic option for the province.

Manitoba: By regulation, all elk and deer are harvested in Game Hunting Areas 5, 6, 6A, 11, 12, 13, 13A, 18 and 18B west of PR 366, 118A, 8C and that part of 22 west of Provincial Trunk Highway 83. This area is that part of Manitoba adjacent to west central Saskatchewan where CWD has been spreading eastward in both farmed and wild elk and deer. A scenario-based action plan has been developed in preparation for any discoveries through hunter-supplied sample surveillance. Approximately 300 wildlife samples are tested annually. A ban has been imposed on the importation of hunter harvested cervids from any province, territory or country, if the specified parts – such as head, hide, hooves, mammary glands, entrails, internal organs and spinal column – have not been removed. Antlers and connecting bone plates are allowed, if they are disinfected and free from all other hide and tissue. Capes are allowed, but they must be immediately chemically processed into a tanned product. Possession of any product that contains urine, feces, saliva or scent glands of a cervid is prohibited.

Ontario: CWD surveillance of wild cervids has resulted in the testing of approximately 9,909 white-tailed deer and 63 elk during the period 2002-2013. To date, all samples have been negative for CWD. Ontario has recently moved to testing geographic areas identified as high risk for CWD detection by computer modeling and will test approximately 460 deer per year within that geographic area. In November 2005, Ontario passed a regulation to prohibit possession of high risk parts of deer, elk and other cervids (except moose and caribou), which were harvested in other jurisdictions, in Ontario. New regulations were passed in 2010 to: 1) prohibit the possession and use of natural attractants that contain parts or bodily fluids of a member of the deer family for the purposes of hunting in Ontario (e.g. natural deer urine/by-products); 2) restrict the possession of certain higher risk carcass parts (e.g. brain, spinal column, antlers) of moose and caribou that were killed outside the province (this regulation is in addition to a previously existing regulation for carcasses of all other members of the deer family); and 3) restrict the transport of live white-tailed deer, American elk, moose, and woodland caribou into Ontario, unless accompanied by a provincial permit. This requirement also applies to any hybrids of these species.

Quebec: A total of 388 free ranging white-tailed deer have been opportunistically tested from 2000-2006. All CWD results were negative. In October 2007, the Minister of Natural Resources and Wildlife (MRNF) began a structured surveillance program using road-killed deer sampling in the southern part of the province. From October 2007 to December 2013, the program led to the collection of 4,400 free ranging white-tailed deer. Between 2011 and 2013, 1,400 additional samples were collected on harvested white-tailed deer. To date, all the results were negative. As of January 2012, the possession of full carcasses or any part of the brain, spinal cord, eyes, retropharyngeal lymph nodes, tonsils, testicles or internal organs of cervids (except caribou) killed outside Quebec is prohibited.

British Columbia: Since 1980's, BC prohibited live-cervid imports. Animal-testing for CWD in wild cervids has been initiated in 2001, through voluntary submissions of animals' head by hunter, and road-killed deer and elk in regions closest to the eastern and southern borders. To date, about 2,500 animals have been tested, and all results are negative. Sampling efforts will be continuously focused on high risk areas, particularly along the Alberta and BC border. For hunted-wild/captive cervids in Canada and the US, specific carcass-preparations are recommended prior to bringing meat or animal parts into BC.

Northwest Territories: Currently, there has no specific CWD regulation in place. Sampling for CWD testing is conducted periodically and opportunistically in wild cervids. No CWD positive cases have been found in both farmed and wild cervids.

2.4. National Animal Identification System (NAIS), Agriculture and Food Traceability System, and National CWD Control Strategy

After outbreaks of BSE in the UK and the first BSE case diagnosed in an imported cow in Canada in 1993, the authorities – federal, provincial, territorial and industrial – were prompted to create animal identification programs. As a consequence, the Canadian Cattle Identification Agency (CCIA) was established in 1998. The National Agriculture and Food Traceability System (NAFTS) were initiated in 2006. The target of establishing a mandatory national system (NSFTS) by 2011 was defined in the summer of 2009 (AAFC, 2010a and 2010b). The NAFTS is expected to improve efficient management of food safety outbreaks in emergency, to promote market access and industry competitiveness, and to regain consumers' confidence in their food purchases and safety. Currently Canadian traceability systems, except in Quebec, are established in a channel from birth to slaughter. In Quebec, a beef traceability system from farm to fork is targeted. The first project (December 2010 to October 2011) – extending traceability from the slaughterhouse to the retailer – was carried out successfully. The government and industry are trying to set up a farm to folk traceability system into reality (ATQ, 2012).

A process and governance structure of developing a CWD Control Strategy was proposed by wildlife directors on 21 October 2004 (CCWHC, 2005). "The objective of Canada's National Chronic Wasting Disease Control proposed strategy was to establish a coordinated national policy and a disease response and management framework to minimize the negative impacts of CWD on biodiversity, human and livestock health, the environment and the economy" (CCWHC, 2005, p.1). The six goals of the proposed strategy were outlined in

2005 and was revised and updated in 2011 (Table 2.1) (CCWHC, 2005 and 2011). The six principles of the strategy are collaboration, science based, integration, strategic investment, adaptive management and achievable (CCWHC, 2011, p.5).

Table 2. 1 Six goals of the proposed National CWD control strategy in Canada

Sr.	2005	2011
1.	Prevention of further emergence of CWD in Canada	Prevention of further expansion of CWD to new locations or species and the prevention of emergence of new forms or variants of CWD
2.	Early detection of CWD in cervid populations	Effective surveillance for CWD
3.	Planned responses to CWD	Planned management and response program
4.	Effective management of CWD in cervids through valid scientific approaches	Research in support of CWD management
5.	Education and training required to achieve goals 1 to 4	Education and Training
6.	Communication, both internal and external, to assure coordination, collaboration, integration, and accurate risk communication	Communication and Consultation

Source: Adopted from CCWHC (2005, p.1) and CCWHC (2011, p.4).

In August 2010, The Government of Canada invested over $1 million in the cervid industry to enhance traceability system (AAFC, 2010c). The investment was targeted for the two separate projects: 1) "$673,500 to develop a national traceability system by gathering, storing and analyzing traceability data for farmed cervids, which include deer, elk, caribou, moose and reindeer; and 2) $361,400 to help build a national food safety system, the Hazard Analysis of Critical Control Points-based cervid on-farm food safety system" (AAFC, 2010c, page 1). There are other programs to support traceability in the cervid industry, but the programs are different across provinces. For example, the Alberta government invested nearly $ 1 million in the use of radio-frequency identification tags for sheep, deer, elk and other cervids, as a support for traceability improvement within the province (Mash, 2011).

2.5. THE IMPACT OF TSEs ON THE INDUSTRY

In Canada, the beef/cattle industry felt some impacts of BSE crisis on three major areas such as trade in terms of imports and exports, domestic consumption, and farm income. Total beef exports had increased to 0.6 million tonnes in 2002 and had decreased to about 0.4 million tonnes in 2003 after the first indigenous BSE case in May 2003 (AAFC, 2010d). The US is the largest Canadian beef export market. Although the US represented 75 percent of beef total exports in 2002, it represented only 51 percent in 2004 (AAFC, 2010d). The live cattle exports (feeder cattle exports) were 574,908 head in 2002 (before BSE) and were 123,316 heads in 2003 (after BSE). The cull slaughter exports were 1,024,378 head in 2002 (before BSE) and were 354,044 head in 2003 (after BSE) (AAFC, 2010d).

According to Statistics Canada, there had a significant decrease in farm cash receipts just after the 2003 BSE positive case ($768 million in 2002 to $516 million in 2003). To date, farm cash receipts have yet to return to pre-BSE levels ($616 million in 2010), although there have many confounding factors such as currency appreciation, and country of origin labelling (COOL). After the opening of the US border in September 2003, which is four months after the border closure for boneless beef from cattle under 30 months of age (Yang, 2010), the number of beef cattle and calves slaughtered in federally inspected slaughter facilities (0.32 million heads in 2003 to 0.4 million heads in 2004 and) and total beef and veal production (1.15 million tonnes in 2003 to 1.46 million tonnes in 2004 and) had increased over historically record-levels (the highest was 1.26 million tonnes in 2002) (AAFC, 2010d). However, the number of slaughtered cattle and beef/veal production has gradually returned to pre-BSE levels (0.33 million heads and 1.18 million tonnes respectively in 2011).

The cervid industry felt impacts of CWD occurrence on three major areas such as trade (imports and exports of venison meats, live animals and antler velvet), consumption – meat consumption (possibly) and hunting activities (potentially) – and farm-income and tourism-revenue from wildlife related recreations. There have different impacts due to BSE and CWD occurrences.

Different from BSE, which affects only on the beef/cattle industry, CWD affects not only the farmed deer and elk industry, but also the wild population and wildlife related sports and recreational activities. In addition, CWD impacts on wildlife are different from impacts on farmed animals due to different nature of the wildlife populations. Different assessments and different strategies are necessary for measuring impacts and for developing management strategies in wildlife. Big game animals in the wild sector provide high economic values to those who consider the wild population as an important contributor to environmental sustainability, for those who derive pleasure from hunting or seeing wild cervids, or for those who have concern about the welfare of wild animals (Adamowicz, 1983). The impacts of CWD are potentially large for those people.

After detection of CWD in a farmed elk (May 2002), and two farmed deer (Fall 2002) in Alberta, export numbers of live animals had dropped significantly and slaughter numbers had increased dramatically (Mueller, 2006). Due to a high demand in the past for breeding stock and antler velvet, the elk meat market had not been well developed in North America, and deer meat markets had been highly developed in European countries, Russia and China (Alberta Ranched Elk, 2010), much more than in North America. Elk meat exists as a gourmet meat now in the Canadian market through up-market hotels, restaurants, farm gates and specialty retail outlets (Alberta Ranched Elk, 2010). The dried- and powdered-Antler velvet, which is obtained from deer and elk antlers harvested in the velvet stage, is in great demand in Asia – especially in Korea – for medicinal uses (Burden, 2010). Due to CWD concerns, Korea has prohibited imports of deer, elk and their products from Canada since December 2000 (Trade Barrier Fiche, 2009). After the indigenous BSE case in May 2003 in Canada, the international border closures for all bovine products and live animals (ruminants and ruminant products) has left the Alberta deer/elk industry with no export markets (Mueller, 2006). "Many producers abandoned the industry and a large number of animals were euthanized" (Mueller, 2006, p.6). Both CWD and BSE contributed to a crippling of the deer and elk markets in Alberta (Markusoff, 2003). According to the Census data from the Statistics Canada, the number of deers dropped from 53,285 (809 deer farms) in 2001 to 20,939 (380 deer farms) in Canada; and the number of elks dropped from 74,478 (1,172 elk farms) in 2001 to 31,112 (572 elk farms) in 2011.

The U.S. still bans all elk from a 40-kilometre zone around positive CWD cases (Finlayson, 2010). Specifically, restrictions associated with CWD differ by states and are ranging from additional testing requirements to the banning of all elk and deer imports – for example, 22 states have banned all elk and deer imports, 32 states have banned or restricted the importation of hunter-harvested deer and elk parts, and 28 states have prohibited the importation of elk or deer from any county, region, and state, where CWD has been prevalent (Hansan, 2010). Canadian producers have tried to expand their markets by selling bulls to game hunting farms in the U.S. and Saskatchewan, and by selling velvet and meat as specialty products locally and in Europe (Holubitsky, 2005). After the first detection of CWD in a farmed mule deer in Saskatchewan in 2000, there were significant decreases in deer/elk farm cash receipts (from $20 million in 1999 to $14 million in 2000), the sector's share in the country's GDP (0.002% in 1999 to 0.001% in 2000), and per capita deer/elk meat consumption (from 0.013 kg in 1999 to 0.0008 kg in 2000) in Canada. The detailed discussions on the calculation of above figures and trends are presented in Chapter 3. Although there have other factors, expenditure for pleasure visits (which include activities such as visiting zoos, aquariums or botanical gardens, visiting a theme or amusement park, visiting national or provincial parks, visiting a historic site, hunting, fishing, bird and wildlife viewing and sightseeing) had decreased slightly in Saskatchewan and decreased significantly in Alberta after the first detection of CWD in two wild deer in Saskatchewan in 2002 (Figure 3.6 and Figure 3.18).

2.6. THE IMPACT OF AND RESPONSE TO TSE OUTBREAKS FROM THE PUBLIC'S PERSPECTIVE

Prion diseases may have raised concerns in consumer's minds about food safety associated with meat. In addition, consumer' confidence in the safety of food, and food risk management might be affected and reduced, due to an accumulation of food safety incidents, and increased media attention to food safety issues (de Jonge et al., 2008 and Frewer and Salter, 2002). Consumers have been left with frustration, and distrust, whenever there have perception gaps between authorities, and the public, over risks associated with food (Sato, 2010). In such an environment, the food industry and regulatory institutions might face negative outcomes, and negative reactions to policy development in the area of consumer protection (de Jonge 2008, Buzby 2001, Verbeke and Ward 2001). Meanwhile, consumers' desire to access certification and/or verification of food safety attributes – including animal disease testing and traceability – may have risen in their food-purchase decisions (McCluskey et al. 2005; Hobbs et al. 2005; Schroeder et al. 2006; Steiner et al. 2009; and Aubeeluck 2010). Over 50 percent, on average, of consumers were willing to pay a premium for BSE-tested beef in Japan (McCluskey et al., 2005). Schroeder et al. (2006) highlighted willingness to pay (WTP) premiums for food safety attributes by consumers in Canada, the US and Japan. Aubeeluck (2010) found higher WTP premium for traceable and BSE-tested attributes in imported beef steaks in Canadian and Japanese consumers.

The literature has shown the importance of risk perceptions and risk attitudes towards specific food products. Results from BSE-studies revealed that risk perceptions and risk attitudes influence consumers' purchase behaviour, and lead to significant changes in beef consumption (Pennings et al. 2002; Schroeder et al. 2007; Kalogeras et al. 2008; Yang 2010; Yang and Goddard 2011a, and Yang and Goddard 2011b). On the other hand, consumers' risk perceptions/ attitudes towards beef showed an influence on consumers' response to media coverage about BSE (Yang 2010; and Yang and Goddard 2011a). Media coverage about animal disease and food-safety issues has been shown to have an impact on consumer behaviour (Piggott and Marsh, 2004; Myae and Goddard, 2010) and market share for beef (Burton and Young, 1996).

In the case of CWD, impacts can happen not only on consumers, but also on wildlife recreational activities. The increased number of CWD occurrences in wild animals showed a significant negative effect on hunters' welfare (Zimmer, 2009). Lesser population of wild deer and elk due to culling animals in CWD affected areas – one of CWD management strategy – greatly reduced hunters' satisfaction and welfare (Zimmer, 2009).

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3. THE POLITICAL ECONOMY OF CWD TESTING IN FARMED AND WILD CERVIDS (COMPARED TO BSE TESTING IN CATTLE)

3.1. INTRODUCTION

As discussed in the previous chapter, the risks associated with TSEs include risks to food safety outbreaks, risks to public health, and risks to economy – due to the costs to governments for regulatory policies, and possible trade barriers, reduction in tourism revenue and consumer demand in terms of meat consumption, hunting participation, and wildlife-related recreational activities. CWD surveillance programs have been adopted in different ways in different countries and different province/states. The adoptions of animal testing and traceability are two common responses to TSE-associated risk by governments (see section 1.1). However, there remains a significant debate about the number of animals to be tested – whether to test a sample or the entire population – and about the appropriate age of animals for reliable testing. Given that a clear understanding of underlying factors that have influenced the decision of *animal-testing for BSE* (Canada, the US, Japan) and *CWD* (Canada, the US) is an important area to be explored.

The major objective of this paper is to understand governments' animal-testing strategies in response to CWD in farmed and wild cervids across countries (Canada and the US). As discussed in Section 1.2, the aim of this paper is to assess why governments undertook specific levels of animal testing in response to TSEs. Although there are some studies on BSE/CWD surveillance across countries (for example Koizumi et al., 2005), no previous study has explored the adopted BSE/CWD testing regulations from a political economy perspective, using empirical data and econometric estimation procedures. In this study, factors that explain the level of CWD testing will be determined empirically at national levels for the farmed cervid sectors, and at provincial levels for the wild cervid sectors in Canada and the US. Significantly different factors in explaining TSE-testing – between BSE in cattle from previous study and CWD in farmed-cervids in this study, and between CWD in farmed and wild cervids in this study – will be highlighted and compared.

The study will contribute to the literature in three aspects:

(i) Introduce a new conceptual model about the impacts of government regulations on market behaviour (demand and supply shocks);

(ii) Develop a new relative political weight formula from observed prices and quantities in an assumed perfectly competitive market; and

(iii) Reveal underlying-factors in the government decision-making process for a health risk related regulatory policy.

The results of this study are expected:

- To provide decision-makers with information about particular factors, which were considered in TSE-management strategies; and
- To broaden stakeholders' and consumers'/society's knowledge about important factors in the development process of TSE-management policy, and how much their welfare was taken into consideration in that process.

3.2. LITERATURE REVIEW

This section provides the basis for a conceptual framework, and for defining the empirical model for this study. The literature shows various studies about underlying factors in particular regulatory policies in agricultural products from a political economy perspective. In general, political economy models can play a key role in examining and explaining conflicts that may arise among related/interested parties, and in explaining why governments intervened and took specific actions (Grossman and Helpman, 2001; Brander, 2005). Specifically, economic policy outcomes are associated with the demands of the voters and special interest groups participating in the political process (Grossman and Helpman 1994). The costs, benefits, deals, and trade-offs are important characteristics, embedded in efficient policy solutions (Johnson 1995). A theoretical explanation of the political economic methodology and assumptions had been provided by Becker (1983), Gardner (1987), von Cramon-Taubadel (1992), and Bullock (1994). Becker (1983) presented a theory of competition among pressure groups, and concluded that governments' interventions in correcting market failures were in favour of political power. From the results, Becker (1983) suggested that the link between deadweight costs and efficiency of political influence is negative for subsidized groups and positive for taxpayers. Backer's theoretical finding is supported by many scholars using empirical estimations (for example by Zusman and Amiad, 1977; Carter et al., 1990).

Bullock (1994) discussed a generalization of the Becker (1983) model, which included the possible altruism of political agents. Gardner (1987) discussed, theoretically and empirically, public choice considerations through a revealed weighting of producers' rents and losses in buyers' surplus due to production controls and farm price support programs. Additionally, the significant importance of variables associated with the cost to producers and society, which is also called *dead weight losses*, was suggested. von Cramon-Taubadel (1992) discussed the popularity, amongst economists, of the political preference or governing criterion function (PPF) approach in explaining the origin of government policies. In PPF, it is assumed that a group's voting behaviour is related to its economic well-being and policy-makers' concerns are related to attaining and/or maintaining their power (von Cramon-Taubadel, 1992). In a simple way, a PPF is a function of interest groups' utilities (typically producer and consumer surplus and budget expenditures are used as a proxy) with different weights attached by policy-makers (von Cramon-Taubadel, 1992).

It has been demonstrated that not only political preferences, but also market parameters, could change PPF weights, and that current policies could be a reflection of political economic equilibrium, where an efficient policy solution could be obtained (Swinnen and van Der Zee, 1993). An efficient policy solution (political economic equilibrium) is defined as a situation in which the interest groups' relative political strength (PPF weights), and their success in capturing private benefits through the political instruments of the decision-making process, are associated with a certain level of protection for the total welfare of that interest group (Grossman and Helpman, 1994). Given observable policy actions, numerous studies have used the PPF in determining the political economy equilibrium of a situation (for example, Carter et al., 1990; Sarker et al., 1993; Johnson, 1995). Implicit political weights are derived from the first order condition of PPF function. The weights are calculated using observed prices (Sarris and Freebairn, 1983, and Paarlberg and Abbott, 1986; Rausser and Foster, 1990; and Sarker et al. 1993). Sarris and Freebairn (1983) and Paarlberg and Abbott (1986) used the derived relative political weights as exogenous variables. Rausser and Foster (1990) and Sarker et al.

(1993) used the weights as endogenous variables in their political economy models. Rausser and Foster (1990) and Johnson (1995) provided a theoretical explanation, and Sarker et al. (1993) provided empirical estimations, in explaining that the relative success of a group depends on certain characteristics, and on the effectiveness of its lobbying efforts.

Some empirical studies, in determining power relations and influential factors in government intervention, will be discussed further. As one of the earliest studies, Zusman and Amiad (1977) investigated power relations and the structure of conflicts among interest groups in a Israeli dairy program. They used a game theoretic approach and formulated a political economy structure with four sets of components – economic structural equations, the set of feasible policy instruments, policy makers' and interest groups' objective functions, and interest groups' strength. Using the data set including consumer price of fluid milk, price of other dairy products, farm price, production share and import of dairy products, their results suggested that producers' desire to decrease imports and to increase domestic production was reflected in the country's regulation on dairy supply-management decision.

Carter et al. (1990) have evaluated the causes of intervention in Canadian agricultural policy using time series data for the period from 1965 to 1987. The ratio of domestic to world price as the proxy for measuring country's level of protection was used as the endogenous variable. They identified the three sets of explanatory variables such as variables that reflect interest group, underlying commodity characteristic and national interest variables. Variables that reflect interest group included regional concentration of production, retail to farm price ratio, production growth and regional production variability. Variables such as import and export shares, absolute difference of demand and supply elasticity, interaction on supply management and net export share were used to represent the underlying commodity characteristic. The ratio of farm to non-farm income, liberal party and time trend were used as a proxy for national interest variable. Their results suggested that the protection level would be increased if producers' welfare such as income and production growth decreased.

Some scholars determined the underlying factors of government intervention in agriculture policy across countries. Sarker et al. (1993) determined empirically about the most influential factors in the government intervention for the systematic subsidization of wheat producers in 12 developed and 13 developing countries from 1985 to 1987. In the model, the implicit political weight for producer group relative to that of consumer group was used as a dependent variable. The set of exogenous variables includes agriculture's comparative advantage, agriculture's share in the economy (in employment or in country's GDP), agriculture's international terms of trade, imports financed by agricultural exports and share of food in disposable income. The results suggested that different factors influence the systematic subsidization of wheat producers in developed and in developing countries. The labor productivity ratio and the share of food in disposable income were more important in developed countries, while the factor endowment ratio and import shares were more important in developing countries. However, gradual changes occurred in the incentive mechanism in agricultural price policy formulation.

Clague and Desser (1998) determined the causes of international differences in agricultural price level based on factor endowments, transportation costs, and the political economy of agricultural protection. Three sets of regression models (Appendix 3A) were estimated for 39 countries using data in 1970s to 1990s. The results suggested that the greater protections were found in richer countries and that import restriction was a politically easier way than protection through deficiency payments and farm-support programs. Olper (1998) analyzed the determinants of Common Agricultural Policy (CAP) protection across EU countries and over the time from 1975 to 1989 from a political economy perspective. The results revealed a positive relationship between the protection levels (supports) and comparative disadvantage in agriculture of the respective countries. Thornsbury (1998) determined the likely political economy influences on regulatory decisions to enact questionable technical barriers to the US's agricultural exports. Using survey data in 1996, the results suggested the continuing influence of technical barriers in international agricultural markets. As an updated research of previous version, Thornsbury et al. (2004) determined the political economy of disputed technical regulations in mid-1996, shortly after the WTO agreements came into effect. Their study used survey data of 302 disputed technical regulations among 62 countries and two regional trading blocs. The results suggested negative relationships between technical barriers and factors such as agriculture's contribution to an economy, the level of other forms of interventions, and the level of open market economy in respective countries.

Lee and Kennedy (2006) investigated the equilibrium level of trade interventions even under Uruguay Round Agreement on agriculture in order to understand the optimal program for the US rice exports from a political economy perspective. Using time-series data from 1960 to 1999, the results suggested a possible Nash equilibrium if Japan and Korea exercise a 4% tariff reduction on US rice exports. Apart from the political economy studies in agriculture area, Sutter and Poitras (2002) determined government intervention in vehicle safety inspection for both special interest motives such as repair shops and auto clubs, and public interest such as highway causalities in the absence of inspection using time series data from 1981 to 1993. The results suggested that political transaction costs determined the existence of inspection program.

In Appendix 3A, the comprehensive review of previous studies on research objectives, the development of the empirical political economy model, the data and the results are presented. Variables that are used in political economy models by selected scholars are presented in detail in Appendix 3A. In general, explanatory variables to determine underlying factors about regulatory-policy development in the agricultural farm sector include:

- Political market effects;
- Economic factors that reflect interest groups;
- Commodity characteristics; and
- Society's concerns.

For example, Carter et al (1990), Sarker et al. (1993), Clague and Desser (1998), and Olper (1998) used regional concentration of production, size of farms, production growth, revealed comparative advantage, gross value added, and retail-to-farm price ratio in political economy models as proxies for economic factors that reflect interest groups (Appendix 3A). In terms of commodity characteristics, country's trade status such as import and export shares, net export shares, international terms of trade, trade balance (Carter, 1990; Sarker et al. 1993, Thornsbury 1998; and Olper 1998) and share in country's GDP (sarker et al. 1993; Thornsbury 1998; Olper 1998; and Thornsbury et al.

2004) were included as explanatory variables (Appendix 2A). In terms of society's concerns, Sarker et al., (1993), and Olper (1998) used a "share of food expenditure in disposable income" in their models (Appendix 3A). In this study, the political weight and explanatory variables will be developed for the farmed-cervid sector based on the literature reviewed above.

The wild cervid sector needs different variables to be considered due to the different nature of commodity and the lack of market determinants. Different from the farmed sector, there are four types of economic values in wild cervids in both demand (consumptive values, non-consumptive values, option values and existence values) and supply (environmental conditions, biological conditions, institutional conditions and wildlife managements) as discussed in the previous chapter. Many scholars have demonstrated that CWD has significant impacts on the wildlife-related economy and on society. Prather (1974), Adamowicz (1983), Rush (1995) and Rush et al. (1996) used survey data to determine the economic value of wildlife for hunters. Bishop (2002, 2004) and Zimmer (2009) determined the economic impact of CWD on hunters and hunting behaviour. Using data from literature and state agencies, Bishop (2002, 2004) suggested that hunters suffer economically more than other sectors in Wisconsin due to CWD. Using stated preference and revealed preference survey data in nested logit model, Zimmer (2009) found different effects of CWD management strategies on hunters in Alberta – for example, the presence of CWD and culling of wild cervid herds caused negative impact on hunters' economy but extra tags for buying a hunting licence made hunters happier. Petigara (2011) determined the direct and indirect economic effects if CWD is transmitted to farmed populations in Alberta and Canada and relative impacts on related industries. Using economic data from Statistics Canada's 2006 provincial and national input-output tables, the results suggested relatively smaller spillover effects on the economy due to shocks in the cervid sector compared to the cattle sector.

Brown et al. (2006), Holsman and Petchenik (2006), Needham et al. (2006), Petchenik (2006), Cooney and Holsman (2010), Holsman et al. (2010), and Lischka et al. (2010) determined hunter's harvest behaviours in response to CWD for better disease management strategies in the wild population. More specifically, Brown et al. (2006) characterized early public awareness and their information seeking behaviour about

CWD, their reaction to the CWD discovery and the effect of CWD on hunters' plans to hunt deer during the first few weeks of CWD detection in New York. Using a telephone survey to general public and big game license purchasers, the results suggested that hunters showed relatively higher awareness of the discovery of CWD and higher concerns about the disease and venison consumption. However, the hunting habit was not affected much. Holsman and Petchenik (2006) determined hunters' harvest behaviour in response to CWD management strategies in Wisconsin's CWD eradication zone. Using data from mail survey and hunters' diaries, the results suggested that the deer harvest level was positively related to hunting efficiency, number of deer seen and hunters' willingness to harvest, regardless of hunting efforts.

Needham et al. (2006) determined the influence of CWD on hunters whether to hunt in other states or quit hunting permanently, their acceptance of disease management strategies and the differences across residency, hunted species and hunting region. Using mail survey data in eight states for deer hunters and in three states for elk hunters, the result suggested that hunters were more likely to quit than switch states, residents were more likely to quit and non-residents were more likely to switch states, and they would prefer CWD testing and herd reduction programs to no disease management plan. Petchenik (2006) determined landowners' responses to harvest incentives and actual hunting participation in response to these incentives in Wisconsin's southwest CWD eradication zone using mail survey data. The results suggested that landowners who hunt were more likely to be aware of incentives to promote deer harvest. Among various incentives, free buck tags and the longer season are influential factors to increase hunting participation.

Cooney and Holsman (2010) investigated the influence of risk perceptions on hunters' support in deer density reduction program in Wisconsin as a CWD management strategy using mail survey to deer hunters in the Fall of 2006. The results showed that the influence of risk perceptions on hunter support for population goals was mediated by their beliefs about whether eradication was a necessary in the region. Holsman et al. (2010) determined hunters opinion on the CWD eradication strategy in Wisconsin using six psychological bases such as opposition to the population goal, conflicts with traditions, conflicts with consumption norms, the uncertainty of the plan's efficacy and perceived lack of credibility in the agency. Using survey data from hunters and landowners, the results revealed resistance from hunters to eradication effort and suggested that the use of recreational hunting was not the best way to use as a viable tool for severe deer population reduction strategy in the region. Lischka et al. (2010) determined the knowledge and support for CWD management among residents of the infected area in Illinois. They used a survey data collected from the public and hunters, who were randomly selected from one of 20 CWD positive or adjacent counties. The results showed that public awareness was less than hunters' awareness about CWD. More than half of respondents welcomed all necessary measures to manage the disease.

In summary, important factors to be considered in the wild political economy model can be drawn based on the literature review on the studies about CWD in wild cervids. In general, explanatory variables to determine underlying factors about regulatory-policy development in the wild cervid sector include:

- Economic factors that reflect interest groups;
- Society’s concerns; and
- Society's acceptance to disease management strategies.

The specific factors generalized from the literature review can be summarized as follows. CWD has impacted on the three factors:

- By shifting economic activities – for example, cervid farms, hunting and outdoor recreation moved away from CWD prevalent areas (Seidl and Koontz, 2004);
- By reducing total economic activities – for example, approximately 0.3% of the total annual economic activity ($1.6 million loss from elk hunting) was reduced as a direct economic impact in rural northwest Colorado (Seidl and Koontz, 2004).
- By reducing government revenues – for example, there was a direct reduction of more than $11.0 million in Ontario provincial revenues from the hunting community alone (Ontario Ministry of Natural Resources, 2005); and
- By reducing society's interest on the part of hunters in diseased, and/or a reduced number of wild cervids because of the culling of herds found with CWD (Bishop 2004, James, 2008; Zimmer, 2009).
- By increasing society's concerns about wilderness since economic values in the wild cervid sector were associated with different types of wilderness involvement,

such as game hunting, environmental conservation, natural tourism (that is recreational hunting and the viewing of wild cervids), concern about wild animals' welfare, and passive recreation (knowing the presence of wild cervids).

- By changing hunters' and land owners' perceptions and attitudes towards CWD management strategies.

3.3. BACKGROUND OF CWD REGULATIONS

3.3.1. Canada

CWD was first reported in a Colorado research facility in 1967. The importation of farmed cervids from a South Dakota farm in 1989 caused CWD to spread amongst Canadian cervids (Office of the Auditor General of Canada, 2003). Although the spread of CWD in Canadian herds is believed to have begun with the importation of farmed cervids, the spread of the disease among farmed animals, among wild animals, and from wild to farmed animals is not well understood. Disease outbreaks in the wild can also become serious concerns in related farmed sectors, if disease vectors pass infection on to farm animals (Bennett et al., 2009). As a consequence, the lobbyists representing the farmed sector may put political pressure on the government to test wild animals. According to the Canadian Food Inspection Agency (CFIA), the Canadian government's responses to BSE and CWD have included establishing the National Animal Identification System (NAIS) in 1998, the National Agriculture and Food Traceability System (NAFTS) in 2006 and the National CWD Control Strategy (Section 2.4) in 2004.

For the surveillance of captive (farmed) cervids in Canada, the Canadian Food Inspection Agency (CFIA) sets the policy, but testing regulations are not mandated (leaving them a provincial concern). Some provinces (Alberta, Saskatchewan, Yukon and Manitoba) currently have mandatory surveillance programs testing all deaths and all slaughtered animals for CWD, and some provinces (Quebec, British Columbia, Ontario and North-west Territories) have voluntary surveillance programs (CWD Alliance, 2012). Although there is no information posted yet, all slaughtered animals are tested in Canada. Decisions about surveillance in wild animals can be influenced by the interest of the public in wild populations, stemming from the pleasure of hunting or seeing wild cervids, from concerns about the welfare of wild animals (Bennett et al., 2009), and from an interest in environmental quality. There are different surveillance programs in different provinces (Section 2.3). Alberta, for example, had active surveillance – set the designated number of animals to be killed in particular areas, and arrange to be killed and examined for those animals – in designated CWD surveillance areas from 2005 to 2008. The program has been since adapted to be a passive surveillance system, which asks hunters to voluntarily submit of cervids' heads. Other sources for the passive surveillance program include road-killed and clinical cases. Since 2001, Saskatchewan has pursued province-wide testing with an emphasis on wildlife-management zones adjacent to infected areas (CWD Alliance, 2012). These latter programs are usually managed by the provincial ministries of natural resources.

3.3.2. The United States

The first CWD was recognized in wild mule deer in Northern Colorado in 1967. Given that CWD was detected in wild deer and elk in Colorado and Wyoming during 1980s, these regions are determined as CWD endemic area (APHIS, 2011a). However, due to CWD surveillance by wildlife agencies and APHIS from 1997, CWD has been identified in six additional states – Illinois, Nebraska, New Mexico, South Dakota, Utah, and Wisconsin (APHIS, 2011a). The first CWD in a farmed elk herd was detected in South Dakota in 1997. Since then State CWD surveillance in farmed animals has been initiated, and laboratory costs for all testing in farmed cervids are taken by APHIS-VS (APHIS, 2005a). The USDA has initiated a CWD eradication program using the Commodity Credit Corporation Emergency Funds from the Secretary of Agriculture in September 2001 (APHIS, 2011a). The extension of the program has provided a support for the surveillance in wild deer and elk. By 2010, 933303 cervids (149690 in captive cervids and 783613 in free ranging cervids) has been tested for CWD.

The Federal CWD herd-certification program in farmed cervids was developed by APHIS in coordination with states, the farmed cervid industry, and the US Animal Health Association (USAHA) in late 2003 (APHIS, 2010) in order to control and eradicate CWD from farmed cervid herds (APHIS, 2005a). The final regulatory review of the (HCP) program was completed and published on July 21, 2006 (APHIS, 2011b). In the program, farmed herds will be certified if there is no evidence of disease during 5 years of surveillance (APHIS, 2005a). The cervid herds with CWD positive cases are depopulated or quarantined and indemnity (95% of appraised market value) is offered by APHIS-VS (APHIS, 2005b) (Table 3.1).

3.4. Conceptual Approach

As mentioned in Section 1.2, a political economy perspective in this study means determining the factors that explain the level of animal testing for CWD (which is the policy created and implemented by government agencies), considering political market effects, economic factors, society's concerns, and disease prevalence/ management strategies. There are significant differences between wild and farmed cervids: **(i)** different nature and different impacts (Section 2.5); and **(ii)** different regulatory authorities (Section 2.3) who have taken responsibility for CWD surveillance in the farmed and wild cervid sectors separately. Due to the differences between the two sectors, data limitations (price, demand and supply) in the wild cervid sector, and lack of knowledge about the exact path of disease spread between the farmed and wild populations, the analysis will be conducted separately for wild and farmed cervids.

In the **farmed cervid model**, the four sets of variables will be used:

- Political market effects;
- Economic factors/Commodity characteristics;
- Society's concerns; and
- Disease prevalence/ Management strategies.

The first three sets of variables come from the literature review in section 3.3. The fourth variable set "disease prevalence and management strategies" will be used in the political economy models for both farmed and wild cervids as a proxy to measure the impact of CWD positive cases on regulatory policy in each country/provinces/states. Variables that represent economic factors and society's concerns are used in the political economy model in order to reflect interest groups' pressure in the CWD-testing decision-process. In this framework, it is assumed that interest groups consist of venison suppliers (such as farmers, processors) from the supply side, and consumers from the demand side.

Assuming the unequal capacity of interest groups in collective action on policy formation (Sarker et al., 1993), variables that reflect interest groups are defined under two perspectives: i) selected variables to describe economic factors which include the number and profitability of farmers and processors (producer groups); and ii) variable to describe society's concerns – public health considerations and consumers' concerns about food safety – (consumer group). The selected variables to describe economic factors are: i) real farm cash receipts (deflated by CPI) (FCR); ii) regional concentration in farmed-cervids inventories (RECON); iii) the farmed-cervid sector's share in countries' GDP (SGDP); and v) venison exports and imports.

In the **wild cervid models**, the following three sets of variables will be used. Due to a lack of market data (supply, demand and prices) in wild cervid model, it is not feasible to measure the political market effects. The three variable sets include:

- Economic factors;
- Society's concerns; and
- Disease prevalence/ Management strategies.

Since it is difficult to measure the level of passive recreation in society, other measureable factors – such as wildlife-related recreational revenue, and participation in wildlife-related recreational activities – will be used in the model. Variables that represent economic factors and society's concerns/responses are used in the political economy model in order to reflect interest groups' pressure in the CWD testing decision-process. In this framework, it is assumed that interest groups consist of wildlife related provincial/ national agencies and the consumer society (hunters and people who are getting benefits from wildlife-related recreational activities). Participation in wildlife-related recreational activities will be used as a proxy for society's concerns about the health risks to humans and wild animals.

The comparisons of models, conceptualized for farmed and wild cervids in both Canada and the US along with the proxy use of data, are presented in Table 3.2. The detailed explanation about the conceptual measurement of political market effect due to CWD-testing regulations in the farmed cervid models is discussed in the following Section 3.4.1.

3.4.1. Political Market Effects

In this section, the concepts of political market effects will be discussed in detail. First, a political market has been referred by Grossman and Helpman (1994) and Johnson (1995) as the total area in which decisions are made regarding the political and economic situation based on politicians' decision-making power, and on their interest in voters versus lobbyists' incentives. As discussed previously, numerous studies (for example, Carter et al., 1990; Sarker et al., 1993; Johnson, 1995) have used the PPF in determining the political economy equilibrium of a situation. Given observable policy actions, a simple PPF is used in this study. The PPF in equation 3.1 is determined by the relative lobbying activity of the two interest groups – producers and consumers in this case (Sarker et al., 1993, p.291):

$$W = \lambda PS(t) + CS(t) \qquad \textbf{(3.1)}$$

where t is the government's policy instrument measured in a direction that favours producers, λ is the relative weight the government attaches to producers welfare relative to consumers, PS is producer surplus and CS is consumer surplus. In the political economy space, the government has a choice set with a feasible combination of PS and CS, which is called the Surplus Transformation Curve (STC) (Figure 3.2). For interest groups, a non-cooperative Cournot-Nash game is assumed. The equilibrium is where each groups' choice of lobbying activity is optimal given the other group's choice, and a Social Indifference Curve (SIC) is defined through the choice of a different optimal set of lobbying activities (Sarker et al. 1993). The slope of the SIC changes depending on the optimal set of lobbying activities, which in turn determines the relative political weight the government attaches to interest groups (λ). The political economy equilibrium (E_1) is where the SIC is tangent to the STC (Figure 3.2).

The political weights are derived from the first order condition of PPF function in Equation 3.2.

$$\frac{\partial W}{\partial t} = \lambda PS'(t) + CS'(t) = 0 \qquad \text{(Sarker et al., 1993, p.292)} \qquad \textbf{(3.2)}$$

The weights (λ) are calculated using observed prices following Sarker et al. (1993) and Johnson (1995) and called the relative political weight attached to producers' (farmers, processors and retailers) welfare relative to consumers' welfare.

The detailed calculation of the political weight for this specific study is discussed as follows. In order to define the PPF function (equation 3.1) for this study, the method of calculating CS and PS in the face of CWD-testing in venison market will be explained first. The relative political weight is developed only for the farmed cervid sector. Since the actual market price and demand is difficult to obtain in the wild cervid sector (as discussed in Section 1.2), the relative political weight is not developed for the wild cervid sector. Assuming a perfectly competitive farmed cervid market, the equilibrium price P_0^0 and quantity Q_0^0 , at the pre-CWD testing equilibrium E_0^0 , are where the demand D_0 equals the supply S_0^0 (Figure 3.3). The nature of goods and consumers' tastes can change in a market in the face of CWD testing. Compared to the original demand curve (D_0), consumers' demand for a new product of quality assured CWD tested venison is on a new demand curve (D_1). If a government regulates CWD testing without any subsidy for cost, the supply can shift from S_0 to S_1, along the new demand curve (D_1) for CWD tested venison, due to the higher costs of providing CWD-tested products to the market. There can be a higher price or a lower quantity or both at the new equilibrium E_1, where governments bear no cost of CWD testing, as compared to the price and quantity at equilibrium E_0, where governments bear the full cost of CWD testing. Under such a government regulation on CWD testing with full cost coverage, the supply of domestic CWD tested product may remain the same at S_0 (Figure 3.3).

After the product has been bundled with CWD testing, the nature of product has been changed. Given that the demand for venison at the pre- and post-CWD-testing regulation are different and are associated with pre and post CWD-testing utility functions respectively (Dixit and Norman, 1979). Since the two pre- and post-CWD-testing demands derived from two utility functions are different, changes in consumer welfare do not include the area between the two demands carves. Then, the assumption about consumers' perception towards CWD tested products becomes crucial in choosing the demand curve in analysis. The post- (pre-) CWD-testing demand will be used in evaluating consumer welfare, if it is assumed that an action which changes consumer tastes due to CWD testing in this study represents consumers' true interest (is pure deception) (Dixit and Norman, 1979).

Assuming that the preference for CWD tested meat represents consumers' true interests in this study, the post-CWD testing demand is used in welfare evaluation. In Figure 3.3, changes in *PS* and *CS* (producers' and consumers' gains and losses) due to demand and supply shocks associated with the CWD testing are illustrated. If it is possible that CWD testing costs are borne by the industry, a supply-shift from S_0 to S_1 at the post-CWD-testing demand D_1 generate a decreasing *CS* – represented by the area "*cdef*" – and a changing *PS* – represented by the area *"hijk - cd"* (Figure 3.3). George (2012, p.11) identified deadweight as "the CS lost due to monopoly, or the loss represented by the tax wedge when a tax is enacted, or the lost surplus experienced by an individual who changes her mix of purchases." However, if a net overall loss in CS due to demand shift is the area of interest, there will be no deadweight loss (George, 2012). In this study, there is no deadweight loss, since the interest is the net overall loss or gain in the welfare of consumers and producers.

Although deadweight losses do not appear in this CWD-testing regulation procedure, changes in market structure and changes in economic behaviour due to imposing CWD-testing regulation can occur as deadweight losses in venison markets (Diewert and Lawrence, 1995). Any government's necessary involvements, associated with an imposed regulation – such as inspection, monitoring, and public communication – may be thought of as deadweight losses, if these involvements are not treated as rational responses to an unfortunate event (George, 2012).

It is assumed that both supply function [$S = a + bP + tw$ ($S_0 = a + bP_{S0} + tw_0$, $S_1 = a + bP_{S1} + tw_1$, and $w_1 > w_0$)] and demand function [$D = c + dP$ ($D_0 = c + dP_{S0}$ and $D_1 = c + dP_{S1}$)] are linear. In supply and demand functions, P_{S0}, P_{S1} are market equilibrium prices for before and after CWD testing regulations, and w_0 (cost of CWD testing under government's full subsidy program) and w_1 (cost of CWD testing without any subsidy program) are supply shifters under CWD-testing regulations. Assuming that governments are not bearing any costs associated with CWD-testing, the equilibrium will shift from E_0 to E_1. Losses in consumer surplus and changes in producer surplus are calculated as follows:

$$\Delta CS = cdef$$
$$= (P_{S1} - P_{S0})Q_1 + \frac{1}{2}(P_{S1} - P_{S0})(Q_0 - Q_1)$$
$$= \frac{1}{2}(P_{S1} - P_{S0})(Q_1 + Q_0) \quad \textbf{(3.3)}$$

$$\Delta PS = hijk - cd$$
$$= \frac{1}{2}(P_{S0} - \hat{P}_{S0})Q_0 - \frac{1}{2}(P_{S1} - \hat{P}_{S1})Q_1 \quad \textbf{(3.4)}$$

There are three reasons to make an assumption that consumers may lobby for higher CWD testing, and that producer (farmer, processors, retailers) may prefer lower CWD testing levels: *(i)* the importance of lobbying abilities of producers (farmers and processors) and consumers in the policy outcome – the level of CWD testing – which in turn can depend on the relative political weights of interest groups (producers and consumers); *(ii)* the previous assumption that the taste for CWD tested meat represents consumers' true interests; and *(iii)* the food safety additive era. The PPF function (equation 3.1) is modified for this study as follows:

$$\Delta W = \phi \Delta PS + \gamma \Delta CS \quad \textbf{(3.5)}$$

where ΔPS (Change of PS), and ΔCS (Change of CS) are the respective effects of the testing regulation on welfare, and ϕ, γ are the weights for producers and consumers respectively. By normalizing weights, the welfare function can be written as:

$$\Delta W = \lambda \Delta PS + \Delta CS \quad \textbf{(3.6)}$$

where $\lambda = \frac{\phi}{\gamma}$ is the relative political weight (RPW) attached to producers' welfare relative to consumers' welfare. From the first order condition (equation 3.2), the λ can be obtained as (Sarker et al., 1993; Johnson, 1995).

$$\Delta W = \frac{\lambda}{2b}(S_0 Q_0 - S_1 Q_1) + \frac{1}{2}(P_{S1} - P_{S0})(Q_1 + Q_0)$$

$$\frac{\partial \Delta W}{\partial P_1} = -\frac{\lambda}{2b}(dS_1 + bQ_1) - 2Q_1 = 0$$

$$\lambda = \frac{2bQ_1}{dS_1 + bQ_1}$$

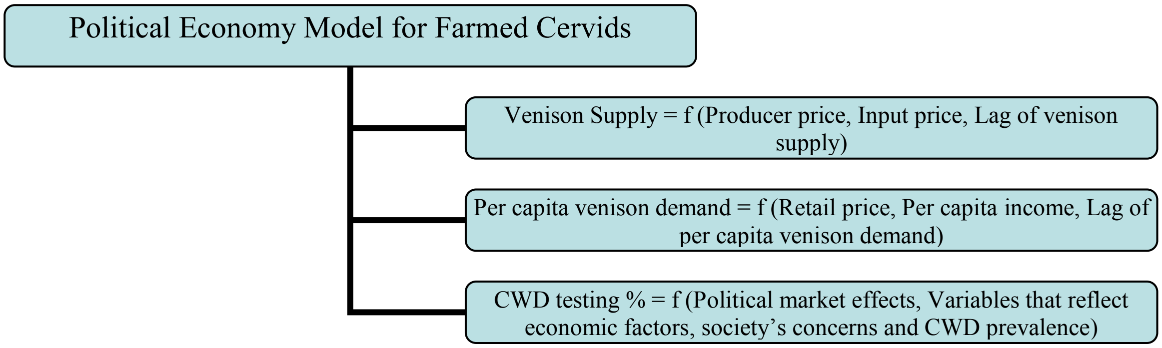
$$\lambda = \frac{2\varepsilon_1}{\eta_1 + \varepsilon_1} \qquad \left(\eta_1 = \frac{\partial D_1}{\partial P_1} \cdot \frac{P_1}{D_1},\ \varepsilon_1 = \frac{\partial S_1}{\partial P_1} \cdot \frac{P_1}{S_1} \right) \qquad \textbf{(3.7)}$$

where D_1 and S_1 are post-CWD-testing demand and supply quantities respectively, ε_1, and η_1 are post-CWD testing price elasticity of supply, and price elasticity of demand respectively. The derived relative political weights are used as the variable for the political market effects. The sign will represent the relationship between the relative weights – government place on producers' welfare relative to consumers' welfare – and government's regulatory policy – the level of CWD-testing in the farmed sector.

3.5. Empirical Approach

3.5.1. Farmed Cervid Sector

In the farmed-cervid sector, the number of animals tested for CWD is used as dependent variable. The relative political weight, attached to producers' welfare relative to consumers' welfare (Equation 3.7), is used as a proxy for the political market effect variable. Since the relative political weight is calculated using supply and demand elasticities, the political economy models of the farmed cervid sector require supply and demand functions. Therefore, three equations (Equations 3.8, 3.9 and 3.10) below are estimated simultaneously. The variables used in the model are defined based on the literature review. The political economy model for the farmed cervid sector is illustrated as follows:



$$VPRO_t = \alpha_0 + \alpha_1 Pp_t + \alpha_2 \Delta P_{Input_t} + \alpha_3 VPRO_{t-1} + \alpha_4 TIME + \nu_t \quad \textbf{(3.8)}$$

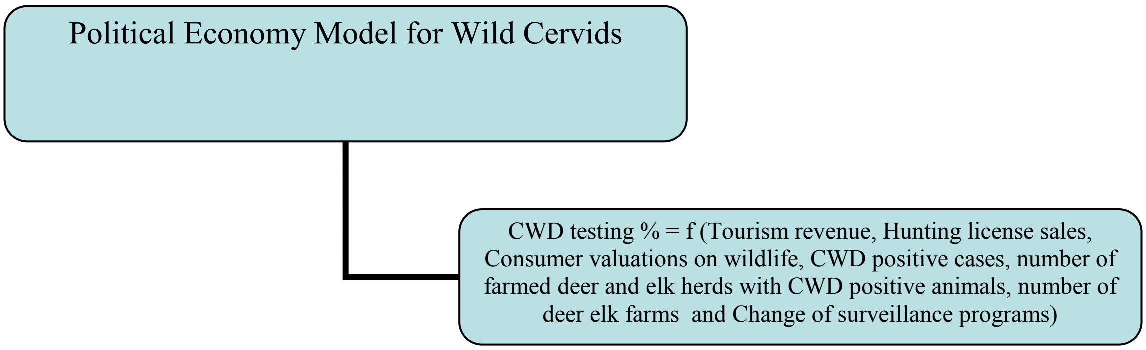
$$VCON_t = \gamma_0 + \gamma_1 Rp_t + \gamma_2 Inc_t + \gamma_3 \Delta Inc_t + \gamma_4 VCON_{t-1} + \gamma_5 CWD_{t-1} + \gamma_6 TIME + \omega_t \quad \textbf{(3.9)}$$

$$\begin{aligned} TESTING_t = \beta_0 + \beta_1 \left\{ \lambda = \frac{2 * \varepsilon_t}{\eta_t + \varepsilon_t} \right\} + \beta_2 FCR_t + \beta_3 RECON_t + \beta_4 SGDP_t + \\ \beta_5 FRPS_t + \beta_6 VCE_t + \beta_7 VEM_t + \beta_8 VIM_t + \beta_9 CWD_{t-1} + \mu_t \end{aligned} \quad \textbf{(3.10)}$$

where, $VPRO_t$ is total venison production, Pp_t is farm level (producer) price deflated by CPI, ΔP_{Input} is changes in input prices (first differences of farm input price index as a proxy), $VPRO_{t-1}$ is lagged dependent variable of total venison production, $VCON_t$ is per-capita venison consumption, Rp_t is retail price deflated by CPI, Inc_t is per capita income, ΔInc_t is changes in per-capita income, $VCON_{t-1}$ is a lagged dependent variable of per-capita venison consumption, CWD_{t-1} is a lagged total number of CWD positive cases which are detected in each country, *TIME* is a time trend for the 1991-2012 period, TESTING is the number of animal tested for CWD, λ is relative political weight government attached to producers' welfare relative to consumers' welfare, $\varepsilon_t = \frac{\left(\alpha_1 \cdot \frac{Pp_t}{VPRO_t}\right)}{1-\alpha_3}$ is long run supply elasticity at time t, $\eta_t = \frac{\left(\gamma_1 \cdot \frac{Rp_t}{VCON_t}\right)}{1-\gamma_4}$ is long run demand elasticity at time t, FCR is venison farm cash receipts, RECON is the regional concentration in deer and elk inventories, SGDP is the venison sector's share of GDP, FRPS is farm-retail price spread, VCE is the share of venison consumption expenditure in total food expenditure, VEM is venison exports, VIM is venison imports, CWD is the number of animals found with CWD positive in the farmed/wild/both population, and ν_t, ω_t, μ_t are error terms.

3.5.2. Wild Cervid Sector

In the wild cervid sector, the number of wild deer and elk tested for CWD is used as the dependent variable. Since relative political weight, which is a non-linear formula, is not used in the wild cervid model, a linear regression method (equation 3.11) will be used. The political economy model for wild cervids, in Canada and the US, is illustrated as follows:



$$\begin{aligned} TESTING_t = \beta_0 + \beta_1 TOUR_{t-1} + \beta_2 HLS_t \text{ or } HUNTERS_t + \beta_3 VIEW_t + \beta_4 VISIT_t + \\ \beta_5 POSITIVE_{t-1}\,(WILD/BOTH) + \beta_6 POSITIVE_{t-1}\,(FARMEDHERD)_t + \\ \beta_7 FARMS_t + \beta_8 SURVEILLANCE + \mu_t \end{aligned} \qquad \textbf{(3.11)}$$

where, TESTING is the number of heads tested for CWD; TOUR is expenditure on visits for pleasure (wildlife-related), deflated by CPI, in Alberta and Saskatchewan (Canada), and expenditure on wildlife-related recreation, deflated by CPI, in Colorado and Wyoming (U.S.A), as proxy for wildlife-related tourism revenue; HLS or HUNTERS is the number of hunting license sales in Alberta and Saskatchewan, and the number of deer and elk hunters in Colorado and Wyoming; VIEW is bird/wildlife viewing in Alberta and Saskatchewan, and wildlife-viewing, photographing and feeding in Colorado and Wyoming, as proxy for consumers' valuations on wildlife; VISIT is the number of persons who visit the zoo, aquarium or botanical garden, a theme or amusement park, a national or provincial park, or an historic site, in Alberta and Saskatchewan, and the number of persons who visit public parks in Colorado and Wyoming; POSITIVE (wild or farmed or both deer/elk population) is CWD positive cases in wild/farmed/both cervids, in Alberta and Saskatchewan (in respective province and in other province), and CWD positive cases in wild/farmed/both cervids in Colorado and Wyoming (in respective state and in other states), in order to determine the influence of CWD-positive cases in each region, across region sand across sectors; POSITIVE (FARMED HERD) is the number of farmed deer and elk herds, found with CWD-positive animals; FARMS is the number of deer and elk farms in respective provinces/states, SURVEILLANCE is the dummy, capturing intensive CWD surveillance period in wild cervids in respective provinces/states. These dummy variables (SURVEILLANCE) are used as a proxy for the impact of different CWD management strategies during different periods. The dummy variables defined are as follows: Alberta (2005-2008) - mandatory submission of deer heads in designated high-risk areas and increased fall hunting opportunities for herd reduction; Saskatchewan (2001 to date) – intensive surveillance surrounding the infected area (herd reduction areas - HRA) and high risk CWD infected captive facilities (HPA-high priority areas); in Colorado (2006 to date) – mandatory hunter-harvested testing in designated wildlife management units; and in Wyoming (2003 to date) – increased hunter-harvested surveillance in deer and elk. μ_t is a random error term.

3.6. THE VARIABLES AND SPECIFICATIONS

The most limiting factor of the estimation of the cervid political economy models in this research is the availability of data. Time series data for the 1991-2012 periods (22 observations) is used and is presented in Figures 3.4 to 3.27, along with data sources. Since CWD testing in farmed cervids was initiated in 1991, the data from that year is used. Due to limited historical information, the sample size can create a problem to fit the models, developed in previous sections. For a model with almost negligible randomness, m+1 observation is the minimum theoretical number for estimation, where m is the number of parameters in the model (Hyndman and Kostenko, 2007). In this paper, the political economy model for farmed cervids (Equation 3.11) includes 9 parameters in Canada and 8 parameters in the US. For the wild cervid sector, 8 parameters in Alberta, Saskatchewan and Colorado models and 7 parameters in the Wyoming model are included.

The national level data is used in farmed cervid models and the provincial level data is used in wild cervid models (as discussed in Section 1.2). The descriptive statistics for the farmed-cervid sector and the wild cervid sector are presented in Appendices 3C and 3D respectively. More detailed data sources are presented in Appendices 3E to 3H. Data used in this study are presented in Appendices 3I to 3L. Some variables are derived using data from different sources or different methods such as total deer and elk farm cash receipts, sector's contribution in country's GDP, concentration of deer/elk inventories, producer price, retail price, expenditure share, per capita venison consumption, and venison production. The data derivation is summarized as follows. The linear extrapolation and interpolation methods are applied on the rare occasions when there is missing data for one year wherever data is not available throughout the time period.

- Farm cash receipts = Total farm value ($) = Edible venison (calculated)*Average of weight average of Canadian White-tail deer sales (Nixdorf, R. 2005).
- Concentration of deer/elk inventories = the sum of squared shares of deer/elk inventories across provinces in Canada.
- Sector's contribution in country's GDP = Farm Cash receipts/GDP*100.
- Producer price = retail price – a constant margin.
- Retail price data used in this study are from Market Track™ scanner data (Nielsen Company). Bison prices are computed as a weighted average of retail prices of ground bison, roast bison and steak bison. For elk and venison, annual average retail prices of all meat products from elk and deer are used.
- Per capita venison consumption = Edible venison meat weight/population.
- Expenditure share = (per capita venison consumption * retail price)/per capita expenditure for food and beverages.
- Venison production = Edible venison meat weight = Edible deer meat weight + Edible elk meat weight
- Edible meat weight calculation:
  - Slaughter head*live weight=total live weight*0.55=Hot carcass weight*0.66=Edible deer meat weight
  - Slaughter head*live weight=total live weight*0.59=Hot carcass weight*0.8 = Edible elk meat weight
  - Source of conversion system used for deer: http://www.askthe meatman.com/estimate_deer_weight.htm (accessed October 21, 2010)

- Source of conversion system used for elk: http://www.albertaelk.com/Producers/Reference/Marketing/meat_sales.shtml (accessed October 21, 2010).

In the wild cervid models, the variables that reflect the changing CWD-management strategies are developed using dummy variables such as the change from voluntary surveillance to mandatory surveillance or passive surveillance, and the period of herd reduction programs. To understand the impact of the farmed sector on the wild sectors' management strategies, the number of CWD-tested animals in the farmed sector and the number of deer-elk farms in the province/state are used in the model. The data structures (trends) and assumptions are discussed below.

3.6.1. The Number of CWD-Tested Cervids and CWD-Positive Farms (Dependent Variables)

In Canada, testing nears but does not quite approach 100% across the country as a whole farmed cervid sector (Figure 3.4). The number of slaughtered elk and deer under federal inspection and the number of tested-heads increased drastically since 2000 in Canada (Figure 3.5). From 2000 onward as a result of the subsequent cases of domestic CWD, the provincial governments of Canada enhanced their CWD surveillance testing. Figure 3.6 presents positive deer and elk in Alberta and Saskatchewan. In the US, the number of animal-tested for CWD in the wild deer and elk population is much higher than that in the farmed population (Figure 3.7). The number of deer/elk sold decreased during the 1997-2007 period, and CWD-testing percentage in farmed deer/elk population increased drastically just after the first detection in 1997 (Figure 3.8). The number of deer and elk, found CWD positive in Colorado and Wyoming are presented in Figure 3.9. From FY 1997 to FY 2010 period, CWD has been detected in 50 elk and deer farmed-herds (37 farmed-elk-herds and 13 farmed white-tailed-deer-herds) in eleven states (Table 3.1).

3.6.2. The Explanatory Variables for the Farmed-Cervid Model

The trends of production, consumption and price from 1991 to 2012 are presented in Figure 3.10, Figure 3.11 and Figure 3.12 respectively. A relatively stable trend in venison production and per-capita venison consumption can be observed in the US. In Canada, both the production and consumption increased since 2000, probably due to the government's encouragement on the alternative livestock sector development. In Figure 3.12, the nominal price series in Canada and the US are presented. The trends of the data for economic factors and society's concerns with detailed auxiliary assumptions are discussed below.

Farm Cash Receipts (FCR): FCR is measured using deer/elk farm cash receipts deflated by the consumer price index in the two countries– Canada, and the US:

- Canada = total slaughtered heads under federal inspection*annual average price of Canadian white-tail deer and elk sales.
- US = number sold*annual average price of Canadian white-tail deer and elk sales.

The FCR of farmed-cervids is presented in Figure 3.13. A significant decrease in FCR (in real terms) can be observed after detection of first CWD cases in farmed cervids 1997/98 in the both countries (Figure 3.13). Although the FCRs had been restored during 2005 to 2006 periods, they have decreased since after 2006 in both Canada and the United States (Figure 3.13). It is assumed that the higher incentives for lobbying in producer groups are associated with higher gross incomes in the beef-cattle/cervid industry (Sarker et al., 1993). Rationale is that a higher income attracts producers to express more homogeneous interests to get their specific desires with respect to the level of CWD testing. However, higher farm cash receipts indicate favourable economic conditions for producers (Carter et al., 1990). In general, a higher level of output growth (higher farm cash receipts) is associated with a lower level of lobbyist power over decision makers (Carter et al., 1990). The sign of FCR in determining the level of CWD testing will reflect how policy makers take producers' benefits in the decision making process.

Regional Concentration in Deer-Elk Inventories (RECON): It is assumed that the higher the concentration (Herfindahl index) in cervid inventories, the more advantageous it is for producer groups to subscribe to a lobbying activity that promotes policies favouring their interests (Sarker et al., 1993). The rationale for this assumption is that a larger Herfindahl index generally suggests more market power and an increasing competitiveness in lobbying activities for desirable policy outcomes. RECON is calculated using Herfindahl indices (the sum of squared shares of inventories), which measure the relative size of deer-elk inventories across provinces in Canada and across states in the US. As suggested by Hannah and Kay (1977), the weighting function $h(m_i) = m_i^{\theta-1}$ is used (for $\theta > 0,\ \theta \neq 1$) and the corresponding family of indices of concentration is:

$$H = F_2(m_1,...,m_n) = \sum m_i^2 ,$$

where i equals 7 in Canada (provinces), and 46 in the US (States). In Figure 3.14, an increasing trend in deer-elk inventories in Canada until 2011 can be observed. In the United States, RECON in deer-elk inventories decreases since after 2002. The sign on the RECON will indicate the linkage between producers' market/lobbying power and the level of animal-testing for CWD.

Sector's Share in Country's GDP (SGDP): It is assumed that a decrease in the sector’s contribution to the country’s GDP draws attention from government and society, and makes it easier for producer groups (farmers and processors) to get benefits from lobbying activities (Sarker et al., 1993). The rationale for this assumption is that the deer/elk industry (include in agricultural sector) is likely to be protected in industrialized countries (Thornsbury et al., 2004). In both countries, significant decreases in the venison sector’s contribution to the country’s GDP are observed after 1997/98 (first CWD cases in farmed cervids) (Figure 3.15). Since after 2005, when the sector’s contributions had been restored to the pre-CWD level, SGDP is decreasing in both countries again (Figure 3.15). The sign on SGDP will suggest the influence of sector's contribution in the CWD-testing decision making process. The variable is calculated using the ratio of farm cash receipts to country’s GDP.

Exports and Imports: To analyze the links between the levels of CWD testing and country’s trading positions, venison net-exports (NCEM = total venison exports – total venison imports) in Canada and venison imports (CIM) in the US (no export data is available in the US) are defined. In Figure 3.16, venison net-exports in Canada and imports in the US are decreasing after 2005 in the US and after 2009 in Canada. There was no venison exports from Canada in 2003 – after detection of 15, 21, and 3 farmed deer/elk herds with CWD positive cases in 2000, 2001, and 2002 respectively (Table 3.1).

Given that the exports/imports sector is associated with the secondary and tertiary sectors in the country economy, it is assumed that governments' regulatory policies (level of CWD-testing) and countries' trading position (venison imports/exports) will be significantly linked in the favour of trade promotion.

Share of Venison Expenditure in Total Food Expenditure (SCE): This variable is used to partially capture the importance of CWD-testing to consumer groups and the political costs of intervention. The assumption is that the more consumers want to consume venison, the greater is their interests in lobbying for higher levels of food safety assurance (higher CWD-testing level) (Sarker et al., 1993). The data is developed as the ratio between per-capita venison consumption in kg multiplied by retail price in $/kg, and per-capita food expenditure – expenditure on food and non-alcoholic beverages divided by population. The share of venison expenditure in total food expenditure showed an increasing trend during the period from 2000 to 2004 and a decreasing trend after that in Canada (Figure 3.17). In the US, a decreasing trend can be observed until 2007 and an increasing trend can be observed after 2007 (Figure 3.17). The sign of estimated coefficient will indicate consumers' preference to or interest in the CWD-tested attributes in their meat purchases. The significant level will indicate decision makers' consideration about consumers' concerns in CWD-testing.

3.6.3. The Explanatory Variables for the Wild-Cervid Model

In the wild-cervid models, provincial level data – in Alberta and Saskatchewan in Canada, and in Colorado and Wyoming in the US – is used. The trends of the data for economic factors and society's concerns with detailed auxiliary assumptions are discussed below.

Wildlife-related Tourism Revenue: Total expenditures for all type of travel for pleasure are used in Alberta and Saskatchewan; and total revenues from hunting, watching, observing, photographing and feeding wild animals are used in Colorado and Wyoming. The variable is used to partially capture the importance of wildlife-related profitability to provincial/state agencies in their decision making process for CWD management strategies. Similar to SGDP in the farmed-cervid sector, the assumption here is that a decrease in the wildlife-related provincial revenue draws attention from the government and society, and makes the wildlife agencies to get benefit from lobbying activities (Sarker et al., 1993). The rationale is that the wildlife recreational sector is likely to be promoted in well-developed and environmentally responsible countries. The total expenditure for wildlife recreational activities in Alberta decreased after 2002, when the first CWD positive case was found in the province, and increased again since after 2005 (Figure 3.18). In the US, a decreasing trend can be found in Colorado until 2001 since CWD was first recognized in wild mule deer in Northern Colorado in 1967 and subsequent CWD-detection in the region during 1980s and 1990s (Figure 3.19). Historically, the total expenditure for wildlife related recreation in Canada and the US showed stable and increasing trends (Figure 3.18 and Figure 3.19). The sign of estimated coefficient will indicate the relationship between wildlife-related profitability and the level of CWD surveillance in the provinces.

Number of Deer/Elk Hunters or Hunting-License Sales: This variable is used as a proxy to measure hunters' risk perceptions through their participation in hunting activities. The assumption is that hunters' risk-perceptions about CWD in wild animals and infectivity to human is low if more people participate in hunting activities. The rationale is that the more hunters show lower perceived risk about CWD and higher participation in hunting activities, the more animals can be tested for CWD infection and it is easier to reduce population in targeted areas. The number of deer/elk hunting license sales in Alberta shows a steady and slightly increasing trend (Figure 3.20). In Saskatchewan, a significant decrease can be observed between the period from 1998 to 2000, which is the period after the first detection of CWD in a farmed elk in 1996 and the initial implementation of CWD surveillance program in 1997. Since then, the number of deer/elk hunting license sales shows a steady and slightly increasing trend in Saskatchewan (Figure 3.20). The number of deer/elk hunters was the highest in 1996 in Colorado. Since after the first CWD surveillance implemented by wildlife agencies and APHIS in 1997, the number of deer/elk hunters declined significantly in Colorado until 2001 (Figure 3.21) but a stable trend presents since then. The number of deer/elk hunters in Wyoming is stable throughout the period (Figure 3.21). The sign of estimated coefficient will indicate the relationship between hunters' risk perception, which is measured through their participation in hunting activities, and the level of CWD surveillance in the provinces/states.

Number of Persons Who Visit Public Parks, Zoos, Aquariums or Botanical Gardens: This variable is used as a proxy to measure non-consumptive users' response to the presence of CWD in wild cervids. The assumption is that the more persons visit natural parks, the lower will be non-consumptive users' risk-perceptions about the presence of wild animal diseases. The number of visits to parks and gardens declined for about three years from 2000 to 2003 in Alberta and Saskatchewan. The relatively higher perceived risk due to the subsequent cases of CWD infected deer/elk and the provincial governments' enhanced CWD-surveillance-program affected negatively to non-consumptive users in Canada (Figure 3.22). However, increasing trends after 2003 reveal the effectiveness of governments' surveillance efforts in building non-consumptive users' confidence with regard to CWD in wild cervids (Figure 3.22). A stable trend can be observed in Saskatchewan. In Colorado (Wyoming), a significant (slight) decrease in the number of people who visited to public parks can be observed since after CWD-detections and enhanced CWD-surveillance by wildlife agencies and APHIS in 1997 (Figure 3.23). The sign of estimated coefficient will indicate the relationship between non-consumptive users risk perceptions about CWD in wild cervids and the level of CWD surveillance in the provinces.

Number of Persons Who Take Part in Viewing, Photographing and Feeding Wild-Animals: This variable is used as a proxy to measure the impact of regulations on feeding deer and the impact of herd reduction program in the wild cervid sector. The assumption is that the more is the number of participation in wildlife viewing, photographing and feeding activities, the lower is the impact of governments' regulatory strategies with regards to feeding restrictions and herd reduction programs in CWD prevalence regions. A fluctuation between the 1998 to 2005 period in Alberta and a decrease between the 1998 to 2000 period in Saskatchewan can be observed (Figure 3.24). Historically, the number of wildlife viewers, photographers and feeders is relatively stable in Wyoming compared to the number of participants in Colorado, which shows a significant decrease between the 1996 to 2001 period (Figure 3.25). The sign of estimated coefficient will indicate the relationship between societal response to wildlife-feeding restrictions/herd-reduction programs and the level of CWD surveillance in the provinces/states.

Number of Deer/Elk Farms: This variable is used as a proxy to measure the farmed sector's response to CWD in wild cervids. The assumption is that an increasing number of deer/elk farms in the province/state imply a lesser impact of CWD-detection in wild cervids on the farmed-cervid sector. In Figure 3.26, a decreasing trend in the number of deer/elk farms in Alberta and Saskatchewan since 2002-03 can be observed. In Colorado a decreasing trend between the periods from 1991-2001 and a relatively stable number of farms after that period can be observed (Figure 3.27). In Wyoming, cervid farms are not allowed to exist. The sign of estimated coefficient will indicate the link between the farmed sector's growth and CWD surveillance levels in the wild sector.

3.7. Results and Discussion

Time series data is used for the period from 1991 to 2012. Since data availability is limited only 22 observations are used in all the farmed and wild cervid models in Canada, the US and provinces/states.

3.7.1. Model Results for the Farmed-Cervid Sector

The calculated price, discussed in section 3.6 and deflected by CPI, is used in the analysis. A unit-root test is conducted on the deflected price series. A KPSS test was conducted using Eviews econometric software with the null hypothesis that the prices are trend stationary or do not have a unit root process in the series. Using a constant and linear trend as exogenous variables, KPSS tests suggest the presence of trend stationary in all the price series (producer price and retail price in Canada and the US) at 10% significant level (Table 3.3). Therefore, it can be assumed that current prices are a function of previous prices and can be used without a random walk process in the model (Verbeek, 2008). In Table 3.4, the autocorrelation test results for each equation are presented. Since the production functions and consumption functions in the farmed cervid models include lagged dependent variables, Durbin h-tests are used. Durbin-Watson tests are used for the political economy equations in farmed and wild cervids models. All the test statistics do not reject the null hypothesis of no autocorrelation in both Canada and the US (Table 3.4).

In the estimation of farmed-cervid models, the systems of equations – supply function, demand function and political-economy model – Eq3.8, Eq3.9 and Eq3.10 respectively – were estimated simultaneously for each country. Nonlinear multivariate regression method with least squares (LSQ) command in the TSP (5.0) program is used to get maximum likelihood estimates. By estimating a system of equations simultaneously, cross-equation contemporaneous correlations can be accounted for in the farmed cervid models. The estimated coefficients, signs and significant levels are presented in Tables 3.5 to Table 3.8. The parameter estimates in the supply and demand functions are highly significant and exhibit the correct curvature with respect to producer prices and input prices in the supply functions, and retail prices and per capita incomes (except in the US's farmed-cervid model) in the demand functions respectively (Table 3.5 and Table 3.6). Goodness of fit statistics – R-squared – for all equations is high (lower in the supply equation in the US's farmed-cervid model) suggesting good explanatory power of the models. Robust standard errors with a heteroskedastic consistent covariance matrix approach are used. In the estimation for wild-cervids, a single equation (Eq 3.11) was estimated for each selected province/state – Alberta, Saskatchewan, Colorado and Wyoming. Goodness of fit statistics (R-squared) is high. Since homoskedasticities (LM Statistics) are rejected in the Saskatchewan and Wyoming models, robust standard errors with a heteroskedastic consistent covariance matrix approach are used (Table 3.10).

In Table 3.7, supply elasticities, demand elasticities and *relative political weights* (government focus on producers' welfare relative to consumers' welfare), calculated at the mean of variables (prices, percapita beef consumption and beef production) in the CWD-testing models are presented in comparison to BSE-testing models. In Table 3.8, the results of the political economy models for farmed-cervids in Canada and the United States are presented. In Table 3.11, the comparison of results of political economy models for *CWD-testing level* in the farmed-cervid industries (in Canada and the US) and *BSE-testing level* in the cattle industries (in Canada, the US and Japan) are presented. The price elasticities of venison demand and supply in Canada is higher than that in the US and is higher than beef demand and supply elasticities in all the three countries - Canada, the US and Japan (Table 3.7). The steeper venison demand and supply curve in Canada suggests higher price volatility compared to other countries and beef. Volatile prices do not favour industry competitiveness and consumer satisfaction. In the US, the price elasticity of demand and supply for venison and beef are almost the same (Table 3.7).

The calculated *relative political weights* (λs) at the average of elasticities and prices are 1.7 in Canada and -0.5 in the US. The calculated *relative political weights* (λs) in the beef-cattle models are 1.6 in Canada, 0.9 in the US and 0.5 in Japan (Table 3.7). The results in farmed-cervid model suggest that compared to the weight of government focus on consumers' welfare, the weight of government focus on producers' welfare is 1.7 (λ=1.7) times larger in Canada, and 0.5 (λ= -0.5) times less in the US. Given that, producers' lobbying activities might be more effective in Canada and consumers' lobbying activities might be more effective in the US in determining *CWD-testing level*. Moreover, an increasing trend in Canada and a decreasing trend in the US can be observed in Figure 3.28. One of possible reasons is that although the alternative livestock industry is encouraged in Canada for some reason such as stabilizing farm incomes, utilizing marginal agricultural land, and conserving specialized livestock, cervid farms are not even allowed to exist in some states in the US, for example in Wyoming. The results in beef-cattle model suggest that compared to the weight government focus on consumers' welfare, the weight government focus on producers' welfare is 1.6 (λ=1.6) time larger in Canada, almost the same (λ=0.9) in the US, and only half (λ=0.48) in Japan. Given that, producers' lobbying activities might be more effective in Canada and consumers' lobbying activities might be more effective in Japan in determining respective countries' *BSE-testing level*. However, in terms of trend over time, a decreasing trend of relative political weights in Canada and a rather stable trend in the US can be observed since 1990s (Figure 3.29). It is worth noting that the signs on the *cumulative number of deer & elk farms found with CWD* in both Canada and the US, and the *BSE (domestic animals finding) * Time Trend* in the three countries are positive (Table 3.9). Numerous authors have commented on the counterintuitive sign on the finding of BSE in domestic animals in Canada and the US relative to results in Europe. Given that there is no evidence of human health implication from venison consumption, the level of animal-testing in response to CWD seems mainly for producers' economic growth in Canada and the US.

Another reason that can determine a country's adopted TSE-testing level is the number of animals slaughtered in the country. If a country is exporting more meat than live animals, more animals will be slaughtered inside the country and vice versa. Since Canada is a net venison exporter and the US is net venison importer (Figure 3.16), Canadian government considers more about producers' welfare (λ=1.7) and the US government considers more about consumers' welfare (λ= -0.5). In the beef-cattle sector, Canada exports more live cattle than beef leading to lower slaughtering activities than the US, where imported and home-grown cattle are slaughtered for both domestic consumption and exports. Therefore, Canadian government focus more weight on producers economic benefit (λ=1.6) and the US government put almost the same weight (λ=0.9) on producers' economic benefit and consumers' welfare. Similarly, since Japan is a major beef importing country, government puts more weight on consumers' welfare (λ=0.48) in response to BSE.

The *relative political weight* variable, which measure the weight that government focus on producers' welfare relative to consumers' welfare, in farmed-cervid model is positively significant ($\alpha < 0.05$) and in the beef-cattle model is negatively significant ($\alpha < 0.1$) in Canada (Table 3.8 and Table 3.9). A significantly positive sign on *relative political weight* variable in the farmed cervid model in Canada suggests that as the government attaches more weight on producers' welfare, the higher *CWD-testing level* will be considered. A negatively significant ($\alpha < 0.1$) sign on *relative political weight* variable in *BSE-testing level* in Canada suggests that as the government attaches more weight on producers' welfare, a lower *BSE-testing level* will be considered (Table 3.9). Since, in Canada, the calculated *relative political weight* of government's focus on producer welfare relative to consumer welfare (λ) is 1.7 in the farmed cervid model and 1.6 in the beef-cattle model, producers' lobbying efforts towards higher *CWD-testing level* in the cervid industry and producers' lobbying effort towards lower *BSE-testing level* in the beef industry are more effective compared to consumers' lobbying efforts to change the animal testing levels. It is worth noting that the signs on the dummy variable about the first detection of domestic BSE-case and cumulative CWD positive cases are negative, and the sign on the cumulative number of deer and elk farms found with CWD infected animals in the country are positive in Canada. Some (Fox et al., 2005; Le Roy and Klein, 2005; Le Roy et al., 2007) have suggested that the response was a pro-support for farmers, given the wide perception that BSE and CWD was not a threat to human health but was a threat to farmers' economic health.

In the US, the sign on *relative political weight* variable is negatively significant in both the farmed-cervid model ($\alpha < 0.01$) and beef-cattle model ($\alpha < 0.05$). A tendency of lower *TSE-testing level* is expected as the government focus on producers' welfare. Since the calculated *relative political weights* in the farmed-cervid model and in the beef-cattle model are -0.5 and 0.92 respectively (Table 3.7), producers' lobbying effort towards a lower level of animal-testing for CWD needs to be stronger than their lobbying effort towards a lower level of animal testing for BSE in the US. The *relative political weight* variable in the cattle-model is positively significant in Japan ($\alpha < 0.05$) (Table 3.9). The result suggests that as the government attaches more weight on producers' welfare, a higher *BSE-testing level* will be considered in Japan. Since, the calculated *relative political weight* in Japan is 0.48, producers' lobbying effort towards a higher *BSE-testing level* needs to be more than two times stronger compared to consumers' effort toward a lower BSE-testing level. In another way, since the focus of Japanese government on consumers' welfare is two times higher than on producers' welfare ($\lambda = 0.48$), a tendency of lower *BSE-testing level* is expected if there is no lobbying effort towards a higher level of BSE-testing by producers' group.

The link between *CWD-testing level* and *farm cash receipts* is positive in Canada ($\alpha < 0.01$) and negative in the US ($\alpha < 0.05$) (Table 3.8 and Table 3.9). The results suggest that a higher gross income increases producer's interest to lobby for a higher (lower) level of *CWD-testing* in farmed-cervids in Canada (the US). The results of beef-cattle model in Canada (negatively significant: $\alpha < 0.01$) and Japan (positively significant: $\alpha < 0.01$) provide similar suggestion that a higher gross income increases producer's interest to lobby for a lower level of *BSE-testing* in Canada and a higher level of *BSE-testing* in Japan. The fact in Japan is sensible given that Japan is a beef-importing country and it needs to maintain a certain percentage of food security by maintaining producers' economic health. In contrast, the link between the *BSE-testing level* and *farm* *cash receipts* is significant and positive in the US, where a higher *farm cash receipt* weaken producers' lobbying efforts for lower *BSE-testing level.*

The link between *CWD-testing level* and *regional concentration in deer-elk inventories* is not significant in the US. The positive significant ($\alpha < 0.01$) sign on *regional concentration in deer-elk inventories* in Canada suggests that as producers are more consolidated, they will consider more about a higher *CWD-testing level* in the country. Another possible reason includes being a venison-net-exporting country and the government's weight on producers' welfare which is 1.7 times higher than that on consumers' welfare ($\lambda = 1.7$). However, the significantly ($\alpha < 0.01$) positive (negative) signs on *regional concentration in beef-cow inventories* in Canada and the US (Japan) suggests that as producers are more consolidated, they will consider more about market access and consumer desire for a higher (lower) *BSE-testing level* in the country. The relationship between the *BSE testing level* and *concentration in the meat processing industry* is not significant in all the three countries – Canada, the US and Japan. The result suggests that meat processors' lobbying efforts are not considered in the decision making process associated with the level of animal testing for BSE, for example the Creekstone Farms in the US.

The link between *CWD-testing level* and *sector's share of contribution in country's GDP* is negatively significant in Canada ($\alpha < 0.5$) and is positively significant in the US ($\alpha < 0.01$) (Table 3.8). The results suggest that if *sectors' share in country's GDP* (which is positively related to the total trade and consumption value) tends to decrease, a higher *CWD-testing level* will be imposed in Canada, which is a major exporting country, and a lower *CWD-testing level* will be imposed in the US, which is a venison-importing country, in favour of producers' position of animal-testing level. In the case of the *BSE-testing level* adoption, the sign on *sector's share of contribution in country's GDP* is negatively significant in Canada ($\alpha < 0.05$) (Table 3.9). Different from *CWD-testing level*, Canadian government will impose a lower level of animal testing in favour of producers' welfare (λ=1.59) as the *sectors share of contribution in country's GDP* increases. Since Japan is a major beef-importing country and *beef sector's share of GDP* has been restored since 2005 on, the factor seems unimportant in determining the level of animal testing for BSE in the country. Similarly, the variable is not significantly linked to the *BSE-testing level* consideration in the US, since the sector's contribution to GDP showed an upward trend from 2003 to 2009.

Due to data limitation, the *farm-retail price spread* variable is not used in the farmed-cervid models (Table 3.9). The variable is significant in beef-cattle models in Canada (producer more oriented country: λ=1.59) and Japan (more consumer oriented country: λ=0.48). As a prior assumption, a highly significant and negative sign on *farm-retail price spread* in Canada ($\alpha < 0.05$) suggests that a wider farm-retail price spread draws sympathy from society, and increases the incentives for and marginal benefit of lobbying by producer groups towards a lower *BSE-testing level* in Canada. Highly significant and positive sign in Japan ($\alpha < 0.01$) suggests that a higher profit margin of processors which negatively affects consumers' welfare will inform decision makers to shift *BSE-testing* to a higher level. Studies (McCluskey et al. 2005; Schroeder et al. 2006; Aubeeluck 2010) show a higher consumers' willingness to pay premium for BSE-tested beef in Japan market compared to that in Canada and the US. The variable is not statistically significant in the US (where λ=0.92), since the price spread is relatively less compared to that in Canada and Japan during the first half of 2000s.

Highly significant positive response to the *share of venison consumption in food expenditure* in Canada (α < 0.01) and negative-responses in the US ($\alpha < 0.05$) suggests that if consumers reduce venison consumption due to CWD concerns, the Canada government will consider to shift the *CWD-testing* to a lower level and the American government will consider to shift the CWD-testing to a higher level. The level of CWD-testing will be decreased (increased) according to Canadian (American) consumers' interest in CWD-tested food-safety attributes in their venison purchases. The sing is consistent with the prior assumption in Section 3.6 and the results of BSE-testing model in cattle. A highly significant positive response to the *share of beef consumption in food expenditure* in Canada ($\alpha < 0.01$) and a significant negative response to the *share of beef consumption in food expenditure* in the US (λ=0.92 and $\alpha < 0.01$) suggests that if consumers reduce beef-consumption due to BSE-concerns, Canadian government will consider to shift the *BSE-testing* to a lower level and the American government will consider to shift the *BSE-testing* to a higher level for consumer satisfaction. Highly significant positive sign on the *share of beef consumption in food expenditure* in Japan

($\alpha < 0.05$) suggests that if consumers reduce beef-consumption due to higher prices or due to a lower supply of BSE-tested beef in the market, Japan government (λ=0.48) will consider to impose consumers' desire position of a lower *BSE-testing level*.

Trade status is a significantly ($\alpha < 0.01$) important factor in determining the TSE-*testing level* in both Canada and the US, and Japan. Highly significant negative signs on *venison net export* in Canada and negative sign on *venison imports* in the US can be observed. The negative sign in Canada suggests that the *CWD-testing level* will be increased if domestic consumption decreased and more exports occurred in the country since Canadians do not prefer a higher *CWD-testing* level in their venison supply. Since the US is importing venison meat from other countries, a lower *CWD-testing level* will be imposed on domestic animals. Some differences and similarities can be observed in the beef-cattle sector. All the three countries do exhibit a strong negative relationship between beef trade levels and *BSE testing level* adopted. The negative sing ($\alpha < 0.01$) on *beef exports* and positive sign ($\alpha < 0.01$) on beef net exports in Canada and the US suggest that a higher BSE-testing level will be considered only if beef net exports, which require a higher number of cattle slaughtered in the country, increases. From the previous study about BSE-testing, it was obvious that beef-net-exports and live-cattle exports are highly correlated. Thus, the sign on *cattle and calf exports* in Canada is positive and significant in Table 3.9. Like the venison importer 'the US', beef importer 'Japan' shows a negatively significant ($\alpha < 0.05$) sign on *beef imports* variable. The result suggests that if beef imports from other countries increase, a lower *BSE-testing level* will be imposed on domestic animals in Japan.

The results show highly significant ($\alpha < 0.01$) positive links between *CWD-testing level* and the *cumulative number of deer and elk farms found with CWD infected animals* in Canada. Highly significant ($\alpha < 0.01$) negative relationships between *CWD-testing level* and the *cumulative number of CWD positive cases in both farmed and wild cervids* suggest that a lower the *CWD-testing* level will be considered in farmed cervids if CWD incidents increase in the wild sector in Canada. In addition, a significant negative sign on time trend in Canada suggests that the *CWD-testing* level in the farmed-cervid sector is lowered over the time. In the US, the *CWD-testing* level in farmed cervids is significantly ($\alpha < 0.01$) and positively linked to the CWD-testing level in wild cervids. In the beef model, the link between the *BSE-testing level* and the *number of domestic BSE-cases over time* is positive and significant ($\alpha < 0.01$) in Canada, the US and Japan. A significantly ($\alpha < 0.01$) negative sing on the dummy variable after first BSE-positive-case is observed in Canada. Since Canada follows OIE's standard of *BSE-testing* based on disease prevalence assessment, a higher *BSE-testing level* was imposed just after first BSE positive case in 2003. The *BSE-testing level* was gradually reduced after the OIE classified Canada as a controlled BSE risk country in May 2007. The OIE classified Japan and the US as countries having negligible risk status for BSE in May 2013.

3.7.2. Model Results for the Wild-Cervid Models

Table 3.10 presents the results of the political economy model for CWD-testing in wild cervids in Alberta and Saskatchewan in Canada, and in Colorado and Wyoming in the US. The *wildlife related tourism revenue*, which is used to capture the importance of wildlife-related profitability to provincial/state agencies, is positively significant in Saskatchewan ($\alpha < 0.01$) and Wyoming ($\alpha < 0.01$), and negatively significant in Colorado ($\alpha < 0.05$). The results suggest that to achieve a higher profit from wildlife related recreational activities, a higher *CWD-testing level* in wildlife areas will be imposed in Saskatchewan and Wyoming and a lower *CWD-testing level* will be imposed in Colorado. The incentive to participate in hunting activities for *CWD-testing* might help revenue increase in Saskatchewan and Wyoming (a slight increasing trend in Figure 3.18 and Figure 3.19). In Colorado, a relatively steeper total revenue trend (Figure 3.19) weakens wildlife agencies' lobbying effort to a higher level of *CWD-testing* in the area. Given that the Colorado state government will consider imposing a lower level of *CWD-testing* in wild cervids as long as the profitability from wildlife related recreation is progressing.

A highly significant and positive link between the *CWD-testing level* and the *number of deer/elk hunting license sold* in Alberta ($\alpha < 0.01$) and *the number of deer/elk hunters* in Wyoming ($\alpha < 0.01$) can be observed. But the link between the *CWD-testing level* and the *number of deer/elk hunting license sold* in Saskatchewan ($\alpha < 0.05$) is negative. The results suggest that, as a prior assumption in Section 3.6, if the society has lower perceived risk about CWD and higher participation in hunting activities, a higher *CWD-testing level* will be imposed in Alberta and Wyoming. The reverse is true in

Saskatchewan. An increasing number of deer/elk hunting license sold in Alberta and a steady number of deer/elk hunters in Wyoming meant hunters' lower perceived risk about CWD in the two areas (Figure 3.20 and Figure 3.21). A decreasing number of deer/elk hunting license sold in Saskatchewan during the 1998 to 2000 period and after 2009 suggests hunters' higher perceived risk about CWD in the area. The link between the *CWD-testing level* and the number of *persons who visit natural parks* is positively significant in Alberta ($\alpha < 0.01$) and negatively significant in Colorado ($\alpha < 0.1$). A negative correlation between the *number of visitors in natural parks* and their risk perceptions about wild-animal's disease had been assumed in Section 3.6. The results suggest that to reduce non-consumptive users' risk-perceptions about the presence of wild animal diseases, a higher (lower) *CWD-testing level* in wild cervids will be imposed in Alberta (Colorado).

The link between the *CWD-testing level* and the *number of persons who participate in wildlife viewing, photographing and feeding* is negatively significant in Alberta ($\alpha < 0.01$), Saskatchewan ($\alpha < 0.05$) and Wyoming ($\alpha < 0.1$) and positively significant in Colorado ($\alpha < 0.1$). According to the assumption in the Section 3.6, a higher testing level (which is one of herd reduction program) and other regulation such as restriction on feeding deer in CWD prevalence regions will have a negative impact on non-consumptive users' participation in wildlife-related recreational activities. If the policy is to promote non-consumptive users' recreational activities related to wild cervids, a lower *CWD-testing level* will be imposed in Alberta, Saskatchewan, Wyoming and a higher *CWD-testing level* will be imposed in Colorado. The link between the *CWD-testing level* in wild cervids and the *cumulative number of CWD positive animals* within the province is positively significant in Alberta ($\alpha < 0.01$) and is negatively significant in Saskatchewan ($\alpha < 0.01$), Colorado ($\alpha < 0.01$) and Wyoming ($\alpha < 0.1$). In Alberta, the *CWD-testing level* is positively linked to the *cumulative CWD positive animals* within the province ($\alpha < 0.01$) and it is negatively linked to the *number of CWD-positive animal*s in the whole country ($\alpha < 0.01$). In Wyoming, the *CWD-testing level* is positively linked ($\alpha < 0.1$) to the number of *CWD positive animals* in Colorado States. The *CWD-testing level* is significantly and positively linked to the *cumulative number of deer/elk farms found with CWD-infected animals* in Saskatchewan ($\alpha < 0.01$) and

Colorado ($\alpha < 0.01$); it is negatively linked to the *number of CWD-tested farmed-cervids* in Colorado ($\alpha < 0.05$); and it is negatively linked to the *number of deer/elk farms* within the province in Alberta ($\alpha < 0.01$) and Saskatchewan ($\alpha < 0.05$). As a prior assumption, the *CWD-testing level* in wild cervids is significantly and positively linked to *enhanced CWD-surveillance period (Dummies)* in Alberta ($\alpha < 0.01$), Colorado ($\alpha < 0.01$) and Wyoming ($\alpha < 0.01$).

3.8. CONCLUSIONS

In this study, the underlying factors about *"why did governments implement particular level of animal testing for TSEs?"* is determined in the farmed cervid sectors at national level in Canada and the US, which is in comparison to the study on the beef-cattle sector in Canada, the US and Japan. Given the diverse set of CWD-testing regulations in wild cervids across different regions, political economy models in the wild cervid sector are set up at the provincial/state level – Alberta and Saskatchewan in Canada, and Colorado and Wyoming in the US. The results of relative political weight calculation on average suggest that compared to consumers' welfare, the government attaches more weight (1.7) on producers' welfare in Canada and less than half (-0.5) weight on producers' welfare compared in the US in the farmed-cervid sector. In the beef-cattle sector, government attaches 1.6 times higher weight, almost the same weight and a half lower weight on producers' welfare compared to governments' weight on consumers' welfare in Canada, the US and Japan respectively.

Table 3.11 presents the summary of significant variables across the sectors and across the countries. Governments' responses in general are to change the levels of surveillance for TSEs. The results clearly suggest a tendency of a lower *BSE-testing level* and a higher *CWD-testing level* as the Canadian government focus on producers' welfare in the farm sector. In the US, a higher *BSE*- and *CWD-testing level* will be imposed as the government focus on consumers' welfare. In Japan, a tendency of lower *BSE-testing level* is significant as the government focus more on consumers' welfare. There is a tendency of higher *CWD-testing level* in Canada if domestic consumption increase and export decrease. A tendency of lower *CWD-testing level* in the US – a venison-importing country – can be observed if the governments focus more on producers' welfare and lower domestic slaughtering. In order to promote beef-net-exports in the cattle industry, the results suggest a tendency of higher BSE-testing level due to higher slaughtering activities in domestic animals in Canada and the US. In the wild-cervid sector, the results suggest a tendency of higher *CWD-testing level* in order to promote consumptive users' participation in wildlife-related recreational activities (hunting in Alberta and Wyoming). A higher (lower) *CWD-testing level* is suggested in response to CWD positive cases within province in Alberta (Saskatchewan, Colorado and Wyoming). A tendency of lower *CWD-testing level* can be observed in order to promote non-consumptive users' participation in wildlife-related recreational activities (wildlife viewing, feeding in Alberta and Wyoming).

Ultimately, in the cattle and farmed-cervid sector, the economic profitability of producers, consumers' concerns about the safety of meats and countries' trade-status influence the *TSE-testing* adoption level. In general, export-dependent countries (Canada for beef and venison; the US for beef) attach more weight to producers' welfare and importing countries (the US for venison; Japan for beef) attach more weight to consumers' welfare. For whatever reasons, possibly mostly due to costs, neither producer nor processor groups in general, seem to be much in favour of *TSE-testing* in the farmed sector. The determination of the *CWD-testing levels* in wild-cervids varies across provinces/states (Table 3.10). Economic profitability to wildlife-related agencies, society concerns about wild-animals' health, the CWD-infection levels in both wild and farmed-cervid are important factors in the consideration of the *CWD-testing level* in the wild sector in Alberta, Saskatchewan, Colorado and Wyoming. Since different factors influence the testing levels in different ways across provinces/states in Canada and the US, testing levels in the wild cervid sector will be determined according to the regional requirements and the welfare-consideration of interested parties. Responding to different situations in different regions seems the easier way to manage CWD in wild cervids.

Table 3. 1. Positive farmed-deer/elk-herds in Canada and the United States

<table>
<tr><th></th><th colspan="2">Positive farmed herds</th></tr>
<tr><th></th><th>Canada</th><th>US</th></tr>
<tr><td>1996</td><td>1</td><td>0</td></tr>
<tr><td>1997</td><td>0</td><td rowspan="8">34</td></tr>
<tr><td>1998</td><td>1</td></tr>
<tr><td>1999</td><td>0</td></tr>
<tr><td>2000</td><td>15</td></tr>
<tr><td>2001</td><td>21</td></tr>
<tr><td>2002</td><td>3</td></tr>
<tr><td>2003</td><td>1</td></tr>
<tr><td>2004</td><td>1</td></tr>
<tr><td>2005</td><td>0</td><td>6</td></tr>
<tr><td>2006</td><td>2</td><td>1</td></tr>
<tr><td>2007</td><td>6</td><td>0</td></tr>
<tr><td>2008</td><td>4</td><td>4</td></tr>
<tr><td>2009</td><td>2</td><td>3</td></tr>
<tr><td>2010</td><td>5</td><td>2</td></tr>
<tr><td>2011</td><td>4</td><td>3</td></tr>
<tr><td>2012</td><td>2</td><td>2</td></tr>
</table>

Source: CFIA: http://www.inspection.gc.ca/english/anima/disemala/cwdmdc/incnome.shtml
USDA: Animal and Plant Health Inspection Service www.aphis.usda.gov/animal_health/animal_health_report/

Table 3. 2. Conceptual frame of explanatory variables in the models

Farmed-Cervid Model	Wild-Cervid Model
1. Political Market Effects	
Relative Political Weight	
• Used as a proxy for determining the policy instrument levels of CWD-testing decision. • The sign of the variable represents the relationship between the relative weights governments place on producers' welfare and governments' regulatory policy (level of CWD-testing). • Since the variable is developed as the relative weight government focuses on producers' welfare, the expected sign is associated with the producers' desired level of CWD/BSE-testing regulation.	
2. Economic Factors/ Commodity Characteristics: • Used as proxies for the strength of the producers'/ processors' lobby and indirectly the political costs of specifying a particular level of animal-testing regulation in farmed cervids.	**1. Economic Factors:** • Used as proxies for the strength of the agencies' lobby and indirectly the political cost of specifying a particular level of animal-testing regulation in the wild cervid sector.
Real Farm Cash Receipt • Used as a proxy for the farm position and the cost of protection.	***Total Revenue from Wildlife-related Recreation*** • Includes revenues from visiting zoo, aquarium or botanical garden, from visiting a theme or amusement park, from visiting national or provincial park, from visiting a historic site, and from hunting, viewing birds, sightseeing,

	photographing and feeding wild animals. • Used as a proxy for the profitability of wildlife tourism.
Regional Concentration in farmed-cervid inventories • Used as a proxy for the farm position and the cost of protection.	
Farmed-cervid Sector's Share in Countries GDP • Used as a proxy for the farm position and the cost of protection.	
Venison Exports and Imports • To capture the link between the level of CWD-testing and country's trading position.	
3. Society's Concerns: • Used as a proxy for public health consideration and consumers' concerns about food safety.	**2. Society's Concerns:** • Participation in wildlife-related recreational activities is used as a proxy for society's concerns about the health risk to humans and wild animals.
Share of Venison Expenditure in Total Food Expenditure • To capture the importance of consumer groups of CWD-testing and the political costs of protection.	***Number of Deer-Elk Hunters*** • Used as a proxy for hunters' risk perceptions through their participation in hunting activities.
	Number of Persons Who Visit Public Parks, Zoos, Aquariums or Botanical Gardens • Used as a proxy for the measurement of non-consumptive users' response to the presence of CWD in wild cervids.
	Number of Persons Who Take Part in Wildlife Viewing, Photographing and Feeding

	• Used as a proxy for the impact of regulations on feeding deer-elk and herd reduction programs.
	Number of Deer-Elk Farms • Used as a proxy for the farmed cervid sector's response to CWD in wild cervids.
4. Disease Prevalence/ Management Strategies • Used as a proxy for the impact of CWD positive cases and the reflection of the length of active intervention on regulatory policy.	**3. Disease Prevalence/ Management Strategies** • Used as a proxy for the impact of CWD positive cases and the reflection of the length of active intervention on regulatory policy.
Number/ Cumulative Number of CWD Positive Cases in the Farmed Deer-Elk Population	***Number/ Cumulative Number of CWD Positive Cases in the Farmed Deer-Elk Population***
Number of Deer-Elk Farms, Found with CWD Positive Cases	***Number of Deer-Elk Farms, Found with CWD Positive Cases***
Time Trend	***Dummy:*** • Representing an updated CWD management plan for example moving from voluntary surveillance to mandatory surveillance and instituting a temporary herd reduction program.

Table 3. 3. Results of unit- root test on price series

Price series deflected by CPI	KPSS test statistics
Canada	
Producer Price	0.0818
Retail Price	0.0822
The US	
Producer Price	0.1013
Retail Price	0.0999
Critical Values	
1%	0.216
5%	0.146
10%	0.119

Table 3. 4. Results of auto-correlation test

Equations	Test	Statistics (p-value)
Farmed Cervid Models		
Canada		
Production	Durbin's h-Test	0.22 (0.82)
Consumption	Durbin's h-Test	-1.48 (0.14)
Political Economy	Durbin-Watson Test	2.13 (0.001)
The US		
Production	Durbin's h-Test	0.83 (0.40)
Consumption	Durbin's h-Test	-0.32 (0.75)
Political Economy	Durbin-Watson Test	2.03 (0.01)
Wild Cervid Models		
Canada		
Alberta	Durbin-Watson Test	2.2 (0.01)
Saskatchewan	Durbin-Watson Test	2.3 (0.02)
The US		
Colorado	Durbin-Watson Test	1.6 (0.00)
Wyoming	Durbin-Watson Test	2.0 (0.002)

Table 3. 5. Results of Supply Equation in Farmed Cervids model in Canada and the US

Venison production as dependent variable	Canada			United States		
	Coeff.	**Sign**	**Sig.**	**Coeff.**	**Sign**	**Sig.**
Constant	0.42	+	**	3.77	+	***
Producer Price	4.36	+	***	15.3	+	*
Input Price	0.01	-	***	0.12	+	
Venison production (-1)	0.52	+	**	0.42	+	**
Number of Observations		20			20	
R^2		0.80			0.67	
LM Statistics		0.04 [0.84]			1.94 [0.16]	

Note: : '***' 1% level of significance; '**' 5% level of significance, '*' 10% level of significance.

Table 3. 6. Results of Demand Equation in Farmed Cervids model in Canada and the US

Venison consumption as dependent variable	Canada			United States		
	Coeff.	**Sign**	**Sig.**	**Coeff.**	**Sign**	**Sig.**
Constant	0.01	+		0.5	+	***
Retail Price	0.09	-	***	1.32	-	**
Per capita income	0.0001	+		0.003	-	***
Venison consumption (-1)	0.46	+	***	1.22	+	***
Cumulative number of farms found with CWD infected animals	0.001	-	*	0.00003	+	
Cumulative number of wild deer & elk tested for CWD				0.00003	+	
Dummy: Canada - 2002; US-1997	0.004	+	***	0.01	+	**
Number of Observations	20			20		
R^2	0.75			0.99		
LM Statistics	**0.1 [0.75]**			**1.81 [0.18]**		

Note: : '***' 1% level of significance; '**' 5% level of significance, '*' 10% level of significance.

Table 3. 7. Comparison of Calculated Demand/Supply Elasticities and Relative Political Weights

	CWD		BSE		
	Canada	**US**	**Canada**	**US**	**Japan**
Demand Elasticity	-0.35 (-3.15)	-0.10 (-1.94)	-0.28 (-4.04)	-0.09 (-2.92)	-0.27 (-2.55)
Supply Elasticity	3.12 (6.96)	0.05 (1.65)	0.50 (2.86)	0.08 (2.29)	0.01 (2.50)
Relative Political Weight (λ)	1.73 (22.9)	-0.50 (-3.93)	1.59 (11.04)	0.92 (3.68)	0.48 (1.74)

Note: T-statistics in parentheses.

Table 3. 8. Results of Political Economy Model for CWD-Testing in Farmed Cervids in Canada and the US

Number of CWD-tested deer & elk as dependent variable	**Canada**			**United States**		
	Coeff.	**Sign**	**Sig.**	**Coeff.**	**Sign**	**Sig.**
Constant	59.7	-	***	131.8	-	***
Political market effects:						
Relative political weight	13.3	+	**	32.5	-	**
Economic factors:						
Farm cash receipts	0.49	+	**	0.02	-	***
Regional concentration in deer & elk inventories	346	+	***	847	+	***
Venison sector's share in GDP	47754	-	***	8655	+	***
Venison exports (Canada: net exports; US: imports)	0.03	-	***	8.4	-	***
Public health consideration and consumer concerns about food safety						
Share of venison consumption in food expenditure	220715	+	***	4277	-	***
Disease prevalence:						
Cumulative CWD positive cases in the country	0.13	-	***			
Cumulative number of deer & elk farms found with CWD infected animals in the country	1.68	+	***	0.12	+	***
Number of wild deer & elk tested for CWD				0.0002	+	***
Time trend	4.62	-	***			
Number of Observations	20			20		
R^2	0.89			0.96		
LM Statistics	0.18 [0.67]			2.75 [0.1]		

Note: : '***' 1% level of significance; '**' 5% level of significance, '*' 10% level of significance.

Table 3. 9. Comparison of Political Economy Model Results for CWD-Testing in the Farmed Cervid Sector and BSE-Testing in the Cattle Sector (Signs & Significant Levels)

	CWD		BSE		
Dependent variable: Number of CWD-tested deer & Elk; BSE-testing %	**Canada**	**US**	**Canada**	**US**	**Japan**
Constant	- ***	+ **	- ns	+ ns	- ***
Political market effects:					
Relative political weight	+ **	- ***	- *	- **	+ **
Economic factors:					
Farm cash receipts	+ ***	- **	- ***	+ ***	+ ***
Regional concentration inventories	+ ***	ns	+ ***	+ **	- ***
Concentration in meat processing industry			+ ns	- ns	- ns
Sector's share in GDP	- ***	+ **	- **	+ ns	- ns
Farm-retail price spread			- **	+ ns	+ ***
Cattle and calf exports			+ ***	+ ns	
Venison exports (Canada: net exports; US: imports); Beef exports (Canada and US: exports; Japan: imports)	- ***	- ***	- ***	- ***	- **
Beef net exports			+ ***	+ ***	
Public health consideration and consumer concerns about food safety					
Share of consumption in food expenditure	+ ***	- **	+ ***	- ***	+ **
Disease prevalence:					
Cumulative CWD positive cases in the country ; Number of BSE positive cases*time trend	- ***			+ ***	+ ***
Cumulative number of deer & elk farms found with CWD infected animals in the country	+ ***				
Number of wild deer & elk tested for CWD		+ ***			
Time trend	- *		+ ***		
BSE Dummy 2003 in Canada			- ***		
Number of Observations	20	20	36	36	37
R^2	0.89	0.96	0.88	0.79	0.88
LM Statistics	0.18 [0.67]	2.75 [0.1]	0.79 [0.37]	23.4 [0.00]	0.56 [0.46]

Note: : '***' 1% level of significance; '**' 5% level of significance, '*' 10% level of significance.

Table 3. 10. Results of Political Economy Model for CWD-Testing in Wild Cervids in Canada and the US

Number of CWD-tested deer & elk as dependent variable	**Alberta**			**Saskatchewan**			**Colorado**			**Wyoming**		
	Coeff.	**Sign**	**Sig.**	**Coeff.**	**Sign**	**Sig.**	**Coeff.**	**Sign**	**Sig.**	**Coeff.**	**Sign**	**Sig.**
Constant	31742	-	***	454	-		64772	-	*	9715	-	*
Wildlife related tourism revenue	0.08	+		1.36	+	***	0.002	-	**	0.002	+	***
Number of hunting license sold/hunters	0.28	+	***	0.02	-	*	0.01	-		0.13	+	***
Visit public parks	0.98	+	***	0.26	+		0.04	-	*	0.001	-	
Wildlife watching, viewing	17.39	-	***	6.29	-	**	0.02	+	*	0.005	-	*
Cumulative CWD positive cases in both farmed and wild cervids in the province/state	86.81	+	***	34.1	-	***	22.5	-	***	7.387	-	*
Cumulative CWD positive cases in both farmed and wild cervids in the country	67.79	-	***									
Cumulative CWD positive cases in the other province/state										6.08	+	*
Cumulative number of deer & elk farms found with CWD infected animals in the country				152	+	***	172	+	***	0.08	-	
Number of CWD-tested animals in the farmed sector							0.31	-	**			
Number of deer & elk farms in the province/state	8.9	-	***	4.32	-	**						
Dummy Alberta: 05-08; Saskatchewan: 01-07 Colorado: from 2006; Wyoming: from 2003	2403	+	***	374	-		26209	+	***	2245	+	***
Number of Observations	22			22			22			22		
R^2	0.97			0.93			0.99			0.97		
LM Statistics	0.06 [0.8]			5.0 [0.3]			0.08 [0.8]			3.96 [0.05]		
Durbin Watson Statistics	2.2			2.3			1.6			2.0		

Note: : '***' 1% level of significance; '**' 5% level of significance, '*' 10% level of significance.

Table 3. 11. Summary of Significant Variables

Farmed Cervids	Cattle	Wild Cervids
Political Market Effects (Relative Political Market Effect)		
(+) Canada (-) the US	(-) Canada and the US (+) Japan	
Economic Factors		
Farm cash receipts (+) Canada (-) the US	Farm cash receipts (-) Canada (+) the US, Japan	Wildlife-related revenue (+) Sask and Wyoming (-) Colorado
Inventory concentration (+) Canada and the US	Inventory concentration (+) Canada, the US (-) Japan	
Sectors share in GDP (-) Canada, (+) the US	Sectors share in GDP (-) Canada	
	Farm-retail price spread (-) Canada, (+) Japan	
Venison exports/imports (-) Canada - net exports (-) the US - imports	Cattle exports (+) Canada Beef exports/imports (-) in the three countries Beef net exports (+) in Canada, the US	
Society Concerns		
Share in food exp. (+)Canada (-) the US	Share in food exp. (+) Canada and Japan, (-) the US	Hunting participation (+) AB and Wyoming (-) Sask
		Visit parks (+) AB (-) Colo
		Wildlife viewing, feeding (+)Colo (-) AB, Sask and Wym
Disease Prevalence/Management		
Positive cases (-) Canada	Positive cases*Time trend (+) the US, Japan	Positive cases in prov/st. (+) AB (-) Sask, Colo, Wym
Positive farms (+) in both Canada and the US		Positive cases in country (-) AB
		Positives in other state (+) Wyoming
Tested wild-cervids (+) the US		Tested farmed-cervids (-)Colorado
	Dummy CA 2003 (-) Canada	Number of farms (-) AB and Sask
		Dummy (increased surveillance) (+) AB, Colo, Wym (-) Sask
Time trend (-) Canada	Time trend (+) Canada	

Note: AB = Alberta, Sask = Saskatchewan, Colo = Colorado and Wym = Wyoming.

Figure 3. 1. The model for CWD testing in the farmed and wild cervid sector

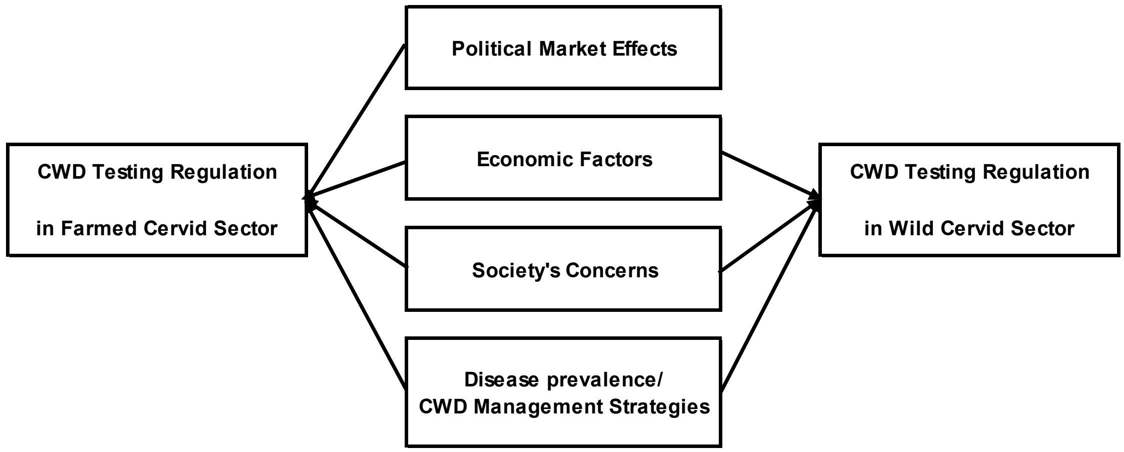
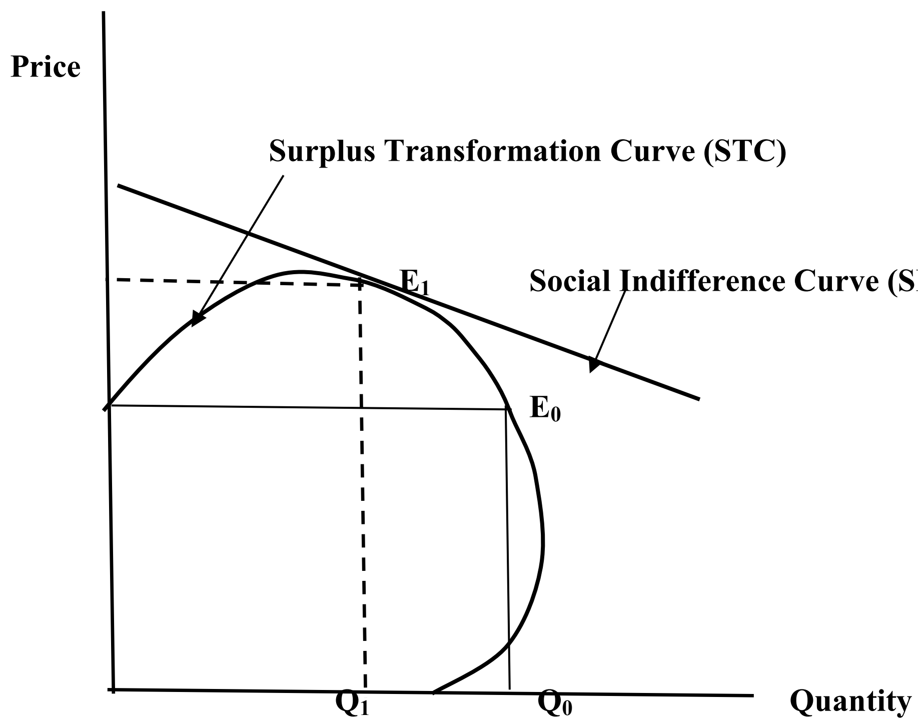


Figure 3. 2. The political economy equilibrium



Source: Sarker et al., (1993, p.292)

Figure 3. 3. Welfare changes associated with mandated CWD testing in farmed cervids

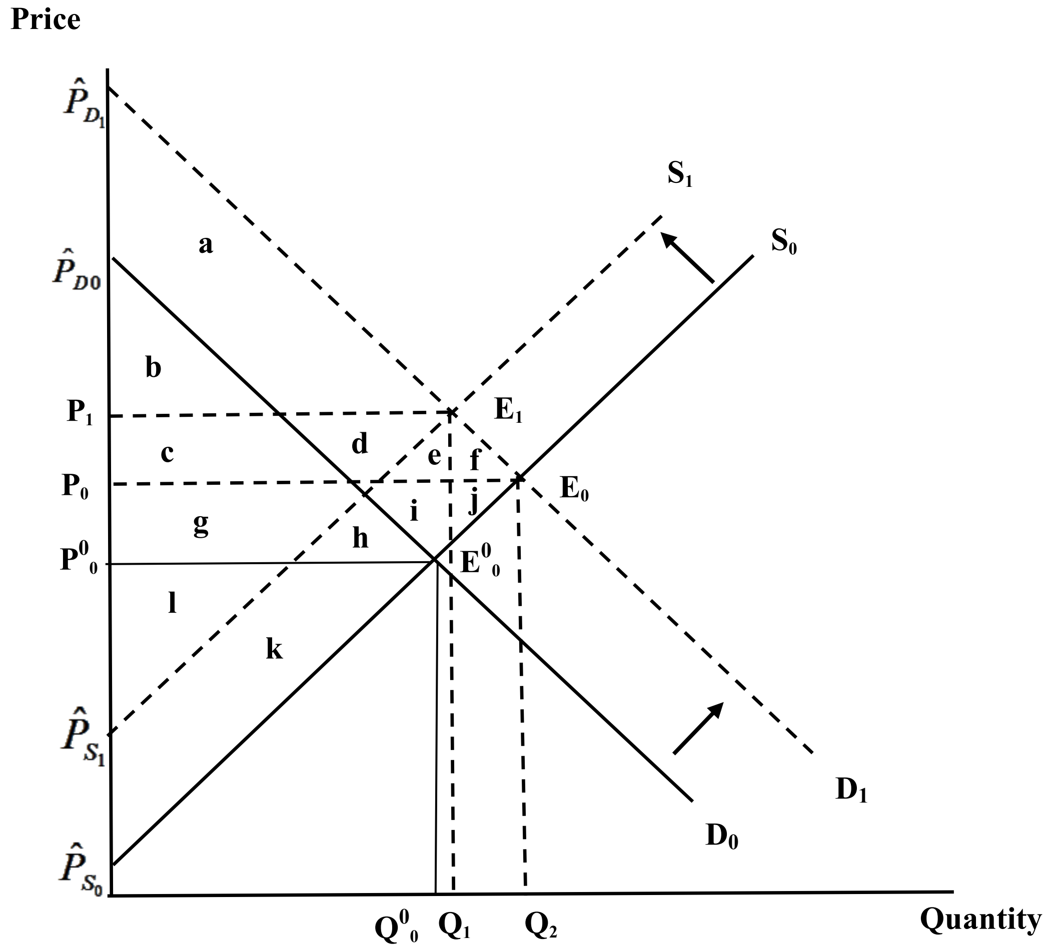
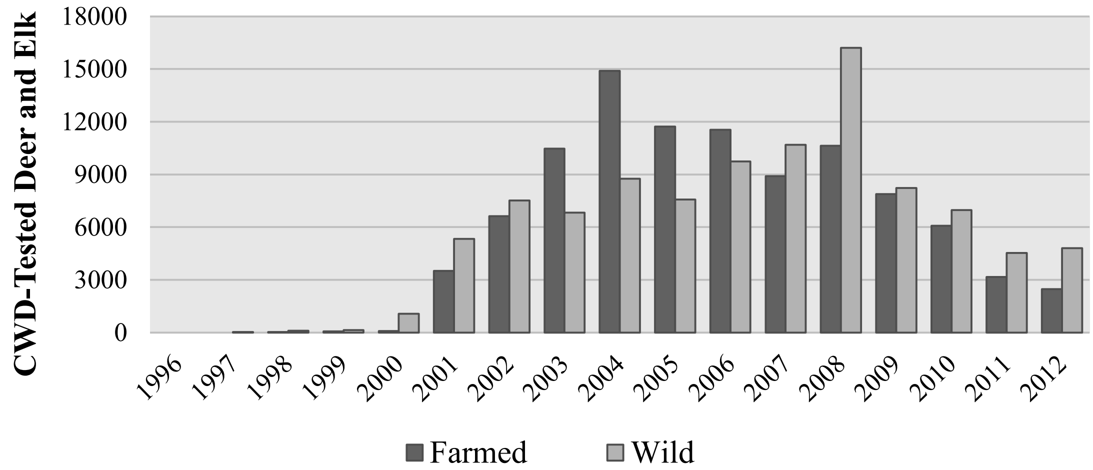
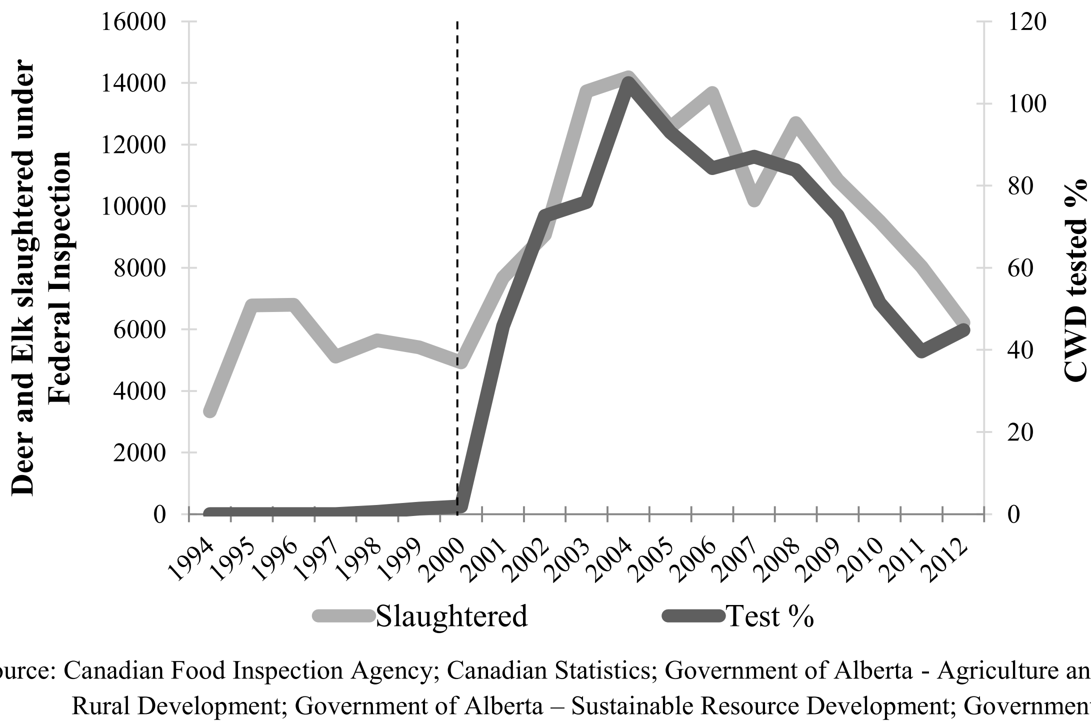


Figure 3. 4. The number of CWD-Tested Deer and Elk in Canada



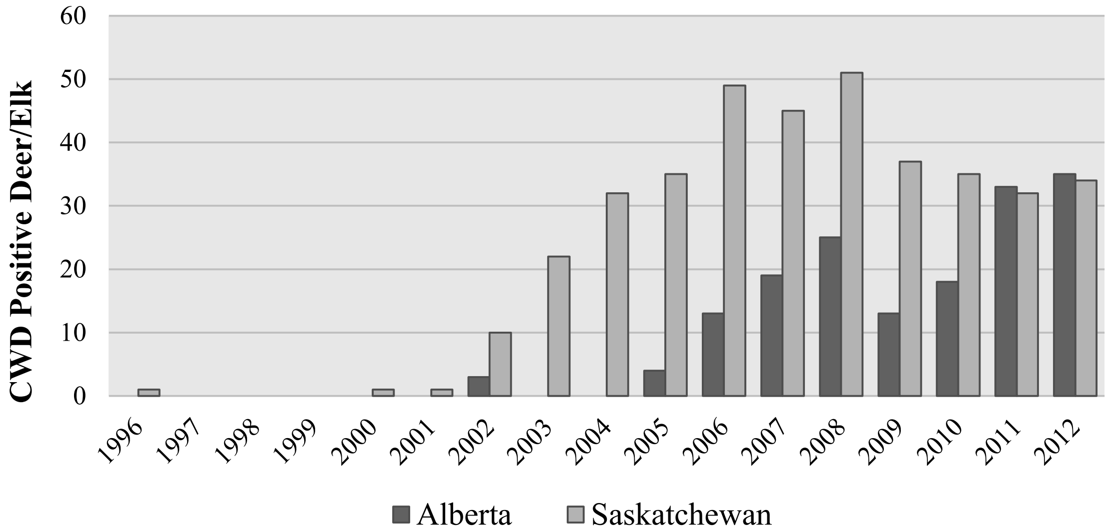
Source: Government of Alberta - Agriculture and Rural Development; Government of Alberta – Sustainable Resource Development; Government of British Columbia – Ministry of Environment; Government of Saskatchewan – Environment; Ontario – Ministry of Agriculture, Food and Rural Affairs. http://www.inspection.gc.ca/english/anima/disemala/cwdmdc/incnome.shtml (Accessed on Nov 16, 2011)

Figure 3. 5. The number of slaughtered deer-elk and the percentage of testing for CWD in farmed deer-elk in Canada



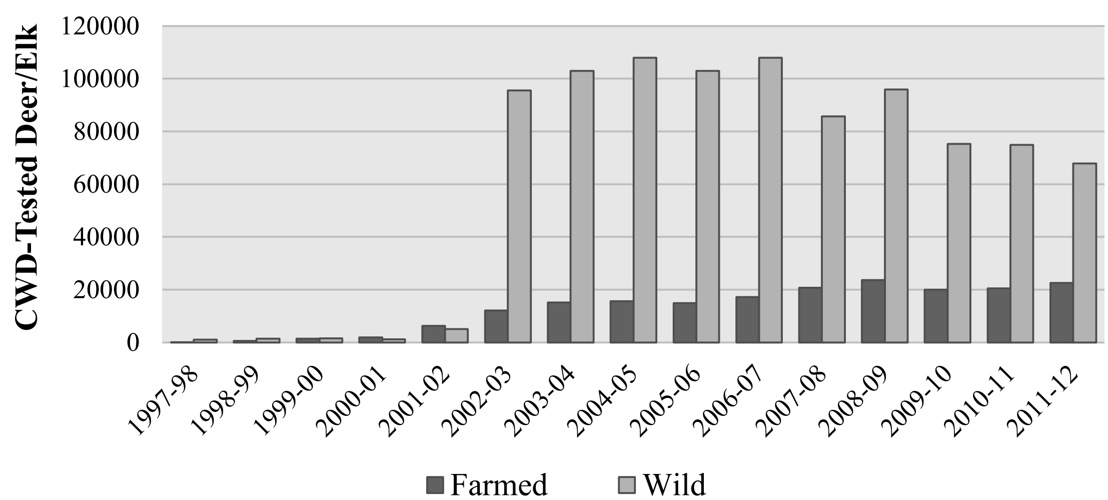
Source: Canadian Food Inspection Agency; Canadian Statistics; Government of Alberta - Agriculture and Rural Development; Government of Alberta – Sustainable Resource Development; Government of British Columbia – Ministry of Environment; Government of Saskatchewan – Environment; Ontario – Ministry of Agriculture, Food and Rural Affairs.

Figure 3. 6. CWD Positive Deer/Elk in Alberta and Saskatchewan



Source: Government of Alberta - Agriculture and Rural Development; Government of Alberta – Sustainable Resource Development; Government of British Columbia – Ministry of Environment; Government of Saskatchewan – Environment; Ontario – Ministry of Agriculture, Food and Rural Affairs. http://www.inspection.gc.ca/english/anima/disemala/cwdmdc/incnome.shtml (Accessed on Nov 16, 2011)

Figure 3. 7. Number of CWD-Tested Deer and Elk in the United States

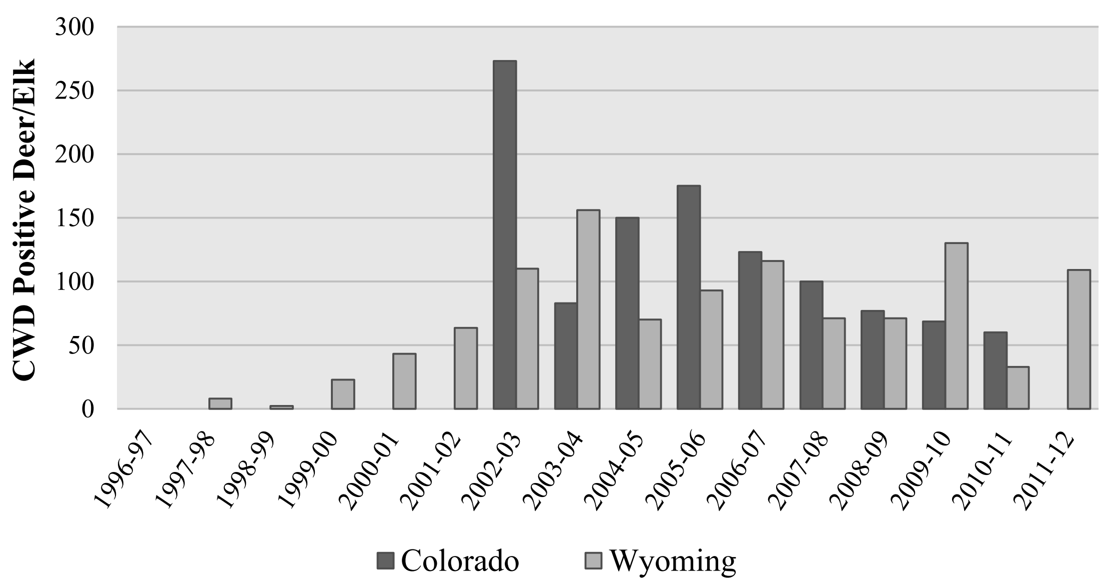


Source: Captive : http://www.aphis.usda.gov/animal_health/animal_diseases/cwd/images/captive_cer_tested.jpg (Accessed on Nov 16, 2011); and Wild : http://www.aphis.usda.gov/animal_health/animal_diseases/cwd/images/graphf-rsurv.jpg (Accessed on Nov 16, 2011)

Figure 3. 8. The number of slaughtered deer-elk and the percentage of testing for CWD in farmed deer-elk in the United States

Source: USDA http://www.aphis.usda.gov/animal_health/animal_diseases/cwd/images/captive_cer_tested.jpg (Accessed on Nov 16, 2011); Census of Agriculture (2007) http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_US/st99_1_029_031.pdf (Accessed on Jan 5, 2012)

Figure 3. 9. CWD Positive Deer/Elk in Colorado and Wyoming



Source: Wyoming Game and Fish Department, Colorado Department of Natural Resources: Colorado Division of Wildlife

Figure 3. 10. Venison production

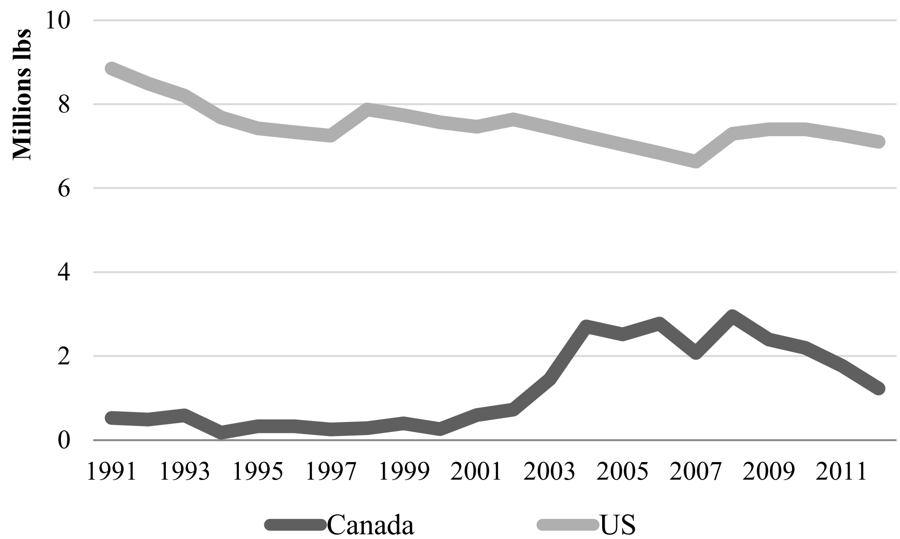


Figure 3. 11. Per-capita venison consumption

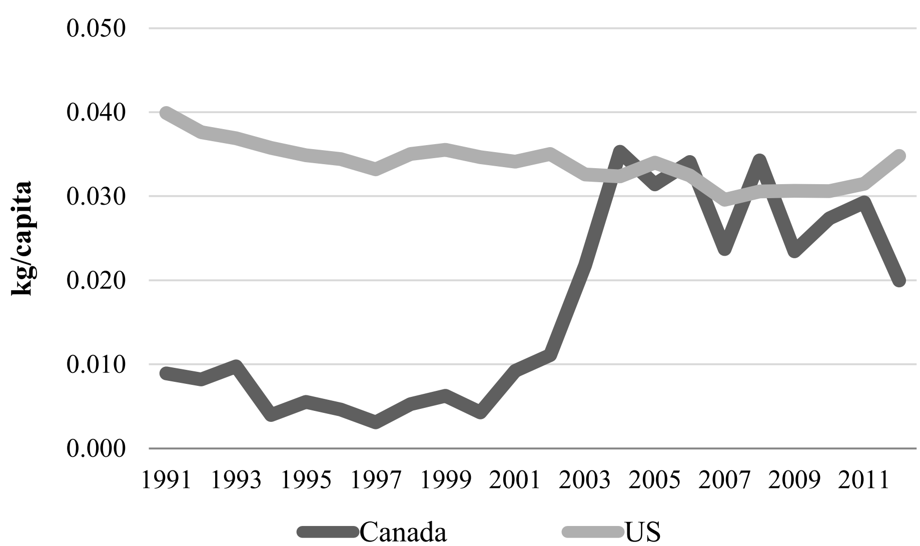


Figure 3. 12. Nominal price series of venison

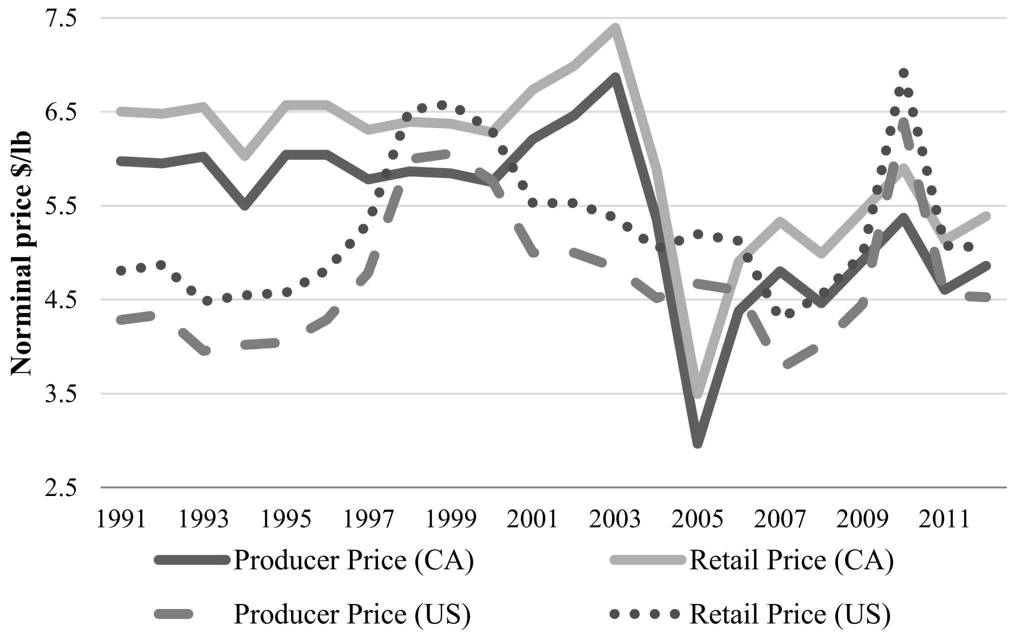
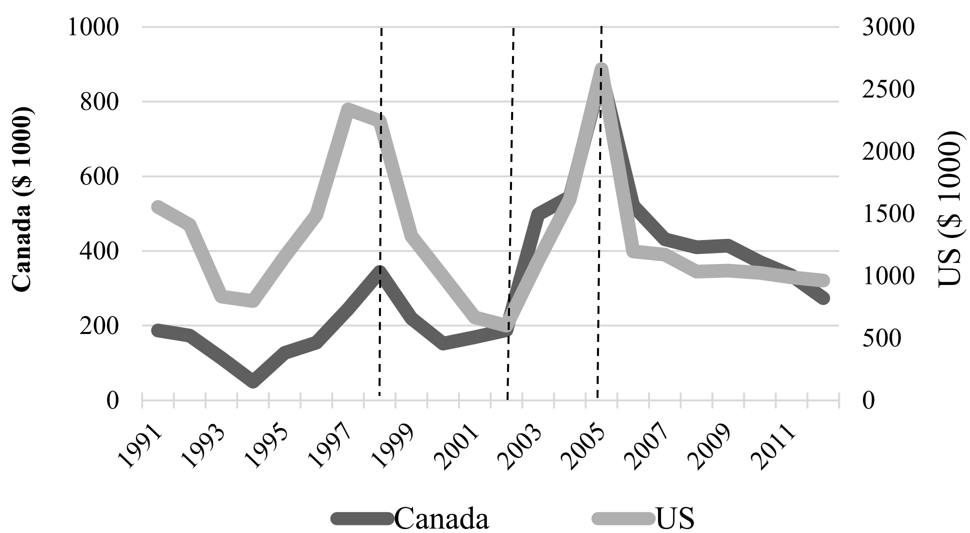
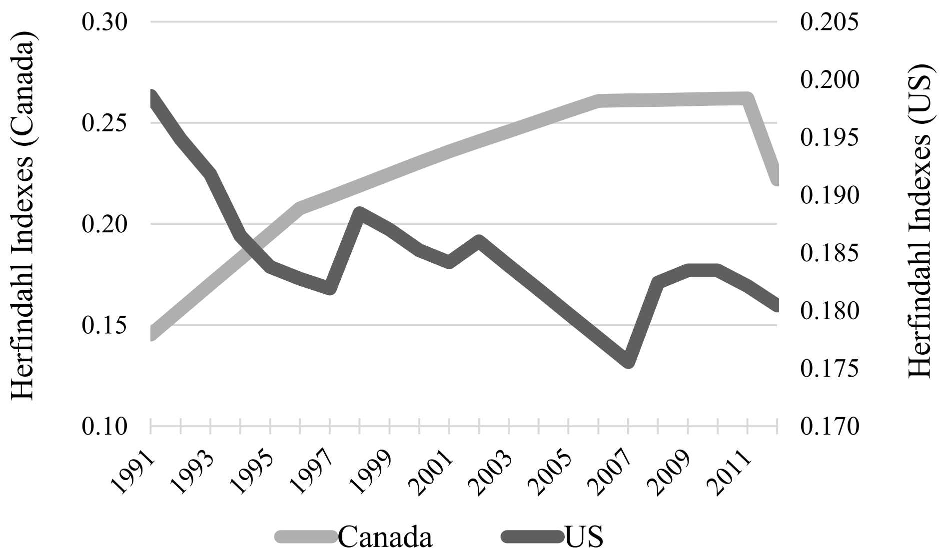


Figure 3. 13. Farm cash receipts (deflated by CPI) in the farmed-cervid sector



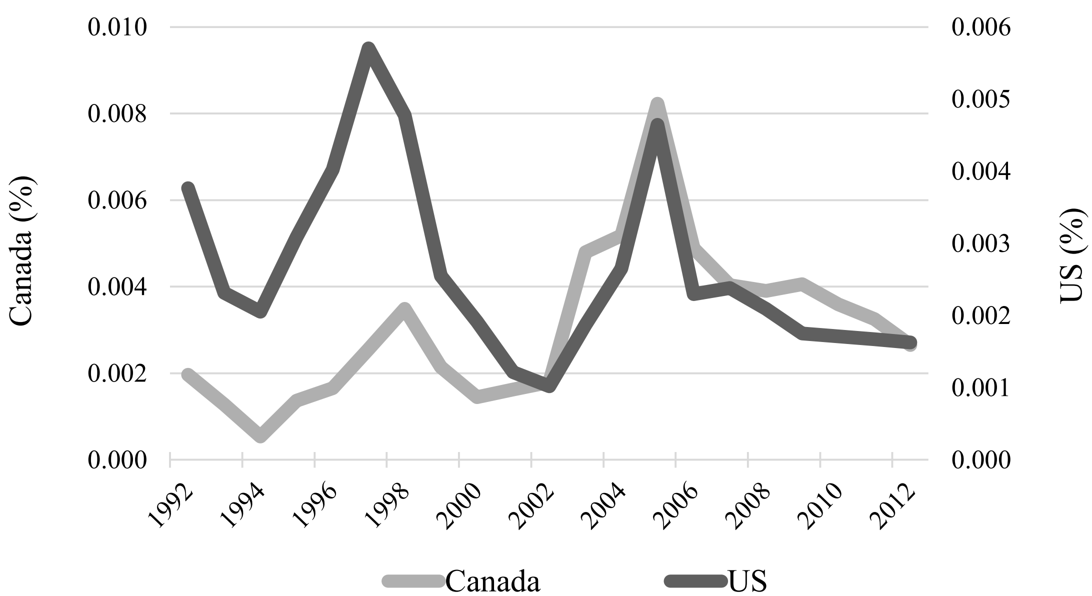
Source: Author's calculation based on data from Statistics Canada http://www.statcan.gc.ca/pub/23-502-x/23-502-x2007001-eng.pdf and USDA- Census of Agriculture

Figure 3. 14. Regional concentration in cervid (deer and elk) inventories



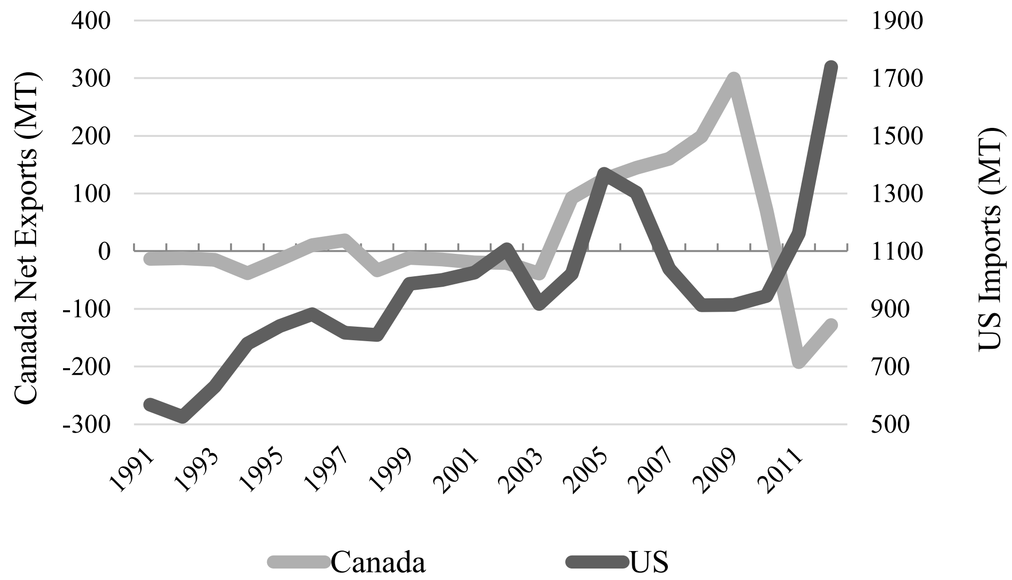
Source: Statistics Canada http://www.statcan.gc.ca/pub/23-502-x/23-502-x2007001-eng.pdf; USDA-Census of Agriculture

Figure 3. 15. Cervid sector's share in country's GDP



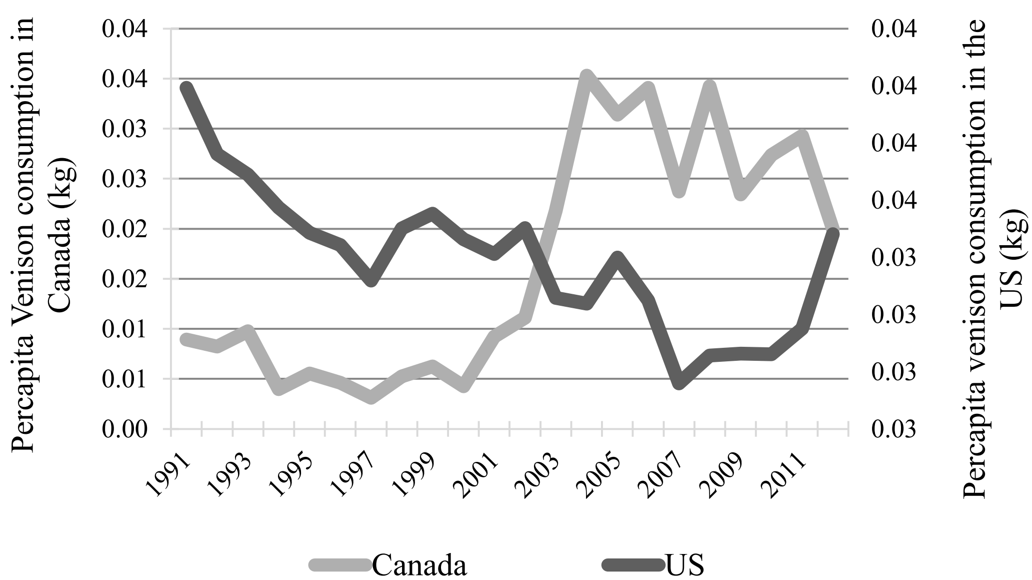
Source: Statistics Canada, AAFC, USDA

Figure 3. 16. Venison Trade



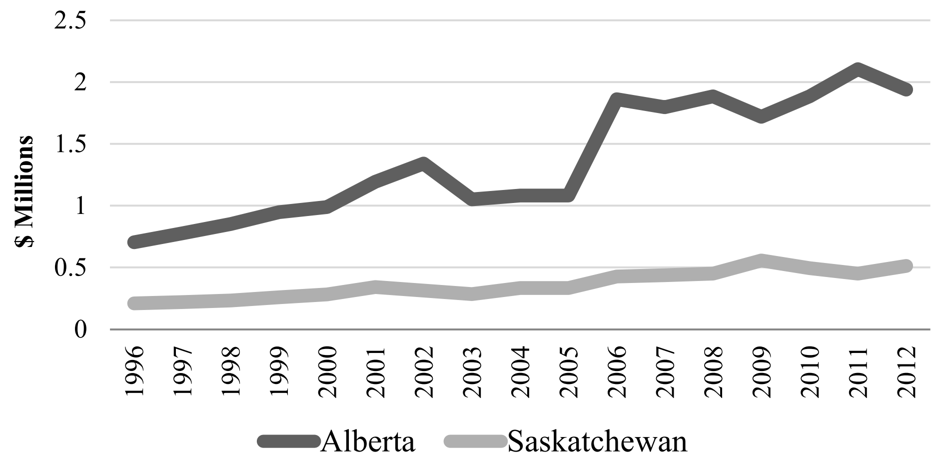
Source: AAFC: Red Meat Market Information : http://www.agr.gc.ca/redmeat-vianderouge/rpt/ 10tbl36_eng.htm; USDA, The global agricultural trade system (GATS).

Figure 3. 17. Share of per capita venison expenditure in total food expenditure



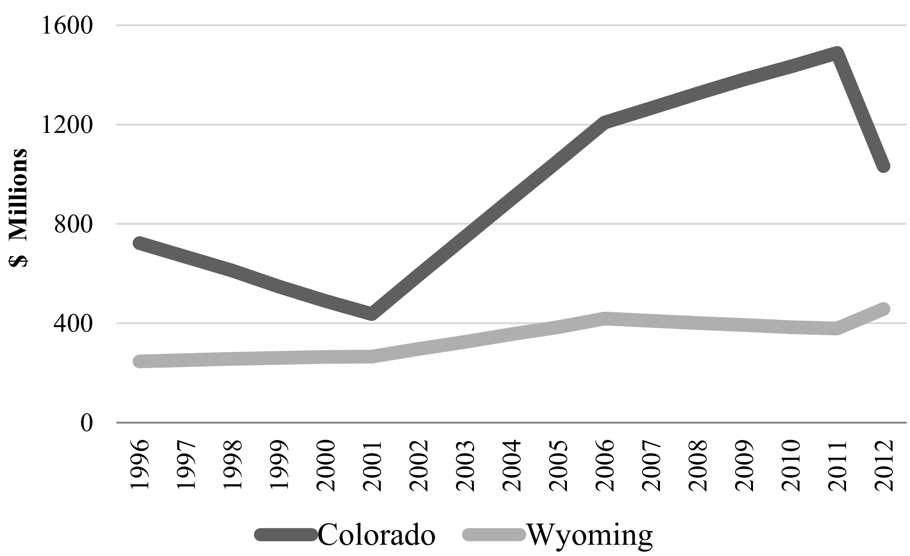
Source: Statistics Canada MarketTrackTM scanner data (Nielsen Company), Agriculture and author's calculation

Figure 3. 18. Expenditure for Wildlife-related Recreations in Canada



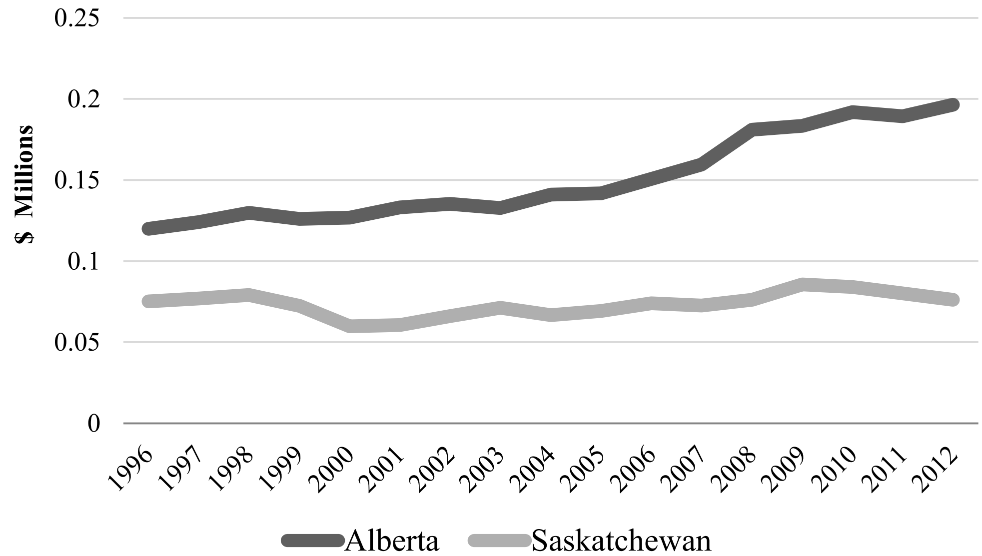
Source: Statistics Canada, Tables (426-0005, 426-0017 and 426-0022)

Figure 3. 19. Expenditure for Wildlife-related Recreations in the US



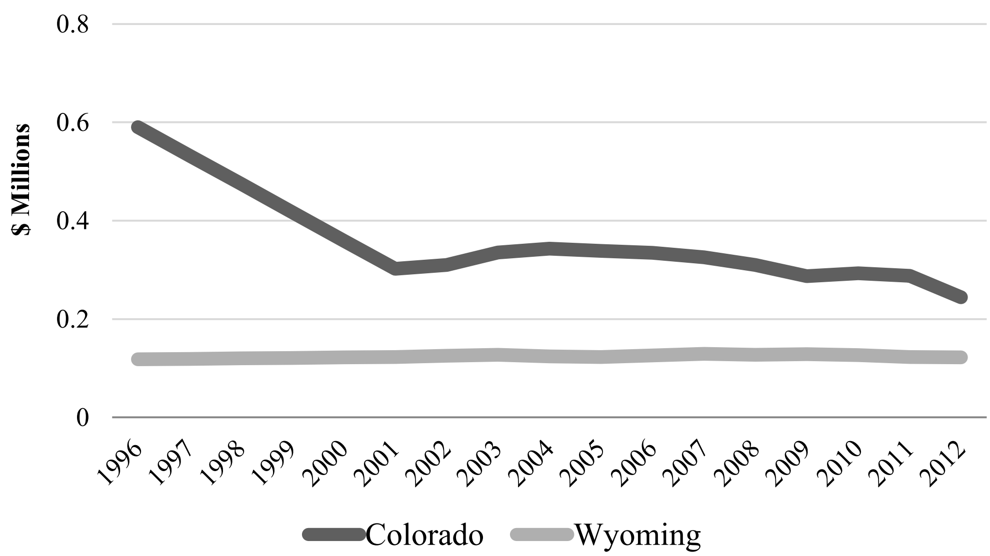
Sources: Harvest and Hunter statistics from Colorado, Division of Wildlife, Harvest and hunter statistics: Wyoming Game and Fish Department; National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR)

Figure 3. 20. Deer and Elk Hunting License Sales in Alberta and Saskatchewan



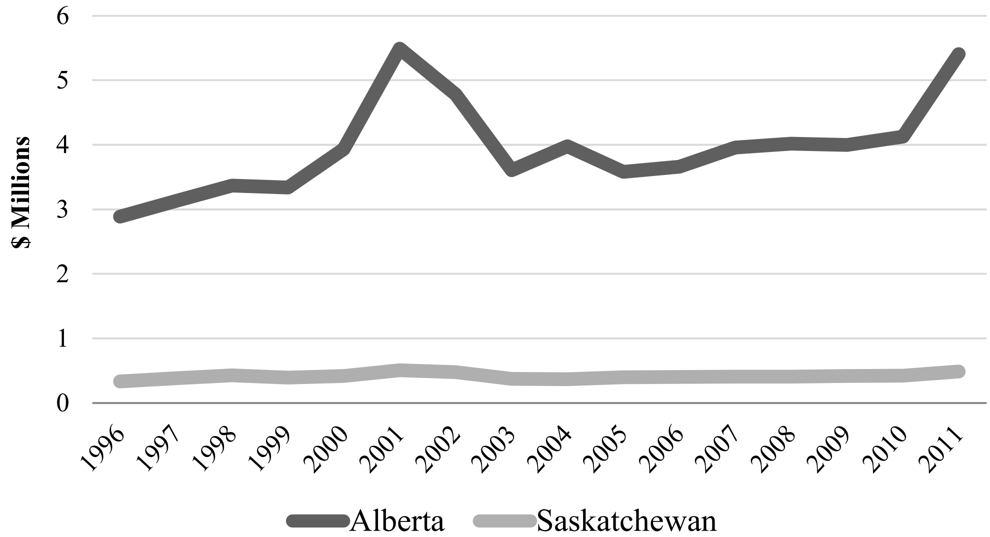
Source: Ministry of Environment http://www.environment.gov.sk.ca/licences/, Government of Saskatchewan; and Ministry of Environment and Sustainable Resource Development, Government of Alberta http://www.mywildalberta.com/Hunting/LicencesFees/LicenceSalesStatistics.aspx.

Figure 3. 21. The Number of Deer and Elk Hunters in Colorado and Wyoming



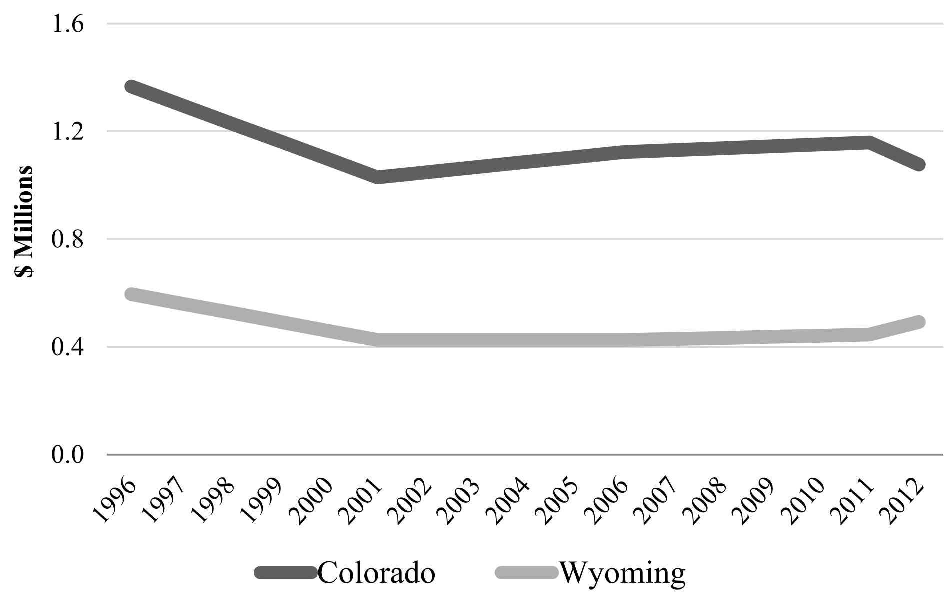
Sources: Harvest and Hunter statistics from Colorado, Division of Wildlife, Harvest and hunter statistics: Wyoming Game and Fish Department; National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR).

Figure 3. 22. Number of persons who visit zoos, aquariums, botanical gardens and public parks in Alberta and Saskatchewan



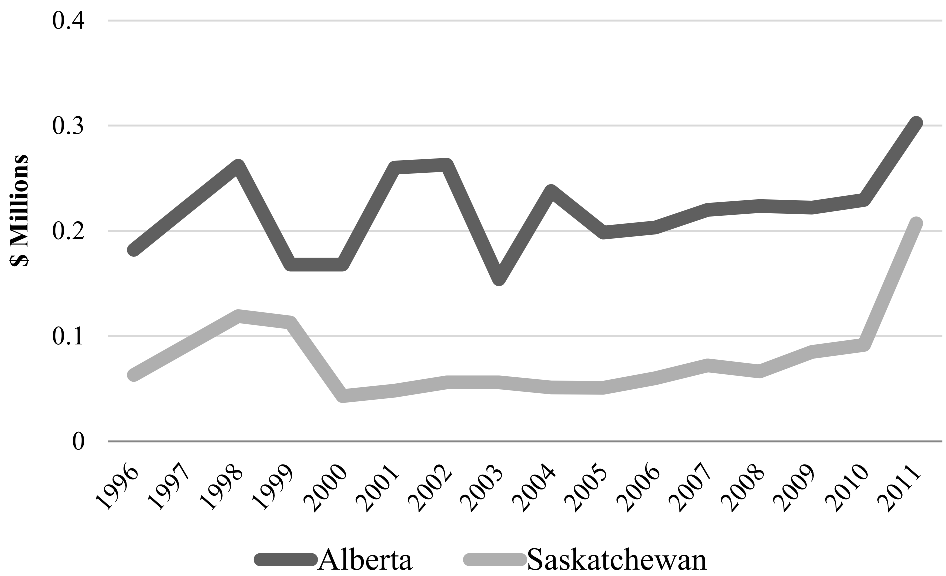
Source: Statistics Canada, Tables (426-0002, 426-0006, 426-0014)

Figure 3. 23. Number of persons who visit zoos, aquariums, botanical gardens and public parks in Colorado and Wyoming



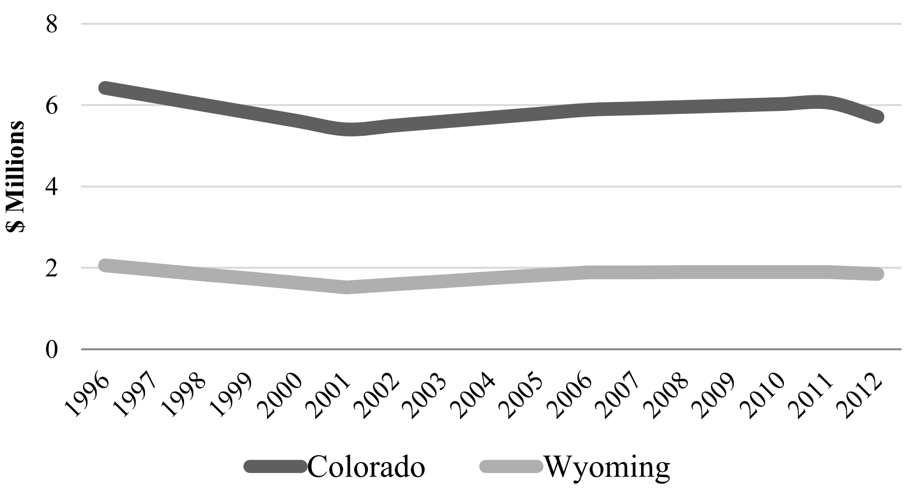
Sources: Harvest and Hunter statistics from Colorado, Division of Wildlife, Harvest and hunter statistics: Wyoming Game and Fish Department; National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR)

Figure 3. 24. Number of person who participate in wildlife viewing in Alberta and Saskatchewan



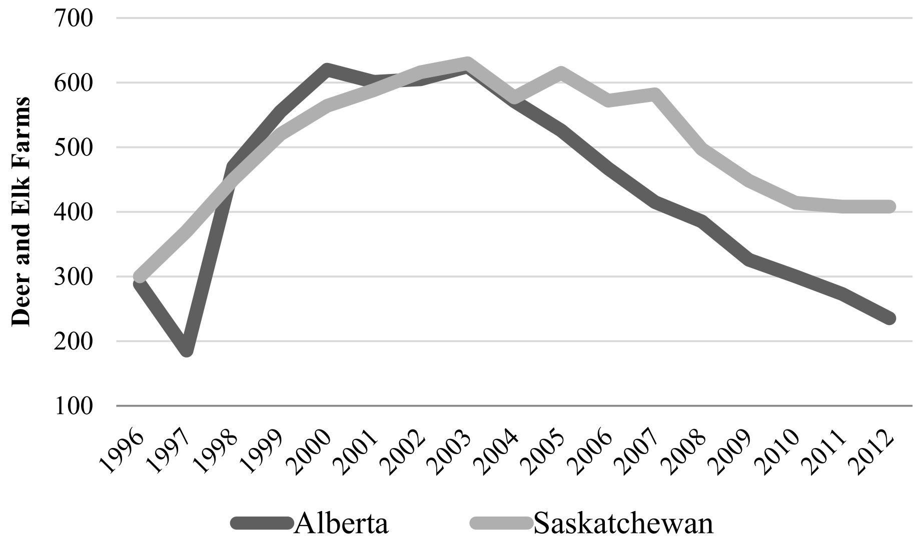
Source: Statistics Canada, Tables (426-0002, 426-0006, 426-0014)

Figure 3. 25. Number of person who participate in wildlife viewing, photographing and feeding in Colorado and Wyoming



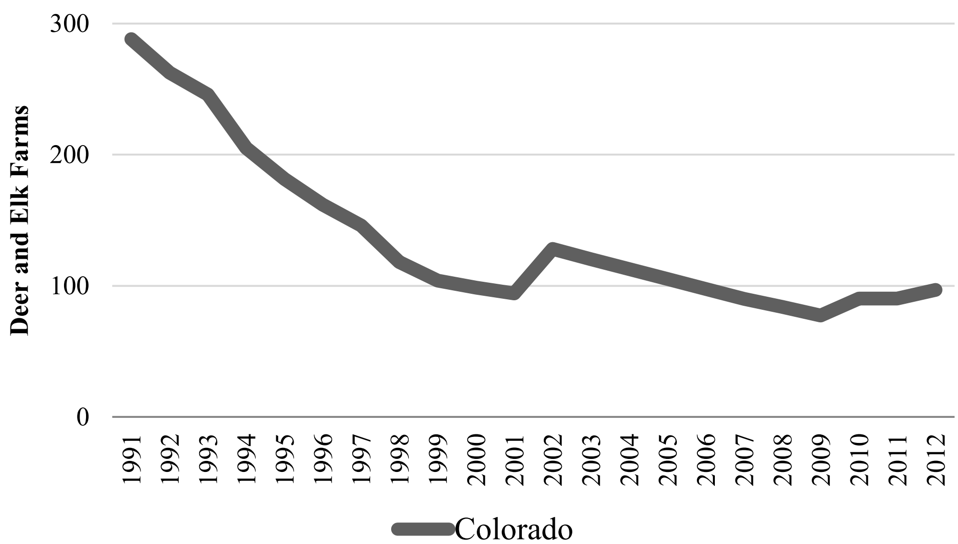
Sources: Harvest and Hunter statistics from Colorado, Division of Wildlife, Harvest and hunter statistics: Wyoming Game and Fish Department; National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR)

Figure 3. 26. The number of deer/elk farms in Alberta and Saskatchewan



Source: AAFC: Farmed populatin and Number of farms

Figure 3. 27. The number of deer/elk farms in Colorado



Source: USDA: Census of Agriculture

Figure 3. 28. Relative Political Weight in the CWD-testing Model

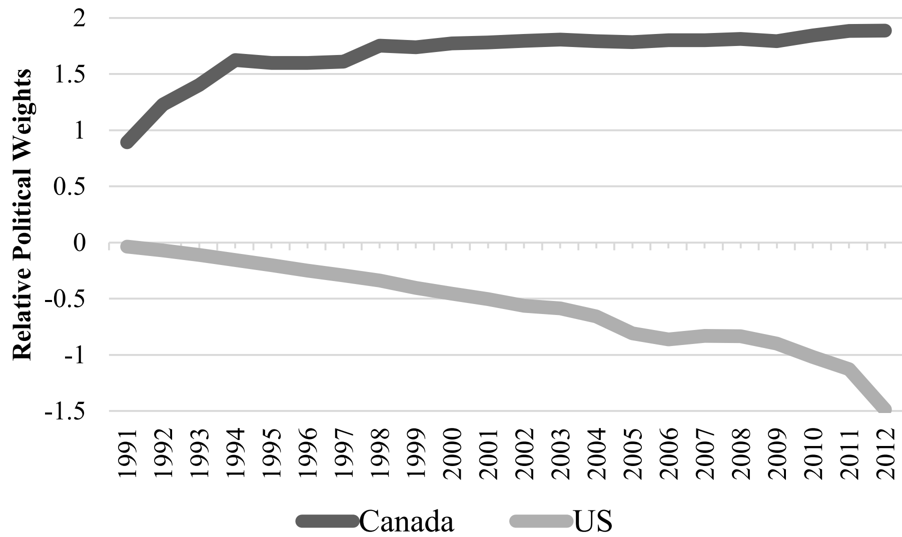
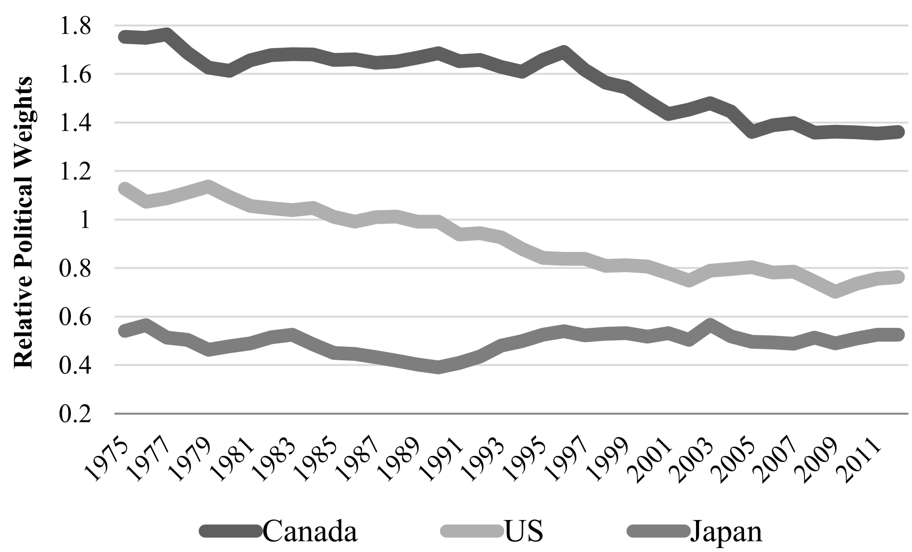


Figure 3. 29. Relative Political Weight in the BSE-testing Model



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4. PUBLIC PREFERENCES FOR TRACEABILITY AND ANIMAL TESTING IN RESPONSE TO TSE OUTBREAKS

4.1. INTRODUCTION

In the face of the TSE outbreaks, three potential risks – risks to food safety, risks to economic benefits for farmed animals and risks to society from changed behaviour – can be identified as discussed in Section 1.1. Risky events can influence consumers' perceptions about risks associated with food and their concerns about product quality (de Jonge et al., 2008 and Frewer and Salter, 2002). As discussed in previous chapters, governments have used animal testing and traceability systems to monitor TSE infections among other possible risk management policies frequently in the case of BSE. However in Canada and the US these interventions are not applied in national programs. The Government of Canada has encouraged the development of a traceability system for venison in the farmed sector. In Alberta, all animals slaughtered from farms are tested for CWD although consumers may not be aware of this intervention.

It has been shown that traceability systems and animal-testing are important tools for improving consumers' confidence in meat products from animals affected by diseases (McCluskey et al. 2005 and Aubeeluck 2010). However those interventions likely affect consumers in different ways depending on their individual risk perceptions and risk attitudes towards the product (Pennings et al. 2002; Schroeder et al. 2007; Kalogeras et al. 2008; Yang 2010; Yang and Goddard 2011a, and Yang and Goddard 2011b). The linkage between consumer's risk perceptions/attitudes and his/her preferences for product attributes could provide valuable information for regulatory agencies and/or industry groups.

Given that the question "how society's preference for food-safety attributes are affected by their risk perceptions and risk attitudes towards venison meat" is the major research question in this paper. This paper is focused on public interest in traceability and animal testing in venison. The objective of the analysis is to determine preferences for those attributes given respondents' levels of risk perceptions and risk attitudes towards venison and allowing for preference heterogeneity across respondents. Since heterogeneity in responses could arise from socio-demographics, personality and psychological constructs, these variables are included in the mixed logit models which also capture other unobserved preference heterogeneity. Stated preference survey data collected from online surveys conducted in Canada in 2009 and in the US in 2010 will be used. The results are expected to broaden knowledge about how the public wish to see traceability and animal testing applied in this exotic meat category.

Although many studies have resulted in estimates of consumers' willingness to pay (WTP) for traceable and food safety certifications in traditional meats, there have been no previous studies on venison meat in particular. The detailed comparison of consumers' WTP for CWD-tested and traceable attributes across consumer segments with different risk perceptions/ attitudes towards venison will reveal how sensitive preferences for the attributes are to risk perceptions/attitudes. The findings can be informative as to whether there is a consistent pattern of regulatory systems that need to be in place to alleviate potential outcomes from animal diseases whether the product is in wide consumption or not. To that end results from this study are compared to those from other studies related in most cases to BSE and beef.

In summary, the paper will contribute to the literature that seeks to explain the link between public preferences for food safety interventions and perceived risks. Broadened knowledge about the link for a specific product such as venison is valuable for informing risk management techniques for other relatively unique foods (such as bison), and can be valuable in identifying whether interventions have the capability of ameliorating market responses in the face of animal disease risks in the future.

4.2. LITERATURE REVIEW

In Appendix 4A, the research objectives, the methodologies, the data and the results of previous studies using choice experiments and experimental auctions are reviewed comprehensively. Based on the findings of these research articles, this section provides the conceptual framework, and the empirical model for this paper. In general, numerous studies have determined consumer's WTP for traceable and food safety certifications and verifications in traditional meats. Understanding preferences is important in determining pricing decisions or new product development (Breidert et al., 2006). Recently, WTP measurement has been used in investigating consumer preferences in food risk management: for example –responses to labels and bans on GM food (Carlsson et al., 2004), country-of-origin labelling in beef purchases (Alfnes and Rickertsen, 2003; Umberger et al., 2003), regulation and certification of growth hormones and GM feeds (Lusk et al., 2003); and traceability and labeling systems for beef (Gracia and Zeballos, 2005). Various studies have attempted to measure the size of negative food – especially traditional meats – consumption impacts from food safety concerns, to determine the level of consumer confidence in food safety of products, and to quantify attitudes towards risk management and risk communication practices in food supply chains (Pennings et al., 2002; Gellynck and Kuhne, 2006; Schroeder et al., 2006; and de Jonge et al., 2008) using survey data and exploratory analysis. But there is no single study to measure the preferences for venison particularly in the context of CWD– attributes from food safety concerns.

There are many factors that affect consumers' food consumption behaviour. Given the continuing incidents of animal disease outbreaks (CWD, BSE, Avian Influenza etc.), credence attributes and certification or verification of credence attributes, including animal disease-testing and traceable attributes, could become important in food purchase decisions (McCluskey et al. 2005; Hobbs et al. 2005a; Schroeder et al. 2006; Steiner et al. 2009; and Aubeeluck 2010). Unlike experience attributes (eg. flavour, tenderness, etc.), "credence attributes cannot be discerned by consumers even after consuming the product" (Loureiro and Umberger, 2007, p. 479). Some examples of credence attributes include animal-tested, traceable, food safety inspections, organically produced, the use of agri-chemicals and antibiotics in agri-food production, animal welfare, genetically modified and country of origin. Many scholars have proven that consumers' concerns over credence attributes have increased (Nelson, 1970; Caswell, 1998; Miles and Frewer, 2001; Golan et al., 2004; Toyne et al., 2004; Innes and Hobbs, 2011). In addition, credence attributes such as country-of-origin labelling, traceability and food safety inspections have been shown to take a primary role in the consumers' perceptions of food safety and quality (Loureiro and Umberger, 2007). When consumers are concerned about credence attributes, they may want to have those attributes proven. A requirement for verifying attributes, particularly related to production or the animal rearing phase, is that the product be traceable through the supply chain back to the farm of origin. Given that, a role for either public or private initiatives to implement traceability in order to protect consumers, to enhance efficiency of supply chains and to generate market signals for all participants seems clear (Hobbs et al., 2005b).

The literature shows that consumers' risk perceptions and attitudes towards specific food products are important factors influencing their purchase behaviour (Pennings et al. 2002; Piggott and Marsh, 2004; Mazzocchi, 2006; Schroeder et al. 2007; Maynard et al., 2008; and Yang and Goddard 2011a). Risk perceptions represent "a person's view about the riskiness of a particular situation", and risk attitudes represent "a person's overriding tendency towards risk in a consistent way across different risky situations" (Schroeder et al. 2006, p.26). Since consumers' judgements about risks associated with food potentially can come from "outrage factors" rather than from the likelihood of food causing health hazards (Sandman, 1993), consumers' estimates of risk (perceived risk) may be different from the real risks (objective risks). Consumers' perceived risks are a reflection of real risks when risks are well-known and familiar (Sjoberg, 1979; 1995). Objective risks may be calculated and described using statistics and probability distributions. Perceived risks are how an individual understands and experiences the objective risks and the phenomena (resulting in perceptions and attitudes respectively) (Oltedal et al., 2004). Whether a person is a risk-averse, a risk-neutral or a risk-lover can be determined using expected utility theory, where the von-Neumann-Morgenstern utility function and the Bernoulli utility function are commonly used in determining a person's risk perceptions and risk attitudes (Mas-Colell et al., 1995). Another competing theory, in the study of risk perceptions, is the psychometric paradigm in which an individual's risk perceptions (about a situation) subject to a cognitive process (Sjoberg, 1995) are discovered. The important factors in subjective risk judgement by an individual include the effect of risk, knowledge about risk, the newness of risk, and the type of risk (chronic versus catastrophic) (Fischoff et al. 2000).

In addition, it is obvious that risk perceptions is a social phenomenon and as such, is accepted to be a function of an individual's cultural adherence (Douglas, 1978; and Boholm, 1996). Statements to assess a person's risk perceptions and risk attitudes were developed by Penning et al (2002) and were used by scholars such Schroeder et al (2007) and Yang and Goddard (2011a). For example, questions to assess a person's risk perceptions include: (i) when eating product X, my household is exposed to very little risk to a great deal of risk; (ii) members of my household think eating product X is risky – strongly disagree to strongly agree; and (iii) for members of my household, eating product X is not risky to risky. Questions to assess a person's risk attitudes include: (i) members of household accept the risks of eating product X – strongly disagree to strongly agree; (ii) for members of my household, eating product X is worth the risk – strongly disagree to strongly agree; and (iii) my household is – not willing to accept -to- willing to accept – the risk of eating product X. In general, consumers' risk perceptions and attitudes are measured using Likert scales (for example, 1=strongly disagree to 5=strongly agree) which were originally developed by Likert (1932). For example, Pennings et al. (2002) used nine-point scales, Schroeder et al. (2007) used 10-point scales and Yang and Goddard (2011a, 2011b) used five-point scales. Johns (2010) discussed that the accuracy and strength of Likert scales (agreement/disagreement of the statements) are significantly reduced when the number between disagreement to agreement of the statement is below five or above seven. The five-point scale is preferred by most scholars.

A sizeable literature investigates differences in risk perceptions and risk attitudes across countries and cultures (for example, Weber and Hsee, 1998 and Schroeder et al. 2007). In addition, many scholars have suggested the empirical evidences of factors that may influence an individual's perceptions of risk. These factors include knowledge about risk (Fischoff et al., 2000), familiarity with the source of danger (in this case venison) (Ittelson, 1978), control over the situation (including psychological constructs such as Locus of Control) (Rachman, 1990; Grobe et al., 1999; and Nganje et al., 2005), and personality traits such as general trust in people (Siegrist et at., 2005; Myae and Goddard 2012) and the level of worry about situations around a person (de Jonge 2008; Myae and Goddard 2012). People's general trust level is one of important personality traits. Consumers' response to risk has been discussed as being related to psychological characteristics, including ethical concerns, trust and distrust in scientific institutions, risk regulators and information providers, and perceptions about risk management processes (Frewer, 2000).

Consumers' trust in a particular institution is based on a multi-dimensional concept such as an institution's competency and knowledge for better confidence in the institution, and honesty, openness and care for improved social trust (Renn and Levine, 1991). de Jonge (2008) suggested that consumers' confidence in the safety of food could be enhanced by improving consumers' trust in societal actors. In terms of venison meat purchases, households that have a lower level of trust in government and a higher level of trust in farmers are more likely to consume venison (Myae and Goddard, 2010). Consumers' trust in origin of products and/or retailers is another influential factor in their consumption behaviour (Ilbery and Kneafsey, 2000; Green et al., 2003; and Muringai and Goddard, 2012). Consumers' confidence in the safety of a food product has also been found to have two dimensions: optimism and pessimism (de Jonge et al., 2008). In addition, attribute-preferences and psychological constructs may vary depending on individual differences, such as region, ethnicity, socio-economic characteristics, and gender.

Given the potential links between risk perceptions and preferences for attributes such as animal testing and traceability (which might reduce risks) it is surprising that there aren't more studies empirically focussed on measuring the link. Only a limited number of studies – for example, Lim et al., 2012 – have determined the relationship between choices of products with hypothetical attributes (animal-tested and traceable attributes) and other behaviour such as risk perceptions and attitudes towards animal diseases in meat purchases. Factors that have been shown to influence consumers' desire for traceable information in their purchases include individual socio-demographic characteristics, knowledge about disease and traceability, reported behaviour such as food and place-of-purchase preferences, familiarity with eating product X, and psychological constructs (Dickinson and Bailey, 2005; Verbeke and Ward, 2006; Myae et al., 2011; and Myae and Goddard, 2012). Demographic characteristics have been shown to be a compelling factor that affects consumer's preferences for attributes in their purchase decisions (Dickinson and Bailey, 2005; McCluskey et al. 2005; and Steiner et al. 2009). The summary in Figure 4.1 illustrates all the facts discussed above from previous studies.

In terms of method, Breidert et al. (2006) classified various methods in examining preferences (Appendix 4B). One of the popular methods for measuring preferences for benefits/attributes is choice modelling to get revealed preference data (which is based on actual market behaviour) or stated preference data (which is based on hypothetical scenarios). Choice modelling was developed in parallel by economists and cognitive psychologists, to determine respondents' choices between alternative choice sets (Ben-Akiva and Lerman, 1985; MaFadden, 1980, 1986). Choice experiments and experimental auctions are the most commonly used methods in determining consumers' preferences for product attributes, and tradeoffs between these attributes (Alfines et al., 2003; Lusk et al. 2001; Lusk et al, 2003; Umberger et al. 2003; Carlsson et al. 2004; McCluskey et al. 2005; Hobbs et al. 2005a; Schoreder et al. 2006; Alfines et al. 2006; Steiner et al. 2009; and Aubeeluck 2010). The compatibility and limitations of both methods are discussed by scholars – for example, Lusk and Schroeder (2004); and Corrigan et al (2009). Choice experiments are increasingly preferred for their added advantage of ease of implementation and ability to replicate consumers' real shopping experiences (Louviere et al., 2000; Louviere and Timmermans, 1990; Aubeeluck, 2010). Since stated choice methods (stated preference data) can elicit preferences for new alternatives while revealed choice methods (revealed preference data) cannot directly predict response to new alternative, stated choice methods have been chosen in determining the type of markets (niche or general) for new products and/or new attributes, which are not available in markets yet (Louviere et al., 2000; Sanderson et al. 2002; Steiner et al., 2009 and Aubeeluck, 2010). The utility structure has been estimated from data collected on choice sets with different alternatives including a no-choice alternative (DeSarbo et al., 1995; Haaijer et al., 2001; Schroeder et al., 2006; Angulo and Gils, 2007; and Aubeeluck, 2010). Forcing consumers to choose between two alternatives without a no-choice alternative creates an inability to opt out of the choice and makes the choices unrealistic. Thus, the no-choice alternative is used as one of the alternatives in order to provides a more realistic choice set for decision makers (Hensher et al. 2005).

In the literature, different scholars have used different models in the estimation of the probability that individuals choose products with particular attributes (Appendix 3A). For example, multinomial logit was used by Haaijer et al. (2001), Loureiro and Umberger (2007), Steiner et al. (2009), Aubeeluck (2010) and Innes and Hobbs (2011); conditional logit models were used by Desarbo et al. (1995) and Lusk and Schroeder (2004); and mixed logit or random parameter logit model was used by Alfines (2004), Carlsson et al. (2004), Schroeder et al. (2006) and Ubilava and Foster (2009). Recently, due to the advancement of computational technology, mixed logit models have become more popular among scholars. The primary motivation for using mixed logit models is to avoid the independence of irrelevant alternatives (IIA) property, which is assumed in the multinomial logit or conditional logit models (Revelt and Train, 1998). The IIA assumption is that the ratio of the probability of choosing the alternative 1 over the probability of choosing the alternative 2 remains unchanged whether the alternative 3 is in the choice set or not. Since the IIA assumption is relaxed, mixed logit models can estimate preference heterogeneity that accounts for the unobserved similarities and differences across consumers (Glasgow, 2001). Revelt and Train (1998) mentioned that mixed logit models explicitly account for correlations in unobserved utility over repeated choices by each customer and allow efficient estimation to determine latent preference heterogeneity. Due to these added advantages of mixed logit models (or random parameter logit models) over standard logit models, mixed logit models can represent a more flexible and realistic determination of individual preference heterogeneity for food safety attributes (Greene and Hensher, 2003; Train, 2003; and Hensher et al 2005). Given that mixed logit models will be used in this paper.

4.3. CONCEPTUAL APPROACH

As discussed in the previous section, investigating consumers' preferences for a particular quality or attribute is important in determining pricing decisions or new product development. According to empirical evidence as discussed in the Section 4.2, individual characteristics such as knowledge about risk, familiarity with the source of risk, control over the situation (including psychological constructs), personality and trust in institutions can influence an individual's risk perceptions and attitudes; and the individual's risk perceptions and risk attitudes can influence consumption and preferences for particular food safety attributes (Figure 4.1). However, there have been no previous studies that determine the influence of the individual characteristics on preferences for food safety attributes considering the level of individual's risk perceptions and risk attitudes, particularly in venison. This study will fill the identified gap in the literature. This study will determine the influence of individual characteristics – demographic characteristics, psychographics and personality on preference for CWD-related food safety attributes across consumer segments with different risk perceptions and risk attitudes towards venison – on the preference for traceable and CWD-tested attributes in venison purchases. The model is illustrated in Figure 4.2.

The influence of individual risk perceptions and risk attitudes on the preference for CWD-related food safety attributes in venison will be determined by segmenting respondents into different groups with different risk perceptions/ attitudes towards venison in this study. Although the two variables can be simply used as explanatory variables in mixed logit models, it is believed that preference for the attributes across segments can give better explanatory power about the linkages. Given that cluster analysis is used in order to understand and compare differences in individual characteristics and preferences for product attributes among consumer segments. Magidson and Vermunt (2002) highlighted the *advantages* and *difference* of latent class model (LCM) for clustering compared to standard non-hierarchical cluster techniques such as K-means clustering. The *advantages* of using LCM include flexibility in choosing distributional forms for the observed variables within clusters and ability to use rigorous statistical tests in determining the optimal number of clusters. But the *difference* is that group (cluster) membership is unknown and provides only the probability of particular respondents in a particular group. In discriminate analysis like K-means clustering, group (cluster) membership is observable in the data (Magidson and Vermunt, 2002). K-means clustering allocates objects to clusters based on some criteria such as the minimum within-cluster variation or the maximum between-cluster variation. Following Yang and Goddard (2011a), K-means clustering will be applied to cluster the sample into different groups in this paper. Six survey questions will be used in order to understand a consumer's perceived risk assessments about venison. The specification of questions were developed by Penning et al (2002) and used by Schroeder et al (2007) and Yang and Goddard (2011a). The questions are as follows.

- Three risk perception questions:
    - When eating venison, my household is exposed to: *1=very little risk to 5=a great deal of risk;*
    - Members of my household think eating venison is risky: *1=strongly disagree to 5=strongly agree; and*

  - For members of my household, eating venison is: *1=not risky to 5=risky*).
- Three risk attitude questions:
  - Members of household accept the risks of eating venison: *1=strongly disagree to 5= strongly agree;*
  - For members of my household, eating venison is worth the risk: *1=strongly disagree to 5=strongly agree;*
  - My household is ... the risk of eating venison: *1=not willing to accept to 5=willing to accept*.

Based on consumers' responses to these questions, a hierarchical cluster analysis will be used to cluster consumer segments according to their risk perceptions and attitudes towards venison. After clustering the samples into groups, the risk perception and risk attitude indices will be calculated as a simple average of the responses to the three statements about risk perceptions and the three statements about risk attitudes, mentioned above. Then the groups can be identified as whether each is a CONCERNED group, a CONFIDENT group or a NEUTRAL group based on the calculated averaged number of the group. If a group or respondent expresses high risk attitudes and low risk perceptions, it implies that the consumer (group) has a high willingness to accept the risks and a low perceptions of risks in eating venison. This consumer will be considered to be a member of the CONFIDENT group (confident in eating venison). The reverse will be observed in the CONCERNED group, which includes risk adverse consumers who have concerns about eating venison (a low willingness to accept the risks and high perceptions of the risks associated with venison). In the NEUTRAL group, where consumers respond with reasonably high risk perceptions and high risk attitudes towards venison consumption, are assumed to be a relatively risk neutral in eating venison. The detailed procedures for the cluster analysis are presented in the Section 4.5.

For different segments with different risk perceptions and attitudes towards venison, stated preference choice data will be used in this paper. A fractional factorial design was used in SAS to determine the minimum number of choice sets to be used in this study. That minimum number of 30 combinations from 256 complete combinations of 4 levels of prices and 4 food safety attributes was divided into groups of 15 questions and online respondents were directed to the next choice set as determined electronically. Respondents have to choose one of the three options between two steaks with different prices (ranging from CN$ 5.50/500gms to CN$ 16.00/500gms) and different food safety attributes (CWD-tested, traceable, CWD-tested and traceable), or neither of the two steaks in their purchase decision (Table 4.1). A more detailed discussion about the data set can be seen in the data and methods section. It is assumed that individual's choice of a particular venison steak with a particular attribute at a particular price reveals his/her preference for that attribute. In the analysis, venison steak with no food safety attributes will be used as the base case in order to determine relative preferences for CWD-related food safety attributes in venison.

As discussed previously, an individual's demographic characteristics, psychographics and personality traits are considered to be influential factors on the preference for CWD-related food safety attributes across consumer segments with different risk perceptions and risk attitudes (Figure 4.2). The factors to be included in the analysis are chosen based on the literature review in the previous section. In terms of demographic characteristics, age of household head, gender of respondent, education level of household head, household's income and region of residence are used in the analysis to determine their different influences on the preferences for CWD-related food safety attributes.

In terms of psychographics/personality traits, familiarity of eating venison, food safety locus of control, trust in institutions, general trust in people and worry are used in the analysis based on the findings in previous studies as discussed in the literature review section. In order to understand the preference for CWD-related food safety attributes by a consumer with venison eating habit, a dummy variable representing whether the respondent eat (or ever eaten) venison or not is used as an explanatory variable. In order to understand the influence of internal versus external control of food safety attitudes on preferences for CWD-related food safety attributes, two internal (LC1: *I am in control over the safety of the* *food products that I eat*; and LC2: *the safety of food products is mainly influenced by how I handle food products*) and two external (LC3: *the safety of food products is mainly influenced by parties in the food chain other than myself*; and LC4: *the safety of food products cannot be controlled but is determined by coincidental factors*) loci of food safety control are used. These food safety loci of control were developed by de Jonge et al. (2007) following the concepts of Rotter (1966), Hersch and Scheibe (1967), Levenson (1974), and Lefcourt (1982). It is assumed that consumers with low internal or high external food safety loci of control would prefer more food safety attributes in venison products.

In terms of trust in institutions with regards to food safety, the multi-dimensional index is calculated as an average response to an individual's trust in an institution's competency, knowledge, honesty, openness and care about the safety of products (Renn and Levine, 1991; and de Jonge, 2008). Four types of institutions, defined by de Jonge (2008) and used in this study, include governments, farmers, manufacturers of food and retailers. An individual's trust in the government for the safety of food will be used in regressions in order to understand the influence of trust in regulatory authorities on preference for food safety attributes in venison. Two other personality traits, general trust level in people and the level of worry, are used in the study to determine a negative or positive influence on the preferences for food safety attributes in venison. The detailed development of data, used in this study, is discussed in the Section 4.5 "Data and Methods".

4.4. Empirical Approach

As discussed in previous sections, consumers' preferences for traceable and animal-tested attributes in venison meats are determined across consumer segments with different risk perceptions and attitudes towards venison in Canada and the US. The utility value for a choice by a participant is modeled based upon random utility theory (Revelt and Train, 1998, p.647) as:

$$U_{njt} = V_{njt} + \varepsilon_{njt} = \beta_n x_{njt} + \varepsilon_{njt} \quad \textbf{(4.1)}$$

where U_{njt} is the utility that person n obtains from alternative j in choice situation t ; x_{njt} is a vector of observed variables, β_n is coefficient vector and unobserved for each n and varies in the population with density $\int(\beta_n \mid \theta^*)$ where θ^* are the true parameters of this distribution, and ε_{njt} is an unobserved random term that is distributed iid extreme value, independent of β_n and x_{njt}. The probability that person n chooses alternative i in period t conditional to β_n is standard logit (multinomial or conditional logit) (Revelt and Train, 1998, p.647):

$$L_{nit}(\beta_n) = \frac{e^{\beta_n x_{nit}}}{\sum_j e^{\beta_n x_{njt}}} \quad \textbf{(4.2)}$$

The probability of person n's observed sequence of choices is the product of standard logits (Revelt and Train, 1998, p.647):

$$S_n(\beta_n) = \prod_t L_{ni(n,t)t}(\beta_n) \quad \textbf{(4.3)}$$

The unconditional probability for the sequence of choices is the integral of the conditional probability over all possible values of β_n (Revelt and Train, 1998, p.647):

$$P_n(\theta^*) = \int S_n(\beta_n) f(\beta_n \mid \theta^*) d\beta_n \quad \textbf{(4.4)}$$

The coefficient vector in this description can be described as $\beta_n = b + \eta_n$ where b is the population mean, and η_n is the stochastic deviation that represents the person's tastes relative to the average tastes in the population (Revelt and Train, 1998, p.649). The utility function in equation (4.1) will be changed to $U_{nji} = b'x_{njt} + \eta' x_{njt} + \varepsilon_{njt}$. The difference from standard logit is the stochastic portion ($\eta' x_{njt} + \varepsilon_{njt}$) that is correlated over alternatives and time due to the common influence of η. Relaxing IIA assumption, mixed logit model will estimate θ^* that capture the distribution of individual parameters (Revelt and Train, 1998).

The mixed logit estimation includes two steps. First, for a given value of parameters θ, a value of β is drawn from its distribution and the probability $S_n(\beta_n)$ that is a product of standard logit (multinomial logit) in equation (4.3) is calculated. Second, the process is repeated for many draws to construct simulated log-likelihood function (4.4) $SLL(\theta) = \sum_n \ln(P_n(\theta))$. Then, SLL is maximized to obtain estimated parameters (Revelt and Train, 1998). Finally, using the estimated part-worths for different prices, the WTP for each attributes will be calculated as an estimated exchange rate between utility and price (Breidert et al., 2006).

Mixed logit models in equation 4.4 are constructed using the choice-sets of venison steaks with different food safety attributes, prices versus would purchase neither as dependent variable. Variables such as price, attributes, and interaction terms of attributes and individual characteristics – such as age, gender, general trust level, trust in manufacturers of food, the level of worry, food-safety locus of control and whether respondents eat venison at least once in their live or not – are used as independent variables. Alternatives with different food-safety attributes (TRA: Traceability, ATE: Animal-Testing, TAT: Traceability and Animal-Testing, and NEI: Would Purchase Neither) are used as random parameters. For simplicity in WTP calculation, price is used as a non-random parameter. To simplify empirical model explanation, the observable component (V_{njt}) in equation 4.1 will be described as follows:

$$V_{njt} = \beta_{PRICE} * P_{njt} + \beta_{ATTRI\,n} * x_{njt} + \gamma_{TRA} * (D_n \times TRA_{njt}) + \gamma_{ATE} * (D_n \times ATE_{njt}) + \gamma_{TAT} * (D_n \times TAT_{njt}) \qquad \textbf{4.5}$$

where, β_{PRICE} is fixed parameter of the price scalar P_{njt}; x_{njt} represents the 4x1 vector for the food safety attributes of venison steaks in the choice experiments [x_{njt}=TRA, ATE, TAT and NEI]; and the interaction terms between food-safety attributes and demographic variables [D_n=Age, Female, General-trust, Trust in government, Worry, Food-safety locus of control #4, and Eat venison]. The base cases are venison steaks with no food-safety attributes. The random parameters $\beta_{ATTRI\,n}$ are specified to be normally distributed and correlated across attributes. Such kind of specification will allow the information relevant to making a choice that is unobserved may induce correlation across the alternatives with different food safety attributes in each choice situation and across choice situations. The interaction terms are used to capture the co-variation between demographic factors and preference for food safety attributes.

Following Breidert et al. (2006), the relative WTP, where the base case is the venison steak with no safety attributes (animal-tested, traceable or animal-tested and traceable) for each consumer segment are calculated using equation 4.6. The nominator is the combination of the estimated mean values of the coefficients associated with a particular attribute ($\hat{\beta}_{ATTRI}$), and its interaction effect ($\hat{\gamma} \times D$). The denominator is the fixed price coefficient (equation 4.6). The standard errors of the WTP estimates are calculated using Krinsky and Robb (1986) simulation procedure with 5000 replications.

$$WTP_{ATTRIBUTE} = -\frac{\hat{\beta}_{ATTRI} + \hat{\gamma} \times D}{\hat{\beta}_{PRICE}} \qquad \textbf{(4.6)}$$

4.5. DATA AND METHODS

Internet based survey data, collected from national samples of the population in Canada (1516) in 2009 by Leger Marketing and in the US (1016) in 2010 by TNS Global, are used (Appendix 4C). Both surveys recruited regular household food shoppers. A requirement of the survey was that 50% of respondents had eaten venison at least once in their life, resulting in a sample that is not necessarily a close representation of the population from the 2006 Census in Canada (Appendix 4I) and the 2009 Census in the US (Appendix 4J). In order to understand whether respondents had ***eaten venison*** or not, a yes or no question "Do you eat or have you ever eaten venison (deer, elk, or moose meat)?" was used in the survey. The rest of the survey was designed to elicit consumers' risk perceptions and risk attitudes towards venison, knowledge about CWD, confidence about the safety of venison, and perceived risks to human health, personality traits such as general trust level in other people and the level of worry, trust in various agents to manage food safety, and food safety locus of control.

In order to understand a consumer's perceived risk level about venison safety, six survey questions – three risk perceptions questions and three risk attitudes questions – as discussed in the Section 4.3 are used to determine their perceived risks about safety of venison. Based on consumers' responses to these questions, a hierarchical cluster analysis is used to cluster consumer segments according to their risk perceptions and attitudes towards venison. Since the number of groups or consumer segments in the sample is unknown, a two-stage *hierarchical cluster analysis* is used. In the first stage, *Ward's method* based on the *squared Euclidean Distance* of *hierarchical cluster analysis* is used to determine the optimum number of clusters. Appendix 4D and Appendix 4F present the agglomeration schedule of the data in Canada and the US respectively. The optimum number of clusters is determined based on the column 'Change', which determines the changes in the coefficients as the number of clusters increase. Since the change is much less with succeeding clusters, 3 clusters in Canada (Appendix 4D) and 2 clusters in the US (Appendix 4F) are selected. After the optimum number of clusters is identified, the hierarchical cluster analysis using K-means clustering algorithm is applied to obtain individuals for each consumer segment in both countries (Canada and the US). In Canada, 373 respondents have been classified in cluster 1, 648 respondents have been classified in cluster 2 and 183 respondents have been classified in cluster 3 (Appendix 4E). In the US, 353 respondents and 646 respondents have been classified in the two clusters respectively (Appendix 4G). The one-way ANOVA results suggested significant differences between the groups in Canada (Appendix 4E) and in the US (Appendix 4G).

As discussed in the Section 4.3, risk perception and risk attitude indices are calculated as a simple average of the responses to the three statements about risk perceptions and the three statements about risk attitudes for each group. Again as discussed in the Section 4.3, the groups are identified as the CONFIDENT, CONCERNED and NEUTRAL groups based on the group's calculated risk-perception and risk-attitude indices (Appendix 4H):

- CONFIDENT group - high risk attitudes and low risk perceptions about venison: Group 1 (n=373) in Canada and Group 1 (n=353) in the US;
- CONCERNED group - low risk attitudes and high risk perceptions about venison: Group 3 (n=183) in Canada and Group 2 (n=646) in the US; and
- NEUTRAL group - reasonably high risk attitudes and risk perceptions about venison: Group 3 (n=648) in Canada.

Across consumer segments, demographic characteristics and individual characteristics such as eat venison, knowledge, confidence about safety of venison, risk perception and risk attitude indices, personality, trust in institutions and locus of control are determined in Table 4.3. In general the demographics characteristics of the surveyed samples in Canada (Appendix 4I) and the US (Appendix 4J) are somewhat younger, better educated, have more households without children, and higher incomes than the average population. In both surveys, respondents' prior knowledge about CWD was determined by using a direct question about whether they had ***heard of CWD***, whether they had known that ***CWD can infect deer and elk***, prior to the survey. Respondent's ***confidence about the safety of venison*** is examined in Canada and the US, using the question "What do you think about venison? 1=not safe, to 5=safe". The respondents are asked about their level of concerns about ***risk to human health*** due to animal diseases using a 4-point scale – 1=important to 3=no risk and 4=don't know. The percentage of respondents who chose "1=important" will be discussed in comparison across consumer segments in the next section. Respondent's personality traits are measured using general tendencies such as levels of general trust in people and the tendency to worry in their daily life. Respondents' levels of ***general trust in people*** are determined using the question from the General Social Survey (GSS) conducted by the National Opinion Research Center in Canada and the US. The question is "Generally speaking, would you say that most people can be trusted? 1=don't know, 2=can't be too careful in dealing with people, and 3=people can be trusted". The trait ***worry*** is derived from the average of three statements with a five-point scale for responses (1=not at all, to 5=very typical) derived from the Penn State Worry scale (Gebhardt and Brosschot, 2002). The three statements to measure respondent's level of worry include: i) many situations make me worry; ii) I know I shouldn't worry about things, but I just cannot help it; iii) I notice that I have been worrying about things.

With respect to the safety of food, the level of respondents' ***trust in institutions*** are determined using six statements with a five-point scale (1=strongly disagree to 5=strongly agree) for four individuals/institutions – government, farmers, retailers and manufacturers of food. The trust index for each institution is derived from the average responses to six statements describing commitment (four statements such as the institution is honest about the safety of food, it is sufficiently open about the safety of food, it takes good care of the safety of our food; and it gives special attention to the safety of food) and competence (two statementssuch as the institution has the competence to control the safety of food and it has sufficient knowledge to guarantee the safety of food products) (de Jonge, 2008).

In order to understand how respondents feel food safety associated with food handling, locus of control for food safety has been measured using four statements on 5-point scales (Likert type visual analogue scale (VAS)) following Bowling (2000) and Redmon and Griffith (2004). The four statements of food safety locus of control was identified by de Jonge et al., (2007) based on the concepts of Rotter (1966) and Lefcourt (1982). The four statements include: LC1 - I am in control over the safety of the food products that I eat; LC2 - the safety of food products is mainly influenced by how I handle food products; LC3 - the safety of food products is mainly influenced by parties in the food chain other than myself; and LC4 - the safety of food products cannot be controlled but is determined by coincidental factors. The five-point response scales from 1=strongly disagree to 5=strongly agree are used. In the next section, all the collected individual characteristics are determined in comparison among consumer segments – CONFIDENT, NEUTRAL and CONCERNED – in Canada and the US.

At the end of the survey questions, the choice experiment for deer and elk meat was conducted with 15 different pairs of alternative venison strip loin steaks. Respondents have to choose one of the three options between two steaks with different prices – ranging from CN$ 5.50/500gms to CN$ 16.00/500gms – and different food safety attributes – TRA, ATE and TAT – or neither of the two steaks in their purchase decision (Table 4.1). As discussed earlier, a "would-purchase-neither" alternative is used as one of the attributes to provide a more realistic choice set for decision makers (Hensher et al. 2005). Using individual's choice data, mixed logit models are estimated. Following mixed logit model estimations, the WTPs for the food safety attributes are calculated for three representative consumers (young adult: age=24; middle age: age=40; and old adult: age=64) under two personality traits (optimistic and pessimistic about food safety) across consumer segments in Canada and the US (Table 4.7 and Table 4.8).

A representative consumer who is optimistic about food safety is defined, in this study, as a person who shows no worry (worry=1 where 1= *not at all*), who trusts in people (Trust=1: where 1=Yes= people can be trusted), who trusts in government (Gtrust=5: where 5= *strongly agree*), and who agree LC4: *the safety of food products cannot be controlled but is determined by coincidental factors* (LC4=5: where 5= *strongly agree*). A consumer who is pessimistic about food safety is defined as a person who shows worry (worry=4: where 4=*typical*), who does not trust in people (where Trust=0: where Can't be too careful in dealing with people and Don't know), who does not trust in government (Gtrust=1: where 1= *strongly disagree*), and who does not agree LC4 (LC4=1: where 1= *strongly disagree*).

In addition, the average WTPs for food safety attributes are presented in Table 4.9 in comparison between those who eat venison and who do not eat venison, between those who have heard about CWD and who have never heard about CWD, and between those who know that CWD can infect deer-elk and those who do not know that CWD can infect deer-elk. The average WTPs for food safety attributes associated with CWD in venison meats will be calculated for all respondents across segments and will be compared to WTPs for food safety attributes associate with BSE in beef from previous studies in Table 4.10.

4.6. RESULTS AND DISCUSSIONS

4.6.1. Descriptive Results

In Table 4.3, the comparison of descriptive data across consumer segments in Canada and the US is presented. More detailed descriptive data and t-statistics for significant differences between consumer segments are shown in Appendices 4H, 4I, 4J and 4K. A more percentage of female and city dwellers fall in the CONCERNED groups than in the CONFIDENT groups in both Canada and the US. The percentage of respondents who have ever eaten venison is at least twice higher in the CONFIDENT groups than in the CONCERNED groups in the two countries. The percentage of respondents, who think that animal diseases such as CWD in wild and farmed deer and elk is an important risk to human health, is higher in the CONCERNED groups than in the CONFIDENT groups in both Canada and the US. A higher percentage of respondents, who said that most people can be trusted, falls in the CONFIDENT groups than in the CONCERNED groups in the two countries. The result is consistent with previous findings from Myae and Goddard (2012) and General Social Survey (GSS) in Canada and the US (National Opinion Research Center, 2010). In determining respondents' prior knowledge about CWD, the percentage of respondents who had heard about CWD and who knew about CWD infection to deer/elk is higher in the CONFIDENT group than the CONCERNED group in both Canada and the US. The results using the percentage of respondents in each groups suggest that there are positive (negative) relationships between a respondent's confident – low risk perceptions and high risk attitudes – level in the safety of venison and gender=male, place of residence=rural areas, his/her knowledge about the CWD and general trust level (perceived risk to human health). If the percentage of the two CONFIDENT groups and the two CONCERNED groups in Canada and the

US are compared, more Canadian respondents had knowledge about CWD than American respondents had (Table 4.3).

Mean scores are used for some characteristics such as age, confidence about the safety of venison, trust in institutions, the level of worry and food safety locus of controls (Table 4.3). In Canada, the mean age of respondents in the CONCERNED group is significantly higher than the mean age of respondents in the CONFIDENT group. In determining respondents' confidence about the safety of venison, the percentage of responses to '5=safe' is higher in the CONFIDENT group than in the other group(s) (NEUTRAL and CONCERNED) in Canada and the US. The mean scores in the CONFIDNET group is significantly higher than that in the other groups (NEUTRAL > CONCERNED) in Canada and is significantly higher than that in the CONCERNED group in the US. The results suggest that consumers' confidence about the safety of venison is significantly lower if their risk perceptions of venison meat is low and risk attitudes about the safety of venison is high. It can be assumed that consumers who fall in this category (the CONFIDENT group) may prefer a lesser level of food safety attributes in their venison purchases.

In terms of respondents' ***Trust in institutions*** with regards to food safety, the trust index for 'farmers' is the highest in all segments in both Canada and the US. The level of trust in *farmers* is significantly higher in the CONFIDENT group than in the CONCERNED group in the two countries. In Canada, the level of trust in *farmers* and *retailers* is significantly higher in the NEUTRAL group than in the CONCERNED group. The level of trust in 'government' is significantly higher in Canadians than in Americans. The level of trust in 'manufacturers of food' is significantly higher in the CONFIDENT group than in the CONCERNED group in both Canada and the US. The results suggest that respondents in the CONFIDENT group show a relatively higher level of trust in institutions with regards to food safety. Among respondents in the CONFIDENT group, Canadians show significantly higher trust in 'manufacturers of food' than do Americans. In terms of respondent's trait worry, Canadian respondents show a lower level of worry than do American respondents across all segments. The results are consistent with the previous findings by Myae and Goddard (2012). The level of worry is significantly lower in the CONFIDENT groups than in the CONCERNED groups; and it is significantly lower in the NEUTRAL group than in the CONCERNED group in Canada. This means that regardless of a specific food safety issue, people who have low risk perceptions and high risk attitudes towards venison show a lower level of worry than do other types of people.

In determining respondents' locus of control for food safety, LC3 *(the safety of food product is mainly influenced by parties in the food chain other than myself)* is ranked the highest and LC4 *(the safety of food products cannot be controlled but is determined by coincidental factors)* is ranked the lowest in all segments in Canada and the US. In Canada, the mean scores for LC3 (LC4) is significantly higher (lower) in the CONCERNED group than in the other two groups. In the US, the mean scores for LC1 *(I am in control over the safety of the food products that I eat)*, LC2 *(the safety of food products is mainly influenced by how I handle food products)* and LC3 are significantly higher in the CONFIDENT group than in the CONCERNED group. It can be expected that Canadians in the CONCERNED group and Americans in the CONFIDENT group who shows a higher mean scores for LC3 might have a higher preference for food safety attributes in their venison purchases. The significant differences across segments and countries in response to the specific questions and links to respondents' perceived risk are summarized in Table 4.4. In Appendix 4M, the percentage of respondents choosing Option C (I would purchase neither of these steaks) can be observed in comparison across consumer segments and across Canada and the US. The average number of people choosing option-C is higher in Canada than in the US and is higher in the CONCERNED groups than the CONFIDENT groups in both countries (Appendix 4M).

4.6.2. Econometric Results

4.6.2.1. Results of Mixed Logit Models

In Table 4.5 and Table 4.6, mixed logit estimates are presented. In all the estimations, venison steak with no food safety attribute is used as the base case. Individual's age, the level of education, the level of trust in general, the level of trust in government, the level of worry, the fourth locus of control about food-safety (LC4: The safety of food products cannot be controlled but is determined by coincidental factors) and a dummy of whether respondents has ever eaten venison at least once in their life or not are used to determine preference heterogeneity around the mean parameter estimates. Because variables that represent consumers' knowledge, confidence about CWD and safety of venison are not statistically significant, the variables are not used in the estimation. Since individual's age, household size and presence of children are relatively correlated in all the segments, only one of the three variables (age), which add explanatory power, is used in the models. Similarly, respondents' education level and income are relatively correlated, one of the two variables is used in the models. But because of low explanatory power, both education level and income variables are not used in this paper. Appendix 4N presents correlation matrix of variables. Since the level of trust in institutions (Trust in government, Trust in farmers, Trust in retailers, and Trust in food-manufacturers) are highly correlated each other, Trust in government is used in the models. Due to high correlations among the three locus of control about food-safety (LC1, LC2 and LC4), the fourth locus of control LC4 is chosen to be included in the models.

The mixed logit model estimates are shown in Table 4.5. The overall model fits (McFadden R^2) are statistically acceptable for the mixed logit model class (Hensher et al., 2005). The Cholesky Matrix of correlated random parameters is presented in Table 4.6 and the WTP estimates are presented in Table 4.7 and Table 4.8. Respondents' WTP for attributes were calculated for three consumer-segments in Canada and two consumer-segments in the US. The standard errors of the WTP estimates were produced using Krinsky and Robb

(1986) simulation procedure with 5000 replications. The following is the interpretation of coefficients since it is feasible in the mixed logit models (Alfines, 2004).

In Table 4.5, the mean sample population parameter estimates are statistically significant and of the correct sign with positive coefficients on all attribute parameters and negative coefficient on NEI as a prior expectation (except in the CONCERNED groups). The negative and significant sign on NEI coefficient suggests that consumers' utility will be reduced if venison steaks with added food-safety attributes are not available in the market. In contrast, the positive signs on NEI coefficients in the CONCERNED groups in Canada and the US suggest that consumers would not make them suffer utility loss if venison steaks with added food-safety attributes are not available in the market. As the theory suggests, the non-random parameter PRICE is negative and highly significant at the 1% level in all respondent segments in both Canada and the US. The parameter estimates for derived standard deviations for all random-parameters are highly statistically significant, which suggest that the heterogeneity exist over the sampled population. The preference heterogeneity on food safety attributes due to unobserved effects that are correlated amongst alternatives in a given choice set leads to correlated errors across alternatives in different choice sets. In Table 4.6, the off diagonal values are statistically significant supporting the hypothesis that individuals' preferences for the food safety attributes that are common across alternatives are correlated. The diagonal values from the Cholesky matrix confirmed significant unobserved effects that are correlated amongst alternatives. There are significant latent preference heterogeneity in *TRA* and *ATE* in all segments in Canada and the US; significant latent preference heterogeneity in *TAT* and *NEI* in the Confident group in Canada; and significant latent preference heterogeneity in *NEI* in all the groups in the US (Table 4.6).

Using individual's age, gender, the level of general trust, the level of trust in government, the level of worry, the LC4 and a dummy of eating venison, the heterogeneity in mean parameter estimates are presented in Table 4.5. The results suggest that the preferences for *TRA: traceability* attribute decreases for older consumers in all groups in Canada and the US; it decreases for females in the NEUTRAL and CONCERNED groups in Canada; it decreases for respondents with higher general trust level in the CONCERNED group in Canada; it increases for respondents with higher level of trust in government in both the CONFIDENT and CONCERNED groups in the US; it increases for respondents who show lower level of worry in the CONCERNED group in Canada; it decreases (increases) for respondents who agree that *the safety of food products cannot be controlled but is determined by coincidental factors* in the CONFIDENT group in Canada (in the CONCERNED group in the US); and it increases for respondents who eat venison in all the groups in Canada and the US (except in the CONCERNED group in Canada).

The preference for *ATE: animal testing* attribute decreases for older consumer in all the groups in Canada and the US; it decreases for females in all groups (except in the CONFIDENT group in Canada); it increases for respondents with a higher (lower) trust level in the CONFIDENT group (the CONCERNED group) in Canada; it increases for respondents with the higher level of trust in government in the NEUTRAL group in Canada and in all the groups in the US; it decreases (increases) for respondents who agree that *the safety of food products cannot be controlled but is determined by coincidental factors* in the CONFIDENT and NEUTRAL groups in Canada (in all the groups in the US); and it increases (decreases) for respondents who eat venison in the NEUTRAL group (the CONCERNED group) in Canada and in all the groups in the US.

The preference for *TAT: traceability and animal testing* attribute decreases for older consumer in all the groups in Canada and the US; it decreases for females in all the NEUTRAL group and the CONCERNED group in Canada; it decreases for respondents with a lower (higher) trust level in the CONFIDENT group (the CONCERNED group) in Canada; it increases for respondents with the higher level of trust in government in all the groups in the US; it decreases for respondents who agree *LC4: the safety of food products cannot be controlled but is determined by coincidental factors* in the CONFIDENT and NEUTRAL groups in Canada; and it increases for respondents who eat venison in all the groups in Canada and the US (except in the CONCERNED group in Canada).

4.6.2.2. WTP Estimates Following Mixed Logit Models

In Table 4.7 and Table 4.8, the WTP estimates for food safety attributes of selected females and males in each group are calculated according to their personality (optimist and pessimist – see Section 4.5) and age (young adult, middle age and older age – see Section 4.5) using the Equation 4.5. As discussed previously on the mixed logit model estimates in Table 4.5, the WTPs for the three food-safety attributes in male consumers are higher than that of female consumers compared to the respective groups in both Canada and the US. In all the groups in Canada and the US, younger consumers are willing to pay a higher premium for all food-safety attributes than older consumers do (WTPs in young-adult>middle-age>older-age groups).

Compared to the two countries among young-adults and middle-age consumers in the CONFIDENT groups, the WTP premiums for all safety attributes are higher in American consumers than in Canadian consumers. Compared to a pessimist, an optimist's WTP premiums for the food safety attributes at each age-group are (mostly) higher in all the groups in Canada. The reverse is true in all the groups in the US. In Figure 4.3, Figure 4.4 and Figure 4.5, the WTPs for food safety attributes among young consumers can be determined across segments in the two countries. Regardless of whether a consumer is an optimistic or pessimistic about food safety, consumers who fall in the CONFIDENT group in both Canada and the US, and in the NEUTRAL group in Canada are willing to pay a lower premium for food safety attributes than do consumers in the CONCERNED group in both countries. However, if the CONCERNED groups' WTP premiums for food safety attributes are compared between those who are optimistic about food safety and who are pessimistic about food safety in each country, male consumer pay a higher premium than a female consumer in Canada. The WTP distribution for the three food safety attributes across consumer segments are presented in Figures 4.6 to 4.11.

Canadians' WTP distribution for all the three attributes in the CONFIDENT group ranges from \$0.7/500g to \$10.7/500g, while that in the NEUTRAL group is wider – ranging from \$-8.5/500g to \$15.1/500g – and that in the CONCERNED group is the widest – ranging from \$5.7/500g to \$51/500g. In the US, respondents' WTP for the three attributes ranges from \$-5.4/500g to \$17.4/500g in the CONFIDENT group and the distribution shifts rightwards (\$-6.1/500g to \$25.3/500g) in the CONCERNED group. The differences in WTPs for the three food safety attributes among consumers who eat venison and who do not eat venison across segments in the two countries are presented in Figures 4.12 to 4.23. An obvious right-ward shift of WTP distribution and bigger WTP premiums on average (Table 4.9) in those who eat venison compared to those who do not eat venison can be observed (except in the Canadian CONCERNED group). The average WTPs for food safety attributes between those who had prior knowledge about CWD (have heard about CWD and have known about CWD infection to deer-elk) is higher in the NEUTRAL group in Canada and in the CONFIDENT group in the US than those who had no prior knowledge about CWD (Table 4.9). The reverse can be seen in the CONCERNED group in Canada (Table 4.9). The WTP premiums for food safety attributes are not different in the CONFIDENT group in Canada and in the CONCERNED group in the US (Table 4.9). In general, prior knowledge about CWD does not have significant effect on the WTP premiums in each group. In Table 4.10, a comparison of marginal WTPs for different food safety attributes in this study for venison steak and in previous studies for beef steak is presented. The comparison of average WTP across segments in Canada with the results from previous studies suggests that Canadian consumers' WTP for CWD-related food safety attributes in venison steak is lower than WTP for BSE-related food safety attributes in beef stake. The reverse can be seen in the US. The results suggest that Americans are willing to pay a higher premium for CWD-related food safety attributes in venison steak on average across segments, compared to the WTP for BSE-related food safety attributes in beef stake.

4.6.3. Summary of Results

In summary, the results suggest that consumers with different risk perceptions and risk attitudes towards venison take the risk of venison consumption differently. Consumers in the CONCERNED groups in both Canada and the US are those who have higher risk perceptions and lower risk attitudes towards venison, who are less familiar with venison consumption, who have less knowledge about CWD, who think that CWD in wild and farmed cervids is an important risk to human health, and who show more pessimism in terms of personality (lower general trust level in people, higher worry, lower level of trust in institutions and more (in Canada) agree with the LC4: the safety of food products cannot be controlled but is determined by the coincidental factors). Consumers who have more concerns about the safety of venison in the CONCERNED groups prefer food safety attributes (higher WTPs) more than those in the CONFIDENT groups in both Canada and the US. The CONCERNED group should be regarded as those who will seek food-safety attributes in their venison purchases whenever they want to eat this specific exotic meat. In contrast, the CONFIDENT groups include those who have lower risk perceptions and higher risk attitudes towards venison, who are more familiar with venison consumption, who have more knowledge about CWD, who do not think that CWD in wild and farmed cervids is an important risk to human health, and who show more optimism in terms of personality. Consequently, consumers in the CONFIDENT groups do not want to pay a high premium for food safety attributes in their venison purchases. Ultimately, the results suggest that more people who are younger, pessimists, who eat venison and those in the CONCERNED groups pay higher WTP premium for the attributes in the market.

4.7. CONCLUSIONS

Traceability and animal testing are most commonly used by governments to do surveillance on TSEs infection in a region, and are used as the food safety attributes to improve consumers' confidents in consuming the product. Schroeder et al. (2007) argued that the effectiveness of governments' regulatory practices and industry's added attributes depends on consumers' concerns/preferences for these practices/attributes. In this study, how consumers perceive regulatory policies and risk in their lives is examined by determining consumers' preferences for the CWD-tested and traceable attributes in their venison purchases. In order to understand the role of perceived risk on consumers' preference for food-safety attributes, consumer segments with different risk perception and risk attitudes are used in Canada and the US. Consumers' knowledge, confident about CWD and safety of venison, familiarity with eating venison and psychological constructs are determined across segments in Canada and the US.

The exploratory analysis in Table 4.3 and Table 4.4 reveals positive relationships between consumers' perceived risk (high risk perceptions and low risk attitudes) and i) their knowledge about CWD and infection to deer/elk; ii) their perceived risk about CWD to human health; and iii) their level of worry in both Canada and the US. A negative relationship exists between consumers' perceived risk and i) their confident about the safety of venison; ii) their eating habit of venison; iii) their trust levels (general trust and trust in institutions); and iv) their agreement with LC1, LC2 and LC4 in the two countries. The link between consumers' perceived risk and LC3 is positive in Canada and negative in the US. The results express that compared to other segments, in the CONCERNED groups, less respondents knew about CWD and infection to deer/elk, more respondents thought that CWD is risk to human health, more respondents do not eat or have not ever eaten venison at least once in their life, more respondents show pessimism in terms of trust/worry levels and more respondents choose the option C (I would purchase neither of these steaks) in both Canada and the US (Table 4.3). If the two countries are compared, more Canadians had heard about CWD, thought that CWD is a risk to human health, showed a higher level of trust in general, showed a lower level of trust in farmers and retailers, showed a higher level of trust in government and manufacturer of food, and showed a lower level of worry than do Americans (Table 4.3).

The mixed logit model estimates across consumer segments with different risk perceptions and risk attitudes towards venison consumption suggest that respondents in the CONFIDENT groups in both Canada and the US, and respondents in the NEUTRAL group in Canada show utility reduction if the venison steaks with food safety attributes are not available in the market place (minus sign on NEI variables in Table 4.5). The preference heterogeneity exists over the sampled population. The individual specific characteristics such as age, gender (female=1), trust in people (yes=1), trust in institutions, worry, food-safety locus of control, and venison eating habit (yes=1) influence preference for food safety attributes in venison (Table 4.5). The WTPs for the three food-safety attributes among male consumers and younger consumers are higher than that of female consumers and older consumers in both Canada and the US. Compared to a pessimist, an optimist's WTP premiums for all the three food safety attributes at each age-group are mostly higher in Canada and lower in the US. Compared to the two countries among the young-adult and middle-age consumers, the WTP premiums for all safety attributes are higher in American consumers in the CONFIDENT group and the CONCERNED group than in Canadian consumers in the CONFIDENT group and the NEUTRAL group respectively (Table 4.7 and Table 4.8). Canadian consumers in the CONCERNED group show the highest WTPs compared to other groups in both Canada and the US in each age group. In terms of WTP distribution, Canadians shows a smaller range in the CONFIDENT group and the NEUTRAL group than do Americans in the CONFIDENT group and the CONCERNED group respectively. Canadians in the CONCERNED group are significantly different that WTP distributions for all the attributes (traceable, animal-tested, traceable plus animal-tested) are very flat and craw rightwards (Figure 4.6 to Figure 4.23). The possible reasons of flat distribution include smaller sample size and less variation among respondents in the group. In addition, consumers who eat venison are willing to pay a higher premium for food-safety attributes than those who do not eat venison (except in the CONCERNED group in Canada).

The findings from this study provide sound answers to the research question about preferences for different types of intervention in the context of varying risk perceptions risk attitudes. The results suggest that traceability and animal-testing attributes in venison meat can increase the utility of consumers in the CONFIDENT and NEUTRAL groups – 85% of the sample – in Canada and in the CONFIDENT group – 35% of the sample – in the US. The CONFIDENT groups include those who have lower risk perceptions and higher risk attitudes towards venison, who are more familiar with venison consumption, who do not think that CWD in wild and farmed cervids is an important risk to human health, and who are more optimistic (in terms of personality traits such as no worry, trust in people, trust in government, do not agree that the safety of food products is mainly influenced by parties in the food chain other than myself in terms of food safety) and who show the lowest WTPs for food safety attributes compared to other segments in each country. The CONCERNED groups include those who show higher risk perceptions and lower risk attitudes towards venison, who are less familiar with venison consumption, who think that CWD in wild and farmed cervids is an important risk to human health, who are more pessimistic in terms of personality traits and about food safety, and who show the highest WTPs for food safety attributes compared to other segments in each country.

Finally, the links discussed above suggest that if there arises human health implication from venison consumption due to CWD infection, consumers in the CONFIDENT groups should be given a priority to communicate effectively and provide food safety information more efficiently. It is obvious that the broaden knowledge about the link towards venison from this paper is valuable to categorise risk management techniques for other relatively unique foods. The results of this study also suggest that in terms of market extension, there are relatively better potential niche markets for venison with added food safety attribute among those who show a higher perceived risks about venison safety. Moreover, niche market potential is more prominent in younger consumers, male food shoppers, those who eat venison and those who show higher perceived risks about venison safety in both Canada, and the US. Moreover, the comparison of

WTPs for these specific attributes in this study and previous studies suggests the confirmation of previous literature that WTPs for CWD-related food safety attributes are lower (higher) than those for BSE-related food safety attributes in Canada (the US). It can be concluded that animal-disease related interventions should be justified depending on the percentage of consumers whose utility is affected (85% of the sample in Canada and 35% of the sample in the US as discussed above) in a particular society since the responses towards food safety attributes are different. Ultimately, as stated in the Section 4.1, the results from this study provide a bench mark to determine whether interventions have the capability of alleviating market responses in the face of animal disease risk in the future.

Table 4. 1. Stated preference survey options

	Attributes	None
Price ($/500gm)	5.50 9.00 12.50 16.00	I would not purchase any of these products.
Food Safety	Traceable Animal-tested Traceable + Animal-tested None	

Table 4. 2. Comparison of risk perception index and risk attitude index from previous studies

	This Study		**Muringai and Goddard (2011)**		**Yang (2010)**	**Schroeder et al. (2007)**		**Tonsor et al. (2009)**		**Pennings et al. (2002)**
Country	CA	US	CA	US	CA	CA	US	CA	US	US
Meat type	Venison		Beef							
Survey Year	2009	2010	2006	2009	2008	2006		2006		2001
Respondent number	1516	1016	325	1409	4076	1002	1009	1002	1009	228
Scale	5	5	5	5	5	10	10	10	10	9
RP Index	2.48	2.97	2.22	2.15	2.00	3.3	3.68	3.34	3.7	3.72
RA Index	3.04	3.18	2.78	3.62	3.46	4.9	4.81	3.94	4.8	5.02

Table 4. 3. Comparison data across consumer segments in Canada and the US

	CA-G1 (Confident)	CA-G2 (Neutral)	CA-G3 (Concerned)	US-G1 (Confident)	US-G2 (Concerned)
Sample this analysis	373	648	183	353	646
Risk perception index	1.69	2.90	4.26	2.40	3.28
Risk attitude index	4.56	3.17	1.71	4.35	2.53
	% response				
Gender - female	36	45	54	56	60
City, town, rural - City	62	62	69	41	48
Eat venison - Yes	91	65	35	80	41
Heard of CWD - Yes	45	40	36	29	17
Know CWD infection to deer - Yes	27	19	21	19	8
Know CWD infection to elk - Yes	25	17	19	16	7
Risk to human health - important	29	43	64	44	54
General trust in people - yes	63	46	49	39	31
Confident about the safety of venison (5=safe)	36	6	1	33	5
	Mean (Standard deviation)				
Age - years	46.6 (15)	48.9 (16)	50.6 (15)	40.6 (14)	41.5 (14)
Confident about the safety of venison (1=not safe to 5=safe)	4.24 (0.66)	3.31 (0.8)	2.25 (0.91)	4.02 (0.92)	2.91 (0.98)
Trust in government (1= strongly disagree to 5=strongly agree)	3.63 (0.78)	3.50 (0.77)	3.54 (0.78)	3.37 (1.02)	3.31 (0.83)
Trust in farmers (1= strongly disagree to 5=strongly agree)	3.94 (0.56)	3.67 (0.69)	3.56 (0.81)	3.89 (0.76)	3.59 (0.70)
Trust in retailers (1= strongly disagree to 5=strongly agree)	3.48 (0.69)	3.35 (1.71)	3.20 (0.72)	3.61 (0.83)	3.40 (0.73)
Trust in manufacturers (1= strongly disagree to 5=strongly agree)	3.71 (0.70)	3.56 (0.72)	3.54 (0.61)	3.58 (0.84)	3.48 (0.73)
Worry (1=not at all typical to 5=very typical)	2.53 (0.90)	2.79 (0.99)	2.95 (0.98)	3.36 (1.14)	3.31 (1.08)
Four Food Safety Loci of Control (1= strongly disagree to 5=strongly agree)					
LC1: I am in control over the safety of the food products that I eat.	3.34 (0.97)	3.22 (0.96)	3.20 (1.03)	3.26 (1.06)	3.14 (0.93)
LC2 : The safety of food products is mainly influenced by how I handle food products.	3.36 (1.02)	3.34 (0.96)	3.28 (0.98)	3.38 (1.09)	3.26 (0.91)
LC3 : The safety of food products is mainly influenced by parties in the food chain other than myself	3.87 (0.81)	3.89 (0.78)	4.14 (0.73)	3.89 (0.88)	3.64 (0.87)
LC4 : The safety of food products cannot be controlled but is determined by coincidental factors.	3.18 (1.07)	2.31 (1.05)	2.09 (1.04)	2.60 (1.19)	2.69 (1.01)

Table 4. 4. Highest response to questions and link to consumers' perceived risk

	By Group	By Country	Link to Perceived Risk (High RP & Low RA)
Knowledge, Concerns and Perceived risk			
Heard of CWD	Confident	Canada	+
CWD Infection to Deer	Confident	Canada	+
CWD Infection to Elk	Confident	Canada	+
Confident About the Safety of Venison	Confident	Canada	-
Risk to Human Health	Concerned	US	+
Psychological Constructs			
General Trust	Confident	Canada	-
Trust in Government	Confident	Canada	-
Trust in Farmers	Confident	US	-
Trust in Retailers	Confident	US	-
Trust in Manufacturers of Food	Confident	Canada	-
Worry	Concerned	US	+
LC1	Confident		-
LC2	Confident		-
LC3	Confident in US/ Concerned in Canada		-/+
LC4	Neutral in Canada		

Table 4. 5. Mixed logit model estimates

	CANADA						US			
	G1 (Confident) (N=373)		G2 (Neutral) (N=648)		G3 (Concerned) (N=183)		G1 (Confident) (N=353)		G2 (Concerned) (N=646)	
	Coef.	T-stat.	Coef.	T-stat.	Coef.	T-stat.	Coef.	T-stat.	Coef.	T-stat.
Random Parameters										
Traceability (TRA)	7.02***	5.72	2.61***	2.95	26.5***	3.65	1.48*	1.79	3.88***	4.24
Animal-Testing (ATE)	3.15**	2.34	2.61***	2.59	21.9***	3.33	1.69**	2.15	4.12***	4.59
Traceability and Animal-Testing (TAT)	6.77***	5.19	4.55***	4.99	26.8***	3.72	3.22***	3.69	5.13***	5.42
NEI	-6.49***	-11.0	-1.14***	-4.24	17.0***	2.98	-1.57***	-4.44	1.73***	3.08
Standard deviations of parameter distributions										
sdTRA	2.53***	6.09	7.62***	10.6	13.0***	3.39	5.10***	8.14	8.02***	7.94
sdATE	5.83***	9.75	8.57***	11.8	17.1***	3.88	5.18***	10.8	7.12***	8.25
sdTAT	3.42***	8.11	8.36***	12.8	15.1***	3.51	5.63***	9.13	8.40***	8.96
sdNEI	9.13***	9.82	1.69***	5.44	11.8***	3.50	3.06***	9.17	3.33***	6.05
Non-random Parameters										
Price	-0.83***	-17.1	-0.54***	-20.8	-0.42***	-6.72	-0.41***	-14.5	-0.30***	-15.0

Table 4. 5. Mixed logit model estimates (Cont.)

	CANADA						US			
	G1 (Confident)		G2 (Neutral)		G3 (Concerned)		G1 (Confident)		G2 (Concerned)	
	Coef.	T-stat.	Coef.	T-stat.	Coef.	T-stat.	Coef.	T-stat.	Coef.	T-stat.
Heterogeneity in mean, Parameter: Variable										
TRA:AGE	-0.07***	-6.08	-0.07***	-7.18	-0.17***	-4.18	-0.08***	-7.29	-0.09***	-7.97
TRA:GENDER	-0.50	-1.55	-2.25***	-7.61	-2.78***	-2.90	-0.36	-1.54	-0.22	-1.01
TRA:TRUST	0.61	1.79	0.08	0.31	-4.96***	-3.84	0.38	1.59	0.01	0.06
TRA:GTRUST	0.05	0.23	0.12	0.79	0.12	0.23	0.52***	4.10	0.36***	2.72
TRA:WORRY	-0.21	-1.16	-0.02	-0.12	-1.24***	-2.70	0.16	1.53	0.02	0.17
TRA:LC4	-0.24*	-1.68	-0.16	-1.37	0.11	0.30	-0.01	-0.14	0.31***	2.82
TRA:EAT	0.81*	1.73	4.50***	10.7	-0.13	-0.27	3.26***	7.94	1.94***	6.72
ATE:AGE	-0.03**	-2.10	-0.07***	-6.19	-0.13***	-3.52	-0.06***	-6.27	-0.09***	-7.23
ATE:GENDER	-0.11	-0.30	-1.92***	-5.81	-1.45*	-1.64	-0.52**	-2.25	-0.32*	-1.60
ATE:TRUST	0.74*	1.87	-0.22	-0.76	-4.62***	-3.66	0.13	0.59	-0.18	-0.84
ATE:GTRUST	0.32	1.35	0.31*	1.66	0.75	1.33	0.38***	3.19	0.22*	1.78
ATE:WORRY	0.33	1.48	0.05	0.38	-0.54	-1.36	0.06	0.60	0.03	0.31
ATE:LC4	-0.32**	-1.89	-0.29**	-2.13	0.27	0.75	0.19**	1.97	0.40***	3.68
ATE:EAT	0.29	0.51	4.08***	8.88	-1.88***	-2.98	2.05***	6.09	1.83***	6.57
TAT:AGE	-0.06***	-5.21	-0.07***	-7.28	-0.17***	-4.12	-0.08***	-6.91	-0.10***	-8.26
TAT:GENDER	-0.06	-0.17	-2.12***	-7.36	-1.86**	-1.97	-0.27	-1.12	-0.10	-0.46
TAT:TRUST	0.65*	1.77	0.26	1.04	-5.21***	-3.60	0.15	0.60	-0.26	-1.12
TAT:GTRUST	0.17	0.77	-0.03	-0.21	-0.38	-0.72	0.50***	3.84	0.43***	3.24
TAT:WORRY	0.19	0.95	0.14	1.06	-0.20	-0.47	-0.03	-0.24	0.02	0.20
TAT:LC4	-0.27*	-1.75	-0.29**	-2.50	0.03	0.07	-0.12	-1.15	0.11	1.04
TAT:EAT	1.78***	3.38	4.79***	12.1	-0.86	-1.47	3.21***	7.93	2.11***	7.54
Model Statistics										
McFadden R^2	0.26		0.25		0.48		0.18		0.17	
Log Likelihood Function	-4472.89		-7831.56		-1545.00		-3783.51		-6942.49	
AIC	1.64		1.7		1.17		1.82		1.83	
Halton Draws	100		25		75		75		25	

Note: ***, ** and * indicate significant at the 1%, 5% and 10% significant levels. Results produced with NLOGIT 5.0

Table 4. 6. Cholesky matrix of correlated random parameters

	TRA	ATE	TAT	NEI
CANADA: G1_CONFIDENT GROUP				
TRA	2.53***			
ATE	9.10***	4.58***		
TAT	8.41***	11.25***	0.76**	
NEI	7.08***	24.9***	14.4***	3.34***
CANADA: G2_NEUTRAL GROUP				
TRA	7.62***			
ATE	-52.1***	5.16***		
TAT	-63.6***	54.9***	0.09	
NEI	-7.65***	-0.13	8.96***	0.10
CANADA: G3_CONCERNED GROUP				
TRA	13.0***			
ATE	-219***	2.97***		
TAT	-195***	258**	0.50	
NEI	-119***	133	122	1.16
US: G1_CONFIDENT GROUP				
TRA	5.10***			
ATE	-19.5***	3.50***		
TAT	-28.7***	22.3***	0.07	
NEI	-10.6***	14.5***	12.2***	1.21***
US: G2_CONCERNED GROUP				
TRA	8.02***			
ATE	-48.2***	3.81***		
TAT	-97.0***	47.2***	0.12	
NEI	-23.9***	12.9**	26.1***	0.64**

Note: ***, ** and * indicate significant at the 1%, 5% and 10% significant levels.

Table 4. 7. WTP estimates following mixed logit model for female respondents who eat venison

	CA-G1 (Confident)		CA-G2 (Neutral)		CA-G3 (Concerned)		US-G1 (Confident)		US-G2 (Concerned)	
	CN$/500g	T-stat.	CN$/500g	T-stat.	CN$/500g	T-stat.	CN$/500g	T-stat.	CN$/500g	T-stat.
Optimist: No worry, Trust in people, Trust in government and Agree LC4 (Worry=1, Trust=1, Gtrust=5, LC4=5)										
Young adult (Age=24)										
TRA	5.30***	6.48	7.06***	9.81	14.2**	2.47	10.2***	11.4	11.0***	9.90
ATE	3.82***	4.24	6.65***	7.90	12.7**	2.14	7.63***	9.13	10.5***	9.79
TAT	7.70***	8.68	8.56***	11.6	11.6**	1.95	11.0***	12.2	12.0***	10.9
Middle age (Age=40)										
TRA	4.22***	5.54	6.02***	8.69	11.4**	2.04	8.89***	10.8	9.50***	9.29
ATE	3.40***	3.95	5.60***	7.01	10.7*	1.81	6.59***	8.44	9.12***	9.08
TAT	6.72***	8.01	7.52***	10.5	8.76	1.50	9.74***	11.5	10.4***	10.3
Olds (Age=64)										
TRA	2.59***	3.58	4.46***	6.23	7.29	1.35	6.95***	8.68	7.26***	7.59
ATE	2.78***	3.23	4.03***	4.95	7.55	1.30	5.03***	6.69	7.04***	7.39
TAT	5.24***	6.56	5.96***	8.19	4.57	0.78	7.92***	9.74	8.11***	8.49
Pessimist: Worry, No trust in people, No trust in government and Disagree LC4 (Worry=4, Trust=0, Gtrust=1, LC4=1)										
Young adult (Age=24)										
TRA	4.82***	6.52	7.09***	11.1	14.5***	2.75	8.27***	10.5	9.34***	9.35
ATE	4.06***	5.05	6.96***	9.66	11.6**	2.17	5.40***	7.68	9.22***	9.37
TAT	8.03***	9.67	10.0***	15.1	17.6***	3.07	9.20***	11.5	10.9***	10.9
Middle age (Age=40)										
TRA	3.74***	5.44	6.04***	9.72	11.7**	2.36	6.97***	9.65	7.85***	8.46
ATE	3.64***	4.81	5.91***	8.56	9.56*	1.80	4.37***	6.66	7.83***	8.43
TAT	7.04***	8.98	8.98***	14.2	14.8***	2.71	7.99***	10.8	9.38***	10.1
Olds (Age=64)										
TRA	2.11***	3.00	4.48***	7.07	7.59*	1.61	5.03***	6.93	5.62***	6.22
ATE	3.02***	3.69	4.34***	5.95	6.45	1.25	2.81***	4.19	5.75***	6.57
TAT	5.56***	7.00	7.42***	11.8	10.6**	2.02	6.17***	8.47	7.05***	7.88

Note: ***, ** and * indicate significant at the 1%, 5% and 10% significant levels. Results produced with Krinsky-Robb method used with 5000 draws

Table 4. 8. WTP estimates following mixed logit model for male respondents who eat venison

	CA-G1 (Confident)		CA-G2 (Neutral)		CA-G3 (Concerned)		US-G1 (Confident)		US-G2 (Concerned)	
	CN$/500g	T-stat.	CN$/500g	T-stat.	CN$/500g	T-stat.	CN$/500g	T-stat.	CN$/500g	T-stat.
Optimist: No worry, Trust in people, Trust in government and Agree LC4 (Worry=1, Trust=1, Gtrust=5, LC4=5)										
Young adult (Age=24)										
TRA	5.80***	7.15	9.31***	12.6	17.0***	2.94	10.5***	11.6	11.2***	10.1
ATE	3.93***	4.37	8.57***	9.70	14.2**	2.39	8.14***	9.32	10.8***	9.67
TAT	7.76***	8.82	10.7***	14.3	13.4**	2.30	11.2***	12.2	12.1***	10.9
Middle age (Age=40)										
TRA	4.72***	6.28	8.27***	11.9	14.2**	2.55	9.26***	11.0	9.71***	9.28
ATE	3.52***	4.21	7.52***	9.27	12.1**	2.11	7.11***	8.89	9.44***	9.29
TAT	6.78***	8.29	9.64***	13.5	10.6*	1.86	10.0***	11.8	10.5***	10.2
Olds (Age=64)										
TRA	3.09***	4.41	6.71***	10.2	10.1**	1.88	7.31***	9.39	7.48***	7.75
ATE	2.89***	3.53	5.95***	7.43	9.00	1.57	5.55***	7.60	7.36***	7.95
TAT	5.30***	6.90	8.08***	11.8	6.43	1.14	8.19***	10.3	8.20***	8.43
Pessimist: Worry, No trust in people, No trust in government and Disagree LC4 (Worry=4, Trust=0, Gtrust=1, LC4=1)										
Young adult (Age=24)										
TRA	5.32***	7.13	9.33***	13.7	17.3***	3.08	8.63***	10.3	9.56***	9.49
ATE	4.17***	5.19	8.87***	11.6	13.1***	2.31	5.92***	7.78	9.54***	9.17
TAT	8.09***	9.73	12.1***	17.0	19.5***	3.24	9.48***	11.2	11.0***	10.8
Middle age (Age=40)										
TRA	4.24***	6.05	8.29***	12.9	14.5***	2.74	7.34***	9.43	8.07***	8.44
ATE	3.76***	4.84	7.82***	11.0	11.0**	2.03	4.88***	6.86	8.15***	8.66
TAT	7.10***	9.00	11.1***	16.8	16.7***	2.95	8.26***	10.6	9.48***	9.98
Olds (Age=64)										
TRA	2.61***	3.73	6.73***	10.7	10.4**	2.14	5.40***	7.28	5.83***	6.43
ATE	3.13***	3.77	6.25***	8.81	7.90	1.50	3.33***	4.81	6.08***	6.83
TAT	5.62***	7.13	9.54***	14.9	12.5**	2.36	6.44***	8.46	7.15***	7.80

Note: ***, ** and * indicate significant at the 1%, 5% and 10% significant levels. Results produced with Krinsky-Robb method used with 5000 draws

Table 4. 9. Comparison of Average WTP estimates

	Traceable	Animal-tested	Traceable + Animal-tested
CA-Confident			
Eat venison	4.83	4.56	7.80
Do not eat venison	3.83	4.17	5.69
Heard about CWD	4.76	4.50	7.59
Have not heard about CWD	4.70	4.53	7.57
Know about CWD infection to deer & elk	4.57	4.38	7.40
Do not know about CWD infection to deer & elk	4.80	4.57	7.68
CA-Neutral			
Eat venison	5.57	5.65	9.23
Do not eat venison	-3.10	-2.15	-0.04
Heard about CWD	3.31	3.53	6.78
Have not heard about CWD	1.85	2.35	5.27
Know about CWD infection to deer & elk	3.74	3.82	7.27
Do not know about CWD infection to deer & elk	2.31	2.75	5.74
CA-Concerned			
Eat venison	25.9	27.9	28.0
Do not eat venison	26.8	33.3	31.0
Heard about CWD	24.3	28.4	26.6
Have not heard about CWD	27.7	33.2	31.9
Know about CWD infection to deer & elk	23.3	27.2	25.6
Do not know about CWD infection to deer & elk	27.4	32.6	31.3
US-Confident			
Eat venison	8.70	6.79	10.96
Do not eat venison	0.74	1.84	3.03
Heard about CWD	7.46	5.93	9.71
Have not heard about CWD	6.96	5.74	9.23
Know about CWD infection to deer & elk	8.09	6.40	10.3
Do not know about CWD infection to deer & elk	6.20	5.00	8.58
US-Concerned			
Eat venison	13.0	13.3	16.2
Do not eat venison	6.47	7.17	9.10
Heard about CWD	9.59	10.1	12.6
Have not heard about CWD	9.00	9.54	11.8
Know about CWD infection to deer & elk	9.48	9.95	12.4
Do not know about CWD infection to deer & elk	9.70	10.2	12.7

Table 4. 10. Comparison of WTP estimates from previous studies

	Traceable	**Animal-tested**	**Traceable + Animal-tested**
Lim (2012) ($/lb beef steak)	5.85	5.70	8.05
Aubeeluck (2010) ($/lb) Canadian sample			
Domestic beef steak	17.41	17.23	19.34
US beef steak	9.06	9.37	11.28
Canada/Australian steak	6.66	7.52	10.39
This Study (CND/500g venison steak)			
CA-Confident	5.07	4.42	7.76
CA-Neutral	2.43	2.85	5.97
CA-Concerned	11.15	17.13	14.93
US-Confident	5.90	4.79	8.28
US-Concerned	8.78	9.39	11.59
CA-Average	4.57	5.50	7.89
US-Average	7.76	7.77	10.42

Figure 4. 1. The linkages identified in the literature

Figure 4. 2. The model for the WTP for traceable and CWD-tested attributes in venison consumption

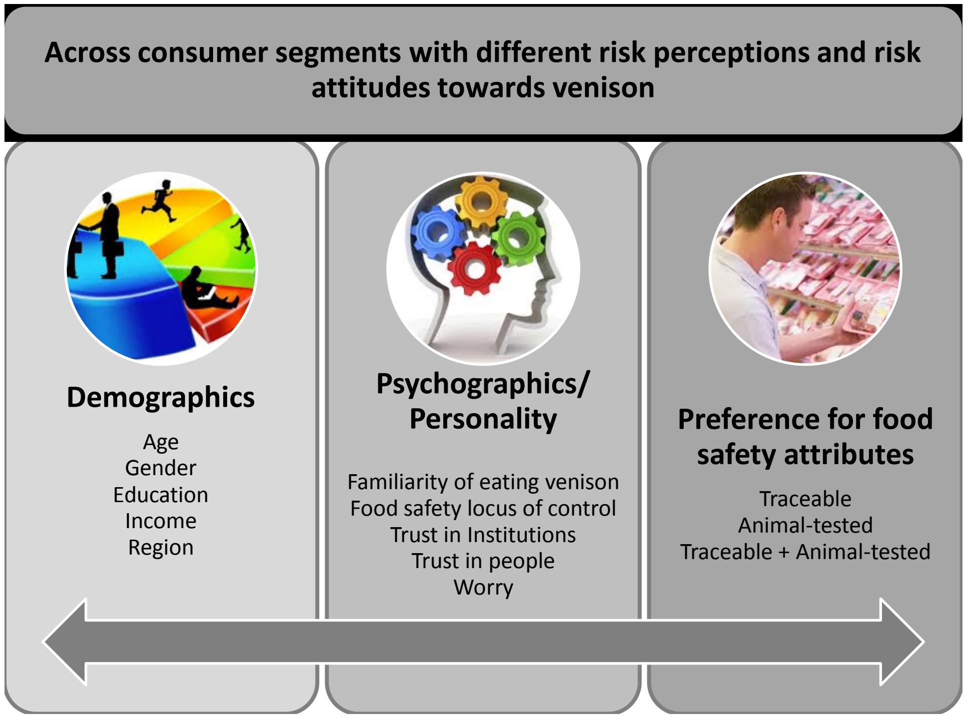

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Figure 4. 3. WTPs for traceable attribute among young consumers

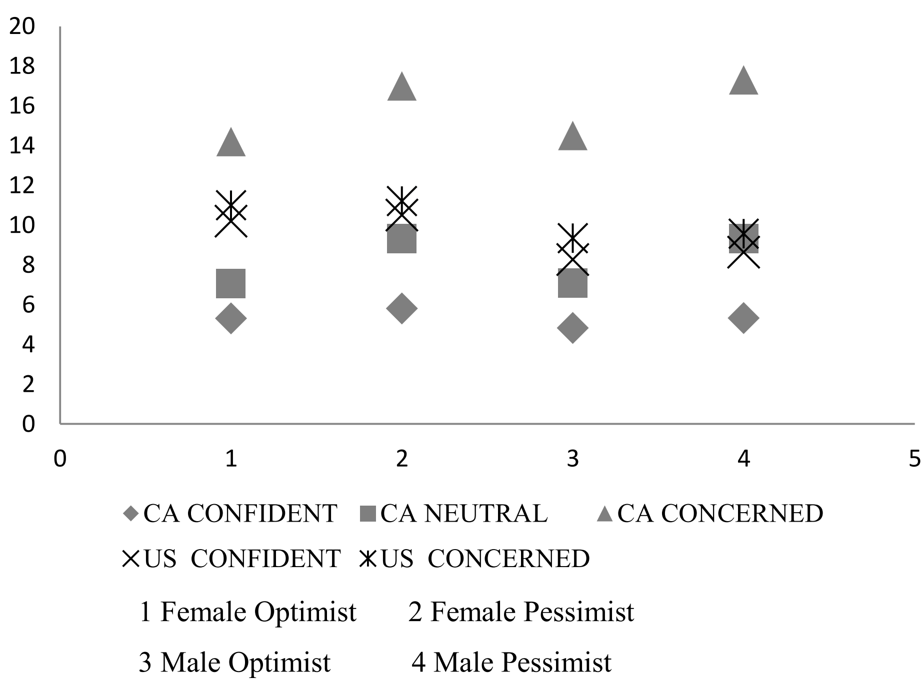
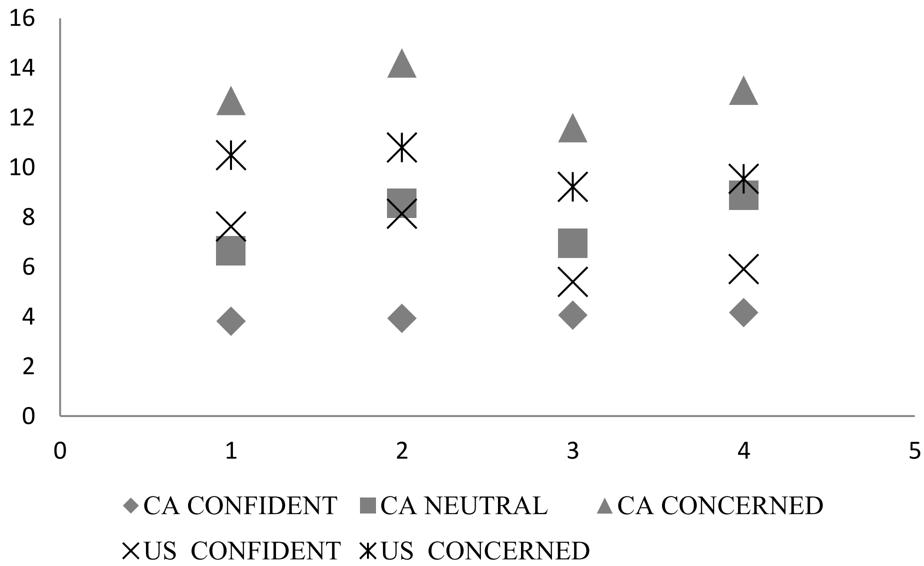
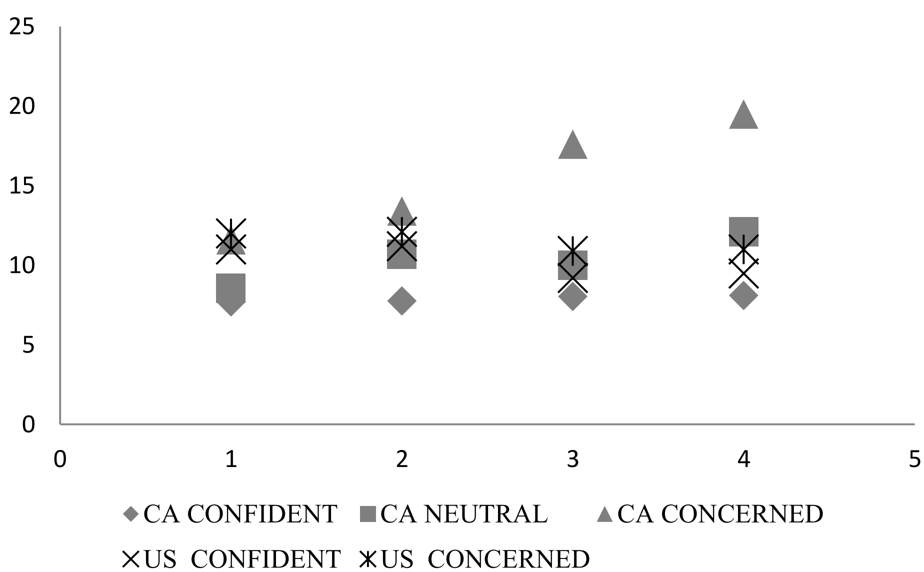


Figure 4. 4. WTPs for animal-tested attribute among young consumers



1 Female Optimist 2 Female Pessimist
3 Male Optimist 4 Male Pessimist

Figure 4. 5. WTPs for traceable plus animal-tested attribute among young consumers



1 Female Optimist 2 Female Pessimist
3 Male Optimist 4 Male Pessimist

Figure 4. 6. WTP distribution for traceability attributes in Canada

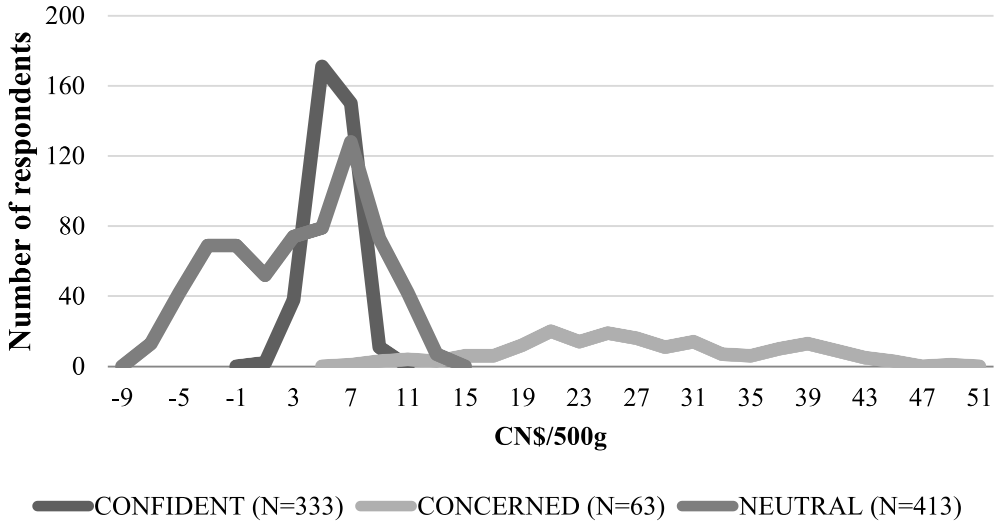


Figure 4. 7. WTP distribution for traceability attributes in the US

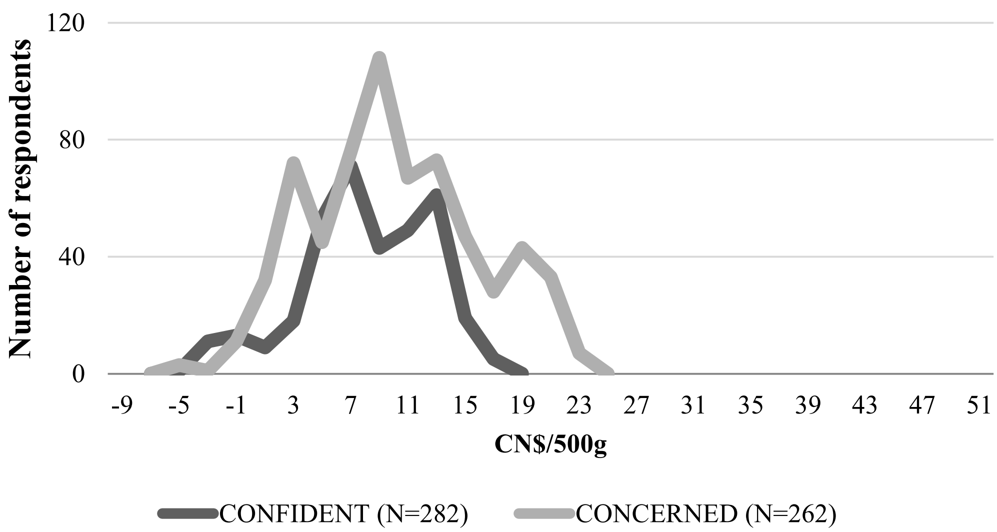


Figure 4. 8. WTP distribution for animal-tested attributes in Canada

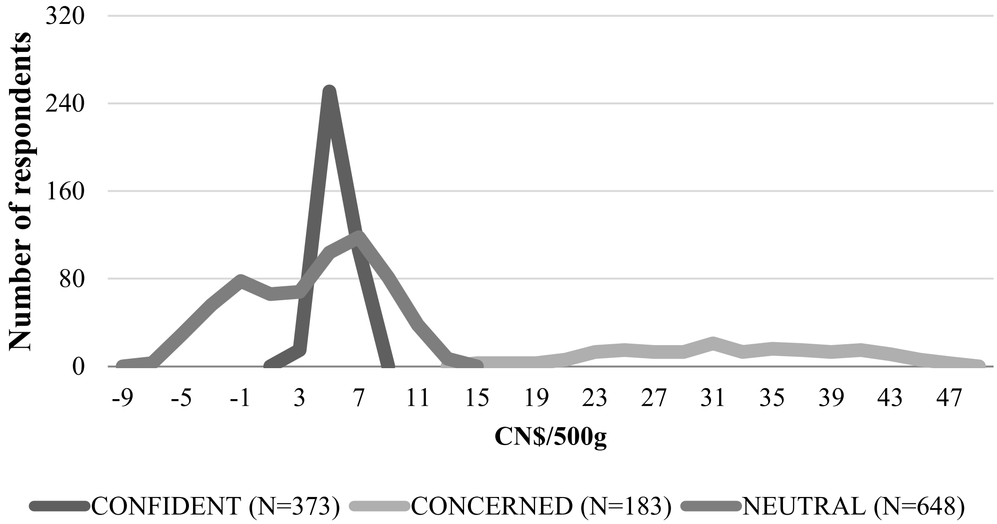


Figure 4. 9. WTP distribution for animal-tested attributes in the US

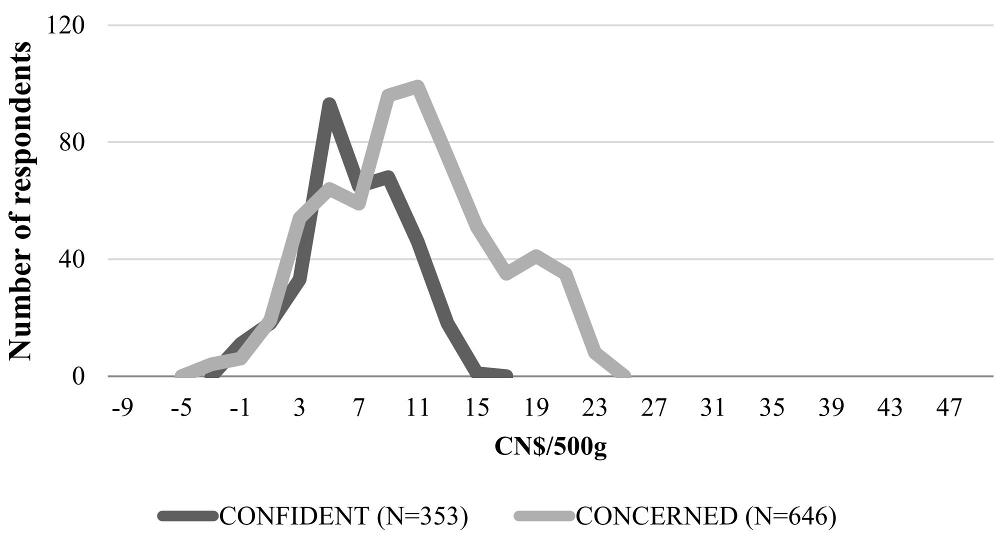


Figure 4. 10. WTP distribution for traceability and animal-tested attributes in Canada

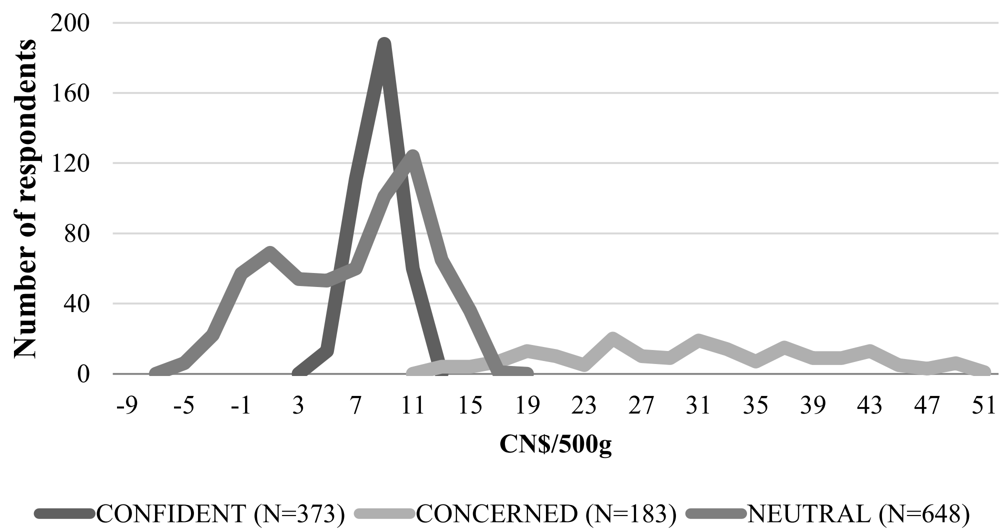


Figure 4. 11. WTP distribution for traceability and animal-tested attributes in the US

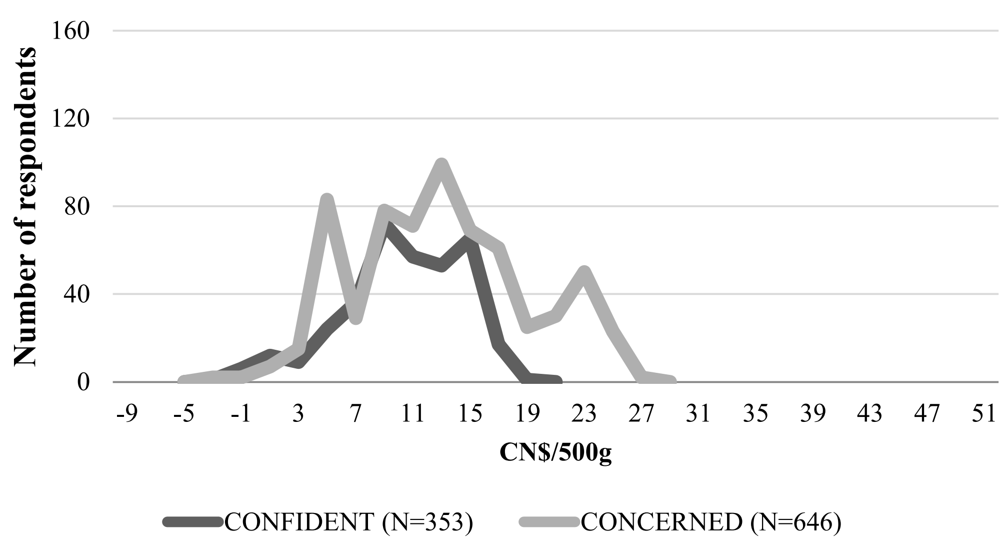


Figure 4. 12. WTP distribution for traceable attribute among consumers who eat venison in Canada

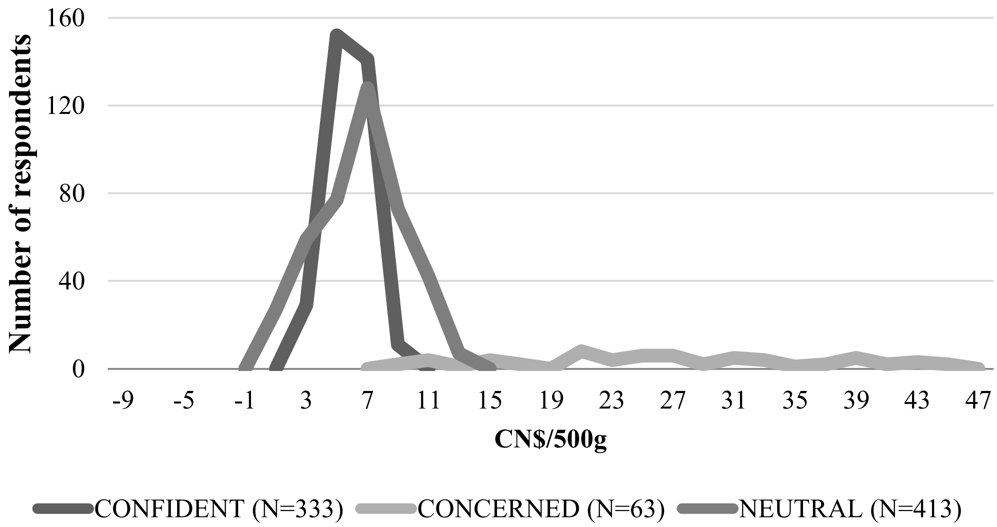


Figure 4. 13. WTP distribution for traceable attribute among consumers who do not eat venison in Canada

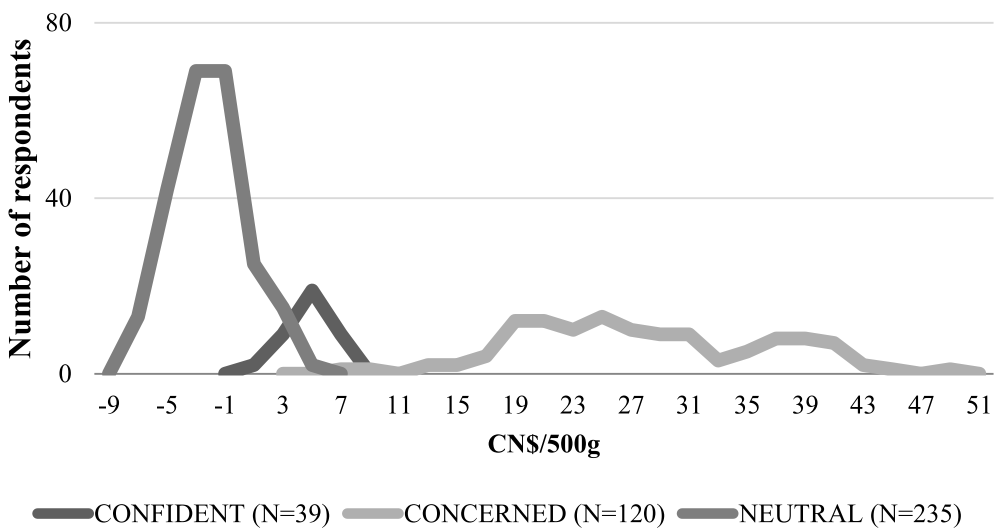


Figure 4. 14. WTP distribution for traceable attribute among consumers who eat venison in the US

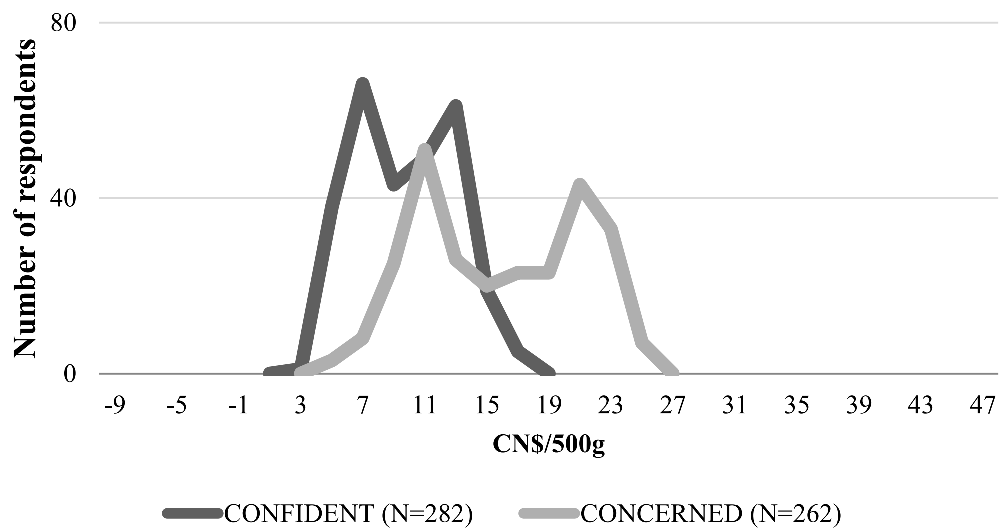


Figure 4. 15. WTP distribution for traceable attribute among consumers who do not eat venison in the US

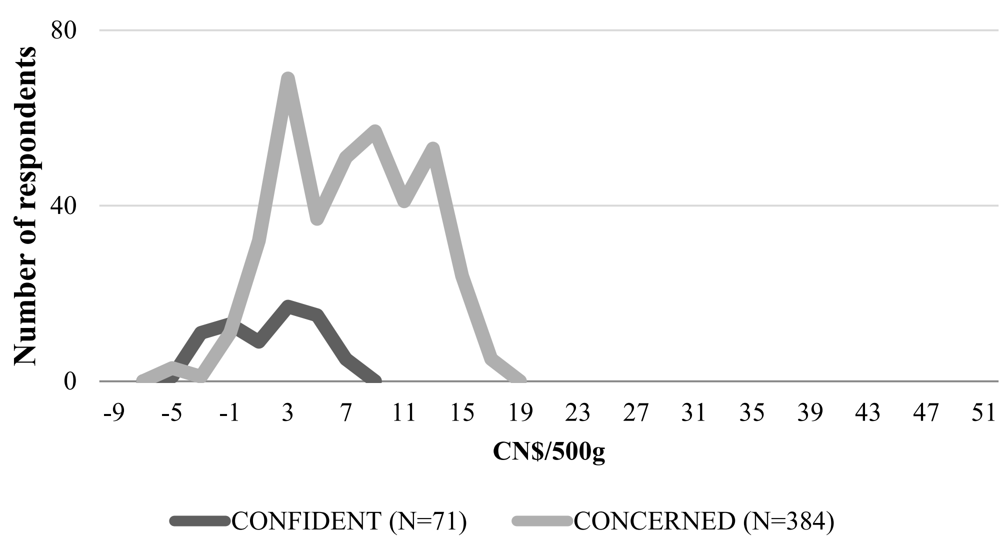


Figure 4. 16. WTP distribution for animal-tested attribute among consumers who eat venison in Canada

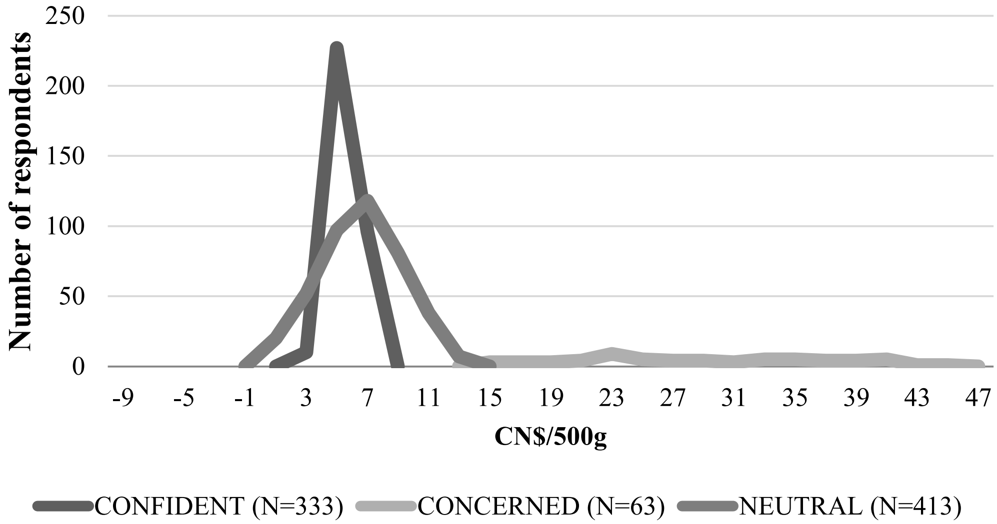


Figure 4. 17. WTP distribution for animal-tested attribute among consumers who do not eat venison in Canada

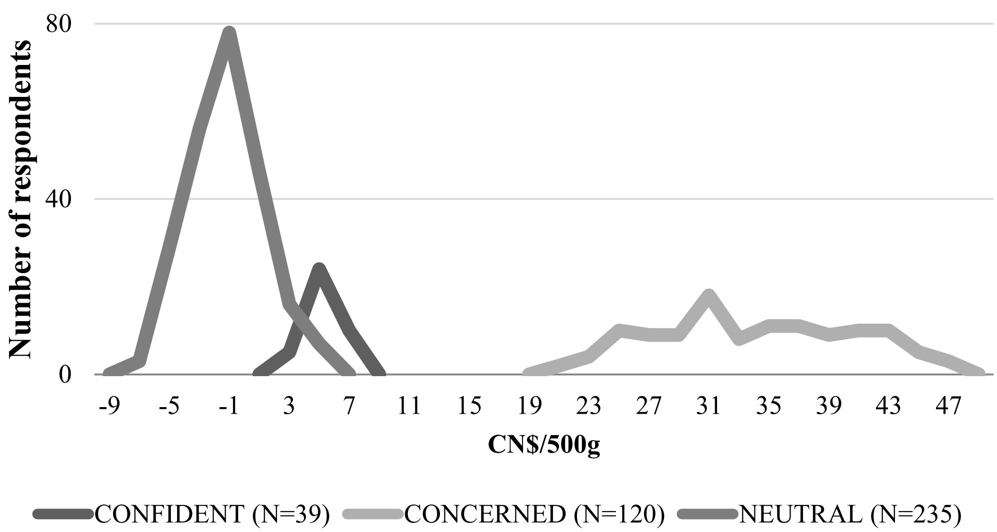


Figure 4. 18. WTP distribution for animal-tested attribute among consumers who eat venison in the US

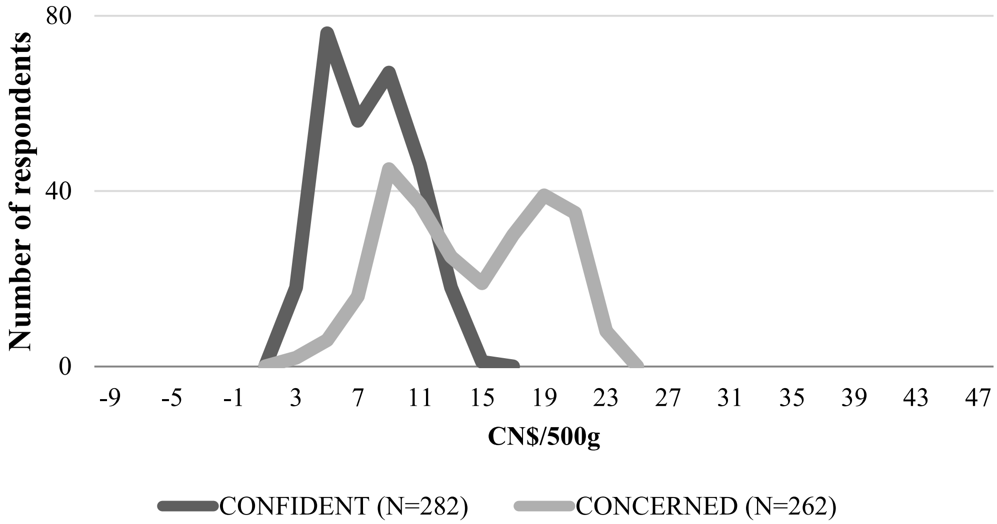


Figure 4. 19. WTP distribution for animal-tested attribute among consumers who do not eat venison in the US

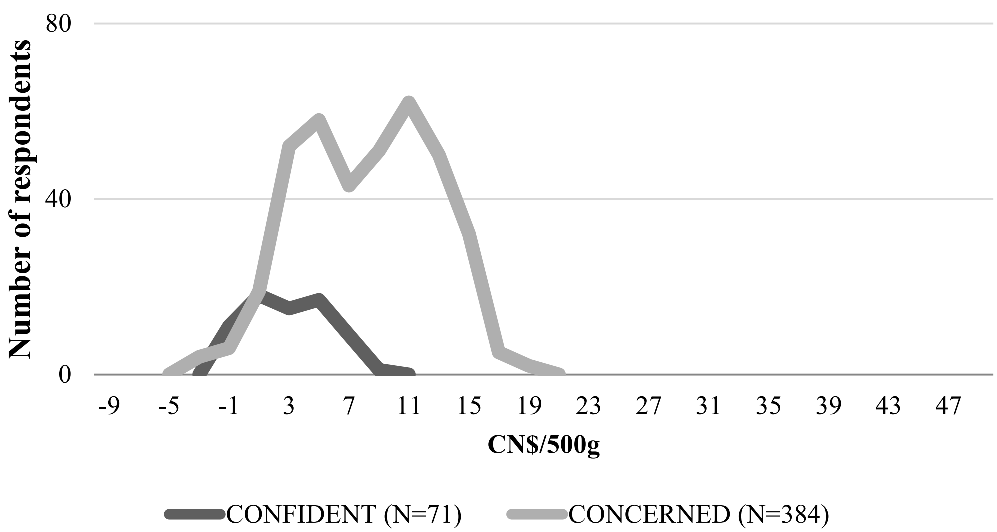


Figure 4. 20. WTP distribution for traceable and animal-tested attribute among consumers who eat venison in Canada

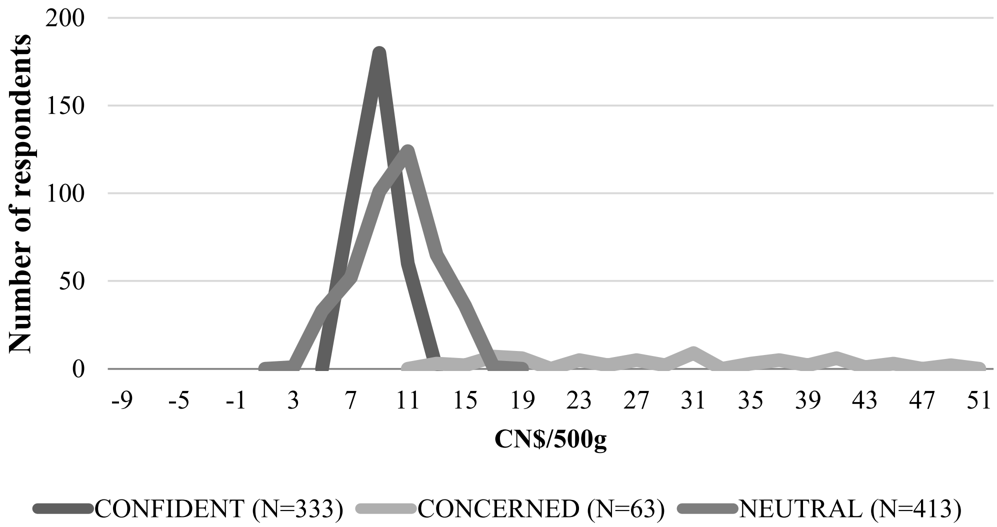


Figure 4. 21. WTP distribution for traceable and animal-tested attribute among consumers who do not eat venison in Canada

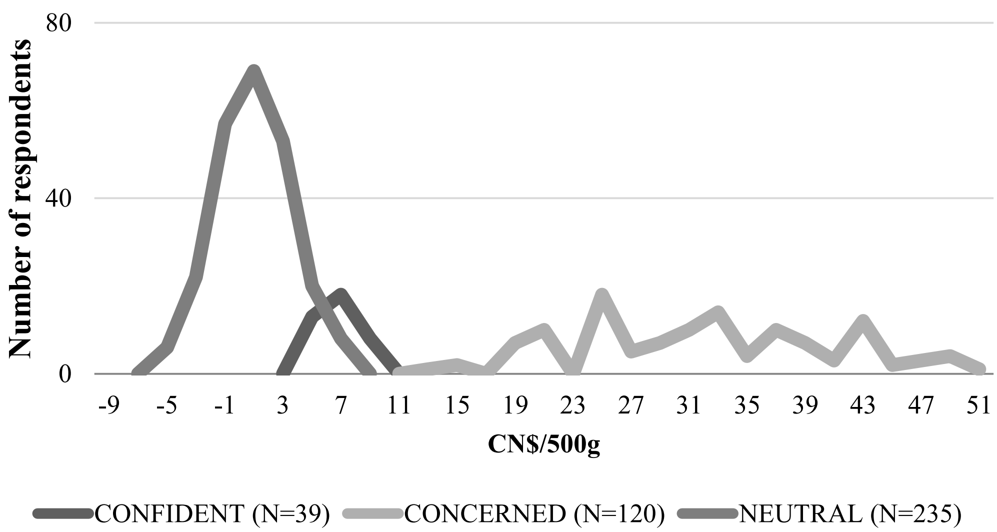


Figure 4. 22. WTP distribution for traceable and animal-tested attribute among consumers who eat venison in the US

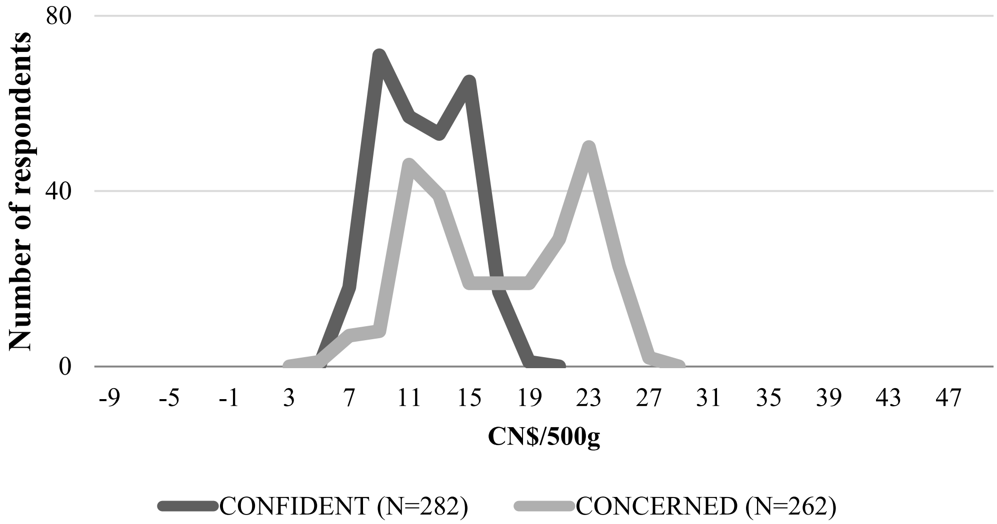
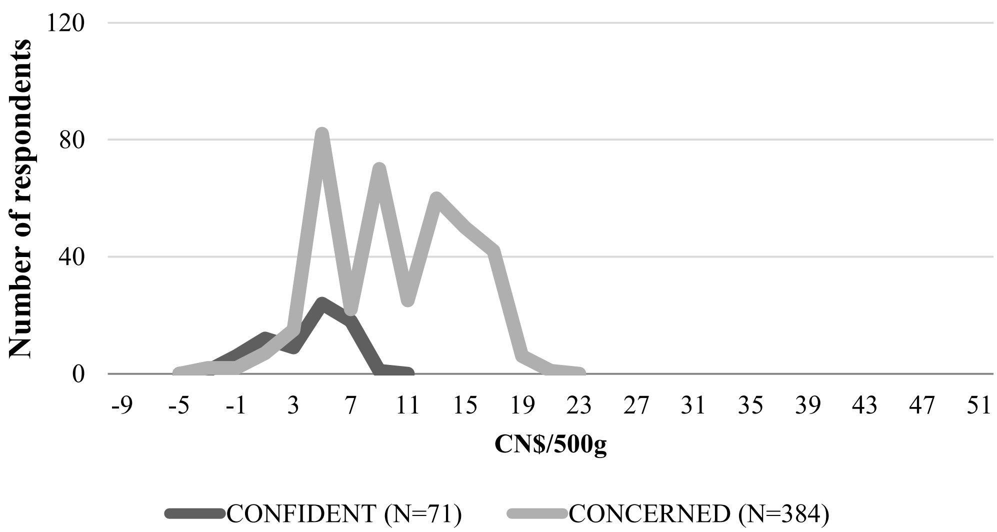


Figure 4. 23. WTP distribution for traceable and animal-tested attribute among consumers who do not eat venison in the US



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5. HOUSEHOLD BEHAVIOR WITH RESPECT TO MEAT CONSUMPTION IN THE PRESENCE OF BSE AND CWD CONCERNS

5.1. INTRODUCTION

Since the 1990s, concerns about food safety, whether perceived such as BSE and vCJD or real such as *E. coli* (Frewer et al. 1996, 1997, 2001) have been affecting consumers. Globally BSE (and possibly CWD) changed many consumer perceptions about the risks of eating beef (and/or venison). There have been differences in self-reported and actual beef consumption across consumers with different risk perceptions and attitudes towards beef in response to BSE (Pennings et al, 2002; Schroeder et al, 2007; Yan and Goddard, 2011a and 2011b).

There is less knowledge, however, about the public response to CWD in terms of actual changes in venison or other meat consumption. Although the percentage of consumers who purchase venison from stores is still low (1.3% of the sample for this study) in Canada, about 39% of the sample – a balanced household panel of 2393 household per year, see Section 5.5 – consumes venison from hunted sources. Moreover, the diversification of livestock enterprises has been encouraged since the 1980s, and an increased demand for venison and bison has been observed possibly due to added health benefits such as more protein, less total fat and lower calorie levels than beef or pork (as shown in Appendix 5A), different qualities and different tastes (Hobbs and Kerr, 2000; Hobbs et al, 2006; and Statistics Canada, 2008).

The linkages between household meat consumption behaviour (including both exotic and commodity meats) and individual/household characteristics such as meat preferences, socioeconomic characteristics, risk perceptions/attitudes towards venison/beef, and sources of meat supply such as from retail stores, from hunting or from farmers markets have not yet been explored. It is useful to identify the households who obtain venison from hunting, since hunting is outside the normal meat purchasing outlets and since their meat purchasing behaviour may be affected in the face of CWD concerns. As a group, depending upon their risk perceptions about CWD, they could stop consuming hunted meat and their domestic meat purchases could increase or be unaffected. These linkages could provide some indication of the differences in public response to TSE risks in daily purchasing/consuming of different meats. The question *"How does consumer society perceive or respond to the risks in their lives?"* is the major research question in this paper. This specific chapter probes deeper into this question and is focused on households' meat consumption behaviour across consumer segments who use different sources of venison supply for those who consume venison.

The objective of the analysis is to determine the factors that explain consumers' decision about meat consumption in the face of food safety risks associated with BSE and CWD incidents in cattle and cervids respectively. Since heterogeneity in household meat purchasing behaviour could arise from traditional demand shifters (such as prices, total expenditure and past consumption), psychological factors (such as individual's risk perceptions/attitudes towards venison, perceived risks due to BSE/CWD media coverage about disease incidents) and socio-demographic characteristics, these variables are included in two stage demand system models of behaviour. Due to infrequent consumption of venison in daily life, the zero-expenditure problem needs to be addressed using the Heien and Wessells two-step procedure in the estimation process.

In order to understand how households' consumption behaviour differs due to different meat preferences (exotic versus traditional meats) and different venison sources (retail store versus hunting versus direct outlets), demand system estimations will be conducted across household segments.

Two sets of data – the Homescan^{TM} household panel (9300 households/year) from 2003 July to 2009 June and the survey data (7000 households) collected in 2011 by Nielsen Company – will be used in this study. A balanced household panel of 2393 households per year is constructed by selecting households who are in both data sets. The results are expected to broaden knowledge about how households with different meat preferences and different venison behaviour are adjusting to the perceived risk of animal diseases in their meat purchasing.

In summary, the paper will contribute to the literature that seeks to explain the link between household consumption behaviour in the presence of BSE/CWD incidents. It is the first study to test for differences in meat purchasing behaviour in the presence of hunting activity. Broadened knowledge about the link between risk perceptions for a specific product such as venison and meat purchasing behaviour can be valuable for market expansion and for efficient risk management and communication strategies whenever they need to be applied.

5.2. LITERATURE REVIEW

This section provides a comprehensive review of literature on previous behavioural modelling on meat demand in the presence of food-safety concerns. The review will help to identify key characteristics for the conceptual framework and empirical model specified for estimation. In Appendix 5B, a comprehensive summary of related studies has been undertaken for consumer behaviour studies using different models/methods. In Appendix 5C, studies exploring the impacts of media coverage on consumers' demands are presented. The summaries have focused on objectives, methods used, data and findings.

A number of studies in the area of consumer behaviour using different models, data and estimation procedures fall into the category of consumer behaviour analysis. Theil and Clements (1987) identified two broad utility-based approaches in applied demand analysis. The first one uses the optimal classical economic optimization (utility maximization, cost/expenditure minimization) approach. Demand systems with quantity dependent equations, linear expenditure systems, expenditure share demand systems with a variety of functional forms including the translog functional form are frequently used. The almost ideal demand systems (AIDS) identified by Deaton and Muellbauer (1980a; and 1980b) and the Working-Leser model used by Working (1943) and Leser (1963) are examples of the optimal classical economic optimization approach (Appendix 5B). Numerous scholars used the AIDS demand system and some scholars such as

Chern et al (2002) and Zhang (2010) used Working-Leser approach (appendix 5B). The second approach is a more mathematical approach - for example the Rotterdam model which is first developed and used by Theil (1965) and Barten (1964). The Rotterdam model was developed from the first difference of the Stone (1954) model, which is derived from a quantity dependent single equation approach. All the demand systems derived from these approaches are parametric models, in which the prior specification of functional form and relationships are crucial to obtaining efficient parameter estimates and inferences (Deaton and Muelbauer, 1980b; and Greene, 1990).

In choosing a demand system specification, a flexible functional form is recommended as it is able to avoid restrictions on demand elasticities, which can be estimated from the data (Hausman and Leonard, 2005). Non-flexible functional forms that need a priori restriction on the possible elasticities such as logit models force the cross elasticity of products to be the same resulting in incorrect conclusion about the extent of competition between products (Hausman and Leonard, 2005). Thus, different flexible functional forms have been used in each stage of the two-stage demand system estimation. For example a doublelog-translog (doublelog functional form in the first stage and translog functional form in the second stage) specification was used by Yang (2010), and Yang and Goddard (2011a); doublelog-AIDS (doublelog functional form in the first stage and AIDS in the second stage) specification was used by Lomeli (2005); LES-AIDS (Linear Expenditure System in first stage and Almost Ideal Demand System in the second stage) specification was used by Fan et al (1995), Richards et al (1997), and Michalek and Keyzer (1992); GLES-AIDS (Generalized Linear Expenditure System in first stage and AIDS in the second stage) specification was used by Gao et al (1996); and LA/AIDS-LA/AIDS (Linearized AIDS in both stages) specification was used by Carpentier and Guyomard (2001) (Appendix 5B). Among the various flexible functional forms discussed above, the double-log functional form gives simplest elasticity calculation, and the translog functional form is the most widely used flexible and non-linear functional form in demand estimation (Pollak and Wales, 1992; Yang, 2010). Since there are theoretical deficiencies in the double-log demand model in terms of satisfaction to consumer demand theory and restrictions (homogeneity restriction can be imposed and other restrictions cannot be satisfied) globally (Alston et al. 2002), the double-log functional form is used only in the first stage.

Recently, more refined data such as cross sectional or panel data – which is collected at the household level and contributes to the determination of individual households' behaviour – has been made available for estimation as opposed to time series data. Moreover, the data can establish robustness of results in model estimations, especially in food safety related issues (Piggott and Marsh, 2004). In the literature, household-level micro data has been widely used (for example by Pitt, 1983; Barnes and Gillingham, 1984; Wales and Woodland, 1983; Deaton and Irish, 1984; Kay et al., 1984; and Blundell and Meghir, 1987) because of its advantages in avoiding "the problem of aggregation over consumers and providing a large and statistically rich sample" (Heien and Wessells, 1990, p.365). Recently, Verbeke and Ward (2001), Yang and Goddard (2011a), and Myae and Goddard (2010) used panel data and Lomeli (2005) used cross sectional data in their analyses (Appendices 5B and 5C).

However, household panel data has two constraints – missing observations and zero expenditure – which were first recognized by Tobin (1958). Although the first problem about missing observations can be solved by removing missing observations in the analysis, the later one – zero expenditure problem due to abstention, infrequency and corner solutions (Chen, 2000) – can cause some biases in estimation and result in inconsistent estimates (Tobin, 1958). In either way, sample selection bias arises and analysis gives the specification error (Heckman, 1979). In this study only 1 to 3 percent of respondents do not eat meat. The zero expenditure comes from the fact that households consumed zero amounts of different meats for the considerations of budget, preference at a particular time and some other concerns – probably diseases, environment and animal welfare. Econometric remedies to overcome this constraint have been proposed by scholars based on different assumptions such as based on the Kuhn-Tucker conditions for non-negativity (Wales and Woodland, 1983; Lee and Pitt, 1986; and Ransom, 1987), based on the Amemiya (1974) estimator when error terms are not heteroscedastic (Ransom, 1987), and based on the discrepancy between observed expenditure and actual consumption (Deaton and Irish, 1984; Kay et al., 1984; Keen, 1986; and Blundell and Meghir, 1987).

There are at least two ways to correct selection biases caused by zero expenditure problems using a two-step approach:

1) A Probit model (of a binary variable – for example buy $meat_i$ or not – as dependent variable) is estimated in the first step to derive an inverse mill ratio, which is incorporated into the second step estimation (Heien and Wessells, 1990). Although the estimates from this procedure are asymptotically consistent, they are inefficient due to heteroscedasticity from the inclusion of nontrivial regressors in probit models Heckman (1976, 1979).

2) An unrestricted Tobit demand model is estimated in the first step to obtain consistent estimates of unrestricted parameters by the jackknife technique and then unrestricted parameters are used in the second step to recover restricted demand parameters using minimum distance estimation methods (Perali and Chavas, 2000). The estimates are consistent, asymptotically efficient and can be estimated by using the full information maximum likelihood estimation method.

Although two step procedures are less efficient, statistically consistent estimates can be obtained (Lin et al., 2009). The proposed methods have been utilized by many scholars (for example in Appendix 5B, Heien and Wessells, 1990; and Perali and Chavas, 2000; and Lin et al., 2009) in demand system estimation procedures.

Another simple way of dealing with the ‘zero expenditure’ problem is using a very small number for the zeros in the data set to avoid estimation complexity (Myae and Goddard, 2010; Yang, 2010; and Yang and Goddard, 2011a) (Appendix 5B). This method is appropriate only for data set with a minimal number of zero expenditure.

After reviews on model specification, functional form and estimation procedure, explanatory variables and significant impacts on consumers' consumption behaviour will be reviewed. The literature has revealed significant impacts of prices (Pitt, 1983; Fan et al. 1995; Richard et al. 1997; Lomeli, 2005; Lin et al, 2009 and Myae and Goddard, 2010) and significant impact of socio-demographics (Barnes and Grillingham, 1984; Gao et al, 1996; Lomeli, 2005 and Myae and Goddard, 2010) on consumer behaviour (Appendix 5A). Media coverage is another impacting factor on market and price (Smith et al. 1988; Johnson, 1988; Burton and Young, 1996; McKenzie and Thomsen, 2001; and Lloyd et al. 2001) and on consumer behaviour with respect to meat-demand (Swartz and Strand, 1981; Verbeke et al. 2000; Verbeke and Ward, 2001; Kalaitzandonakes et al. 2004; Piggott and Marsh, 2004; Maynard et al. 2008; and Yang 2010) (Appendix 5B).

Media indices were constructed differently based on the required qualitative or quantitative need of media information and impacts to be determined (Appendix 5C). Traditionally, media indices are constructed based on the number of articles that cover certain issues (for example about BSE/CWD) in some of most popular press journals/newspapers or TV news. For example, Smith et al. (1988), Johnson (1988), Burton and Young (1996) and Lloyd et al. (2001) used the number of articles in both national and local new sources. Verbeke et al. (2000), and Verbeke and Ward (2001) constructed media indices using news coverage in television to measure consumer awareness of meat-health issues. McKenzie and Thomsen (2001) used the number of recalls from government (here from the USDA). More recently, scholars use media information from a specific newspaper or a group of newspapers. For example, the media index was constructed based on the frequency of coverage in a specific national press agency (Kalaitzandonakes et al. 2004); based on the aggregated number of coverage in the top fifty English language newspapers countrywide (Piggott and Marsh, 2004 in the US); based on the number of articles in major newspapers locally (Maynard et al. 2008 as Alberta index from articles in the *Edmonton Journal* and the *Calgary Herald*; and Ontario index from articles in the 6 of top newspapers); and based on a broad range of databases using different key words search(Yang, 2010). In all the reviewed studies above, the media index was constructed by adding all the number of articles from all the sources defined. In this paper, media indices was constructed using representative newspapers following Mayanrd et al. (2008) and using different key words search related to BSE and CWD following Yang (2010). The detail media index construction for this study will be discussed in the Section 5.5 "Data and Method".

In terms of the impact of media information, Marsh et al. (2004) suggested that meat recall events significantly impacted on meat demand instead of media coverage. Frewer et al. (2002) suggested that the amount and source of information received, and the number of actual disease incidents are important factors that can affect consumers' perceptions towards the safety of food products. It has been suggested that in predicting consumers' reactions to perceived food risks and food safety issues, a more robust conceptualization can be achieved by examining risk perceptions and risk attitudes separately as a part of the behaviour of consumers (Pennings, et al., 2002; Schroeder et al., 2006, 2007; and Kalogeras et al., 2008) (Appendix 5C). Although both concepts can drive the decision behaviour of individual consumers (Arrow, 1971; Pratt, 1964; and Pennings and Wansink, 2004), risk attitudes probably change more slowly than risk perceptions (Yang and Goddard, 2011a), and risk attitudes is more important than risk perceptions in household-level beef purchasing decisions (Yang and Goddard, 2011b). In summary, the literature suggested at least four important factors that can affect consumer meat purchase behaviour: prices, socio-demographics, disease incidence and/or media coverage, and consumers' risk perceptions and risk attitudes.

5.3. CONCEPTUAL APPROACH

A two stage demand system will be applied in this paper since consumers face a large list of potential purchases including goods and services besides meats. Weak separability becomes crucial in defining practical demand system estimation. In the literature, a maintained assumption is that the marginal rate of substitution among the goods inside the group will not be dependent on any goods outside of the group (Green 1976; and Deaton and Muelbauer, 1980a). Using weak separability, it is common to use multistage budgeting (Edgerton, 1997). In this paper, it is assumed that consumers' expenditure will be allocated to two food products including meat (such as venison, bison, beef, pork, chicken, turkey, seafood, etc.) and non-meat products which are accounted by using deflated meat prices. Edgerton (1997, p.62) suggested that "the sensitivity of, for example, beef consumption to changes in income depends both on the reaction of the whole meat group to income changes and on the reaction of beef consumption to changes in meat expenditure". Similarly, a change in price of one meat type (for example, venison) not only can change the consumption of another meat type (for example, beef) directly within the group, but also can change the consumption of the whole meat group indirectly.

In the first stage – total expenditure is allocated between *n* broad groups of commodities, and conditional functions in the second stage – group expenditures are allocated between the elementary commodities in each group as follows (Deaton and Muellbauer, 1980b; Edgerton; 1997, p.63; and Klonaris and Hallam, 2003):

First Stage Unconditional Marshallian Demand Function: $E = G(P, m)$,

where E is real expenditure of the groups (meat and non-meat),

P is the price indices of the groups, and

m is total expenditure.

Second Stage Conditional Demand Function: $Ex_m = H_m(P_m, E_m, R_m)$,

where Ex_m is expenditures of different meat types in meat group,

P_m is the price of different meats,

E_m is total expenditure of meat group, and

R_m is inverse mill ratio of meat group

The "zero expenditure" problem is a case in this study since the sample data (household panel data from 2003 to 2009) contains a large proportion of households, who do not purchase venison very often and each household has zero purchases in some periods although only three percents of respondents do not eat meat. As discussed in the previous section, the zero expenditure comes from the fact that households consumed zero amounts of meats for the considerations of possibly budget, preference and food-safety/welfare concerns. Given that sample selection bias arises and estimating the variables which are omitted from a regression analysis gives the specification error (Heckman 1979). A simple consistent estimation method to eliminate the specification error for the case of censored samples was proposed by Heckman (1979) and was used by Heien and Wessells (1990). Since the observed budget shares cannot be negative values, dependent variables are censored by a subset of unobservable latent variables using a binary indicator variable (to buy or not to buy) and are estimated as a function of the latent variables in binary probit regressions. Assuming iid in the estimation, each household's inverse mill ratio is calculated to provide the probability of a household's consumption for particular meat and will be used in demand system equations. As discussed in previous section, Heckman (1976, 1979) suggested that asymptotically the estimators from this procedure are consistent but are inefficient due to heteroscedasticity from the inclusion of nontrivial regressors in probit models. However, substantially improved results in terms of goodness of fit and the conformity of price elasticities with prior expectations were proven by using censored multiple-regression systems by Heien and Wessells (1990).

Given that Heien and Wessells a two-step procedure – 1st step: probit estimations; and 2nd step: the two stage demand system – will be used in this paper. In the first step of estimation procedure, a probit regression (of binary variables – buy $meat_i$ =1 and do not buy $meat_i$ =0 – as dependent variables) will be estimated to determine the probability of meat consumption by households in the sample. Then, the inverse mill ratio will be calculated using the estimated probabilities for each household. The calculated inverse mill ratios will be used as an additional in the second step – the demand system estimations. More specifically, the calculated inverse mill ratios will be used as one of explanatory variables in the second stage of the two stage demand system equations. More detail discussion about the two stage demand system is presented in the next paragraph. The Heien and Wessells a two-step procedure is chosen due to its simple way to incorporate inverse mill ratio into the second step demand system estimation procedure, and due to its advantage of using the whole data sample in the second step in contrast to Heckman two-step procedure, which uses only the censored (non-zero) observations (Heien and Wessells, 1990). A more detailed explanation is discussed in the next section.

As discussed in the previous section, a flexible doublelog-translog functional form will be applied in this paper. The advantages of using flexible functional form include the possibility of testing various restrictions such as additivity and homotheticity, which are maintained hypotheses of applied demand analysis (for example, translog demand model) (McLaren, 1982). In summary, the whole model for this paper includes a censored demand system with probit model to obtain ML estimates in the first step and doublelog– translog two stage demand system in the second step (Figure 5.1 and Figure 5.2).

Based on the literature in the previous section, factors such as price, socio-demographics, consumers' risk perceptions and risk attitudes, and BSE/CWD incidences and media coverage will be considered as influential demand shifters in the model. In this study, as similar to previous chapter, consumers' risk perceptions and risk attitudes will be considered separately. In order to determine differences among consumers with different meat preferences and choice of venison supply, the four demand models will be conducted for the four different household groups as shown in Table 5.1. The questions used and the steps in grouping household sample are shown in Figure 5.3. The specific meat types to be included for different household groups are also presented in Table 5.1.

5.4. EMPIRICAL APPROACH

A probit participation model for each meat and then doublelog-translog two stage demand system – the first stage as a total meat expenditure function in a DoubleLog function and the second stage as expenditure share functions for different meats such as venison, bison, beef, pork, chicken, turkey and seafood in a TransLog function – will be used. A panel data nonlinear demand system will be estimated. In implementing the objective about determining how individual consumer's behavioural response to animal disease outbreaks differ across consumer segments, individual-specific effects (ISEs) is an important step to add in the estimation procedure. Among the three types of ISE specifications (additive, multiplicative and single-index) defined by Cameron and Trivedi (2005), the single-index ISE (SIISE) will be used in this analysis due to its nonlinear function in demographic variables (Yang and Goddard, 2011a).

In order to remove the sample selection bias as discussed in the previous section, Heien and wessells two-step procedure will be used. In the first step of estimation procedure, a probit regression will be used in order to determine the probability of meat consumption by households in the sample. Then, using the probabilities, the inverse mill ratio will be calculated for each household and used as an additional variable in the second stage demand system estimation to avoid omitted variable bias. The first step probit regression can be represented as follows (Heien and wessells, 1990, p. 369):

$$Y_{ih} = f(\mathrm{p}_h, m_h, \mathrm{d}_\mathrm{h}) \qquad \textbf{(5.1)}$$

where $Y_{ih} = 1$ if $w_{ih} > 0$ (the hth household consumes the ith food item) and

$Y_{ih} = 0$ if $w_{ih} \leq 0$, p_h is a vector of prices for hth household, d_h is a vector of demographic variables for the hth household and m is food expenditure. Then, the inverse mill ratio for the hth household that consumes the ith food item and for those households who do not consume the meat item will be calculated using equation 5.2 and equation 5.3 respectively (Heien and Wessells, 1990, p. 369-370):

$$R_{ih} = \phi(\mathrm{p}_h, \mathrm{d}_h, m_h) / \Phi(\mathrm{p}_h, \mathrm{d}_h, m_h) \qquad \textbf{(5.2)}$$

$$R_{ih} = \phi(\mathrm{p}_h, \mathrm{d}_h, m_h) / (1 - \Phi(\mathrm{p}_h, \mathrm{d}_h, m_h)) \qquad \textbf{(5.3)}$$

where ϕ and Φ are the probability density and cumulative probability density functions respectively. The calculated inverse mill ratios (equations 5.2 and 5.3) will be used in the second stage of demand system estimations as an additional variable.

Next is the second step of the estimation procedure that includes two stages. The first stage demand system will be specified as a DoubleLog function:

$$LnExp_{k,t} = \alpha_{0,k} + \alpha_1 \sum_i w_{i,k,t} * \ln P_{i,k,t} + \alpha_2 Income_{k,t} + \alpha_3 LnExp_{k,t-1} + \alpha\varepsilon_{k,t} \quad \textbf{(5.4)}$$

The second stage demand system will be specified as a TransLog function:

$$w_{i,k,t} = \frac{\beta_{0,i,k} + \sum_j \gamma_{i,j} \ln P_{j,k,t} + \theta_i LnExp_{k,t} + \sigma_i LnQ_{i,k,t-1} + \tau_i R_{i,k,t}}{\sum_j \beta_{0,i,k} + \sum_i \sum_j \gamma_{i,j} \ln P_{j,k,t} + \sum_i \theta_i LnExp_{k,t} + \sum_i \sigma_i LnQ_{i,k,t-1} + \sum_i \tau_i R_{i,k,t}} + \mu_{i,k,t} \quad \textbf{(5.5)}$$

where, $\alpha_{0,k}$ and $\beta_{0,k}$ are the single-index individual-specific effect and can be defined as: $\alpha_{0,k} = \alpha_0 + \sum_k \phi_k DF_k$; and $\beta_{0,k} = \beta_0 + \sum_k \pi_k DF_k$ (where DF_k is demographic factors such as age, education, income, risk perception scores, risk attitude scores and media indices of individual k), $LnExp_{k,t}$ is the log of total meat expenditure of individual *k* at time *t*, $\ln P_{i,k,t}$ is the log of price of *i* meat (beef, pork, chicken, turkey, seafood) of individual *k* at time *t*, $Income_{k,t}$ is the disposable income of individual *k* at time *t*, $Q_{i,k,t-1}$ is the quantity of disappearance of meat *i* for individual *k* at time *t-1*, $R_{i,k,t}$ is the inverse mill ratio of meat *i* for individual *k* at time *t*, nd $\varepsilon_{k,t}$ and $\mu_{i,k,t}$ are random errors. In the model, the same values of risk perception/attitude scores and demographic factors (age of household head, gender, household head's education level, household size, household income, location-city versus town/rural) are used throughout the year 2003 July -2009 June.

Since equation 5.5 represents a system of demand equations for each household segment, each needs to meet a set of three theoretical restrictions: homogeneity, symmetry and adding-up. The restrictions can be defined as:

Homogenerity $\sum_{i=1}^{n} \gamma_{ij} = 0$;

Summetry $\gamma_{ij} = \gamma_{ji}$; and

Adding up $\sum_{i=1}^{n}\beta_i = 1, \sum_{i=1}^{n}\gamma_{ij} = 0, \sum_{i=1}^{n}\theta_i = 0, \sum_{i=1}^{n}\sigma_i = 0, \sum_{i=1}^{n}\tau_i = 0$.

Using the estimated coefficients from equation (5.5), and following Yang (2010), the uncompensated own-price and cross-price elasticities from the second stage estimation can be calculated using the following formulae. The demographics including media coverage, risk perceptions and risk attitudes elasticity formula is developed.

$\varepsilon_{ii} = \frac{r_{ii}}{w_i} * \frac{1}{D} - 1$ (*own-price elasticity)*,

$\varepsilon_{ij} = \frac{\gamma_{ij}}{w_i} * \frac{1}{D}$ *(cross-price elasticity)*,

$\varepsilon_{DF} = \frac{DF_{ij}}{w_i} * \frac{\overline{DF}}{D}$ *(demographics, media-coverage, risk-perceptions/attitudes elas.)*

where r_{ii} is own price coefficient, r_{ij} is cross price coefficient, DF_{ij} is the coefficient of demographics and media coverage about BSE and CWD, w_i, w_j are own expenditure shares and other's expenditure shares, and *D* is the denominator of the Equation 5.5. Six meats – bison, beef, pork, chicken, turkey, and seafood – are used for Group 1, Group 3 and Group 4. Seven meats – venison, bison, beef, pork, chicken, turkey, and seafood – are used for Group 2. Because of the adding up property of the demand system, one expenditure share equation (seafood) from the system is excluded leaving six share equations in Group 2 and five share equations in the other groups for estimation. Using nonlinear multivariate regression with cross-equation constraints estimation procedures, the above equations are estimated simultaneously in Time Series Processing (TSP) version 5.0 with iterative process. It is expected that own-price elasticities will be negative and cross price elasticities for substitutes (complements) have positive (negative) signs. From the results, the impact of demographics, media coverage and risk perceptions and risk attitudes towards venison safety on purchase behaviour can be observed. The comparison across different consumer groups (Groups 1, 2, 3 and 4) will be presented.

5.5. DATA AND METHODS

In this paper, two sets of data are used. One set of data is from the Homescan™ (Nielsen Company) household panel of 9,300 households per year from 2003 July – 2009 June. Another set of data includes a total of 7000 households that responded to a survey administered by the Nielsen Company in 2011. For this study, a balanced household panel (N=2393 per year) data, which includes those households who are in Homescan™ household panel over the period 2003 July to 2009 June, and who responded to the survey, is developed. The sample was segmented for four groups based on household's venison consumption and the choice of venison supply. The steps of differentiating households into the four groups are presented in Figure 5.3. The following steps were used in segmenting households. First, the survey question "Have you ever eaten venison?" was used to determine households that eat venison and that do not eat venison. A total of 2393 households per year, 1318 households had eaten venison and 1075 households had never eaten venison. Second, households are segmented into those who actually buy venison in stores and who do not actually buy venison in stores using actual purchases in Homescan™ data. Among households who had eaten venison, 18 households (named as group A) purchased venison in stores and 1300 households (named as group B) did not purchase venison in stores. Among households who had never eaten venison, 13 households (named as group C) purchased venison in stores – probably those who do not eat venison but people in their households do – and 1062 households (named as group D) did not purchase venison in stores.

Third, in order to know which households obtain venison from hunted sources, the survey question "Do you ever eat venison from animals you or someone else has hunted?" was used. Among households in group A, 9 households obtained venison from hunting and 9 households did not obtain venison from hunting. Among households in group B, 810 households obtained venison from hunting and 490 did not obtain venison from hunting. Among households in group C, all households did not obtain venison from hunting.

Among households in group D, 49 households obtained venison from hunting and 1013 households did not obtain venison from hunting. Then, households were segmented as follows. Table 5.1 and Figure 5.3 are presented for better clarification about household segmentation in this study.

(i) Households who purchase traditional meats but do not purchase venison = 1013 households who do not eat venison, did not purchase venison in stores and did not obtained venison from hunting);

(ii) Households who purchase traditional meats and venison from stores: 31 households = 18 households who eat venison and purchased venison in stores + 13 households who do not eat venison but purchased venison in stores;

(iii) Households who purchase traditional meats and obtain venison from hunting: 859 households = 810 households who eat venison, did not purchase venison in stores but obtained venison from hunting + 49 households who do not eat venison, did not purchase venison in stores but obtained venison from hunting; and

(iv) Households who purchase traditional meats and venison from other sources probably from restaurants = 490 households who had ever eaten venison, did not purchased venison in stores and did not obtain venison from hunting.

The price data for venison (deer and elk) are calculated from MarketTrack™ scanner data (Nielsen Company) at a national level. Because there are no regional consumer price indices for deer and elk meats, the annual average retail prices are used for all regions and households. The price data for traditional meats (provincially) are developed from secondary sources, following Yang (2010) and Yang and Goddard (2011a). Since most meat purchases remain random weight purchases, where there is not detail on product weight available in the Homescan™ panel data (since quantity is determined in number of packages), it is necessary to use proxy prices from other sources. For traditional meats, regional retail prices are derived from national retail prices and regional consumer price indices following Yang (2010) and Yang and Goddard (2011a):

Regional retail prices = (national retail prices * regional price index) / national price index

where the national retail prices of beef are calculated as an average of prices of round steak, sirloin steak, prime rib roasted, blade roast, stewing beef and ground beef available from the Statistics Canada (Cansim table 3260012); the national retail prices of pork is approximated as the price of pork chops available from the Statistics Canada (Cansim table 3260012); the regional retail prices of chicken and turkey are computed based on the average monthly prices of different types of chicken and turkey products in different regions from the Agriculture and Agrifood Canada webpage; and regional seafood prices are developed using prices available from the Homescan data. For missing seafood prices, the means of seafood prices in certain regions and certain time period are used. Figure 5.4 shows the comparison of meat and seafood prices used in the analysis. As discussed in Section 2.5, CWD detection in farmed elk and two farmed deer in 2002 in Alberta, and international border closures for all bovine products and live animals in 2003 caused significant price drop in deer and elk meats in Canada (Figure 5.4). The descriptive statistics for meat prices and expenditure share percentages are shown in Table 5.2.

As discussed in previous paper, statements which use Likert scales as measures are used in establishing risk perceptions and attitudes in the survey, administered by the Nielsen Company in 2011. Since five-points scales give better accuracy and strength (Johns 2010), risk perceptions and risk attitudes statements measured in five-point scales are used in this study. Risk perception and risk attitude scores are calculated as a simple average of the responses to the three statements about risk perceptions *(When eating venison, my household is exposed to ... 1=very little risk,…,5=a great deal of risk; Members of my household think eating venison is risky: 1=strongly disagree,…, 5=strongly agree; For members of my household, eating venison is ... 1=not risky,…, 5=risky),* and as a simple average of the responses to the three statements about risk attitudes *(Members of household accept the risks of eating venison: 1=strongly disagree,…, 5=strongly agree; For members of my household, eating* *venison is worth the risk: 1=strongly disagree,…, 5=strongly agree: My household is … the risk of eating beef: 1=not willing to accept,…, 5=willing to accept)* respectively, following the specification developed by Penning et al. (2002) and used by Schroeder et al. (2007) and Yang and Goddard (2011a). The average of risk perceptions and risk attitudes scores towards venison and beef across consumer segments are presented in Appendix 5D and Table 5.3. The comparison of risk perception and risk attitudes indices in this study and previous studies is presented in Table 5.3. The comparison results are discussed in the next section 5.6 "Results and Discussions".

The socio-demographic variables, used in this paper in determining meat purchase behaviour are from the survey data collected in 2011 by Nielsen Company. They include gender, household size, location, age of household heads, household head education and income. The dummy variables are used for the demographic data defined in index numbers, which are gender (male versus female), household size (2 members and less versus 3 members and more), and location (city versus town/rural). The midpoint of the data range is used for each category defined in value terms (age of household heads and income). For the household head education level, the variable is constructed using numbers such as - *elementary or junior high school =10, high school =12, technical training/community college/some college = 14, four-year college or university = 16, graduate (Masters or PhD) or professional degree (MBA, JD, etc.) = 18*. In Appendix 5E and Table 5.2, the descriptive characteristics of the sample data are presented. Compared to the Canada Census 2006 data, the sample includes more households that have more female household heads, have older household head, earn higher income, use English language, have less than 3 family members, and have no children under 18 years old. Comparisons between consumer segments are discussed in the next section 5.6.

As discussed in the Section 5.2 "Literature Review", the media indices in this paper are built by collecting the number of newspaper articles about CWD and BSE in national newspapers such as the *Globe and Mail (Canada)*, the *National Post* and the *La Presse* – a major Quebec newspaper – through Factiva search engine. Specifically, the media indices are an updated version of Maye and Goddard (2010). The print news coverage of BSE and CWD indices are built separately using key-words searches – *Bovine Spongiform Encephalopathy, BSE, Mad Cow Disease, Mad Cow, Chronic Wasting Disease, CWD,* and *Deer*. Due to a high correlation between the number of media reports from *The Globe and Mail (Canada)* and *National Post* (Table 5.4), the indices created from *The Globe and Mail (Canada)* and *La Presse* will be used in this paper, as a proxy for the depth of media coverage through all outlets. As shown in Figure 5.5, the media coverage about BSE and CWD in the representative newspapers in this study was the highest during 2003-2004 periods and gradually decreased after that period.

5.6. Results and Discussions

In Table 5.2, a comparison of descriptive statistics for demographics, average meat-prices and expenditure share of the specific meat from total meat expenditure across the four Canadian household segments are presented. More detailed demographics descriptive data are presented in Appendix 5E. The demographic characteristics in Groups 1, 3 and 4 who are similar in terms of percentage of households in provinces, language use (72%, 72% and 81% respectively use English language), household size (14 % to 20% of households have 3+ members), number of children under 18 (90% to 93% of households do not have children under 18 at home), household income ($45,200/annum to $46,700/annum in average), age (56-57 on average) and household heads' education levels (15- college/university graduate). Compared to the other groups (Group 1, Group 3 and Group 4), Group 2 (households who purchase traditional meats and venison from stores) includes more households who reside in Quebec (90%), use French language (81%), earn higher income ($51,500/ annum on average), have older household head (58 on average) and have a larger household size (26% of households with 3+ members). The comparison of demographic profile suggests that Group 2 who purchase traditional meats and venison from stores are different from the other 3 groups in terms of region, language, income, age and household size.

5.6.1. Descriptive Results

In Table 5.3 the mean comparison of risk perception and risk attitude indices in this study are presented. More detailed statistics about risk perception and risk attitude indices and t-statistics for significant differences between household segments are shown in Appendix 5D. Households who purchase traditional meats but do not purchase venison in Group 1 show significantly higher risk perceptions and significantly lower risk attitudes towards venison than Group 3 (who purchase traditional meats and venison from hunting) and Group 4 (who purchase traditional meats and venison from other outlets). Although it is not statistically significant, risk perceptions are higher and risk attitudes are lower with regards to venison safety in Group 1 than Group 2 (who purchased traditional meats and venison from stores). The results suggest that compared to other groups, households in Group 1 are those who have more concerns about venison safety.

Compared to Groups 2, 3 and 4, Group 2 shows significantly higher risk perceptions than Groups 3 and 4 and shows significantly lower risk attitudes than Group 3. Thus, Group 2 includes households who have concerns about venison safety following Group 1. Group 3 has the lowest risk perceptions and the highest risk attitudes towards venison among all other Groups 1, 2 and 4. Therefore, the confidence level (low risk perceptions and high risk attitudes) in venison is the highest in Group 3 (who purchase traditional meats and venison from hunting) and the lowest in Group 1 (who purchase traditional meats but does not purchase venison). Similar levels of risk perceptions and risk attitudes towards beef can be observed across segments. The confidence levels in venison and beef across segments can be expressed as: Group 3 > Group 4 > Group 2 > Group 1 (Table5.2 and Appendix 5D). Therefore, Group 3 and Group 4 include those who are willing to take the risk of eating venison and beef associated with food safety risks due to CWD and BSE respectively. Households in Group 1 and Group 2 are risk averse consumers for venison and beef. The comparison of risk perceptions and risk attitudes indices from this study and previous studies is presented in

Table 5.3. Towards venison safety, consumers' risk perception and risk attitude scores are relatively higher in 2011 survey than 2009 survey in Canada. Towards beef safety, both the risk perceptions and risk attitude scores are very similar to the scores in previous studies. The comparison in Table 5.3 suggests that households in the sample show higher risk perceptions and lower risk attitudes towards venison compared to towards beef.

In Table 5.2 and Figure 5.4 meat prices per kilogram are presented. Compared to the prices of other meat types, the prices of elk and venison are highly variable and decreased drastically in the 2003/2004 period, possibly due to BSE and CWD impacts. The export numbers of live animals dropped and slaughter numbers increased after the 2002 CWD cases in Alberta (Mueller, 2006). Beef, turkey and chicken prices show the slight upward trends, and bison prices experienced a slight fluctuation with almost the same price occurring in 2008 as compared to the 2002 period. Pork and seafood prices show the slight downward trends (Figure 5.4). In Table 5.2 and Appendix 5E, expenditure share and mean expenditures for all meat types (venison, bison, beef, pork, chicken, turkey and seafood) are presented. The expenditure data for venison can be obtained only for Group 2 who purchased traditional meats and venison from stores. In terms of meat consumption behaviour across segments, Group 2 shows a different from the other three groups which have similar expenditure shares for all respective meat types (Table 5.2). Compared to the other groups, the expenditure shares for bison and beef are higher and those for pork, chicken, turkey and seafood are lower in Group 2. The comparison of expenditure shares and risk perceptions/attitudes suggests that households who purchase traditional meats and venison from stores (Group 2) are red meat lovers and have confidence in the safety of venison and beef.

5.6.2. Econometric Results

In Table 5.5 and Appendices 5G and 5I, the goodness of fit statistics and the estimates of the demand system equations are presented. As discussed in the Sections 5.3 and 5.4, two stage demand systems are estimated using two step procedures for the four household segments. In the first step, probit equations for all meat types (7 meat types in Groups 1, 3 and 4; and 8 meat types in Group 2 with additional venison data as shown in Table 5.1) are estimated for each household segment in order to calculate inverse mill ratios to be used in the second stage demand systems. The dummy variables of whether household *h* consumes the meat *i* are used as dependent variables. Total meat expenditure, household's income, household head's age, education level, use of language, location (urban), and risk perceptions and risk attitudes scores are used as explanatory variables. Since variables such as household size and presence of children under 18 do not add any explanatory power in all probit equations across segments, these variables are not used. As discussed in previous section, mid-point of data range in income and age for each household is used. Education level of each household head as defined in the previous section is used. For language (1=English, 0=French) and location (1=urban, 0=rural), dummy variables are used. The calculated mean scores of risk perceptions and risk attitudes towards venison are used.

5.6.2.1. Probit Regression Results

The estimated probit regression results across segments are presented along with the statistical significance of each regression in Appendix 5F. The likelihood ratio tests – with the null hypothesis that all slope estimates were zero – are rejected in all regressions (except for the venison equation in Group 2). In addition, the reasonably high scaled-R^2 and the high percentage of prediction accuracies imply that the first steps of the model are statistically significant. The prediction accuracies for all red meat and chicken are higher than 80 percent and that for turkey and seafood are higher than 60 percent.

The marginal effects for all significant variables are presented in Appendix 5G. Although there have some differences across household segments, the probit estimates in general suggest that all types of meat purchases across segments are positively linked to total expenditure, household income and household head's age. The probabilities of red meat and poultry purchases are negatively linked to the household head's education level. But the probability of bison purchases is positively linked to the education level in Group 1, implying that those who are educated and do not eat venison prefer bison to add in their daily meat intake. The probabilities of red meat including bison and chicken (turkey and seafood) purchases are negatively (positively) linked to the use of English language in the households. In terms of place of residence, the probabilities of beef, chicken, turkey and seafood purchases are positively linked and that of pork purchases are negatively linked to living in urban area. The results imply that urban people are driving to health conscious lifestyle.

In terms of risk perceptions and risk attitudes towards venison, risk attitudes show more linkages with meat purchases. For example, the probabilities of bison (in Group 1 and Group 3) and seafood purchases (in Group 1 and Group 4) are negatively linked and pork purchases (in Group 3 and Group 4) are positively linked to the households' risk perceptions about venison. This indicates that households cannot distinguish between CWD infection in deer/elk and diseases in bison. In other words, households associate diseases with all wild animals including seafood. In terms of risk attitudes towards venison, the households who show lower risk attitudes towards venison are more likely to purchase beef in Group 1; less likely to purchase pork and seafood in Group 2; more likely to purchase bison, beef, turkey and seafood in Group 3; and less likely to purchase bison, beef, pork, chicken and more likely to purchase seafood in Group 4. This indicates that households who do not want to take the risk of eating venison will eat more beef in Group 1, reduce meat consumption in Group 2, eat more other meats in Group3 and eat more seafood in Group 4.

5.6.2.2. Two-Stage Demand System Results

Using the inverse mill ratios, calculated from the probit estimates, for each household according to the equations 4.2 and 4.3, the second step – two-stage demand systems in equations 4.4 and 4.5 – for each household segment are estimated. Nonlinear multivariate regression with cross-equation constraints is used for the simultaneous demand equation model in Time Series Processing

(TSP) version 5.0 with iterative process. Standard errors are computed from heteroscedastic-consistent matrix in order to provide asymptotically efficient coefficient and consistent standard errors.

In Table 5.5, the goodness of fit and test statistics for all the estimated equations in both the first stage and the second stage are presented. The R-squared statistics are low and DW-statistics suggest the present of positive autocorrelation in most of equations. However, by imposing the following restrictions in the simultaneous equations estimation method, both within-equation correlations and within-equation heteroskedasticity are ruled out and contemporaneous-correlations between equations are accommodated (Anderson et al. 2009).

The symmetry (cross price effects) and adding-up restrictions were imposed in the model and homogeneity restrictions were tested. Model validation results in Table 5.5 shows that the homogeneity restrictions cannot be rejected at a 10% level of significance (except in the chicken and turkey equations in Group 3). The results suggest that estimated share equations are homogeneous of degree zero in prices and income, and the summation of all expenditure shares is one, implying that the matrix of substitution effects is symmetric.

The results of the first stage, the total expenditure equation, in Appendix 5H suggest that the last year total meat expenditure and current household income have statistically significant and positive impacts on total meat expenditure. There are negative impacts of household head age on total meat expenditure in Group 3 and Group 4. This indicates that older household heads who purchase traditional meats and venison from hunting and other sources may purchase less meat from stores and more meat from hunters, farmers' markets or other outlets. The risk perceptions and risk attitudes towards venison have a significant impact on total meat expenditure in Group 1 who purchase traditional meats but do not purchase venison. The result implies that for those who do not eat venison, either risk perceptions or risk attitudes towards venison can increase their purchases of all other meats in stores. Since the risk perceptions and risk attitudes towards other meat are not included in this study, this factor should be considered in future studies.

In the second stage Translog demand system, all the inverse mills ratios are statistically significant in all household segments. This implies that there are pronounced selection biases in all demand models and the use of inverse mills ratios provides asymptotically consistent estimates. Most of the total expenditure and lagged quantity variables are statistically significant in all models across household segments. This implies that meat consumption in the past can explain current households' meat purchase behaviour. In Table 5.6, own price elasticities, cross price elasticities, demographic relationships and response to media information, calculated based on the second-stage estimates, are presented across household segments. The results show that all meat types have negative own price elasticities. The own price elasticity of demand for bison is significant and relatively elastic compared to other meats in this study. Compared to the previous study by Myae and Goddard (2010), own price elasticity of bison demand is higher in Group 1 and Group 3, but is lower in Groups 2. This implies that those who purchase venison from stores are less sensitive to bison prices in stores compared to those who buy venison from hunting. The own price elasticity of demand for bison is not significantly different from zero in Group 4 who purchase venison from other outlets including restaurant since they might be eating bison as a speciality food. In other words, the bison demand of consumers who obtain venison from stores and who obtain venison from other outlets (including restaurant) are relatively less effected by the bison price. The own price elasticity of venison (-0.99) is significant and relatively elastic following bison (-1.1), turkey (-1.09) and chicken (-1.0); and is slightly higher than beef (-0.98) and pork (-0.99) in Group 2. The sequence of significant own price elasticities from relatively most elastic to least elastic can be described as follows: in Group 1 – bison, pork, beef, seafood, chicken; in Group 3 – bison, beef, chicken, pork, seafood; and in Group 4 – beef, seafood, pork, chicken (Table 5.6).

The results of own price elasticities across segments suggest that bison is relatively more elastic compared to the other meat types. For traditional meats, households who do not purchase venison from stores (in Group 1, Group 3 and Group 4), beef is relatively more elastic than other traditional meats. In contrast, beef is relatively less price elastic than other traditional meats in Group 2 who purchase venison from stores. The results suggest that those who buy venison from stores (Group 2) are those who prefer beef to other traditional meats. Table 5.7 shows a comparison of own price elasticities from selected studies in Canada. The relatively higher own price elasticities reported in this study than the average elasticities from previous studies can be observed. In addition, the own price elasticities reported in this study are higher than those reported in Yang and Goddard (2011b) where the whole Homescan^{TM} panel data was used. A relatively higher own price elasticities of chicken and turkey in Group 2, compared to that in the other groups suggests that consumers who obtain venison/exotic meats from retail stores are more sensitive to prices on poultry meats than general Canadian consumers (Table 5.6).

Cross price elasticity results (Table 5.6) suggest the substitutability of bison for other meats in Group1 (who do not purchase venison and purchase other meats only from retail stores) and Group 3 (who purchase meats from retail stores and venison from hunting). In Group 1, the substitutability of bison for chicken and seafood is 228 times and 131 times larger than the substitutability of chicken and seafood for bison respectively. In Group 3, the substitutability of bison for chicken and seafood is 76 times and 44 times larger than the substitutability of chicken and seafood for bison respectively. It is obvious that the substitutability of bison for chicken and for seafood is larger in Group 1 than in Group 3. However, the substitutability of bison for beef and turkey is 168 times and 128 times larger than the substitutability of beef and turkey for bison respectively. The results suggest that compared to consumers who eat venison and eat meats from hunted sources, those who purchase meats only from retail stores, and do not eat venison from hunting prefer to change bison consumption to chicken and seafood consumption more easily as bison price increases. Even in Group 3, the substitutability of bison for traditional meats (beef, chicken and turkey) and seafood is much larger than the substitutability of the meats for bison. Due to relatively higher own price elasticities of venison and bison, and relatively higher substitutability of traditional meats for bison, the competitiveness of the exotic meat industry is limited. However, venison-seafood and bison-seafood are complements to each other in Group 2 and Group 3, which include consumers who purchase venison in retail stores and from hunting. Since seafood is a substitute to chicken and turkey, a potential of exotic meat market expansion can be expected among consumers in the two groups.

In Table 5.6, the effect of individual's demographics, BSE/CWD media indices are presented. There is a significant income effect on the behaviour of meat consumption in Group 1 and Group 4. It can be suggested that those who purchase venison from stores (Group 2) and who eat venison from hunted sources (Group 3) purchase meat for their own desire regardless of household income amount. In Group 1, the income elasticity is positively significant for turkey and negatively significant for pork and chicken. In Group 4, the income elasticity is positively significant for bison and turkey and negatively significant for chicken. There has a variation of age effect on meat consumption behaviour across segments. As household head is older, pork and turkey consumption increases and chicken consumption decreases in Group 1; venison consumption increases and beef consumption decreases in Group 2; bison and chicken consumption decreases and turkey consumption increases in Group 3; and turkey consumption increases in Group 4. The results suggest that those who purchase venison in retail stores (Group 2) will consume more venison and less beef in households with older household head. Those who do not purchase venison in retail stores (Groups 1, 3 and 4) will consume more pork and turkey, and less bison and chicken as the household head is older. Household heads with higher education levels choose more chicken, less pork and less turkey in Group 1; more venison in Group 2; more bison, more turkey and less pork in Group 3; and less bison, less pork and more chicken in Group 4. In general, household heads with higher education levels choose more venison, more chicken and less pork.

A number of different responses are identified for the media coverage of BSE and CWD (*The Globe and Mail Canada* and *La Presse*). In response to the increasing number of media coverage about BSE, consumers purchase more turkey in Group 1; purchase less beef, more venison and more chicken in Group

2; purchase more bison and turkey in Group 3; and purchase more bison in Group 4. In general, BSE in the media has a negative effect on beef consumption and positive effect on venison, bison, chicken and turkey. There is no significant effect of CWD media coverage on meat consumption in those who purchase venison from other outlets, including restaurants (Group 4). In Group 2 who purchases traditional meats and venison from retail stores purchase less venison, less chicken, less turkey and more beef. Similarly, the media coverage about CWD effects negatively on bison and chicken consumption in Group 1, and bison, turkey and pork consumption in Group 3. Although CWD cannot infect bison, pig and poultry, consumers cannot distinguish the nature of disease infection to particular animals.

Table 5.7 shows the comparison of the estimated animal disease elasticities in this paper to those in previous studies which used Canadian household data. Using the Statistics Canada Family Food Expenditure survey data for 1996 and 2001, Lomeli (2005) analyzed own and cross food safety media elasticities for – BSE, E. coli for beef; Salmonella for pork; and E. coli and Salmonella for chicken. Yang (2010) used panel data (2002-2007) and BSE media coverage as the animal disease index. Myae and Goddard (2010) used panel data (2002-2008) and BSE and CWD media coverage as the animal disease index. The results of this study are similar to the own food safety elasticities of Lomeli (2005) in pork and chicken consumption and a bit larger in beef consumption. Although the results in this study are much smaller than the results of BSE elasticities in Yang (2010) study, they are similar and slightly larger than the BSE-CWD media coverage elasticities of Myae and Goddard (2010). The comparison suggests that those households who purchase exotic meats (bison, elk, and deer) may be less sensitive to animal disease (specifically BSE) media information than the general population.

5.7. CONCLUSIONS

In this paper, household meat consumption behaviour of particular households who purchase traditional meats and exotic meats (especially venison) from different venison supply (from retail stores and hunting or others) in the presence of BSE and CWD concerns is examined in this paper. Demand shifters such as prices, households' socio-demographics, BSE/CWD media coverage are considered in the meat consumption behaviour analysis across the four consumer segments; Group 1 – who purchase traditional meats but do not purchase venison in stores; Group 2 – who purchase traditional meats and venison in stores; Group 3 – who purchase traditional meats in stores and venison from hunting; and Group 4 –who purchase traditional meats in stores and venison from other outlets. Based on the relevant literature about concepts and empirical specifications, an empirical model has been developed to determine how consumers perceive the TSE risks in their daily meat consumption and how the animal diseases effect the substitution possibilities between exotic meats (venison and bison) and domestic meats (beef, pork, chicken, turkey and seafood).

Across segments, bison is relatively more elastic. For consumers who do not purchase venison in retail stores, beef is relatively more elastic than other traditional meats. A relatively higher own price elasticities of chicken and turkey in Group 2, compared to that in the other groups suggests that consumers who obtain venison/exotic meats in retail stores are more sensitive to prices on poultry meats than general Canadian consumers (Table 5.6). Due to relatively higher own price elasticities of venison and bison, and relatively higher substitutability of traditional meats for bison, the competitiveness of the exotic meat industry is limited. However, exotic meats (venison and bison) and seafood (which in turn is a substitute to chicken and turkey) are complements to each other among consumers who purchase venison in retail stores and from other outlets such as restaurant, there is a potential of exotic meat market expansion among Group 2 and Group 4.

There are significant income effects on bison, pork, chicken and turkey consumption in Group 1 and Group 4. Bison and turkey consumption will be increased, and pork and chicken consumption will be decreased as households earn higher income. There are no significant income effects in Group 2 and Group 3. In households with older household head, more venison and less beef will be consumed in Group 2. In the other groups, more pork and turkey, and less bison and chicken will be consumed in households with older household head. The education level of household heads effect positively on venison and chicken consumption and negatively on pork consumption. BSE in the media effects negatively on beef consumption and positively on venison, bison, chicken and turkey consumption. CWD in the media effects negatively on venison, bison, pork, chicken and turkey, while it effects positively on beef. The result suggests that consumers cannot distinguish the nature of disease infection to particular animals.

In terms of potential market expansion, the following percentage should be considered. Only 1.3% of the Canadian sample purchase venison in stores but the potential market for venison in Canada account for 37.2% of the population (Group 2 + Group 3). Another 20.5% of the sample (Group 4) consumes venison from other outlets including restaurants. In terms of animal disease management, exotic meat eaters (bison, elk, and deer) are less sensitive to animal disease media information than the general population. If CWD is found to affect humans through consumption then people who eat venison through many different outlets will need to be the target – for example, restaurants could be contacted through point of sale; people who obtain venison from their own or other hunting will need to be contacted through places that sell licenses and provide hunting information.

Table 5. 1. Household groups and meat types to be included in the analysis

Group	Purchase traditional meats*	Purchase venison from stores	Obtain venison from hunting	Purchase venison from other outlets	# of households	Meat types to be included in demand system
1	√				1013	Bison, Beef, Pork, Chicken, Turkey, and Seafood
2	√	√			31	Venison, Bison, Beef, Pork, Chicken, Turkey, and Seafood
3	√		√		859	Bison, Beef, Pork, Chicken, Turkey, and Seafood
4	√			√	490	Bison, Beef, Pork, Chicken, Turkey, and Seafood
Total					**2393**	

Table 5. 2. Descriptive statistics of demographics, average meat prices and annual expenditure share (%)

	G1 (N=1013)		G2 (N=31)		G3 (N=859)		G4 (N=490)	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Demographics								
Income ($1000)	46.7	20.7	51.5	18.9	45.2	20.8	46.7	21.5
Age	56	14	58	15	57	13	56	13
Education	15	4	15	4	15	4	15	4
RP -CWD	2.5	1.1	2.5	1.2	2.2	1.0	2.6	1.0
RA-CWD	3.2	1.1	3.1	1.2	3.6	1.0	3.1	1.0
RP-BSE	2.2	0.9	2.4	1.05	2.1	0.89	2.2	0.9
RA-BSE	3.7	1.03	3.5	1.10	3.9	0.98	3.87	1.03
Prices ($/kg)								
Venison	11.15	0.03	11.13	0.19	11.16	0.04	11.15	0.05
Bison	10.56	0.005	10.56	0.04	10.56	0.006	10.56	0.008
Beef	11.73	0.008	12.14	0.04	11.72	0.008	11.66	0.01
Pork	9.65	0.007	10.08	0.03	9.64	0.008	9.59	0.01
Chicken	6.78	0.01	6.64	0.07	6.83	0.02	6.81	0.02
Turkey	5.32	0.004	5.36	0.02	5.38	0.005	5.34	0.006
Seafood	16.9	0.02	17.44	0.05	16.8	0.02	16.9	0.03
Exp share (%)								
Venison	0.0		0.8		0.0		0.0	
Bison	0.1		1.6		0.2		0.1	
Beef	40.0		47.0		39.0		40.7	
Pork	18.8		17.3		20.3		18.9	
Chicken	25.1		22.8		24.2		24.0	
Turkey	4.5		3.0		4.8		4.7	
Seafood	11.5		7.5		11.5		11.5	

Table 5. 3. Comparison of risk perception index and risk attitude index from previous studies

	This study		Study in Chapter 4	Muringai and Goddard (2011)	Yang (2010)	Schroeder et al. (2007)	Tonsor et al. (2009)
Country	CA		CA	CA	CA	CA	CA
Meat type	Venison	Beef	Venison	Beef			
Survey Year	2011	2011	2009	2006	2008	2006	2006
Respondent number	2393	2393	1516	325	4076	1002	1002
Scale	5	5	5	5	5	10	10
RP Index	2.85	2.17	2.48	2.22	2.00	3.3	3.34
RA Index	3.22	3.82	3.04	2.78	3.46	4.9	3.94

Table 5. 4. Correlation between the number of reports in different newspapers

	GandM	N-Post	La Presse
BSE			
GandM	1		
N-Post	0.95	1	
La Presse	0.28	0.50	1
CWD			
GandM	1		
N-Post	0.70	1	
La Presse	-0.16	0.51	1

Note: GandM -The Globe and Mail Canada,
N-Post - National Post , and
La Presse

Table 5. 5. Goodness of fit and test statistics for the estimated equations

Equations	**G1 (N=1013)**		**G2 (N=31)**		**G3 (N=859)**		**G4 (N=490)**	
Goodness of Fit Statistics								
	R^2	DW	R^2	DW	R^2	DW	R^2	DW
Total Meat Exp.	0.48	1.5	0.81	2.02	0.50	1.61	0.59	1.91
Venison			0.67	1.48				
Bison	0.07	1.37	0.66	1.37	0.14	1.15	0.14	1.31
Beef	0.09	0.81	0.30	1.46	0.09	0.95	0.03	1.00
Pork	0.09	1.01	0.41	2.30	0.08	1.20	0.27	1.54
Chicken	0.04	0.79	0.31	2.05	0.04	0.96	0.22	1.13
Turkey	0.26	1.17	0.54	1.44	0.24	1.23	0.37	1.18
Homogeneity Restriction $(\sum_{i=1}^{n}\gamma_{ij} = 0)$								
	Wald	P-value	Wald	P-value	Wald	P-value	Wald	P-value
Venison			0.16	0.69				
Bison	4.02	0.05	2.05	0.15	4.07	0.04	0.53	0.47
Beef	1.73	0.19	0.48	0.49	0.87	0.35	0.23	0.63
Pork	2.26	0.13	1.80	0.18	3.80	0.05	0.77	0.38
Chicken	0.01	0.94	3.18	0.07	9.23	0.002	0.75	0.39
Turkey	3.56	0.06	4.77	0.03	8.61	0.003	0.16	0.69
Seafood	0.16	0.69	0.57	0.45	3.97	0.05	0.001	0.97

Table 5. 6. Own price and cross price elasticity, demographic relationship and response to media information

	Venison	Bison	Beef	Pork	Chicken	Turkey	Seafood	Income	Age	Educ.	MBSE	MCWD
G1 (N=1013)												
Bison		-5.16*** (1.84)	-4.31 (3.57)	4.38 (2.89)	0.91* (0.54)	-0.33 (1.92)	2.61*** (0.68)	0.28 (0.18)	0.12 (0.24)	-0.02 (0.33)	0.19 (0.14)	-0.43*** (0.12)
Beef		-0.01 (0.01)	-1.30*** (0.09)	0.28*** (0.08)	-0.05** (0.02)	-0.02 (0.04)	0.02*** (0.01)	-1.11 (1.01)	-0.10 (0.50)	-2.83 (2.39)	0.57 (0.57)	-0.40 (0.42)
Pork		0.02* (0.01)	0.59*** (0.15)	-1.38*** (0.17)	-0.09** (0.04)	-0.26*** (0.08)	0.05*** (0.01)	-0.04*** (0.01)	0.08*** (0.02)	-0.07*** (0.02)	0.004 (0.01)	-0.003 (0.01)
Chicken		0.004* (0.002)	-0.03 (0.04)	-0.05 (0.03)	-0.86*** (0.03)	0.02* (0.02)	-0.05*** (0.01)	-0.04*** (0.01)	-0.04** (0.02)	0.10*** (0.02)	0.01 (0.007)	-0.02** (0.008)
Turkey		-0.001 (0.01)	-0.05 (0.06)	-0.21*** (0.07)	-0.02 (0.02)	-0.03 (0.31)	-0.02*** (0.01)	0.14*** (0.02)	0.17*** (0.03)	-0.11*** (0.04)	0.05** (0.02)	-0.03 (0.02)
Seafood		0.02*** (0.01)	0.24*** (0.05)	0.16*** (0.03)	-0.04*** (0.01)	0.06*** (0.01)	-1.11*** (0.03)	3.86 (3.44)	0.24 (1.68)	9.57 (8.13)	-1.98 (1.93)	1.41 (1.43)
G2 (N=31)												
Venison	-0.99*** (0.01)	0.0002 (0.05)	-0.0001 (0.06)	0.001 (0.04)	-0.01 (0.01)	0.02 (0.04)	-0.02*** (0.005)	-0.23 (0.23)	1.09** (0.46)	1.05** (0.45)	0.58** (0.25)	-0.67*** (0.24)
Bison	-0.0001 (0.02)	-1.10*** (0.10)	-0.02 (0.06)	0.08 (0.06)	-0.004 (0.01)	0.10 (0.10)	-0.06*** (0.02)	0.04 (0.37)	0.07 (0.43)	-0.31 (0.39)	-0.24 (0.35)	0.15 (0.33)
Beef	-0.000001 (0.0007)	-0.0007 (0.002)	-0.98*** (0.01)	-0.01 (0.01)	-0.002 (0.001)	-0.01** (0.003)	-0.004*** (0.001)	0.04 (0.04)	-0.11* (0.06)	-0.08 (0.07)	-0.09*** (0.03)	0.09*** (0.03)
Pork	-0.00003 (0.002)	0.01 (0.01)	-0.02 (0.02)	-0.99*** (0.01)	-0.002 (0.003)	0.01 (0.01)	-0.01*** (0.003)	0.001 (0.08)	0.10 (0.08)	-0.002 (0.13)	-0.0003 (0.03)	-0.05 (0.03)
Chicken	-0.0004 (0.0006)	0.0003 (0.0012)	-0.004 (0.004)	-0.0001 (0.002)	-1.00*** (0.002)	-0.002 (0.002)	0.004*** (0.001)	-0.005 (0.08)	0.18 (0.13)	0.14 (0.13)	0.14*** (0.05)	-0.11*** (0.03)
Turkey	0.001 (0.002)	0.01 (0.01)	-0.01** (0.01)	0.01 (0.01)	-0.002 (0.002)	-1.09*** (0.07)	0.01*** (0.003)	-0.15 (0.19)	0.03 (0.18)	-0.14 (0.21)	0.10 (0.17)	-0.27* (0.16)
Seafood	-0.002** (0.001)	-0.01*** (0.003)	-0.02*** (0.004)	-0.02*** (0.01)	0.01*** (0.003)	0.03*** (0.01)	-0.98*** (0.005)	-0.16 (0.13)	-0.21 (0.23)	0.08 (0.23)	0.04 (0.06)	0.04 (0.06)

Table 5. 6. Own price and cross price elasticity, demographic relationship and response to media information (Continued)

	Bison	Beef	Pork	Chicken	Turkey	Seafood	Income	Age	Educ.	MBSE	MCWD
G3 (N=859)											
Bison	-5.02*** (1.45)	5.04*** (1.33)	-5.67*** (1.32)	0.38* (0.23)	2.55** (0.96)	1.31*** (0.38)	-0.04 (0.07)	-0.33* (0.16)	0.40*** (0.14)	0.15* (0.08)	-0.17** (0.07)
Beef	0.03*** (0.01)	-1.01*** (0.09)	-0.09 (0.07)	0.03 (0.02)	-0.04 (0.04)	-0.03*** (0.01)	0.11 (0.11)	-0.15 (0.16)	-0.06 (0.18)	-0.22 (0.14)	0.07 (0.09)
Pork	-0.06*** (0.01)	-0.18 (0.14)	-0.76*** (0.16)	-0.09** (0.04)	-0.10 (0.07)	0.09*** (0.03)	0.004 (0.01)	0.013 (0.02)	-0.13*** (0.02)	0.004 (0.008)	-0.01* (0.008)
Chicken	0.004* (0.002)	0.08* (0.05)	-0.06** (0.03)	-0.91*** (0.02)	0.03*** (0.01)	-0.18*** (0.05)	0.0037 (0.01)	-0.03* (0.02)	-0.01 (0.02)	0.004 (0.006)	-0.005 (0.01)
Turkey	0.02*** (0.01)	-0.08 (0.06)	-0.09 (0.06)	0.01 (0.01)	-0.11 (0.18)	-0.18*** (0.05)	0.0035 (0.02)	0.14*** (0.03)	0.07** (0.04)	0.04** (0.02)	-0.03* (0.02)
Seafood	0.03*** (0.01)	0.20*** (0.05)	0.30*** (0.07)	-0.20*** (0.05)	-0.18*** (0.05)	-0.50*** (0.14)	-0.39 (0.36)	0.49 (0.53)	0.41 (0.60)	0.68 (0.45)	-0.17 (0.32)
G4 (N=490)											
Bison	-0.05 (4.04)	11.2 (9.02)	-5.96 (4.84)	0.16 (1.84)	-3.31 (5.65)	-2.99*** (0.25)	1.01* (0.59)	0.38 (0.56)	-1.53* (0.90)	0.75* (0.43)	-0.54 (0.43)
Beef	0.02 (0.02)	-1.41*** (0.36)	0.27 (0.22)	-0.05 (0.08)	0.08 (0.12)	0.09*** (0.008)	2.07 (2.13)	3.01 (3.31)	0.58 (2.92)	-0.78 (1.42)	-0.40 (1.25)
Pork	-0.03 (0.02)	0.59 (0.53)	-0.97** (0.47)	-0.19* (0.12)	-0.17 (0.22)	-0.22*** (0.02)	-0.002 (0.02)	0.08 (0.05)	-0.20*** (0.05)	0.02 (0.03)	-0.02 (0.02)
Chicken	0.0006 (0.008)	-0.08 (0.19)	-0.15 (0.11)	-0.83*** (0.10)	-0.005 (0.06)	0.07 (0.01)	-0.09*** (0.02)	-0.03 (0.04)	0.20*** (0.05)	0.02 (0.02)	-0.01 (0.02)
Turkey	-0.01 (0.02)	0.13 (0.24)	-0.13 (0.17)	-0.005 (0.06)	-0.65 (0.72)	-0.05*** (0.004)	0.25*** (0.05)	0.48*** (0.10)	-0.05 (0.10)	0.04 (0.05)	-0.05 (0.05)
Seafood	-0.02*** (0.004)	0.31*** (0.10)	-0.35*** (0.06)	0.14*** (0.02)	-0.10*** (0.03)	-0.98*** (0.001)	-7.10 (7.42)	-10.7 (11.5)	-2.05 (10.2)	2.62 (4.95)	1.47 (4.38)

Notes: All figures in parenthesis (…) are standard errors, *** = significant at 1%, ** = significant at 5%, * = significant at 10%.

Table 5. 7. A comparison of own price elasticities (Canadian studies)

Previous Canadian Studies	Data	Method	Own price elasticities						
			Beef	**Pork**	**Chicken**	**Turkey**	**Seafood**	**Bison**	**Venison**
Tryfos and Tryphonopoulus (1973)	Time series (annual: 1950-70)	Linear	-0.52	-1.05	-0.87				
Hassan and Johnson (1979)	Time series (quarterly: 1965-76)	Box-Cox	-0.45	-0.84	-0.73	-0.41			
Chalfant, Gray and White (1991)	Time series (annual: 1960-88)	LA/AIDS	-0.40	-0.59	-0.77		-0.25		
Chen and Veeman (1991)	Time series (quarterly: 1967-87)	AIDS	-0.77	-0.82	-0.95	-0.09			
Reynolds and Goddard (1991)	Time series (quarterly: 1968-87)	LA/AIDS	-0.74	-0.68	-0.33				
Moschini and Vissa (1993)	Time series (quarterly: 1980-90)	Rotterdam	-0.84	-0.64	-0.42				
Eales (1996)	Time series (quarterly: 1970-92)	AIDS	-0.81	-0.86	-0.45				
Xu and Veeman (1996)	Time series (quarterly: 1967-92)	AIDS	-0.80	-0.69	-0.41				
Goddard et al. (2004)	Time series (quarterly: 1978-02)	Translog	-0.46	-0.15	-0.60				
Lomeli (2005)	Cross-sectional household data (1996, 2001); Time series (1978-2001)	AIDS	-0.43	-0.36	-0.46				
Yang (2011b)	Household panel data (2002-07)	Translog	-0.69	-0.8	-0.67	-0.94	-0.36		
Myae and Goddard (2010)	Household panel data (2002-08)	LA/AIDS	-0.86	-0.79	-0.99	-0.6	-1.28	-1.64	-0.48
Average			**-0.65**	**-0.69**	**-0.64**	**-0.51**	**-0.63**	**-1.64**	**-0.48**
Largest			-0.86	-1.05	-0.99	-0.94	-1.28		
Smallest			-0.40	-0.15	-0.33	-0.09	-0.25		
This study (Average)	**Household panel data (2003-09)**	**Translog**							
	Average		**-1.18**	**-1.03**	**-0.90**	**-1.09**	**-0.89**	**-3.76**	**-0.99**
	Group 1		-1.30	-1.38	-0.86		-1.11	-5.16	
	Group 2		-0.98	-0.99	-1.00	-1.09	-0.98	-1.10	-0.99
	Group 3		-1.01	-0.76	-0.91		-0.50	-5.02	
	Group 4		-1.41	-0.97	-0.83		-0.98		

Table 5. 8. A comparison of food safety/animal disease elasticities and risk perception elasticities (Canadian studies)

Previous Canadian Studies	Food safety/Animal Disease Elasticities						
	Beef	**Pork**	**Chicken**	**Turkey**	**Seafood**	**Bison**	**Venison**
Lomeli (2005)							
Average own-food safety elasticities (1996 food expenditure surveys)	-0.05	-0.02	-0.07				
Average own-food safety elasticities (2001 food expenditure surveys)	-0.02	-0.01	-0.04				
Yang (2010) (2002-2007 household panel data)							
Average BSE/Risk perception elasticities	-1.09	1.01	0.4	-0.9			
Myae and Goddard (2010) (2002-2008 household panel data)							
BSE media coverage elasticities	-0.02	-0.01	-0.004	0.07	0.04	-0.11	0.21
CWD media coverage elasticities	0.02	-0.002	-0.005	-0.02	-0.05	0.13	-0.13
This study (2003-2009 household panel data)							
Average BSE media coverage elasticities	-0.13	0.01	0.04	0.06	0.34	0.21	0.58
Average CWD media coverage elasticities	-0.16	-0.02	-0.04	-0.10	0.69	-0.25	-0.67

Figure 5. 1. The conceptual model for household meat purchase behaviour determination

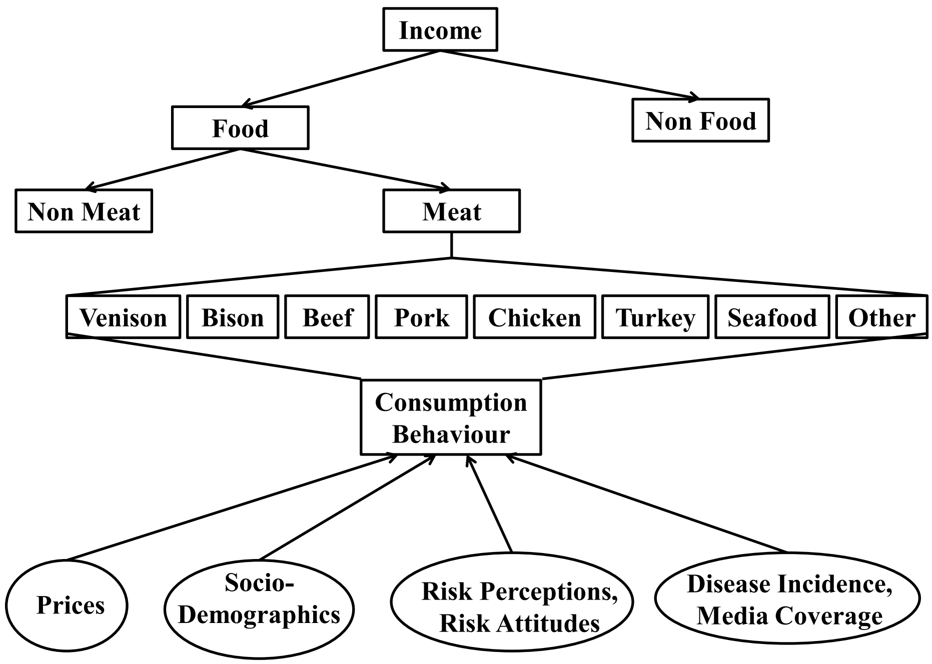


Figure 5. 2. Heien and Wessells two step procedure

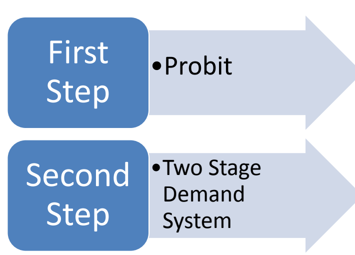
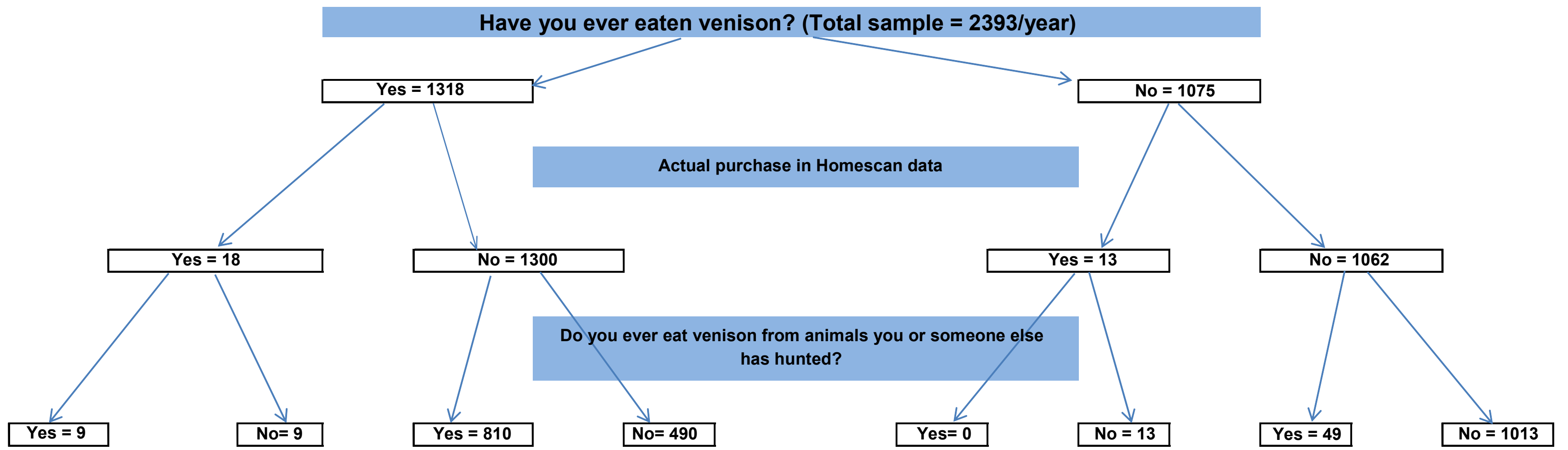
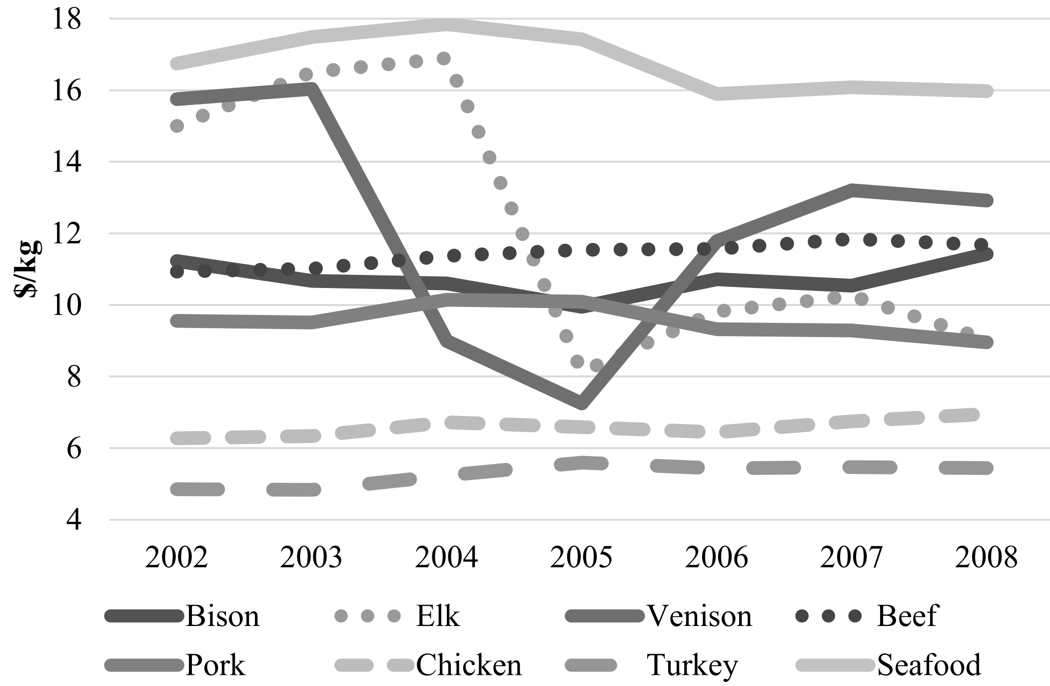


Figure 5. 3. The steps in household grouping



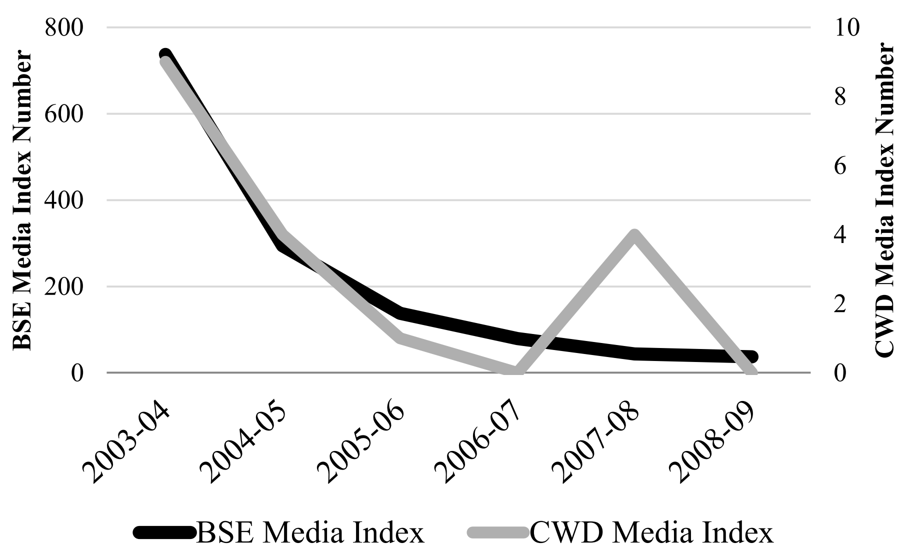
Group 1 (who purchase traditional meat but do not purchase venison) = 1075 - (13 + 49) = **1013**
Group 2 (who purchase traditional meat and venison from stores) = 18+13 = **31**
Group 3 (who purchase traditional meat and obtain venison from hunting) = 810+49 = **859**
Group 4 (who purchase traditional meat and venison from other sources) = **490**

Figure 5. 4. Comparison of nominal prices for all meat types ($/kg)



Source: Homescan™ household data from Nielsen Company, Statistic Canada, Agriculture and Agri-food Canada

Figure 5. 5. BSE and CWD media indices



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6. SUMMARY, POLICY INSIGHTS AND FUTURE DIRECTIONS

The dissertation investigated empirically ***how governments undertook specific regulatory policies in response to TSEs*** and ***how society perceived the regulatory policies and risks in their lives***. The following issues were determined in three separate papers.

(i) Whose economic welfare, concerns and what kind of economic factors were considered in the formation of regulatory policies and which underlying factors were different between CWD testing regulation in Canada and the US and *BSE-testing* regulations in Canada, the US and Japan;

(ii) How and why the society's preferences for CWD tested and full traceability attributes were different depending on the level of perceived risk towards venison in Canada and the US; and

(iii) How meat consumption behaviour is different among households that use the different sources of venison supplies, considering the level of perceived risk in the face of BSE and CWD media coverage.

The first study determined the underlying factors about how *CWD-testing* regulations in wild and farmed cervids were created and implemented in the context of economics, politics and society across countries in Canada and the US. The results were compared to the results of previous study about the political economy of *BSE-testing* regulations in cattle in Canada, the US and Japan. The political economy models for *CWD-testing* in the farmed cervid sectors and for *BSE-testing* in cattle sectors were analysed using time series data from 1991 to 2012 and from 1975 to 2012 respectively at national levels. Given the diverse set of *CWD-testing* regulations in wild cervids across different regions, political economy models in the wild cervid sector were set up at provincial level – Alberta and Saskatchewan in Canada, and Colorado and Wyoming in the US. The results suggest that economic profitability of producers, consumers' concerns about the safety of meats and countries trade-status influenced *TSE-testing levels* adopted in the cattle and farmed-cervid sectors. Export-dependent countries attached more weight on producers' welfare and importing countries attached more weight on consumers' welfare. In the wild cervid sector, economic profitability to wildlife-related agencies, society concerns about wild-animals' health, CWD-infection in both wild and farmed-cervids were important factors in the consideration of *CWD-testing levels* across provinces.

In the second paper, society's preferences towards *CWD-testing* and traceability systems in venison supply were determined. The samples of Canadian (n=1516) and American (n=1016) regular household food shoppers for whom at least 50% had eaten venison in their life were used. The results of the mixed logit models on stated choice data sets across respondent segments with different risk perceptions and risk attitudes towards venison provided the link between society's perceived risks about CWD and preferences for animal testing and traceability attributes, which are outcomes of CWD management strategies in Canada and the US. Three consumer groups were identified in Canada: the CONFIDENT group (Group 1: n=373) that had high risk attitudes and low risk perceptions, the NEUTRAL group (Group 2: n=648) that had reasonably high risk attitudes and perceptions, and the CONCERNED group (Group 3: n=183) that had low risk attitudes and high risk perceptions. Two groups were identified in the US: CONFIDENT group (Group 1: n=353) that had high risk attitudes and low risk perceptions and the CONCERNED group (Group 2: n=646) that had low risk attitudes and high risk perceptions. The results suggest that traceability and animal-testing attributes in venison meat can increase the utility of consumers in the CONFIDENT and NEUTRAL groups – 85% of the sample – in Canada and in the CONFIDENT group – 35% of the sample – in the US. More people who are younger, who are pessimistic about food safety, who eat venison and those in the CONCERNED groups were willing to pay a higher premium for the food safety attributes (traceable, animal-tested and traceable+animal-tested) in the market.

In the third paper, Canadian households' meat consumption behaviour was determined using the Homescan™ panel data from 2003 to 2009 and survey data in 2011 by Nielsen Company. The study provided a comparison of results from two-stage demand models in two step estimation procedure for seven meat types across consumer segments with different preference for obtaining venison from different sources. The four segments were defined and used in the study:

- Group 1: households who purchased traditional meats from stores but do not purchase venison at all (n=1013);
- Group 2: households who purchased traditional meats and venison from stores (n=31);
- Group 3: households who purchase traditional meats from stores and venison from hunting (n=859); and
- Group 4: households who purchase traditional meats from stores and venison from other outlets (n=490).

The price data for venison (deer and elk) were calculated from MarketTrack^{TM} scanner data (Nielsen Company) at the national level. The price data for traditional meats were developed from secondary sources at the provincial levels. The results suggested that due to relatively higher own price elasticities of venison and bison and relatively higher substitutability of traditional meats for bison, the competitiveness of exotic meat industry is limited. In response to BSE-risk (media coverage), consumers purchased less beef and more venison, bison, chicken and turkey. In response to CWD-risk (media coverage), consumers purchased less venison, bison, pork, chicken and turkey, and more beef.

6.1. Summary Results From the Governments' (Decision-Makers') Perspective

The results of the first paper showed that the price elasticities of venison supply and demand in Canada was higher compared to that in the US and the beef sector. Since volatile prices do not favour, especially, industry competitiveness, Canada government's response to CWD was different from its response to BSE. The calculated relative political weights at the average of supply/demand elasticities and prices suggested that the government attached more weight (1.7) in Canada and about half weight (0.5) in the US on producers' welfare compared to the relative weights on consumers' welfare in the farmed-cervid models. In the beef-cattle models, government attached 1.6 times higher weight, almost the same weight and a half lower weight on producers' welfare compared to governments' weight on consumers' welfare in Canada, the US and Japan respectively. A tendency of a lower *BSE-testing level* and a higher *CWD-testing level* in Canada was determined if the government focus on producers' welfare in the farmed-cervid sector. In the US, a higher *BSE-* and *CWD-testing level* was imposed as the government focus on consumers' welfare. In Japan, a lower *BSE-testing level* was imposed as the government focus on consumers' welfare. There had a tendency of higher *CWD-testing level* if domestic consumption goes up in a venison-exporting country (Canada) and a tendency of lower *CWD-testing level* in a venison-importing country (the US) as the governments focus on producers' welfare. BSE-testing level was increased when beef-net-exports increased due to higher slaughtering activities in domestic animals in Canada and the US. In the wild-cervid sector, there had a tendency of higher *CWD-testing level* if hunters' participation was promoted successfully for herd reduction in Alberta and Wyoming. In response to CWD positive cases within provinces, a higher *CWD-testing level* was imposed in Alberta and a lower *CWD-testing level* was imposed in Saskatchewan, Colorado and Wyoming. Considering a higher level of non-consumptive users' participation in wildlife-related recreational activities such as wildlife viewing and feeding, a lower *CWD-testing level* was imposed in Alberta, Saskatchewan and Wyoming, and a higher *CWD-testing level* was imposed in Colorado.

6.2. SUMMARY RESULTS FROM THE SOCIETY'S PERSPECTIVE

The results of the second paper provided the role of perceived risk on consumers' preference for food-safety attributes in Canada and the US. Preference heterogeneity exists over the sampled population. The results of the third paper provided some indications of public responses to TSEs risk in their daily life through their daily meat consumption and how the animal diseases affect the substitution possibilities between exotic meats (venison and bison) and domestic meats (beef, pork, chicken, turkey and seafood).

Both positive and negative relationships between consumers' perceived risk (high risk perceptions and low risk attitudes towards venison) and the following factors in general could be identified.

- **Positive link:** knowledge about CWD and infection to deer/elk, perceived risk about CWD to human health, and the level of worry in both Canada and the US.
- **Negative link:** confident about the safety of venison, trust levels (general trust and trust in institutions), their agreement with LC1, LC2 and LC4.

There are similar characteristics in each segment across countries. In the CONCERNED groups, more percentage of females and city dwellers fall in the groups, fewer respondents knew about CWD and infection to deer/elk, more respondents thought that CWD is risk to human health, and more respondents show a higher level of worry. More respondents in the CONFIDENT groups thought that venison is safe, showed a higher level of trust level in general, a higher level of trust in the institutions, and strongly agree LC1, and LC2. If the venison steaks with food safety attributes are not available in the market place, respondents in the CONFIDNET groups in both Canada and the US, and respondents in the NEUTRAL group in Canada suffered utility reduction. A higher WTP premium for food-safety attributes in venison steaks can be observed in the CONCERNED group compared to the CONFIDENT group (and NEUTRAL groups in Canada) in both countries. Consumers who show relatively lower risk attitudes towards venison and beef fall in Group 2 who buys both traditional meats and venison in retail stores.

The following summarize the relationship between the choice of venison supply and factors such as price elasticities, substitutability, and effect of individual characteristics on meat consumption. Across segments, bison is relatively more elastic. For consumers who do not purchase venison in retail stores, beef is relatively more elastic than other traditional meats. A relatively higher own price elasticities of chicken and turkey in Group 2, compared to that in the other groups suggests that consumers who obtain venison/exotic meats in retail stores are more sensitive to prices on poultry meats than general Canadian consumers (Table 5.5). Due to relatively higher own price elasticities of venison and bison, and relatively higher substitutability of traditional meats for bison, the competitiveness of the exotic meat industry is limited. However, exotic meats (venison and bison) and seafood (which in turn is a substitute to chicken and turkey) are complements to each other among consumers who purchase venison in retail stores and from other outlets such as restaurant, there is a potential of exotic meat market expansion among Group 2 and Group 3. In terms of potential market expansion, the following percentage should be considered. Only 1.3% of the Canadian sample purchase venison in stores but the potential market for venison in Canada account for 37.2% (Group 2+Group 3). Another 20.5% of the sample (Group 4) consumes venison from other outlets including restaurant.

Compared to Americans, more Canadians had heard about CWD, thought that CWD is a risk to human health, showed a lower level of trust in general, showed a higher level of trust in government and manufacturers of food, showed a lower level of trust in farmers and retailers, and showed a lower level of worry. Within each group with different perceived risks about venison safety, male shoppers, younger consumers and Americans want to give a higher WTP premium for all food safety attributes than female shoppers, older consumers and Canadians respectively. Relatively high-income households and older household heads buy both traditional meats and venison from retail stores. There has significant income effect on bison, pork, chicken and turkey consumption. Bison and turkey consumption will be increased, and pork and chicken consumption will be decreased as households earn higher income. In households with older household head, more venison and less beef will be consumed among those who obtain traditional meats and venison in retail stores. Otherwise, more pork and turkey, and less bison and chicken will be consumed in households with older household head. The education level of household heads effect positively on venison and chicken consumption and negatively on pork consumption. BSE in the media effects negatively on beef consumption and positively on venison, bison, chicken and turkey consumption. CWD in the media effects negatively on venison, bison, pork, chicken and turkey, while it effects positively on beef.

6.3. Policy Insights

The results of this dissertation suggest the following policy implications.

1. The calculated relative political weights suggested that consumers' lobbying activities might be more effective in the US than in Canada in determining *CWD-testing* level. One of the possible reasons is that alternative livestock industry is encouraged for stabilizing farm incomes, utilizing marginal agricultural land, and conserving specialized livestock in Canada, while cervid farms are not even allowed to exist in some states in the US (for example in Wyoming). In the beef-cattle sector, producers' lobbying activities might be more effective in Canada and consumers' lobbying activities might be more effective in Japan in determining respective countries' *BSE-testing level*. One of the possible reasons is that Canada is a net-exporting country and Japan is a net-importing country where the number of animals slaughtered in the country should be a factor.
2. In the farmed cervid and cattle sector, higher gross income (*farm cash receipts*) increases producers' interest to participate in lobbying activities. A better economic health of producers could lead to achieve their desire level of animal-testing in Canada and Japan. In the US, a better economic health (including *sector's share of contribution in country's GDP*) weakened the effectiveness of producers' lobbying efforts. Therefore, governments should focus the weight on consumers' welfare when the impact of TSEs on the sector's economy is small.
3. The factors such as a higher *regional concentration in inventories* and *processors*, and a larger *farm-retail price spread* could not help producers' lobbying effort succeed in decision making process. In another way, it could be drawn that as producers were more consolidated and as their profit margins increased, they considered consumers' preferences with regard to animal-testing level in order to achieve a better market access and expansion.

Therefore, when a group is stronger and less affected by animal disease outbreak, a weaker group's interests should be protected.

4. In both sectors (cervids and cattle) and in all the country (Canada, the US and Japan), consumer's concerns about food safety is highly considered in the decision on animal-testing level specification. It is worth knowing that consumers' interest in lobbying effort for a higher food-safety standard is higher in Canadians and Japanese consumers compared to American consumers.
5. In all countries, the level of TSEs-testing increased as the number of TSE-infected animals increased. Although there has no international guidelines for CWD management, all the countries follow similar guidelines for BSE management outlined by the OIE to manage CWD spread in both farmed and wild cervids.
6. The level of CWD-testing in wild cervids has been changing depending on the disease prevalence and interest groups' strength of lobbying efforts. For example, the CWD-testing level should be increased when the disease prevalence in a particular region is high and hunters' participation in herd reduction program is attractive. The CWD-testing level should be decreased when the disease prevalence in a particular region is low and other wild-life recreational users' (wildlife viewing, etc.) lobbying effort is stronger.
7. Since different factors influence the testing levels in different ways across provinces/states in Canada and the US, testing levels in the wild cervid sector will be determined according to the regional requirements and welfare-consideration of interested parties. Responding to different situations in different regions seems the easier way to manage CWD in the wild cervids.
8. Consumers with different risk perceptions and risk attitudes towards venison have different preferences. In addition to other significantly different characteristics (discussed in section 3.6 and section 3.7), consumers in the CONFIDENT groups in both Canada and the US are more familiar with venison consumption and have fewer concerns about to human health risk from CWD. If there arise human health implication from venison

consumption due to CWD infection, consumers in the CONFIDENT groups should be given priority to communicate effectively and to provide food-safety information more efficiently.

9. The preference heterogeneity for food safety attributes – CWD-testing and traceability – exists over the sampled population. Compared to consumers in the CONFIDENT groups, consumers in the CONCERNED groups in both Canada and the US are willing to pay a higher premium for food safety attributes. A relatively potential niche market for venison with added food safety attribute could be expected among younger consumers, male food shoppers, those who eat venison and those who show higher perceived risks about venison safety in both Canada and the US.
10. The comparison of WTPs for these specific attributes in venison in this study and previous studies suggest the confirmation of previous literature that WTPs for CWD-related food safety attributes are lower (higher) than those for BSE-related food safety attributes in Canada (the US). Given that animal-disease related interventions should be justified depending on the percentage of consumers whose utility is affected (85% of the sample in Canada and 35% of the sample in the US) in a particular society since the responses towards food safety attributes are different. The results should be used as a bench mark in determining whether interventions have the capability of alleviating market responses in the face of animal disease risk in the future.
11. Consumer behaviour across segments with different uses of venison supply suggests that the level of confidence in venison safety is the highest in Group 3 – households who obtain venison from hunting. In Group 3, those who show higher risk attitudes towards venison eat fewer traditional meats and those who show lower risk perceptions about venison eat bison. Therefore, the more a person prefers exotic meats and has fewer concerns in the safety of exotic meats, he/she prefers less traditional meats in daily diet.
12. Due to relatively higher own price elasticities of venison and bison across segments and relatively higher substitutability of traditional meats for bison, the competitiveness of the exotic meat industry is limited. However, exotic

meats (venison and bison) and seafood (which in turn is a substitute to chicken and turkey) are complements; and seafood is substitute to poultry meats (chicken and turkey) among consumers who purchase venison in retail stores (1.3% of the sample) and in restaurants (20.5% of the sample), and obtain from hunting (35.9% of the sample). There is a potential of exotic meat market expansion.

13. Media coverage about BSE affects negatively on beef consumption and positively on venison, bison, chicken and turkey consumption. Media coverage about CWD affects negatively on venison, bison, pork, chicken and turkey and positively on beef. The results suggest that consumers cannot distinguish the nature of disease infection in particular animals. If CWD is found to affect humans through consumption then people who eat venison through many different outlets will need to be the target – for example, restaurants could be contacted through point of sale; people who obtain venison from their own or other hunting will need to be contacted through places that sell licenses and provide hunting information.

6.4. LIMITATIONS AND FUTURE DIRECTIONS

The major limitations of the first paper to reveal underlying factors in *TSE-testing* regulations across countries and regions in both farmed and wild cervids is data availability. Although the political economy models are developed based on rigorous literature reviews and theoretical background, data accuracy and sample size are concerns in model estimation. Data limitation is more intense in the wild cervid sectors. Although proxy variables were carefully developed, the accuracy to represent a specific interest group is less satisfied. Updated estimations with added data and careful manipulations in the future would provide valuable implications. In the paper, a new conceptual model about the impacts of government regulations on market behaviour, which include demand and supply shocks, was introduced. In an assumed perfectly competitive market, a new relative political weight formula was developed based on observed prices and quantities. In calculating the relative political weight formula, deadweight losses do not appear in TSE-testing regulation assuming that all these costs – such as cost for inspection, monitoring, and public communication – are treated as rational responses to unfortunate event. Further introduction of conceptual models and calculation of relative political weight formula considering the above mentioned costs as deadweight losses under different assumed market condition – such as monopoly/oligopoly markets under government support programs for animal testing – could be warranted. In determining consumers' surplus, the value of information approach was not evaluated in this study. Since consumers who had knowledge about CWD would choose different demand curve, comparison of political market effects under different choice of demand curve in response to CWD in future studies will provide valuable insights from a political economy perspective. Moreover, the results using data from a designed survey to the industry and consumers could be warranted in order to validate the results in this study.

In the 2nd paper, the results provide information on the differences in preferences for food safety attributes across segments with different risk perceptions and attitudes towards venison. The results suggested that animal-disease related interventions should be justified depending on the percentage of consumers whose utility is affected (85% in Canada – CONFIDENT and NEUTRAL groups; and 35% of the sample in the US – CONFIDENT group). The demonstrated results in this study could provide an initial platform for future related studies. The research on consumers' preferences for food safety attributes in venison meat can be enhanced using different data collection methods such as experimental auction, field experiments in addition to stated preference and revealed preference data using in this study. The comparison of results from different methods could validate and enhance meaningful interpretations. Moreover, since consumers' responses to risk perceptions/ attitudes questions can change across time and methods, measuring the evolution of changing risk perceptions/attitudes is warranted using different methods. Omitted variables, if exist, may create specification errors and decrease estimation efficiency. Increased data coverage – such as demographic profiles including other factors in behavioural economics, food safety/health information and production practices – and more advanced modelling techniques to capture more omitted latent preferences could be warranted.

In the 3rd paper, the limitations include zero expenditures and lack of household level price data. The household panel data (2003-2009) contains a large proportion of households who do not purchase venison very often and each household has zero purchases in some periods. In order to avoid specification error due to sample selection bias, a two-stage Heckman procedure – first stage probit and second stage demand system – was used in the study. Having different methods to correct selection biases such as Parali and Chavas's (2000) two step procedure – first stage tobit and second stage demand system – the comparison of results from different methods could validate and enhance meaningful interpretations. Due to the luck of household level price data, the price data for traditional meats were developed from secondary sources at provincial level. The price data for venison are calculated from MarketTrack™ scanner data (Nielsen Company) at a national level due to the lack of regional consumer price indices. A deeper analysis of price effects using more refined data at the household level could provide better economic implications of meat industry's competitiveness in the future.

Another limitation in this paper is inclusion of a small portion (1 to 3 % of the sample segments) of non-meat eaters in the sample. The removal of non-meat eaters or corner solutions in the estimation could provide more efficient estimates. The results of this study are informative of meat consumption behaviour by people who use different sources of venison supply. Since these differences are not fixed across time and to establish whether the proportion of the population who obtain venison from retail stores (now is only 1.3% of the sample) is changing, updated analysis is warranted. Moreover, continuously changing demographics, meat preferences and choice of supply could need a continuous investigation. Since a larger percentage of venison consumers obtain venison from hunted sources and other sources including restaurants, further investigation about consumers' response to added BSE/CWD cases and media coverage is warranted. Information on quantities of venison consumed from hunted animals is critical to further analysis.

APPENDICES

APPENDIX 3

Appendix 3 A. Literature review of selected papers for political economy models

Author (s)	Objective	Model development	Data	Results
Zusman and Amiad (1977)	To investigate power relations and the structure of the conflict among interest groups in Israeli dairy program.	A game theoretic approach is employed in formulating political economy structure with four components: the economic structural equations; the set of feasible policy instruments; the policy makers' and interest groups' objective functions; and the interest groups' strength (political power) functions.	Consumer price of fluid milk, other dairy products; farm price; production share and import of dairy products	A power relationship reflects producers' desire to decrease imports and to increase domestic production.
Becker (1983)	To present a theory of competition among pressure groups for political influence.	The study started from discussions about the influence functions of two homogeneous pressure groups competing for political favours and then extended to the comparative static properties when many groups compete in a market equilibrium condition.	No empirical estimation	It was suggested that, deadweight costs and efficiency of producing pressure for political influence is negatively linked for subsidized groups and positively linked for taxpayers.
Carter et al. (1990)	To evaluate the causes of intervention in Canadian agricultural policy.	**Endogenous variable:** The ratio of domestic to world price (level of protection) Exogenous variable: ***Variables that reflect interest group:*** regional concentration of production; retail to farm price ratio;	Time series data over the period 1965-87	Inefficiency in terms of redistribution in Canadian agriculture is suggested.

		production growth; and regional production variability. ***Underlying commodity characteristic:*** Import and export shares; absolute difference of demand and supply elasticity; interaction-supply management; and net export share. ***National interest:*** ratio of farm to non-farm income; liberal party; and time trend.		
Sarker et al. (1993)	To determine empirically the factors explaining the systematic pattern of government intervention in agriculture.	**Endogenous variable:** Implicit political weight for producer group relative to that of consumer group Exogenous variable: agriculture's comparative advantage; agriculture's share in the economy (in employment or in GDP); agriculture's international terms of trade; imports financed by agricultural exports; and share of food in disposable income.	Wheat data for 12 developed and 13 developing countries from 1985-1987.	The results suggested different factors influence the systematic subsidization of wheat producers in developed and in developing countries. The labor productivity ratio and the share of food in disposable income are more important in developed countries, while the factor endowment ratio and import shares are more important in developing countries. However, gradual changes occur in the incentive mechanism in agricultural price policy formulation.
Thornsbury (1998) (Page 114-117)	To determine the likely political economy influences on regulatory decisions to enact	**Endogenous variable:** Quantitative measures of the incidence of disputed technical trade regulations. Exogenous variable: ***Individual Agents:*** capital/land ratio; agricultural trade balance; growth in trade balance; agricultural trade balance with the U.S.; average growth in	Survey data: the USDA survey of Technical Barriers to U.S. Agricultural Exports in 1996.	The results suggested the continuing influence and the impact of technical barriers in international agricultural markets.

	questionable technical barriers to U.S. agricultural exports.	agricultural trade balance with the U.S.; labour/land ratio; agricultural import penetration relative to domestic production; private consumption; average annual growth in nominal food prices. ***Effective Political Power:*** labour force employed in agriculture; rural population; GDP from the agricultural sector; value-added in agriculture; GDP. ***Policymaker Preferences:*** percentage of exports in GDP; percentage of government consumption in GDP. ***Institutional Structures:*** 1995 ratio of official to parallel exchange rate; projected 1999 applied MFN average tariff rate for agricultural imports; difference between 1999 bound tariff rate and projected applied tariff rate on agricultural imports; projected 1999 MFN tariff rate faced by agricultural exports; change in projected 1999 tariff faced by agricultural exports as a result of Uruguay Round commitments from the country's trading partners; 1996 WTO membership. ***Measurement Issues:*** 1996 USDA Foreign Agricultural Service (FAS) post in country.		
Clague and Desser (1998)	To determine the cause of international differences in agricultural price level based on factor endowments, transportation costs, and the	Three sets of regression models were developed; **APL** (agricultural producer price level) = **F** (domestic production quantities of agricultural exports and import-competing products, the level of protection, transport cost) **BAL** (agricultural trade balance) = **F** (factor endowments, level of protection) Level of agricultural **Protection** = **F** (political strength of farmers versus that of consumers and taxpayers)	Data in 1970s to 1990s for 39 countries.	The results suggested that lower domestic producer prices were associated with countries having rich resource endowments, higher transportation costs, and less protection via import restrictions. The greater protections are found in richer countries, and that import

	political economy of agricultural protection.			restriction is a politically easier way than restriction through budgetary outlay in protecting farmers.
Olper (1998)	To analyse the determinants of Common Agricultural Policy (CAP) protection across countries and over time from a political economy perspective.	**Endogenous variable:** Nominal (or) Effective Protection Rate Exogenous variable: per worker agricultural gross value added relative to per worker GDP in the rest of the economy; number of farms larger than one hectare; share of net extra-EU Trade in total agricultural production; revealed comparative advantage; share of agricultural national expenditure in agriculture gross value added; ratio of agricultural export and import unit values; share of consumption spent on food; and dummy variables.	Time series data (1975-1989)	A positive relationship between the protection levels (supports) and comparative disadvantage in agriculture of the respective countries.
Sutter and Poitras (2002)	To investigate the political economy of vehicle safety inspection using empirical proxies both for special interest motives and public interest treatment effects.	**Endogenous variable:** Quantitative measures of the incidence of disputed technical trade regulations. Exogenous variable: **Special Interest:** repair shops; safe drivers (auto clubs) who maintain a high level of vehicle maintenance, and support mandatory inspection in order to increase maintenance by other (mainly poor) drivers. **Public Interest:** highway causalities in the absence of inspection (mean vehicle speed, total vehicle miles, urban vehicle miles, percentage of males among drivers, real per capita income, percentage of	Panel data (1981-1993)	Instead of interest groups' demand for inspection, political transaction costs determined the existence of inspection program.

		registered vehicles that are new, real highway maintenance expenditures, lagged fatalities, lagged injuries, linear time trend, state-specific dummy variables.		
Thornsbury et al. (2004)	To measure and assess broader political economy of disputed technical regulations to U.S. agricultural trade in mid-1996, shortly after the WTO agreements came into effect.	**Endogenous variable:** Quantitative measures of the incidence of disputed technical trade regulations. Exogenous variable: **Characteristics of agricultural sector:** percentage of national agriculture in national GDP; percentage of labour force in agriculture; percent of agricultural import penetration relative to domestic value-added in agriculture; and average change in agricultural trade balance with U.S. **Trade Policy:** percent of expected applied post-Uruguay round MDN average protection rate for agricultural imports; percent reduction in tariffs faced by agricultural exports as a result of Uruguay Round commitments from the country's trading partners; and WTO membership. **Characteristics of the aggregate economy:** countries' GDP; Global integration such as percent of aggregate imports relative to GDP and aggregate trade balance.	Survey data of 302 disputed technical regulations among 62 countries and two regional trading blocks during mid-1996	The results suggested negative relationships between technical barriers and agriculture's contribution to an economy, the level of other forms of interventions, and the level of open market economy in respective countries.
Lee and Kennedy (2006)	To investigate the equilibrium level of trade interventions, which occurred even under the Uruguay Round	The political weights of various interest groups are calculated and three models (production, consumption and export demand) were developed to determine the optimal U.S. rice program in game-theoretic framework: Yield = f(trend, explanatory variables, dummy variables),	Time series data from 1960-1999	The results demonstrated the Nash equilibrium under the US Market Development Program by exercising a 4% tariff reduction in Japan and Korea rice trade.

	Agreement on agriculture, for optimal U.S. rick export programs.	Harvested area = f (lagged area harvested, producer price, production cost, explanatory variables) Per capita Consumption = f (retail price, income, lagged per capita consumption) US export demand = f(production/consumption, the US domestic rice price/the world price, the US govt. export program, the world ending stock, the tariff rate)		

Appendix 3 B. Selected reviews on demand side analysis of wildlife cervids

Author (s)	Objective	Method	Data Used	Results
Prather (1974)	To evaluate and quantify benefits and costs from Alberta big game hunting.	Direct method; Indirect methods such as Hotelling-Clawson and Pearse approach.	Survey data for: Maximum tolerable price over actual cash costs. Distance travelled and income as a proxy for price.	Some theoretical and procedural implications with regards to the selected methods. The results of regional breakdown analysis suggested differential pricing by means of hunting fees and control for hunter intensity.
Adamowicz (1983)	To analyze the economics of big game hunting in the eastern slopes region of Alberta Rocky Mountains.	Direct or contingent valuation method; Travel cost model; Hedonic price method to estimating extra-market benefits; Household production function model.	Survey data from Alberta big game (resident and non-resident) hunters.	A significant connection between the demand for wildlife and the control of harvest (a major policy variable).
Rush et al. (1995)	To provide generalized results on past wildlife benefit reports.	Meta- analysis techniques and Liner and log linear OLS regression models	Survey questions in the reports, database created for the Alberta Fish and Wildlife Division, and 25 previous studies.	The variables such as substitute sites, willingness to pay, consumptive hunting, fishing, and hunting as influential variables in wildlife benefit estimations.
Bishop (2002 and	To determine the impact of CWD in Wisconsin on whom and how	Presenting overview of the	Data from Literature review and state	Hunters suffer more than other sectors of Wisconsin economy due to CWD.

2004)	much on hunting-related economy.	potential economic impacts of CWD and losses suffered by deer hunters in Wisconsin.	agencies.	
Siedl and Koontz (2004)	To determine the political economic impacts of CWD in Colorado	Reviews some of the potential impacts of CWD	Literature review and some data from states and international agencies.	There were direct economic impacts of CWD on Colorado in tens of millions of dollars. It could be inflated to double if indirect and induced impacts are added.
Brown et al. (2006)	To characterize early public awareness, information seeking behaviour, reaction to the CWD discovery, and the effect on hunters' plans to hunt deer.	Descriptive Analysis	Telephone survey to general public and big game license purchasers.	Hunters showed relatively higher awareness of the discovery of CWD and higher concerns about the disease and venison consumption. However, the hunting habit was not affected much.
Holsman and Petchenik (2006)	To assess hunters' attitudes, effort, and harvest behaviour in response to disease management strategies	Logistic and linear regressions	Mail questionnaire and hunter diaries	Hunting efficiency, number of deer seen, and willingness to harvest predicted harvest levels better than hunting efforts.
Needham et al. (2006)	To examine the extent to which CWD may influence individuals to hunt in other states or quit hunting permanently; hunters' acceptance of strategies for managing the disease; and whether hunters' responses differ by residency, species hunted, and state where they hunted.	Descriptive Analysis	Mail survey to resident and non-resident deer hunters in eight states and elk hunters in three states.	Hunters were more likely to quit than switch states; residents were more likely to quit and non-residents would switch states; and CWD testing and herd reduction were acceptable, whereas taking no action was unacceptable.
Petchenik	To determine landowners':	Descriptive	Mail survey sent to	The attitudes of most landowners aligned

(2006)	attitudes regarding the state's eradication strategy; awareness of various incentives to shoot more deer; and actual hunting participation in response to these incentives.	Analysis	landowners	with the state's goals. Landowners who hunt were more likely to be aware of incentives to promote deer harvest. Free buck tags and the longer season are influential factors to increase hunting participation.
Zimmer (2009)	To determine the economic impacts of CWD on hunters in Alberta	Nested Logic model	Stated preference and Revealed preference data	Negative effect of the disease and culling of herds, and positive effect of extra tags on hunters.
Cooney and Holsman (2010)	To investigate the influence of risk perceptions and other salient beliefs on deer hunter support for deer density reduction as CWD management strategy in Wisconsin.	Path analysis and Principle Component Analysis	Mail survey to deer hunters in the fall of 2006.	The influence of risk perceptions on hunter support for population goals was mediated through beliefs about whether eradication is necessary.
Holsman et al. (2010)	To identify six psychological bases that created deer hunter opposition to the Wisconsin plan.	Descriptive Analysis	A survey to hunters and landowners	The use of recreational hunting as a viable tool for severe deer population reduction for disease management may not be the best way to use.
Lischka et al. (2010)	To determine residents' (of the CWD-infected area) knowledge of and support for CWD management strategies.	Descriptive Analysis	A survey to public and hunters from 1 of 20 CWD positive or adjacent counties.	Public awareness about CWD is less than hunters. More than half of respondents felt all necessary measures should be used to manage the disease.
Petigara (2011)	To determine the direct and indirect economic effects if TSE is transmitted to farmed population in Alberta and Canada.	Leontief Input-Output Model	Economic data from Statistics Canada's 2006 provincial and national input-output tables.	Cervid sector shocks yield small spillover effects on the economy, but cattle sector shocks generate larger multiplier effects.

Appendix 3 C. Descriptive statistics for the data used in the farmed-cervid political economy model (1991 - 2012)

Variable	Definition	Units	N	Mean	SD
CANADA					
TESTING	Number of CWD tested head	Head	22	39.1	39.3
FCR	Deer & Elk Farm Cash Receipts, deflected by CPI	Million $	22	0.3	0.2
RECON	Regional Concentration in Cervid Inventories	HHI	22	0.2	0.04
VSGDP	Venison Sector's Share in GDP	%	22	0.003	0.002
VCE	Share of Per-capita Venison Consumption in Food Expenditure	$/kg	22	0.0001	0.0001
VEM	Venison Exports	1,000 lbs	22	108.1	109.1
VIM	Venison Imports	1,000 lbs	22	82.2	78.3
PP	Producer Price	$/lb	22	5.5	0.9
RP	Retail Price	$/lb	22	6.0	0.9
PINPUT	Input Price	Index	22	96.4	13.4
VPRO	Domestic Venison Production	Million lbs	22	1.2	1.0
VCOM	Per Capita Venison Consumption	Kg	22	0.02	0.01
PCIN	Per Capita Income	1,000 $	22	28.7	2.7
UNITED STATES					
TESTING	Number of CWD tested head	Head	22	15.0	15.9
FCR	Deer & Elk Farm Cash Receipts, deflected by CPI	Million $	22	1.3	0.5
RECON	Regional Concentration in Cervid Inventories	HHI	22	0.2	0.01
VSGDP	Venison Sector's Share in GDP	%	22	0.003	0.001
VCE	Share of Per-capita Venison Consumption in Food Expenditure	$/kg	22	0.006	0.002
VIM	Venison Imports	1,000 lbs	22	1.0	0.3
PP	Producer Price	$/lb	22	4.7	0.7
RP	Retail Price	$/lb	22	5.2	0.7
PINPUT	Input Price	Index	22	138.0	38.3
VPRO	Domestic Venison Production	Million lbs	22	7.5	0.5
VCOM	Per Capita Venison Consumption	Kg	22	0.03	0.003
PCIN	Per Capita Income	1,000 $	22	31.3	7.5

Appendix 3 D. Descriptive statistics for the data used in the wild-cervid political economy model (1991 - 2012)

Variable	Definition	Units	N	Mean	SD
ALBERTA					
TESTING	Number of CWD tested head	Head	22	1.8	2.4
TOUR	Wildlife-related Tourism Revenue	Million $	22	1178	546
HLS	Number of Hunting License Sold	1,000	22	143.3	27.5
VISIT	Visit zoo, national park etc.	Million person	22	3.9	0.6
VIEW	Bird, Wildlife Viewing	Million person	22	0.2	0.03
SASKATCHEWAN					
TESTING	Number of CWD tested head	Head	22	2.0	2.2
TOUR	Wildlife-related Tourism Revenue	Million $	22	316.6	127.9
HLS	Number of Hunting License Sold	1,000	22	77.3	10.4
VISIT	Visit zoo, national park etc.	Million person	22	4.2	0.4
VIEW	Bird, Wildlife Viewing	Million person	22	0.1	0.03
COLORADO					
TESTING	Number of CWD tested head	Head	22	4.8	6.8
TOUR	Wildlife-related Tourism Revenue	Million $	22	845.7	360.0
HLS	Number of Hunters	Million person	22	0.4	0.1
VISIT	Visit zoo, national park etc.	Million person	22	1.2	0.1
VIEW	Bird, Wildlife Viewing	Million person	22	6.0	0.3
WYOMING					
TESTING	Number of CWD tested head	Head	22	2.3	2.0
TOUR	Wildlife-related Tourism Revenue	Million $	22	292.8	108.5
HLS	Number of Hunting License Sold	Million person	22	0.1	0.004
VISIT	Visit zoo, national park etc.	Million person	22	0.5	0.1
VIEW	Bird, Wildlife Viewing	Million person	22	1.8	0.1

Appendix 3 E. Definition of data used and data sources for the farmed-cervid model in Canada

Variable	Used data	Source
TESTING	Number of CWD-Tested Head	Government of Alberta - Agriculture and Rural Development; Government of Alberta – Sustainable Resource Development; Government of British Columbia – Ministry of Environment; Government of Saskatchewan – Environment; Ontario – Ministry of Agriculture, Food and Rural Affairs.
FCR	Farm Cash Receipts, annually (Dollars) for Deer and Elk	Author's calculation based on data from Statistics Canada: Alternative livestock on Canadian Farms; and Agriculture and Agri-food Canada: Red Meat Market Information - Alternative Livestock
	Consumer Price Index (CPI), 2005 basket, annually (2002=100)	Cansim (Table 326-0021)
SGDP	Farm Cash Receipts, annually (Dollars) for Deer and Elk	Author's calculation based on data from Statistics Canada: Alternative livestock on Canadian Farms Agriculture and Agri-food Canada: Red Meat Market Information - Alternative Livestock
	Gross Domestic Product (GDP), income-based, at market prices, annually	Cansim (Table 380-0016)
RECON	Deer and Elk on Farms	Statistic Canada: Alternative livestock on Canadian Farms; and Agriculture and Agri-food Canada: Red Meat Market Information - Alternative Livestock
SCE	Total Edible Deer and Elk Meat, annual (kilograms per year)	Author's calculation based on data from Statistics Canada: Alternative livestock on Canadian Farms; and Agriculture and Agri-food Canada: Red Meat Market Information - Alternative Livestock
	Retail Price (cent/kg)	MarketTrack TM scanner data from Nielsen Company
	Personal expenditure on goods and services: Food and non-alcoholic beverages (Dollars)/ Population	Cansim (Table 380-0009) for expenditure; Cansim (Table 051-0001) for population
VNEXP	Venison Net Exports (1,000 lbs)	Agriculture and Agri-food Canada: Red Meat Market Information - Alternative Livestock
PINPUT	Farm Input Price Index (1986=100): Canada: Animal Production	Cansim (Table 328-0001; Table 328-0014 and Table 328-0015)
PCIN	Per capita income - Market, total and after-tax income of individuals, 2011 constant dollars, annually	Cansim (Table 202-0706)

Appendix 3 F. Definition of data used and data sources for wild-cervid model in Canada

Variable	Used data	Source
TESTING	Number of CWD-Tested Head	Government of Alberta - Agriculture and Rural Development; Government of Alberta – Sustainable Resource Development; Government of British Columbia – Ministry of Environment; Government of Saskatchewan – Environment; Ontario – Ministry of Agriculture, Food and Rural Affairs
TOUR	Travel survey of residents of Canada, reallocated expenditures, by travel characteristics: Purpose of trip, pleasure, vacation holiday, total visits	Cansim Tables (426-0005, 426-0017 and 426-0022)
HLS	Number of Hunting License Sales	Ministry of Environment and Sustainable Resource Development: Annual Licence Sales Statistics
VISIT	Number of Persons Who Visit Public Parks, Zoo, Aquarium or Botanical Garden	Cansim Tables (426-0002, 426-0006, 426-0014)
VIEW	Number of Persons Who Take Part in Bird and Wildlife Viewing	

Appendix 3 G. Definition of data used and data sources for the farmed-cervid model in the United States

Variable	Used data	Source
TESTING	Number of CWD-Tested Head	USDA - APHIS - Animal Health Reports
FCR	Farm Cash Receipts, annually (Dollars) for Deer and Elk	Author's calculation based on data from USDA-Census of Agriculture
	Consumer Price Index - All Urban Consumers (1982-84 = 100)	Bureau of Labour Statistics (US department of Labour)
SGDP	Farm Cash Receipts, annually (Dollars) for Deer and Elk	Author's calculation based on data from USDA-Census of Agriculture
	Real GDP (Billion $) (2005=100)	USDA: Economic Research Service :The Economics of Food, Farming, Natural Resources, and Rural America: International Macroeconomic Data Set: Real GDP (2005 dollars) Historical
RECON	Deer and Elk on Farms	USDA - Census of Agriculture
SCE	Total Edible Deer and Elk Meat, annual (kilograms per year)	Author's calculation based on data from USDA-Census of Agriculture
	Retail Price (cent/kg)	USDA: the global agricultural trade system (GATS)
	Per-capita Food Expenditure	USDA: Economic Research Service :The Economics of Food, Farming, Natural Resources, and Rural America: Food CPI and Expenditures: Food Expenditure Tables: Per-capita Food Expenditure
VIM	Venison Imports (1,000 lbs)	USDA: the global agricultural trade system (GATS)
PINPUT	Price Paid Indexes: Monthly and Annual: Average (Items used for production) 1990-92 = 100	USDA: Economics, Statistics, and Market Information System: National Agricultural Statistics Service: Agricultural Prices Summary
PCIN	Per capita income	US. Census Bureau: Income data: Historical table: People

Appendix 3 H. Definition of data used and data sources for wild-cervid model in the United States

Variable	Used data	Source
TESTING	Number of CWD-Tested Head	USDA - APHIS - Animal Health Reports
TOUR	Expenditure for Wildlife-related Recreations	Harvest and Hunter statistics from Colorado, Division of Wildlife, Harvest and hunter statistics: Wyoming Game and Fish Department; National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR)
HLS	Number of Deer and Elk Hunters	
VISIT	Number of Persons Who Visit Public Parks, Zoo, Aquarium or Botanical Garden	
VIEW	Number of Persons Who Take Part in Viewing, Photographing and Feeding Wild-animals	

Appendix 3 I. Data used in farmed-cervid model in Canada

YEAR	TESTING	FCR	RECON	BSGDP	SCE	VIM	VEX	VPRO	CPI	PINPUT	VCOM	PCIN
1991	0	15509618	0.1453	0.0021	0.00007	37898	24714	524650.84	83	77.26	0.0089	25700
1992	0	14580523	0.1578	0.0020	0.00006	36897	24561	489626.31	84	75.59	0.0082	26000
1993	0	9693400	0.1703	0.0013	0.00008	39786	25002	590658.60	86	83.96	0.0098	25800
1994	0	4311467	0.1827	0.0005	0.00002	64156	25767	172664.09	86	86.60	0.0040	25700
1995	0	11162562	0.1952	0.0014	0.00004	36443	22102	330809.25	88	84.48	0.0055	25900
1996	0	13716444	0.2077	0.0017	0.00003	25158	35817	329413.70	89	90.66	0.0046	25500
1997	0	22091184	0.2133	0.0026	0.00002	20526	39597	249185.81	90	95.02	0.0031	25500
1998	33	31418430	0.2190	0.0035	0.00003	45194	11981	280415.84	91	88.44	0.0053	26000
1999	72	20388230	0.2246	0.0021	0.00004	40428	28814	398954.33	93	88.81	0.0062	27400
2000	93	14498551	0.2302	0.0014	0.00002	48169	33581	260721.33	95	96.60	0.0043	27500
2001	3519	16515559	0.2359	0.0016	0.00007	54286	34695	593968.81	98	102.12	0.0092	28900
2002	6591	18821012	0.2409	0.0018	0.00009	68502	47725	728030.37	100	100.00	0.0111	29500
2003	10433	51231160	0.2459	0.0048	0.00018	55425	16677	1445982.25	103	96.65	0.0218	29800
2004	14887	56997063	0.2509	0.0052	0.00028	60124	152763	2703642.44	105	91.73	0.0353	29700
2005	11692	93244973	0.2559	0.0082	0.00012	84991	209499	2516835.63	107	91.83	0.0314	30300
2006	11525	56922757	0.2609	0.0049	0.00017	120411	265018	2772346.63	109	92.20	0.0341	31200
2007	8867	48081888	0.2611	0.0040	0.00013	78833	238898	2073602.45	112	99.55	0.0237	32000
2008	10643	46759915	0.2614	0.0039	0.00016	66018	265283	2947085.13	114	109.58	0.0342	32500
2009	7891	47402270	0.2616	0.0041	0.00012	57504	357126	2390592.17	114	108.58	0.0234	32900
2010	4897	43209510	0.2619	0.0036	0.00016	188304	259840	2194735.75	117	107.08	0.0274	33000
2011	3181	40111319	0.2621	0.0033	0.00018	351265	158565	1770743.76	120	121.48	0.0293	31400
2012	2786	33342554	0.2219	0.0027	0.00012	227152	99260	1227800.77	122	131.68	0.0200	29414

Appendix 3 J. Data used in wild-cervid model in Canada

	ALBERTA					SASKATCHEWAN				
YEAR	TESTING	TOUR	HLS	VISIT	VIEW	TESTING	TOUR	HLS	VISIT	VIEW
1991	0	464329	118128	3826	212	0	144842	79368	4161	78
1992	0	486515	119076	3827	212	0	150314	94681	4160	77
1993	0	525848	116484	3828	212	0	160013	99110	4158	77
1994	0	590164	115375	3831	213	0	175872	94603	4155	77
1995	0	648408	120731	3833	213	0	190235	86672	4152	76
1996	0	703077	119943	2892	182	0	208840	75118	3363	63
1997	0	777830	124042	3132	222	39	220437	77015	3844	91
1998	0	852582	129733	3371	262	109	232034	79085	4324	119
1999	0	947619	126024	3343	168	136	257913	72320	3976	113
2000	0	988419	126855	3938	168	911	283462	59874	4187	43
2001	1804	1193833	133077	5494	260	3526	342762	60568	5099	48
2002	1050	1340701	135301	4782	263	5825	313958	66033	4821	56
2003	1231	1049726	132662	3609	154	4774	285885	71202	3779	56
2004	1302	1082050	141057	3981	238	6736	333800	66636	3719	51
2005	2275	1082050	141794	3584	198	3608	333800	69289	4009	51
2006	3982	1860099	150639	3665	203	3889	427761	74013	4060	60
2007	4958	1797230	159524	3961	220	4335	437783	72598	4130	72
2008	9419	1884758	180962	4022	224	4544	451569	76101	4097	66
2009	3735	1719164	183373	4000	222	2634	557497	85527	4202	85
2010	4200	1884879	191916	4127	230	1195	493323	83991	4241	92
2011	3195	2105681	189385	5407	303	852	449608	80091.5	4898	207
2012	3402	1939966	196377	3892	216	907	513782	76192	4089	65

Appendix 3 K. Data used in farmed-cervid model in the United States

YEAR	TESTING	FCR	RECON	BSGDP	SCE	VIM	VPRO	CPI	PINPUT	VCOM	PCIN
1991	0	211508192	0.1986	0.0042	0.0078	568	8849061	136.2	100	0.0399	19818
1992	0	197927726	0.1948	0.0038	0.0074	525	8491004	140.3	101	0.0376	20799
1993	0	120658059	0.1918	0.0023	0.0069	630	8198665	144.5	103	0.0369	21385
1994	0	118429274	0.1865	0.0021	0.0067	779	7686507	148.2	106	0.0357	22297
1995	0	176046092	0.1838	0.0031	0.0068	841	7428162	152.4	108	0.0349	23262
1996	0	233800623	0.1828	0.0040	0.0076	882	7330716	156.9	115	0.0344	24442
1997	0	375210076	0.1819	0.0057	0.0073	818	7246867	160.5	119	0.0332	25654
1998	115	365888967	0.1884	0.0048	0.0080	810	7874601	163.0	113	0.0350	27258
1999	577	219893839	0.1870	0.0025	0.0073	987	7738629	166.6	111	0.0355	28333
2000	1469	171540435	0.1852	0.0019	0.0068	1000	7566399	172.2	116	0.0346	30319
2001	1920	117938924	0.1842	0.0012	0.0061	1026	7464421	177.1	120	0.0341	31157
2002	6243	107961721	0.1860	0.0010	0.0059	1107	7639550	179.9	119	0.0350	31481
2003	12045	206489851	0.1839	0.0019	0.0052	917	7438815	184.0	124	0.0326	32295
2004	15172	305193759	0.1818	0.0027	0.0049	1021	7238080	188.9	132	0.0324	33909
2005	15628	519885758	0.1797	0.0046	0.0045	1369	7037344	195.3	140	0.0340	35452
2006	14913	240983282	0.1776	0.0023	0.0042	1303	6836609	201.6	148	0.0325	37725
2007	17189	242670057	0.1755	0.0024	0.0035	1039	6635874	207.3	160	0.0296	39506
2008	20777	222686568	0.1824	0.0021	0.0045	912	7296723	215.3	190	0.0306	40947
2009	23642	223546962	0.1835	0.0018	0.0039	913	7398701	214.5	183	0.0306	38637
2010	20000	223546962	0.1835	0.0017	0.0045	945	7398701	218.1	188	0.0306	39791
2011	20430	222513783	0.1821	0.0017	0.0039	1162	7267262	224.9	215	0.0315	41560
2012	22585	221249030	0.1804	0.0016	0.0038	1739	7106363	229.6	224	0.0348	42693

Appendix 3 L. Data used in wild-cervid model in the United States

	COLORADO					WYOMING				
YEAR	TESTING	TOUR	HLS	VISIT	VIEW	TESTING	TOUR	HLS	VISIT	VIEW
1991	0	419468029	386800	1373600	6180200	0	63785680	133600	566500	1879400
1992	0	478484305	427440	1372080	6228760	0	102472823	130480	572200	1915120
1993	0	541864102	468080	1370560	6277320	0	141718544	127360	577900	1950840
1994	0	601123865	508720	1369040	6325880	0	174413197	124240	583600	1986560
1995	0	662286013	549360	1367520	6374440	0	210582462	121120	589300	2022280
1996	0	722589523	590000	1366000	6423000	0	246739438	118000	595000	2058000
1997	0	667606917	532400	1298600	6219000	247	251695104	119000	561000	1950600
1998	0	612472896	474800	1231200	6015000	708	256358534	120000	527000	1843200
1999	0	547047556	417200	1163800	5811000	1168	259975590	121000	493000	1735800
2000	0	489698420	359600	1096400	5607000	1629	263961126	122000	459000	1628400
2001	0	437171003	302000	1029000	5403000	2089	266301587	123000	425000	1521000
2002	24652	593939332	309716	1047800	5499400	2550	296306010	125075	425000	1595000
2003	15424	747000330	335395	1066600	5595800	6171	325394987	127150	425000	1669000
2004	12966	899804132	343203	1085400	5692200	3269	355338010	124322	425000	1743000
2005	13208	1052865130	338278	1104200	5788600	4261	384426987	122718	425000	1817000
2006	11107	1208064105	334344	1123000	5885000	4653	418342387	126274	425000	1891000
2007	10009	1265346536	325545	1130000	5920200	4647	409358076	129458	429000	1892000
2008	6389	1325445920	309684	1137000	5955400	4641	401503704	127002	433000	1893000
2009	3696	1381160520	287065	1144000	5990600	4635	392581104	128400	437000	1894000
2010	2820	1432568810	293139	1151000	6025800	3954	384445935	126394	441000	1895000
2011	2652	1488283410	287837	1158000	6061000	3273	378651536	122930	445000	1896000
2012	2652	1032204648	244566	1076237	5711344	3273	457386447.4	121886	491369	1845232

APPENDIX 4

Appendix 4 A. Previous studies using choice experiments and experimental auction

Author (s)	Objective	Method	Data Used	Results
Desarbo et al. (1995)	To discuss the advantages of choice-based conjoint models in determining market segmentation.	Conditional Logit Model	Choice data	Advantages: i) market segmentation can be determined based on an incomplete data (used in the study) without having to collect additional data; ii) the proposed method could exhibit variations (such as price sensitivity, intrinsic brand utilities, etc.) across segments.
Haaijer et al. (2001)	To investigate the 'no-choice' option from a modelling point of view.	Multinomial Logit (MNL), Nested MNL and No-choice Logit Models	Choice data	If respondents chose the no-choice alternative because they were not interested in the product category under research, they would first decide whether or not to choose the offered product profiles. In this case, the Nested MNL model may be the most appropriate specification to describe this behaviour. The probability of the no-choice alternative would capture the overall attractiveness of the product category. If respondents chose the no-choice because the alternatives are not attractive enough or equally attractive, the MNL model is the approgriate model. The probability of the no-choice alternative would capture an effect specific to the task.
Miles and Frewer (2001)	To investigate public perception of five specific hazards within the food domain (BSE, GM food,	Diagrammati c interpretation of the results	One-to-one (laddering) interviewed data and stated preference	Most of the identified characteristics and concerns were unique to specific food hazards and some were shared. If the risk messages address the specific concerns

	high fat diets, pesticide residues in food and Salmonella food poisoning), and to provide policy implication in developing risk messages to address the public's concerns more directly.	(interview data) Principal components analysis (survey data)	survey data	rather than general issue, it is more likely to lead to an effective risk communication.
Dickinson and Bailey (2002)	To present an evidence on US consumers' WTP for TTA (traceability, transparency and quality assurances) characteristics in beef and pork; and to identify the potential US market(s) for meat produced through a TTA system.	Exploratory analysis and parametric regression analysis	Revealed preference data – Non-hypothetical data on consumer valuation of TTA attributes in meat (Data from a series of controlled laboratory experiments – a demand-revealing auction on meat sandwich upgrades.)	Consumers would be WTP for TTA meat characteristics and a profitable market for TTA systems might exist in the US.
Alfines and Rickertsen (2003)	To determine consumers' willingness to pay for Irish, Norwegian, US hormone-free and US hormone-treated beef.	Exploratory analysis and OLS regressions	Revealed preference data from an experimental Vickrey (second-price) auction on four qualities of beef.	Most participants preferred domestic to imported beef, half the participants preferred Irish to US hormone-free beef, and some participants were indifferent or preferred hormone-treated to hormone-free beef.
Lusk et al. (2003)	To determine consumer preferences for hormone-treated/GM fed beef using willingness-to-pay estimates and to analyze	Conditional logit model	Stated preference (stated choice) survey data	In general, consumers in EU countries (France, Germany and the UK) place higher values on animal production practices and on the safety of their food than US consumers. EU consumers showed higher willing to pay for these products directly (through

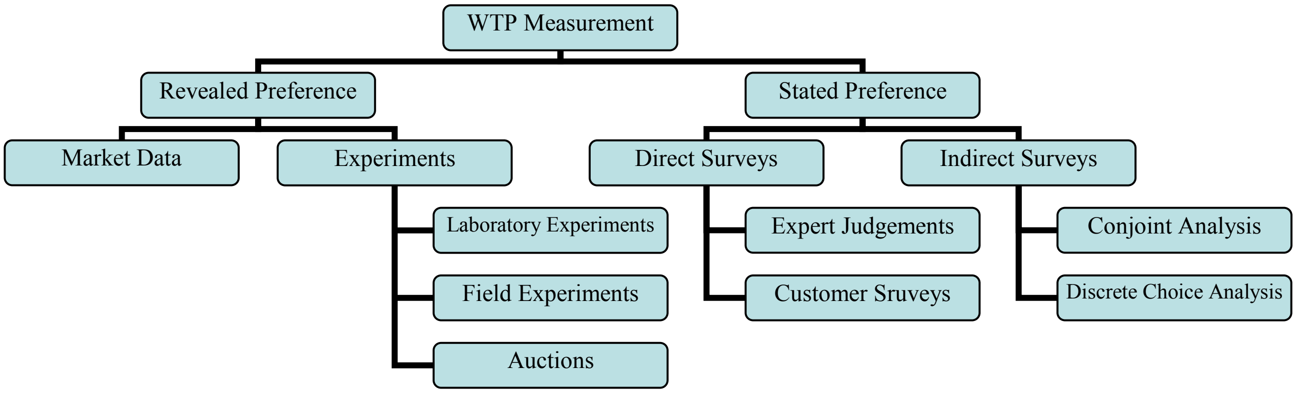
	the implications of various trade policies			higher prices) or indirectly (through compensation paid to the US).
Umberger et al. (2003)	To determine consumer WTP for country-of-origin labeling (COOL) of beef in Chicago and Denver	Binomial logit model	Data from a survey and experimental auction in 2002	The results suggested that a majority of consumers showed WTP for a certain amount of premium for COOL for reasons such as food safety concerns, to support US producers and beliefs in quality of US beef etc.
Alfines (2004)	To investigate Norwegian consumer preferences for country of origin and hormone status of beef, and to illustrate the importance of allowing correlation heteroscedasity in the error terms.	Mixed logit, multinomial logit, and a series of market simulations	Stated preference (stated choice) survey data	After domestic beef, consumers preferred beef from neighbouring country to more distant countries, beef from developed countries to less developed countries, and hormone-free beef to hormone-treated domestic and imported beef. Non- Scandinavian alternatives are close substitutes competing over the import-friendly market segment.
Carlsson et al. (2004)	To measure potential market failures with GM foods.	Random parameter logit (mixed logit) model	Stated preference data – the contingent valuation method (CVM).	Consumers are WTP a substantially higher price premium for GM-free food (labelling) and a total ban of GM within the EU.
Dickinson and Bailey (2005)	To determine consumer WTP for "farm-to-fork" traceable meat products in four industrialized countries (the US, Canada, the UK and Japan)	Exploratory analysis and parametric regression analysis	Revealed preference data – Non-hypothetical data on consumer valuation of TTA attributes in meat (Data from a series of controlled laboratory experiments – a demand-revealing (second-price) Vickery auction on meat	There was WTP a nontrivial premium for traceability. Even a higher WTP was observed for traceability-provided characteristics such as additional meat safety and humane animal treatment guarantees.

			sandwich upgrades.)	
Gracia and Zeballos (2005)	To determine consumer and retailer attitudes towards the mandatory European traceability and labeling system for beef in Spain	Exploratory analysis, K-mean cluster analysis and Factor analysis	Stated preference survey data	Both consumers and retailers highly valued the positive aspects associated with the traceability and labeling system for beef.
Hobbs et al. (2005a)	To examines the economic incentives for implementing traceability systems in the meat and livestock sector.	OLS regression method	Revealed preference data through experimental (Vickery second-price) auctions on beef and pork products	WTP for traceability assurance is stronger for beef than for pork and bundling traceability with additional assurances is likely to be more valuable to Canadian consumers.
Schroeder et al. (2006)	To determine consumer risk attitudes and perceptions about beef food safety in major importing and exporting countries, and to design supply chain management strategies to address these concerns.	Random parameter logit model	Stated preference survey data	The results suggested a significant importance of food safety attributes to consumers in Canada, the US and Japan. While Canadian, the US and Japanese consumers are willing to pay a certain amount of premium for food safety attributes, Mexican consumers were not willing to pay for it. Based on results, a series of recommendation for supply chain management strategy were provided.
Angulo and Gils (2007)	To determine Spanish consumers' WTP for labelled beef considering risk perception and confidence in food safety and factors in determining consumers purchase decisions.	A three-equation recursive model	Stated preference survey data including a contingent valuation (CV) for WTP measurement.	The main determinants of consumers' WTP for certified beef included income, level of beef consumption, the average price consumers pay for beef and the perception of beef safety.

Loureiro and Umberger (2007)	To determine the relative value US consumers placed on attributes such as traceability, country-of-origin, food safety inspection and tenderness.	Multinomial and conditional logit model	Stated preference (stated choice) survey data	The indication of country of origin which is associated with higher food safety or quality could enhance consumers' valuation of the product.
Steiner et al. (2009)	To evaluate consumers' WTP for traceability assurance and GM-free attributes and to compare consumers' valuation for bison versus beef meat attributes.	Multinomial logit model	A web-based stated preference (stated choice) survey data	Consumers value a guarantee for traceability more than a guarantee for GM-free, consumers are WTP significant premiums for GM-free attributes, and consumer group of healthy meat eaters (middle-aged and who exercise regularly) are more likely to choose bison than beef steaks.
Ubilava and Foster (2009)	To estimate consumers' preferences for food safety attributes associated with both private supplied and regulated pork attributes.	Conditional and mixed logit model	Choice experiment data	The presence of any of the selected pork attributes and appearance increases WTP for pork.
Aubeeluck (2010)	To determine consumers' WTP for animal-tested for BSE and traceable attributes across countries (Canada and Japan)	Multinomial logit model	Stated preference survey data	The results highlighted significant increases in WTP premium for imported beef steaks with traceability and animal testing attributes to domestic steaks. And consumers' WTP premium for domestic steaks was higher than imported steaks without safety assurance.
Innes and Hobbs (2011)	To determine consumers' perception towards production-derived attributes verification by government, farmer, supermarket, processor	Latent class and multinomial logit model	Data from discrete choice experiment	The verification of product attributes by government added positive value and by supermarket or third-party added negative value to consumers' utility.

	and a third-party in their purchase decision of food products.			

Appendix 4 B. Classification framework for methods to measure WTP



Source: Breidert et al. (2006, p.3)

Appendix 4 C. Questions from Food Safety, Animal Testing and Traceability Survey

1. In which of the following age groups do you fall?		
1.	❐	18-24
2.	❐	25-29
3.	❐	30-39
4.	❐	40-49
5.	❐	50-64
6.	❐	65+

2. Please indicate your gender.		
1.	❐	Male
2.	❐	Female

3. How many people live in your household?		
1.	❐	1
2.	❐	2
3.	❐	3 +

4. How many children younger than 18 live in your house?		
1.	❐	No home living children < 18 years
2.	❐	1
3.	❐	2
4.	❐	3
5.	❐	4

6. ❐ More than 4

5. What is your position in the household? **ONLY ONE ANSWER POSSIBLE**

1. ❐ Head of household/main income
2. ❐ Partner of head of household
3. ❐ Child
4. ❐ Other family member
5. ❐ Other person (no family)

6. What is your marital status? **ONLY ONE ANSWER POSSIBLE**

1. ❐ Married/Living together/Common Law
2. ❐ Single
3. ❐ Divorced/Separated
4. ❐ Widowed

7. What is the highest level of education you've completed? **ONLY ONE ANSWER POSSIBLE**

1. ❐ Elementary or junior high school
2. ❐ High school
3. ❐ Technical training/ Community college/Some college
4. ❐ Four-year college or university
5. ❐ Graduate (Masters or PhD) or professional degree (MBA, JD,

8. Which of the following best describes your employment status? **ONLY ONE ANSWER POSSIBLE**

1. ❐ Employed full-time or self-employed
2. ❐ Employed part-time
3. ❐ Homemaker
4. ❐ Student and full-time employed
5. ❐ Student and part-time employed
6. ❐ Student only
7. ❐ Retired
8. ❐ Unemployed
9. ❐ Other

9. What is the approximate range of your total household income? **ONLY ONE ANSWER POSSIBLE**

1. ❐ $ 24,999 or under
2. ❐ Between $ 25,000 and $ 39,999
3. ❐ Between $ 40,000 and $ 64,999
4. ❐ Between $ 65,000 and $ 79,999

5.	❒	Between $ 80,000 and $ 99,999
6.	❒	Between $ 100,000 and $ 119,999
7.	❒	$ 120,000 or more

10. Which state do you live in? **ONLY ONE ANSWER POSSIBLE [USE DROP DOWN BAR]**

11. Do you live in a city, in a town or in the countryside? **ONLY ONE ANSWER POSSIBLE**

1.	❒	In a city (>100,000 inhabitants)
2.	❒	In a town (> 10,000 inhabitants)
3.	❒	In the countryside/rural area

Section: General Trust

12. Generally speaking, would you say that most people can be trusted?

People can be trusted	Can't be too careful in dealing with people	Don't know
1	**2**	**3**
❒	❒	❒

13. We would like to know whether you, **in general**, worry a lot in daily life. Please indicate to what extent you find the following statements characteristic of yourself. Give your answer on a scale from 1 ("not at all typical") to 5 ("very typical").

	not at all typical	Un typical	Some-what typical	typical	very typical
	1	**2**	**3**	**4**	**5**
Many situations make me worry	❒	❒	❒	❒	❒
I know I shouldn't worry about things, but I just cannot help it	❒	❒	❒	❒	❒
I notice that I have been worrying about things	❒	❒	❒	❒	❒

14. **Please indicate your level of agreement with the following statements**	strongly disagree	disagree	neither agree, nor disagree	agree	strongly agree
	1	2	3	4	5

I am optimistic about the safety of food products	❒	❒	❒	❒	❒
I am confident that food products are safe	❒	❒	❒	❒	❒
I am satisfied with the safety of food products	❒	❒	❒	❒	❒
Generally, food products are safe	❒	❒	❒	❒	❒
I worry about the safety of food	❒	❒	❒	❒	❒
I feel uncomfortable regarding the safety of food	❒	❒	❒	❒	❒
As a result of the occurrence of food safety incidents I am suspicious about certain food products	❒	❒	❒	❒	❒

Assessment of food industry

15. These statements are about your trust in individuals and institutions with respect to the safety of food. We distinguish between the government, farmers, retailers, and manufacturers of food products. Please indicate to what extent you agree with each statement.

PROGRAMMING INSTRUCTIONS:

DISPLAY IN DIFFERENT ORDER, I.E.:

1. GOVERNMENT FARMERS RETAILERS MANUFACTURERS
2. FARMERS RETAILERS MANUFACTURERS GOVERNMENT
3. RETAILERS MANUFACTURERS GOVERNMENT FARMERS
4. MANUFACTURERS GOVERNMENT FARMERS RETAILERS
RANDOMIZE SECTION

GOVERNMENT	strongly disagree 1	disagree 2	neither agree, nor disagre 3	agree 4	strongly agree 5
The government has the competence to control the safety of food	❒	❒	❒	❒	❒
The government has sufficient knowledge to guarantee the safety of food products	❒	❒	❒	❒	❒
The government is honest about the safety of food	❒	❒	❒	❒	❒
The government is sufficiently open about the safety of food	❒	❒	❒	❒	❒
The government takes good care of the safety of our food	❒	❒	❒	❒	❒

The government gives special attention to the safety of food	❒	❒	❒	❒	❒

FARMERS	**strongly disagree** **1**	**disagree** **2**	**neither agree, nor disagree** **3**	**agree** **4**	**strongly agree** **5**
Farmers have the competence to control the safety of food	❒	❒	❒	❒	❒
Farmers have sufficient knowledge to guarantee the safety of food products	❒	❒	❒	❒	❒
Farmers are honest about the safety of food	❒	❒	❒	❒	❒
Farmers are sufficiently open about the safety of food	❒	❒	❒	❒	❒
Farmers take good care of the safety of our food	❒	❒	❒	❒	❒
Farmers give special attention to the safety of food	❒	❒	❒	❒	❒

RETAILERS	**strongly disagree** **1**	**disagree** **2**	**neither agree, nor disagree** **3**	**agree** **4**	**strongly agree** **5**
Retailers have the competence to control the safety of food	❒	❒	❒	❒	❒
Retailers have sufficient knowledge to guarantee the safety of food products	❒	❒	❒	❒	❒
Retailers are honest about the safety of food	❒	❒	❒	❒	❒
Retailers are sufficiently open about the safety of food	❒	❒	❒	❒	❒
Retailers take good care of the safety of our food	❒	❒	❒	❒	❒
Retailers give special attention to the safety of food	❒	❒	❒	❒	❒

MANUFACTURERS OF FOOD	**strongly disagree** **1**	**disagree** **2**	**neither agree, nor disagree** **3**	**agree** **4**	**strongly agree** **5**
Manufacturers have the competence to control the safety of food	❒	❒	❒	❒	❒
Manufacturers have sufficient knowledge to guarantee the safety of food products	❒	❒	❒	❒	❒
Manufacturers are honest about the safety of food	❒	❒	❒	❒	❒
Manufacturers are sufficiently open about the safety of food	❒	❒	❒	❒	❒
Manufacturers take good care of the safety of our food	❒	❒	❒	❒	❒
Manufacturers give special attention to the safety of food	❒	❒	❒	❒	❒

16. **To what extent are you concerned about the following issues?**

	Not at all	Minor concern	Some concerns	Major Concern	Extremely

	1	2	3	4	5
The feed given to livestock	❒	❒	❒	❒	❒
Conditions in which food animals are raised	❒	❒	❒	❒	❒
Genetically modified animal feeds	❒	❒	❒	❒	❒
Animal diseases	❒	❒	❒	❒	❒
BSE and Creutzfeldt Jakob Disease (vCJD)	❒	❒	❒	❒	❒
The origin of products/ animals	❒	❒	❒	❒	❒
Antibiotics in meat	❒	❒	❒	❒	❒
Animals genetically modified for meat/poultry or dairy production	❒	❒	❒	❒	❒

17. To what extent do you think the following individuals and organizations are responsible for guaranteeing the safety of food? Please give your answer on a scale from 1 ("not at all responsible") to 5 ("completely responsible").

	Not at all responsib le **1**	**Minor responsib ility** **2**	**Some responsib ility** **3**	**Major responsib ility** **4**	**Complete ly responsib le** **5**
To what extent do you think … is/are responsible for the					
Farmers	❒	❒	❒	❒	❒
The government	❒	❒	❒	❒	❒
Manufacturers of food	❒	❒	❒	❒	❒
Retailers	❒	❒	❒	❒	❒
Consumer and health advocacy organizations	❒	❒	❒	❒	❒
The consumer	❒	❒	❒	❒	❒

18. Various individuals and organizations provide information about the safety of food. Please indicate to what extent you trust the information provided by the following sources, where 1 refers to "no trust in information at all" and 5 refers to "complete trust in information".

	No trust in information at all	Some trust in information	Trust most information	Trust majority of information	Complete trust in information
	1	2	3	4	5
To what extent do you trust information about the safety of food provided by …?					
Farmers	❒	❒	❒	❒	❒
The government	❒	❒	❒	❒	❒
Manufacturers of food	❒	❒	❒	❒	❒
Retailers	❒	❒	❒	❒	❒
Consumer and health advocacy organizations	❒	❒	❒	❒	❒

25a. Do you eat or have you ever eaten venison (deer, elk, or moose meat)?

❒ Yes

❒ No

25b. What do you think about eating venison?

When eating venison, I am exposed to …						
	1	2	3	4	5	
very little risk	❒	❒	❒	❒	❒	a great deal of risk
I accept the risks of eating venison						
strongly disagree	❒	❒	❒	❒	❒	strongly
I think eating venison is risky						
strongly disagree	❒	❒	❒	❒	❒	strongly
For me, eating venison is …						
not risky	❒	❒	❒	❒	❒	risky
For me, eating venison is worth the risk						
strongly disagree	❒	❒	❒	❒	❒	strongly
I am … the risk of eating venison						
not willing to accept	❒	❒	❒	❒	❒	willing to

28. The following questions have to do with different factors that influence the safety of food. Could you please indicate to what extent you agree with the following statements?

	strongly disagree 1	Dis agree 2	neither agree, nor disagree 3	agree 4	strongly agree 5
I am in control over the safety of the food products that I eat	❒	❒	❒	❒	❒
The safety of food products is mainly influenced by how I handle food products	❒	❒	❒	❒	❒
The safety of food products is mainly influenced by parties in the food chain other than myself	❒	❒	❒	❒	❒
The safety of food products cannot be controlled, but is mainly determined by coincidental factors	❒	❒	❒	❒	❒

37. When you obtain/buy deer, elk, or moose meat, is it usually from… (Select one only)		
a supermarket or warehouse store,	❒	1
a butcher's shop	❒	2
your own hunting experience	❒	3
a farmer's market	❒	4
or another way (directly from a farm or through acquaintances)	❒	5

46. Before responding to this survey, had you heard of chronic wasting disease (CWD)?

Yes	☐	No	☐

[IF YES, GO TO Q47 and Q48. IF NO, SKIP Q47 and Q48 TO TEXT "CWD in wild population of deer and elk"]

47. Did you know that CWD can infect DEER, before responding to this survey?

Yes	☐	No	☐

48. Did you know that CWD can infect ELK, before responding to this survey?

Yes	☐	No	☐

50. Would you say that the following food issues are an important risk to human health in our society, are not a very important risk or pose no risk at all?	Important	Not very	No risk	Don't know
	1	**2**	**3**	**4**
Salmonella food poisoning	❐	❐	❐	❐
BSE (mad cow disease)	❐	❐	❐	❐
GM foods (genetically modified)	❐	❐	❐	❐
Products from livestock housed in large numbers, in cages or other restricted conditions	❐	❐	❐	❐
Pesticides	❐	❐	❐	❐
Listeriosis (Listeria) food poisoning	❐	❐	❐	❐
Unhealthy eating	❐	❐	❐	❐
Additives (like preservatives,	❐	❐	❐	❐
Food allergies	❐	❐	❐	❐
E. coli food poisoning	❐	❐	❐	❐
Unreasonable food prices	❐	❐	❐	❐
Animal diseases such as chronic wasting disease in wild and farmed deer and elk	❐	❐	❐	❐

Appendix 4 D. Reformed Agglomeration from Hierarchical Cluster Analysis for Canada Data

No. of clusters	Agglomeration last step	Coefficients this step	Change
2	10171.001	7124.571	3046.429
3	**7124.571**	**5019.127**	**2105.445**
4	5019.127	4180.693	838.434
5	4180.693	3679.212	501.481
6	3679.212	3374.079	305.133

Appendix 4 E. The K-Mean Cluster Procedure and Results for Canada Data

Initial Cluster Centers

Questions	Cluster 1	Cluster 2	Cluster 3
RP1: When eating venison, I am exposed to ... (1=very little risk, 5= a great deal of risk)	1	1	5
RA1: I accept the risks of eating venison (1=strongly disagree, 5=strongly agree)	5	1	5
RP2: I think eating venison is risky (1=strongly disagree, 5=strongly agree)	1	5	5
RP3: For me, eating venison is (1=not risky, 5=risky)	1	1	5
RA2: For me, eating venison is worth the risk (1=strongly disagree, 5=strongly agree)	5	1	1
RA3: I am ... the risk of eating venison (1=not willing to accept, 5=willing to accept)	1	5	1

Iteration History

Iteration	Change in Cluster Centers		
	Cluster 1	Cluster 2	Cluster 3
1	3.800	3.929	3.373
2	.804	.761	.578
3	.476	.291	.350
4	.240	.139	.058
5	.100	.063	.035
6	.030	.018	0.000
7	.033	.020	0.000
8	.035	.020	0.000
9	.016	.009	0.000
10	0.000	0.000	0.000

Final Cluster Centers

Questions	Cluster 1	Cluster 2	Cluster 3
RP1: When eating venison, I am exposed to ... (1=very little risk, 5= a great deal of risk)	1.64	2.68	3.89
RA1: I accept the risks of eating venison (1=strongly disagree, 5=strongly agree)	4.45	2.97	1.73
RP2: I think eating venison is risky (1=strongly disagree, 5=strongly agree)	1.49	2.68	4.04
RP3: For me, eating venison is	1.45	2.72	4.26

(1=not risky, 5=risky)			
RA2: For me, eating venison is worth the risk (1=strongly disagree, 5=strongly agree)	4.24	2.84	1.44
RA3: I am ... the risk of eating venison (1=not willing to accept, 5=willing to accept)	4.48	3.03	1.37

Number of Cases in each Cluster

Cluster	1	373
	2	648
	3	183
Valid		1204
Missing		260

ANOVA

		Sum of Squares	Df	Mean Squares	F	Sig.
RP1	Between groups	649.774	2	324.887	518.077	.000
	Within groups	753.150	1201	.627		
	Total	1402.924	1203			
RA1	Between groups	1009.295	2	504.647	667.700	.000
	Within groups	907.715	1201	.756		
	Total	1917.010	1203			
RP2	Between groups	837.467	2	418.733	703.341	.000
	Within groups	715.014	1201	.595		
	Total	1552.481	1203			
RP3	Between groups	1006.354	2	503.177	1005.843	.000
	Within groups	600.805	1201	.500		
	Total	1607.159	1203			
RA2	Between groups	1035.874	2	517.937	813.707	.000
	Within groups	764.454	1201	.637		
	Total	1800.328	1203			
RA3	Between groups	1240.824	2	620.412	1145.847	.000
	Within groups	650.274	1201	.541		
	Total	649.774	2	324.887	518.077	.000

Appendix 4 F. Reformed Agglomeration from Hierarchical Cluster Analysis for US Data

No. of clusters	Agglomeration last step	Coefficients this step	Change
2	**9078.779**	**6438.864**	**2639.915**
3	6438.864	4905.203	1533.660
4	4905.203	3876.031	1029.172
5	3876.031	3266.787	609.244
6	3266.787	3010.895	255.893

Appendix 4 G. The K-Mean Cluster Procedure and Results for US Data

Initial Cluster Centers

Questions	Cluster 1	Cluster 2
RP1: When eating venison, I am exposed to ... (1=very little risk, 5= a great deal of risk)	1	5
RA1: I accept the risks of eating venison (1=strongly disagree, 5=strongly agree)	1	5
RP2: I think eating venison is risky (1=strongly disagree, 5=strongly agree)	1	5
RP3: For me, eating venison is (1=not risky, 5=risky)	1	5
RA2: For me, eating venison is worth the risk (1=strongly disagree, 5=strongly agree)	1	5
RA3: I am ... the risk of eating venison (1=not willing to accept, 5=willing to accept)	1	5

Iteration History

Iteration	Change in Cluster Centers	
	Cluster 1	Cluster 2
1	4.145	3.232
2	.065	.307
3	.399	1.227
4	.491	.851
5	.159	.275
6	.064	.112
7	.008	.015
8	0.000	0.000

Final Cluster Centers

Questions	Cluster 1	Cluster 2
RP1: When eating venison, I am exposed	3	2

to ... (1=very little risk, 5= a great deal of risk)		
RA1: I accept the risks of eating venison (1=strongly disagree, 5=strongly agree)	2	4
RP2: I think eating venison is risky (1=strongly disagree, 5=strongly agree)	3	2
RP3: For me, eating venison is (1=not risky, 5=risky)	3	2
RA2: For me, eating venison is worth the risk (1=strongly disagree, 5=strongly agree)	2	4
RA3: I am ... the risk of eating venison (1=not willing to accept, 5=willing to accept)	2	4

Number of Cases in each Cluster

Cluster	1	646
	2	353
Valid		999
Missing		000

ANOVA

		Sum of Squares	Df	Mean Squares	F	Sig.
RP1	Between groups	156.372	1	156.372	130.278	.000
	Within groups	1196.699	997	1.200		
	Total	1353.071	998			
RA1	Between groups	802.025	1	802.025	1016.750	.000
	Within groups	786.446	997	.789		
	Total	1588.470	998			
RP2	Between groups	182.890	1	182.890	135.572	.000
	Within groups	1344.974	997	1.349		
	Total	1527.864	998			
RP3	Between groups	265.738	1	265.738	217.318	.000
	Within groups	1219.135	997	1.223		
	Total	1484.873	998			
RA2	Between groups	655.396	1	655.396	724.853	.000
	Within groups	901.465	997	.904		
	Total	1556.861	998			
RA3	Between	724.538	1	724.538	856.794	.000

	groups				
	Within groups	843.102	997	.846	
	Total	1567.640	998		

Appendix 4 H. Descriptive Analysis of Risk Perceptions and Risk Attitudes

	Mean score (Standard deviation)				Mean score (Standard deviation)		
	Canada				The US		
	Whole Sample (N=1464)	Group 1 (N=373)	Group 2 (N=648)	Group 3 (N=183)	Whole Sample (N=999)	Group 1 (N=353)	Group 2 (N=646)
Risk Perception (Venison)							
When eating venison, I am exposed to… (1=very little risk,…,5=a great deal of risk)	2.55 (1.08)	1.64 (0.73)	2.68 (0.77)	3.89 (0.97)	2.83 (1.16)	2.29 (1.23)	3.12 (1.01)
I think eating venison is risky (1=strongly disagree,…,5=strongly agree)	2.53 (1.14)	1.49 (0.67)	2.68 (0.75)	4.04 (1.00)	2.78 (1.24)	2.20 (1.29)	3.10 (1.08)
For me, eating venison is … (1=not risky,…,5=risky)	2.57 (1.16)	1.45 (0.60)	2.72 (0.72)	4.26 (0.84)	2.85 (1.22)	2.15 (1.20)	3.23 (1.05)
Risk perception index	2.48 (1.28)	1.69 (0.52)	2.90 (0.61)	4.26 (0.71)	2.97 (1.10)	2.40 (1.13)	3.28 (0.93)
T-test (same group-wise risk perception index)	Group 1 v.s. group 2: T-statistics -33.37*** Group 1 v.s. group 3: T-statistics -43.68*** Group 3 v.s. group 3: T-statistics -23.62***				Group 1 v.s. group 2: T-statistics 12.58***		
Risk Attitude (Venison)							
I accept the risks of eating venison (1=strongly disagree,…,5=strongly agree)	3.25 (1.25)	4.45 (0.74)	2.97 (0.86)	1.73 (1.12)	3.02 (1.26)	4.24 (0.76)	2.36 (0.95)
For me, eating venison is worth the risk (1=strongly disagree,…,strongly agree)	3.06 (1.22)	4.24 (0.85)	2.84 (0.75)	1.44 (0.82)	2.94 (1.25)	4.04 (0.92)	2.35 (0.97)
I am … the risk of eating venison (1=not willing to accept,…,5=willing to accept)	3.22 (1.26)	4.48 (0.67)	3.03 (0.79)	1.37 (0.67)	3.07 (1.25)	4.22 (0.79)	2.44 (0.98)
Risk attitude index	3.04 (1.5)	4.56 (0.56)	3.17 (0.60)	1.71 (0.61)	3.18 (1.15)	4.35 (0.65)	2.53 (0.84)
T-test (same group-wise risk perception index)	Group 1 v.s. group 2: T-statistics 37.38*** Group 1 v.s. group 3: T-statistics 53.45*** Group 3 v.s. group 3: T-statistics 28.82***				Group 1 v.s. group 2: T-statistics -38.31***		

Note: "*, **, ***" represents 90%, 95%, and 99% level of significance respectively.

Appendix 4 I. Demographic characteristics of survey panellists (%) in Canada

		Group 1 (Confident) (N=373)	Group 2 (Neutral) (N=648)	Group 3 (Concerned) (N=183)	Group 4 (No Answer) (N=273)	Whole sample (N=1464)	Canada Census (2006) 31612897
Gender							
	Male	64	55	46	50	55	49
	Female	36	45	54	50	45	51
Language							
	English	64	59	67	62	62	66
	French	36	41	33	38	38	21
Residential Area							
	Urban (City+Town)	85	84	87	88	85	80
	Rural	18	16	13	12	15	20
Household size							
	<= 2members	62	64	61	53	61	60
	>= 3members	38	36	39	47	39	40
Household head age							
	15-19	1	2	2	2	2	8
	20-24	9	8	5	10	8	8
	25-29	5	5	3	8	5	8
	30-39	23	16	15	22	19	16
	40-49	18	19	19	20	19	20
	50-64	29	31	33	25	30	23
	65+	15	20	22	14	18	16
Household Income							
	$24,999 or under	10	13	12	9	11	23
	$25,000 - $39,999	11	15	16	13	14	19
	$40,000 - $64,999	26	23	22	19	23	30
	$65,000 - $79,999	15	15	14	18	15	17
	$80,000 - $99,999	12	15	12	17	14	12
	$100,000 - $119,999	10	8	10	10	9	9
	$120,000 or more	15	11	13	14	13	13
Household head education							
	Elementary/junior high/high school/Secondary (high) school	21	25	25	24	24	60
	Technical/business/ community college	36	35	34	28	34	17
	University	33	29	31	37	32	19
	Postgraduate studies (master's or PhD)	10	10	11	12	11	4
Presence of children							
	All age of children	26	26	29	32	28	43
	Over 18	74	74	71	68	72	57

Appendix 4 J. Demographic characteristics of survey panellists (%) in the US

	Group 1 (Confident) (N=353)	Group 2 (Concerned) (N=646)	Whole sample (N=999)	US Census (2009) 111305000
Gender				
Male	40	44	41	49.2
Female	60	56	59	50.8
Household size				
<= 2members	57	54	56	60.1
>= 3members	43	46	44	39.9
Household head age				
15-19	17	18	17	
20-24	12	14	13	17
25-29	17	19	18	
30-39	18	14	17	
40-49	32	34	33	67
50-64	3	1	2	
65+	17	18	17	16
Household Income				
$24,999 or under	28	25	27	28.2
$25,000 - $39,999	24	25	24	11.8
$40,000 - $64,999	23	26	24	
$65,000 - $79,999	10	9	10	45
$80,000 - $99,999	7	7	7	
$100,000 - $119,999	4	5	4	15
$120,000 or more	4	5	4	
Household head education				
Elementary/junior high/high school/Secondary (high) school	31	27	30	15.1
Technical/business/community college				27.4
University	38	41	39	57.5
Postgraduate studies (master's or PhD)	23	22	23	
Presence of children				
All age of children	35	42	38	52.5
Over 18	65	58	62	47.5

Appendix 4 K. The t-statistics of significant differences in means between consumer segments

	Canada _ Canada			US	Canada _ US					
	G1_G2	G1_G3	G2_G3	G1_G2	G1_G1	G1_G2	G2_G1	G2_G2	G3_G1	G3_G2
Age		-2.95			5.53	5.30	8.55	8.89	7.48	7.34
Confident About the Safety of Venison	2.86	26.1	14.17	17.81	3.60	25.63	-12.2	8.04	-21.15	-8.46
Trust in Government					3.87	6.11	2.04	4.08	2.11	3.34
Trust in Farmers		5.58	1.76	6.06		8.00	-4.43	2.1	-4.59	
Trust in Retailers		4.32	2.49	4.01	-2.32	1.72	-4.99		-5.92	-3.28
Trust in Manufacturers of Food		3.03		1.93	2.20	4.94		2.08		
Worry		-4.81	-1.91		-10.87	-12.29	-7.97	-9.00	-4.43	-4.33
LC1				1.74		3.13				
LC2				1.66						
LC3		-3.85	-3.91	10.6		11.02		13.29	3.45	13.4
LC4			2.46		-5.00	-7.46	-3.88	-6.65	-5.11	-6.91

Appendix 4 L. Stated Choice Questions for Deer and Elk Meat

Deer and elk meat have been found to be healthy meats. In general they are :

- high in protein, iron and B vitamins
- leaner than beef
- leaner than pork tenderloin or chicken breast (with skin).

In this final section of this survey you are provided with 12 different pairs of alternative strip loin steaks (from farmed deer or elk meat) that could be available for purchase in the retail grocery store, butcher or market where you typically shop. Steak prices vary from CN $5.50/500 gms. to $16.00/500 gms. For each pair of steaks, please select the steak that you would purchase, or neither, if you would not purchase either steak. It is important that you make your selections like you would if you were actually facing these choices in your retail purchase decisions.

For your information in interpreting alternative steaks:
Traceable means the product is fully traceable back to farm of origin from your point of purchase Animal Tested means that all animals are verified that they are tested for CWD prior to meat being sold at your point of purchase.

1. During a typical visit to a retail outlet where you could purchase deer or elk meat, if the following strip loin steak options were the only ones available, which option would you purchase?

Option A	**Option B**	**Option C**
500 gm. Strip loin steak (deer or elk meat)		I would purchase neither of these steaks
Strip loin steak	Strip loin steak – verified 'animal tested'	
$5.50	$9.00	

☐**Option A** ☐ **Option B** ☐**Option C**

2. During a typical visit to a retail outlet where you could purchase deer or elk meat, if the following options were the only ones available, which option would you purchase?

Option A	Option B	Option C
500 gm. strip loin steak (deer or elk meat)		I would purchase neither of these steaks
Strip loin steak- verified 'animal tested'	Strip loin steak –Traceable back to farm of origin and verified 'animal tested'	
$16.00	$9.00	
☐Option A	☐ Option B	☐Option C

3. During a typical visit to a retail outlet where you could purchase deer or elk meat, if the following options were the only ones available, which option would you purchase?

Option A	Option B	Option C
500 gm. strip loin steak (deer or elk meat)		I would purchase neither of these steaks
Strip loin steak – Traceable back to farm of origin	Strip loin steak- Traceable back to farm of origin and verified 'animal tested'	
$5.50	$5.50	
☐Option A	☐ Option B	☐Option C

4. During a typical visit to a retail outlet where you could purchase deer or elk meat, if the following options were the only ones available, which option would you purchase?

Option A	Option B	Option C
500 gm. strip loin steak (deer or elk meat)		I would purchase neither of these steaks
Strip loin steak	Strip loin steak- Traceable back to farm of origin	
$9.00	$5.50	
☐Option A	☐ Option B	☐Option C

5. During a typical visit to a retail outlet where you could purchase deer or elk meat, if the following options were the only ones available, which option would you purchase?

Option A	Option B	Option C
500 gm. strip loin steak (deer or elk meat)		I would purchase neither of these steaks
Strip loin steak – Traceable back to farm of origin	Strip loin steak	
$9.00	$9.00	
☐Option A	☐ Option B	☐Option C

6. During a typical visit to a retail outlet where you could purchase deer or elk meat, if the following options were the only ones available, which option would you purchase?

Option A	Option B	Option C
500 gm. strip loin steak (deer or elk meat)		I would purchase neither of these steaks
Strip loin steak – Traceable back to farm of origin and verified 'animal tested'	Strip loin steak- Traceable back to farm of origin	
$12.50	$9.00	
☐Option A	☐ Option B	☐Option C

7. During a typical visit to a retail outlet where you could purchase deer or elk meat, if the following options were the only ones available, which option would you purchase?

Option A	Option B	Option C
500 gm. strip loin steak (deer or elk meat)		I would purchase neither of these steaks
Strip loin steak – Traceable back to farm of origin	Strip loin steak- Verified 'animal tested'	
$12.50	$16.00	
☐Option A	☐ Option B	☐Option C

8. During a typical visit to a retail outlet where you could purchase deer or elk meat, if the following options were the only ones available, which option would you purchase?

Option A	**Option B**	**Option C**
500 gm. strip loin steak (deer or elk meat)		I would purchase neither of these steaks
Strip loin steak – Traceable back to farm of origin and verified 'animal tested'	Strip loin steak - Verified 'animal tested'	
$16.00	$5.50	
☐**Option A**	☐ **Option B**	☐**Option C**

9. During a typical visit to a retail outlet where you could purchase deer or elk meat, if the following options were the only ones available, which option would you purchase?

Option A	**Option B**	**Option C**
500 gm. strip loin steak (deer or elk meat)		I would purchase neither of these steaks
Strip loin steak – Verified 'animal tested'	Strip loin steak- Traceable back to farm of origin	
$5.50	$16.00	
☐**Option A**	☐ **Option B**	☐**Option C**

10. During a typical visit to a retail outlet where you could purchase deer or elk meat, if the following options were the only ones available, which option would you purchase?

Option A	**Option B**	**Option C**
500 gm. strip loin steak (deer or elk meat)		I would purchase neither of these steaks
Strip loin steak –Verified 'animal tested'	Strip loin steak	
$12.50	$5.50	
☐**Option A**	☐ **Option B**	☐**Option C**

11. During a typical visit to a retail outlet where you could purchase deer or elk meat, if the following options were the only ones available, which option would you purchase?

Option A	Option B	Option C
500 gm. strip loin steak (deer or elk meat)		I would purchase neither of these steaks
Strip loin steak	Strip loin steak- Traceable back to farm of origin and verified 'animal tested'	
$12.50	$12.50	

□Option A □ Option B □Option C

12. During a typical visit to a retail outlet where you could purchase deer or elk meat, if the following options were the only ones available, which option would you purchase?

Option A	Option B	Option C
500 gm. strip loin steak (deer or elk meat)		I would purchase neither of these steaks
Strip loin steak- Traceable back to farm of origin and verified 'animal tested'	Strip loin steak	
$5.50	$12.50	

□Option A □ Option B □Option C

13. During a typical visit to a retail outlet where you could purchase deer or elk meat, if the following options were the only ones available, which option would you purchase?

Option A	Option B	Option C
500 gm. strip loin steak (deer or elk meat)		I would purchase neither of these steaks
Strip loin steak- Traceable back to farm of origin	Strip loin steak- Traceable back to farm of origin	
$16.00	$12.50	

□Option A □ Option B □Option C

14. During a typical visit to a retail outlet where you could purchase deer or elk meat, if the following options were the only ones available, which option would you purchase?

Option A	Option B	Option C
500 gm. strip loin steak (deer or elk meat)		I would purchase neither of these steaks
Strip loin steak- Traceable back to farm of origin and verified 'animal tested'	Strip loin steak- Traceable back to farm of origin and verified 'animal tested'	
$9.00	$16.00	
☐**Option A**	☐ **Option B**	☐**Option C**

15. During a typical visit to a retail outlet where you could purchase deer or elk meat, if the following options were the only ones available, which option would you purchase?

Option A	Option B	Option C
500 gm. strip loin steak (deer or elk meat)		I would purchase neither of these steaks
Strip loin steak- Verified 'animal tested'	Strip loin steak- Verified 'animal tested'	
$9.00	$12.50	
☐**Option A**	☐ **Option B**	☐**Option C**

Appendix 4 M. Percentage of choosing option-C in response to 15 different pairs of alternative venison strip loin steaks

	Set1	Set2	Set3	Set4	Set5	Set6	Set7	Set8	Set9	Set10	Set11	Set12	Set13	Set14	Set15	Average
Canada (%)																
Group1 (Confident)	28	29	20	24	34	35	47	24	22	38	45	21	50	33	34	32
Group2 (Neutral)	54	52	46	51	57	56	65	49	50	62	60	47	67	53	56	55
Group3(Concerned)	82	77	73	82	84	78	82	79	80	83	79	74	87	77	80	80
Group4 (No answer to RP/RA questions)	68	67	62	64	69	70	78	65	64	73	75	63	80	68	70	69
All	53	52	45	50	57	56	65	49	49	60	61	47	67	54	56	55
US (%)																
Group1 (Confident)	32	36	26	28	34	41	51	27	31	32	39	24	46	39	39	35
Group2 (Concerned)	55	55	48	52	51	55	58	50	50	56	56	47	59	56	54	53
All	47	48	40	44	45	50	55	42	44	47	50	39	54	50	49	47

Appendix 4 N. Correlation Matrix

		AGE	GENDER	KIDS	EDUC	HHSIZE	INCOME
CAG1	AGE	1					
	GENDER	-0.1	1				
	KIDS	-0.2	-0.1	1			
	EDUC	-0.04	-0.1	0.03	1		
	HHSIZE	-0.2	-0.1	0.6	-0.02	1	
	INCOME	-0.2	-0.1	0.99	0.02	0.6	1
CAG2	AGE	1					
	GENDER	-0.12	1				
	KIDS	-0.31	0.01	1			
	EDUC	0.01	-0.15	0.05	1		
	HHSIZE	-0.41	0.01	0.67	-0.04	1	
	INCOME	-0.29	0.01	0.99	0.05	0.63	1
CAG3	AGE	1					
	GENDER	-0.2	1				
	KIDS	-0.4	-0.02	1			
	EDUC	0.04	-0.11	0.08	1		
	HHSIZE	-0.5	-0.03	0.68	0.01	1	
	INCOME	-0.4	-0.03	0.99	0.08	0.65	1
USG1	AGE	1					
	GENDER	0.1	1				
	KIDS	-0.3	-0.2	1			
	EDUC	0.03	0.03	-0.02	1		
	HHSIZE	-0.3	-0.1	0.5	-0.1	1	
	INCOME	0.04	-0.1	0.03	0.3	0.1	1
USG2	AGE	1					
	GENDER	0.1	1				
	KIDS	-0.3	-0.2	1			
	EDUC	0.1	0.1	0.01	1		
	HHSIZE	-0.4	-0.1	0.5	-0.1	1	
	INCOME	0.1	0.03	0.03	0.4	0.1	1

		TRUST	GOVTRUST	FTRUST	RTRUST	MTRUST
CAG1	TRUST	1				
	GOVTRUST	0.1	1			
	FTRUST	0.1	0.2	1		
	RTRUST	0.1	0.4	0.4	1	
	MTRUST	0.1	0.5	0.4	0.6	1
CAG2	TRUST	1				
	GOVTRUST	0.14	1			
	FTRUST	0.1	0.3	1		
	RTRUST	0.1	0.42	0.4	1	
	MTRUST	0.13	0.53	0.43	0.58	1
CAG3	TRUST	1				
	GOVTRUST	0.08	1			
	FTRUST	0.08	0.3	1		
	RTRUST	0.13	0.5	0.4	1	
	MTRUST	0.07	0.6	0.4	0.6	1
USG1	TRUST	1				
	GOVTRUST	0.2	1			
	FTRUST	0.2	0.5	1		
	RTRUST	0.3	0.6	0.6	1	
	MTRUST	0.3	0.7	0.6	0.7	1
USG2	TRUST	1				
	GOVTRUST	0.2	1			
	FTRUST	0.2	0.5	1		
	RTRUST	0.2	0.6	0.6	1	
	MTRUST	0.2	0.6	0.6	0.7	1

		LC1	LC2	LC3	LC4
CAG1	LC1	1			
	LC2	0.6	1		
	LC3	-0.004	0.01	1	
	LC4	0.2	0.23	-0.03	1
CAG2	LC1	1			
	LC2	0.5	1		
	LC3	-0.01	-0.0	1	
	LC4	0.12	0.19	-0.09	1
CAG3	LC1	1			
	LC2	0.51	1		
	LC3	0.02	0.1	1	
	LC4	0.13	0.16	-0.05	1
USG1	LC1	1			
	LC2	0.5	1		
	LC3	-0.02	0.02	1	
	LC4	0.3	0.3	0.1	1
USG2	LC1	1			
	LC2	0.5	1		
	LC3	0.05	0.1	1	
	LC4	0.3	0.3	-0.1	1

APPENDIX 5

Appendix 5 A. Nutritional Compositions of Meats

Nutrient name	Unit	Value per 100g of edible portion							
		Bison	Elk	Venison	Beef	Pork	Chicken	Turkey	Seafood
		(top round lean steak, raw)	(raw)	(raw)	(lion top sirloin steak lean, raw)	(fresh loin whole lean, raw)	(breast raw)	(all classes breast, raw)	(farmed Atlantic salmon, raw)
Proximate									
Protein	g	23.3	24	23	22.5	21.4	22.7	21.9	19.9
Total Fat	g	2.4	1.5	2.4	4.0	5.7	1.6	7	10.9
Energy (kcal)	KCal	122	111	120	132	143	112	157	183
Minerals									
Calcium, Ca	mg	5	4	5	6	17	5	13	12
Iron, Fe	mg	2.7	2.8	3.4	2.4	0.8	0.4	1.2	0.4
Magnesium, Mg	mg	27	23	23	25	23	28	24	28
Phosphorus, P	mg	237	161	202	195	211		186	233
Potassium, K	mg	390	312	318	339	389	287	275	362
Sodium, Na	mg	47	58	51	59	52	56	59	59
Zinc, Zn	mg	2.9	2.4	2.1	5.1	1.8	0.8	1.6	0.4
Copper, Cu	mg	0.1	0.1	0.3	0.1	0.1	0.4	0.1	0.05
Manganese, Mn	mg	0.1	0.01	0.04	0.01	0.01	0.02	0.02	0.02
Selenium, Se	µg	35.3	9.8	9.7	19.8	36.1	17.8	22.4	36.5
Vitamins									
Vitamin B-6	mg	0.6		0.4	0.4	0.5	0.6	0.5	0.6
Vitamin B-12	µg	1.6		6.3	2.5	0.6	0.4	0.4	2.8
Vitamin C	mg					0.6	1.2		3.9
Vitamin D	µg		0.2		0.5	0.2	0.3	0.5	6.0
Cholesterol	mg	65	55	85	53	59	58	65	59

Source: Health Canada, Canadian Nutrient File 2007; adapted from Myae and Goddard (2012b).

Appendix 5 B. Selected review of studies in the area of consumer behaviour using different models/methods

Author (s)	Objective	Model/ Method	Data	Findings
Working (1943)	To discover uniformities in tendencies of expenditure among families of different sizes, incomes, occupational classes in different regions/community in the US in the mid-1930s.	Engel function and exploratory analysis	Statistical data on family expenditures	The proportions of expenditure on different purposes out of total expenditure tended to be the same for families of the same total expenditure per persons even though family income, size and proportion of income saved differed.
Leser (1963)	To investigate the properties of various forms of Engel functions which are satisfying the additivity criterion.	Engel functions	Household expenditure data on different commodity groups	A form of relationship used by Working (1943) is a flexible function form which gives a good fit for most commodity groups in the study.
Barten (1964)	To introduce a modification of direct additivity in consumer demand studies as a specific interaction between the different types of consumers' expenditure.	Demand system equations	Time series data describing total consumer expenditure in the Netherlands on fourteen types of commodities or services and the corresponding price indices during the periods 1921-1939 and 1948-1958.	The sample supplies somewhat more evidence against complete additivity. In demand analyses, it should be regarded in the results that the standard errors of the posterior estimates are much smaller than those of the corresponding sample estimates (two or three times).
Deaton and Muelbauer	To propose and estimate a new model – the Almost Ideal	Single equations	Postwar British data (1954-1974) on eight	The AIDS explains a high proportion of the variance of the commodity budget

(1980a)	Demand System (AIDS) in which the budget shares of the various commodities are linearly related to the logarithm of real total expenditure and the logarithms of relative prices – which has considerable advantages over the Rotterdam and translog models.	and AIDS demand model	nondurable groups of consumers' expenditure	shares. Although there are some constraints, the AIDS having the simplicity of structure, generality, and conformity with the theory is expected to offers a platform for further developments.
Pitt (1983)	To explain consumer behaviour in which food preferences vary with food expenditure and nutrient intake.	Tobit demand model	Data from Household Expenditure Survey of Bangladesh in 1973-74.	The results suggested that the poor responded very differently to changes in prices, substitution effects are strong which would result in absolute declines in nutrient intake, and nutrient elasticities with respect to total food expenditure were small for low income households.
Barnes and Grillingha m (1984)	To determine the impact of demographic variables on consumer demand behaviour using micro data.	The quadratic expenditure system (QES) – a generalizatio n of the LES allowing for nonlinear Engel curves	The data from the 1972-73 Consumer Expenditure Survey of the Bureau of Labor Statistics.	Among four types of good (food at home, food away from home, shelter and clothing), food away from home and clothing are the relative luxuries and demographic variables showed significant impact on demand behaviour.

Heien and Wessells (1990)	To present a technique for dealing with zero expenditure problem in household level demand behaviour estimations and to compare the results of proposed method with a those of conventional methods.	A two-step Probit-AIDS demand model	Data from the USDA's 1977-1978 household food consumption survey (HFCS)	The censored model showed over five fold in goodness of fit (R^2) as an average proportionate increase than conventional model. There are significant differences among the two models in terms of price elasticities, substitubility, complementarity, and demographic effects.
Michalek and Keyzer (1992)	To discuss and report the specification, construction and estimation of a complete demand system for eight EC countries.	A two stage LES-AIDS consumer demand model	National time series data of expenditure and prices for the period 1970-1987	The work could identify three AIDS-aggregates to explicitly maintain concavity of the expenditure function within a given range of budget shares, and could ensures that the aggregate price index in the AIDS is consistent with the parameters of the system.
Fan et al. (1995)	To determine household demand in rural china for five commodity groups – food, clothing, fuel, housing and other commodities.	A two stage LES-AIDS model	Time series data from Rural Household Survey for the period 1982-1990 by China's State Statistical Bureau (SSB).	The results suggested price-inelasticity in demand for all commodity groups, housing and other commodities as luxury goods, clothing and food as necessities, and lower (higher) expenditure elasticities for grains (meat, tobacco, and alcohol).
Gao et al. (1996)	To evaluate economic and demographic effects on China's rural household consumption behaviour, income distribution and poverty.	A two stage AIDS-GLES demand model	Data from Rural Household Survey in 1990 by China's SSB.	The results suggested a slow growth of food consumption during late 1980s due to income stagnation and figured out a growing demand for better food and shelter since 1990s as a major concern.

Richard et al (1997)	To determine how much export promotion can increase market share and total import demand for US apples from the two largest apple trade partners – Singapore and the UK.	A two stage LES-AIDS demand model	Time series data for the period 1962-93	Results suggested that export promotion had a significant and positive effect on the total expenditure on apples from all sources; promotion would be more effective the less elastic was demand and more easier to differentiate.
Perali and Chavas (2000)	To develop an econometric methodology in estimating a system of censored demand equations using a large cross-section data with zero expenditures.	Tobit and reduced form AIDS model	Data is from the Survey "Encuesta Nacional de Ingresos y Gastos de Colombia 1984-85"	The Tobit model was chosen to determine statistical representation of consumer behaviour and AIDS model was introduced incorporating demographic translations. The results from demand model estimation illustrated the usefulness of the proposed approach.
Chern et al. (2002)	To analyze the food consumption patterns and to conduct econometric analysis of food demand structure in Japan.	Working-Leser model, Heckman's sample selection model and Tobit model	Cross-sectional household data from the Annual Report on the Family Income and Expenditure Survey (FIES) in 1997 in Japan.	The expenditure elasticity of beef is greater than unity and that of other meat products are inelastic. The expenditure and price elasticities of all products including rice are similar to the results in western countries.
Klonaris and Hallam (2003)	To determine differences between conditional and unconditional elasticities and how to correct conditional elasticities using a multistage demand system estimates.	Dynamic AIDS model	Time series data from the National Accounts of Greece (1959-1995)	The results suggested a significant deviation between conditional and unconditional elasticities and correction should be applied to unconditional elasticities before providing policy implications.
Lomeli	To determine the impact of	A two stage	Time series data of	The results suggested significant impact

(2005)	possible demand shifters (price, expenditure, food safety scares, health information and advertising) on Canadian meat aggregate demand.	Double log-AIDS demand model	beef, pork and chicken consumption from 1978 to 2001	of food safety issues, health concerns and advertising on total household meat expenditure, and on specific meat cuts. Other factors such as demographic characteristics and price play significant role on Canadian household meat consumption behaviour.
Oniki (2006)	To evaluates dynamic changes in consumers' willingness to accept (WTA) and concerns after the food safety outbreaks of E. coli (1996) and BSE in Japan.	LA-AIDS model and Kalman filter model	Data from the Family Income and Expenditure Survey (FIES) from January 1990 to March 1998 in Japan	There was a considerable impact on beef and fresh foods consumption and a short-immediate increase of WTA after food safety outbreak had been observed.
Saghaianet al. (2007)	To explore the dynamic responses of Japanese consumers to the impact of E. coli, FMD, and BSE food safety shocks.	Cointegrated, multivariate VAR/structural VEC model	Data from Meat Statistics, the FIES, and the Agriculture and Livestock Industries Corporation (ALIC) for the period April 1994 – May 2002.	Different negative impacts of beef safety shocks (E. coli, FMD and BSE) on beef retail prices.
Lin et al. (2009)	To determine household demand behaviour for organic and conventional fresh fruits in the US.	Two-step Probit-Translog demand model	Data from the Nielsan Homescan panel	Household income and price affect organic fruit consumption. Consumers are less responsive to price of conventional fruits. Although, there could be a possibility that a change in relative price can change consumers to consume more organic fruits, it is less likely to revert organic consumers to

				buying conventional fruits.
Yang (2010); Yang and Goddard (2011a)	To quantify the impact of BSE on Canadian household meat-purchasing behaviour, distinguished by varying risk perceptions and risk attitudes.	Doublelog-Translog two- stage demand model	Data from the Nielsen Homescan™ panel over the period 2002-07	Beef risk perceptions and attitudes affect household meat purchase behaviour.
Myae and Goddard (2010)	To examine meat purchase behaviour of selected households that include bison and venison (deer and elk meat) in their total meat consumption in the presence of animal disease (BSE and CWD) concerns	LA/AIDS demand model	An unbalanced panel data from Homescan™ (Nielsen Company) for the period of 2002-08	The esults suggested significant impacts of demographic characteristics, price, expenditure and food safety concerns associated with BSE and CWD on their meat purchase decisions.
Zhang (2010)	To determine the variability of Canadian's value added meat purchase patterns by animal species, by level of processing, by branding and by grocery store chains.	Heien and Wessels (1990) two step procedure: The first step probit and the second step Working-Leser demand system.	A balanced panel of sample data in Ontario and Alberta from the ACNielsen Homescan™ panel data for calendar years 2002 to 2007.	The results suggested a strong linkage between meat demand and factors such as meat price, advertising, household socio-demographic characteristics and regional segments. There are no common pattern of meat product development and no store loyalty.

Appendix 5 C. Selected review of studies in determining the impacts of media coverage on consumers' demands

Author (s)	Objective	Method	Data	Findings
Brown (1969)	To examine household consumption of cranberries before and after pesticide scare in 1959 in Atlanta, Georgia.	Linear and logarithmic least-squares estimation	Self-reported weekly food purchase data for the period 1957-62	1959 incident appeared not to have had any significant effect on the elasticity of demand for processed cranberries among households.
Swartz and Strand (1981)	To examine the impact of kepone contamination (using various newswire stories as an explanatory variable) on consumer demand for oysters in Baltimore wholesale market after the closure of Virginia's James River.	Two-stage least squares	Biweekly observations during Maryland's oyster season (usually Sept-March) from 1973-76	A moderate and temporary negative impact (-0.5) on oyster demand had been found out. However, consumer reaction wore off and consumption returned to previous levels after a certain period.
Smith et al. (1988)	To presents a procedure for estimating sales loss following heptachloe contamination of fresh fluid milk in Oahu, Hawaii in 1982.	Ordinary least squares	Monthly data from January 1977 to June 1983	Negative information in the media about a contamination incident had a greater impact relative to positive information. Although sales increased again after some months, it was not back to pre-contamination levels after fifteen months.
Johnson (1988)	To determine the impact of media coverage about pesticide ethylene dibromide (EDB) contamination in grain	Fixed effect/ Random effect	Weekly household purchased data (dessert, bread, ad roll mixes)	Media reports had a negative impact on grain sales for a short period and possible to quantify market disruption.

	products in US.		in 19 marketing regions for the period June 1982 – May 1984	
Burton and Young (1996)	To evaluate the impact of media coverage of BSE on beef, lamb, pork and poultry.	Dynamic AIDS model	Data from the National Food Surveys of household food expenditure in Great Britain for the period 1961:1 – 1993:3	BSE had a significant impact on the allocation of consumer expenditure among meat consumptions and suggested a significant long-run impact on beef market share.
Robenstein and Thurman (1996)	To determine the behavior of traders upon scientific information about the negative health implications of eating red meat.	Market returns model, Event study regressions	Daily market data of red meats traded on the Chicago Mercantile Exchange for the period from January 1983 to December 1990	A lack of reaction to health information from the future market had been observed, leaving the question about the link between the scientific pronouncements and consumer behavior.
Verbeke et al. (2000)	To determine the impact of mass media coverage (TV) and demongrphic characteristics on fresh meat consumption.	Probit - Discrete choice model	The cross-sectional survey data collected in April 1998	The number of television coverage, greater attention to television messages, presence of young children, and increasing age of consumers had negative impact on fresh meat consumption.
McKenzie	To examine the impact of	Event study:-	Data on recalls	Negative impact on the price for boneless

and Thomsen (2001)	food safety informationon (recalls for E. coli) on wholesale and farm-level beef prices.	mean return model and sensitivity analysis	for *E. Coli* O157:H7 activity were from FSIS and price data were from secondary sources	beef, no impact on live cattle prices, and very little impact on boxed beef prices. There was no price shock transmission from wholesale to farm level boneless beef.
Verbeke and Ward (2001)	To investigate fresh meat consumption in Belgium using AIDS demand model and incorporating media index of TV coverage and advertising expenditures.	Almost Ideal Demand System (AIDS)	Monthly time series data for the period from January 1995 to December 1998. Quantity and price data are from the GfK consumer household panel	Negative impact of television publicity on hormones, BSE, and vCJD had been observed on beef/veal expenditure and pork/mixture. Fresh meat advertising had a minor impact compared with negative press.
Lloyd et al. (2001)	To determine the impact of 'food scares' specifically BSE on UK beef market by incorporating 'food publicity' index in the empirical model.	Co-integration Method using vector autoregressive (VAR) framework	Monthly data from January 1990 to December 1998	'Food publicity' index had negative impact on the prices in all stages (farm, wholesale and retail) and demand. Food safety concerns also cause the marketing margins between the stages to widen.
Kalaitzandonakes et al. (2004)	To measures the impact of media coverage on GM food demand and to examine how consumer behavior has been	Linear approximation of the almost ideal demand system (LA-AIDS)	National-level, syndicated point-of-purchase grocery store	There was no impact of the media coverage on purchasing patterns of consumers in Netherlands. There was a negative significant response to media coverage by US consumers for the shell

	influenced by the media coverage of biotechnology in the United States and in the Netherlands.		scanner data from AC Nielsen for the period 1997-2002	products.
Marsh et al. (2004)	To investigate the impact of meat product recall event and newspaper reports on US consumer demand (beef, pork, and other consumption goods).	Rotterdam model	Data from meat product recalls database by USDA_FSIS over the period 1982-1998	Although there was no impact of media coverage on meat demand, Food Safety Inspection Service's meat recall events significantly impacted meat demand in small magnitude relative to price and income effects, and shifting to non-meat consumption.
Piggott and Marsh (2004)	To investigate the impact of publicized food safety events of Listeria monocytogenes, E. coli, Salmonella and BSE on meat (beef, chicken and pork) consumption.	Generalized Almost Ideal model	Quarterly data for the period from 1982(1) to 1999(3)	Direct effect of food safety media coverage elasticities (negative) was detrimental toward demand. Poultry demand was more responsive to food safety concerns than beef and pork while there was a large indirect effect on beef relative to pork and poultry.
Hu et al. (2006)	To understand Chinese consumers behavior and willingness to pay (WTP) for GM food (GM soybean oil) in respond to real-life cases reported in the media.	A hybrid of the double-bounded and payment card elicitation approach	Telephone survey conducted in Nanjing, China during 2003	A drastic reduction of WTP by negative reports and no effect on WTP by positive reports had been observed.
Mazzocchi (2006)	To show an alternative way in modeling demand-	Dynamic (partial adjustment) LA-	Used two data sets. One from	Impact of food safety information can be captured providing better short-term

	response to media coverage index (MCI) about food scare.	AIDS,	Piggott and Marsh (2004) and another one from Smith et al. (1984, 1988)	forecasts by the inclusion of time-varying parameters. The results suggested un-necessary evaluation of distinction between positive and negative media impact on demand.
Maynard et al. (2008)	To test the impact of BSE media coverage on Canadian fast food consumers using double-hurdle count data model.	Double-hurdle count data model	Canadian food away-from-home purchases (May 2000 – May 2005) from the market research information company NPD Group Inc.	Consumers responded differently by region that negative impact on Ontario consumers and no significant impact on Alberta consumers had been suggested.

Appendix 5 D. Descriptive Analysis of Risk Perceptions and Risk Attitudes

	Mean score (Standard deviation)									
	Venison					Beef				
	Whole Sample	Group 1 (N=1013)	Group 2 (N=31)	Group 3 (N=859)	Group 4 (N=490)	Whole Sample	Group 1 (N=1013)	Group 2 (N=31)	Group 3 (N=859)	Group 4 (N=490)
Risk Perception										
When eating venison/beef, I am exposed to… (1=very little risk,…,5=a great deal of risk)	2.66 (1.21)	3.13 (1.23)	2.48 (1.26)	2.14 (1.03)	2.63 (1.06)	1.96 (1.03)	2.00 (1.03)	2.10 (1.22)	1.90 (1.00)	1.98 (1.03)
I think eating venison/beef is risky (1=strongly disagree,…,5=strongly agree)	2.66 (1.23)	3.15 (1.23)	2.65 (1.33)	2.18 (1.08)	2.52 (1.09)	2.00 (1.10)	2.04 (1.10)	2.10 (1.11)	1.95 (1.07)	1.99 (1.09)
For me, eating venison/beef is … (1=not risky,…,5=risky)	2.71 (1.22)	3.20 (1.22)	2.74 (1.32)	2.18 (1.54)	2.63 (1.06)	2.02 (1.08)	2.08 (1.08)	2.48 (1.18)	1.95 (1.03)	2.00 (1.03)
Risk perception index	2.85 (1.11)	3.30 (1.11)	2.81 (1.25)	2.37 (0.93)	2.77 (0.95)	2.17 (0.95)	2.22 (0.95)	2.35 (1.05)	2.12 (0.89)	2.16 (0.92)
T-test (same group-wise risk perception index)	G1 v.s. G2: 0.76 G1 v.s G4: 9.51*** G2 v.s G4: 0.14		G1 v.s. G3: 19.8*** G2 v.s. G3: 1.94** G3 v.s. G4: -7.6***			G1 v.s. G2: -0.20 G1 v.s G4: 1.19 G2 v.s G4: 1.01		G1 v.s. G3: 2.41*** G2 v.s. G3: 1.24 G3 v.s. G4: -0.81		
Risk Attitude										
I accept the risks of eating venison/beef (1=strongly disagree,…,5=strongly agree)	3.05 (1.26)	2.57 (1.23)	3.00 (1.41)	3.57 (1.16)	3.13 (1.08)	3.53 (1.25)	3.44 (1.25)	3.26 (1.32)	3.60 (1.25)	3.62 (1.22)
For me, eating venison/beef is worth the risk (1=strongly disagree,…,strongly agree)	2.99 (1.22)	2.54 (1.20)	2.87 (1.52)	3.54 (1.07)	2.96 (1.11)	3.53 (1.20)	3.38 (1.20)	3.26 (1.26)	3.68 (1.18)	3.58 (1.20)
I am … the risk of eating venison/beef (1=not willing to accept,…,5=willing to accept)	3.07 (1.26)	2.48 (1.18)	3.42 (1.34)	3.75 (1.05)	3.09 (1.12)	3.77 (1.18)	3.64 (1.18)	3.48 (1.23)	3.91 (1.09)	3.79 (1.16)
Risk attitude index	3.22 (1.09)	2.67 (1.05)	3.35 (1.10)	3.83 (0.92)	3.27 (0.94)	3.82 (1.03)	3.71 (1.03)	3.48 (1.10)	3.94 (0.98)	3.87 (1.03)
T-test (same group-wise risk perception index)	G1 v.s. G2: -1.09 G1 v.s G4: -11.1*** G2 v.s G4: 0.63		G1 v.s. G3: -25.4*** G2 v.s. G3: -1.69* G3 v.s. G4: 10.7***			G1 v.s. G2: 0.40 G1 v.s G4: -2.80*** G2 v.s G4: -1.90*		G1 v.s. G3: -4.95*** G2 v.s. G3: -2.28*** G3 v.s. G4: 1.25		

Note: "*, **, ***" represents 90%, 95%, and 99% level of significance respectively.

Appendix 5 E. Descriptive statistics of households in the Sample

	G1 (N=1013)		G2 (N=31)		G3 (N=859)		G4 (N=490)	
	Mean	Std dev	Mean	Std dev	Mean	Std dev	Mean	Std dev
Venison expenditure	0.00	0.00	2.46	10.69	0.00	0.00	0.00	0.00
Bison expenditure	0.23	7.89	2.91	17.32	0.26	3.00	0.36	5.13
Beef expenditure	254	495	405	428	258	430	279	509
Pork expenditure	105	205	180	348	118	203	122	358
Chicken expenditure	139	262	169	263	136	223	143	265
Turkey expenditure	21	116	13	20	22	61	23	49
Seafood expenditure	43	116	37	52	44	173	51	103
	G1		G2		G3		G4	
Maritimes	10%		0%		17%		12%	
Quebec	27%		90%		27%		21%	
Ontario	31%		3%		18%		25%	
Man_Sask	9%		6%		12%		10%	
Alberta	10%		0%		14%		15%	
BC	13%		0%		13%		17%	
Gender (male)	32%		26%		37%		36%	
English	72%		19%		72%		81%	
Hhsize (3+)	20%		26%		16%		14%	
No Children under 18	90%		87%		92%		93%	
Eat venison in a restaurant	0.3%		16%		17%		10%	

Appendix 5 F. Estimates of probit equations

Equation	Variables	Group 1	Group 2	Group 3	Group 4
Venison equation (*Dependent variable: buy venison=1, do not buy venison=0*)	Constant		-1.84 (0.96) **		
	Total expenditure		0.03 (0.12)		
	Income		-0.01 (0.07)		
	English speaking		-0.10 (0.26)		
	Household head age		0.01 (0.01)		
	Household head educ.		0.02 (0.03)		
	Live in urban area		0.11 (0.23)		
	Risk perceptions		0.02 (0.10)		
	Risk attitudes		0.06 (0.12)		
	Regression Statistics				
	Scaled R^2		0.01		
	LR (zero slopes)		1.67		
	Schwarz B.I.C		125.6		
	Log Likelihood		-101.4		
	Predictions		82%		
Bison Equation (*Dependent variable: buy bison=1, do not buy bison=0*)	Constant	-2.19 (0.35) ***	-2.40 (1.06) **	-1.24 (0.35) ***	-2.47 (0.49) ***
	Total expenditure	0.04 (0.04)	-0.04 (0.02)	-0.02 (0.06)	0.01 (0.005) ***
	Income	-0.03 (0.02)	0.19 (0.08) **	0.01 (0.02)	0.03 (0.03)
	English speaking	-0.41 (0.09) ***	-0.53 (0.30) *	-0.27 (0.08) ***	-0.10 (0.13)
	Household head age	0.006 (0.003) *	-0.001 (0.01)	-0.001 (0.003)	-0.001 (0.004)
	Household head educ.	0.03 (0.01) **	-0.04 (0.04)	-0.003 (0.01)	-0.02 (0.02)
	Live in urban area	-0.09 (0.09)	0.45 (0.29)	-0.01 (0.08)	-0.04 (0.10)
	Risk perceptions	-0.11 (0.04) ***	0.16 (0.12)	-0.08 (0.05) *	0.11 (0.07) *

	Risk attitudes	-0.05 (0.04)	0.22 (0.14)	-0.10 (0.05) **	0.13 (0.07 *
	Regression Statistics				
	Scaled R^2	0.01	0.07	0.002	0.004
	LR (zero slopes)	36.4***	14.8*	15.3**	13.3*
	Schwarz B.I.C	475.5	104.0	604.9	373.9
	Log Likelihood	-435.7	-79.8	-565.9	-337.4
	Predictions	99%	86%	98%	98%
Beef equation *(Dependent variable: buy beef=1, do not buy beef=0)*	Constant	1.13 (0.20) ***	-11.4 (6.45) *	1.17 (0.25) ***	0.89 (0.36) **
	Total expenditure	0.02 (0.001) ***	0.09 (0.03) ***	0.14 (0.01) ***	0.04 (0.003) ***
	Income	-0.02 (0.01) *	0.75 (0.40) *	0.05 (0.01) ***	-0.02 (0.02)
	English speaking	-0.42 (0.06) ***	-0.36 (0.96)	-0.21 (0.06) ***	-0.18 (0.11)
	Household head age	0.01 (0.002) ***	0.14 (0.08) *	0.01 (0.002) ***	-0.001 (0.003)
	Household head educ.	-0.01 (0.01) *	0.12 (0.19)	-0.04 (0.01) ***	-0.05 (0.01) ***
	Live in urban area	0.06 (0.05)	4.80 (2.30) **	0.21 (0.05) ***	0.15 (0.08) *
	Risk perceptions	0.008 (0.02)	-0.61 (0.97)	-0.002 (0.03)	0.06 (0.05)
	Risk attitudes	-0.06 (0.02) ***	-0.56 (1.07)	-0.07 (0.03) **	0.14 (0.05) ***
	Regression Statistics				
	Scaled R^2	0.09	0.29	0.09	0.14
	LR (zero slopes)	629.8***	49.0***	529.9***	437.0***
	Schwarz B.I.C	1785.5	40.2	1484.3	687.7
	Log Likelihood	-1745.7	-16.02	-1445.3	-651.1
	Predictions	91%	97%	91%	93%
Pork equation *(Dependent variable: buy pork=1, do not buy pork=0)*	Constant	0.79 (0.17) ***	-4.24 (1.79) **	0.92 (0.22) ***	0.80 (0.27) ***
	Total expenditure	0.01 (0.001) ***	0.04 (0.01) ***	0.15 (0.01) ***	0.02 (0.001) ***
	Income	0.004 (0.01)	0.31 (0.16) **	0.06 (0.01) ***	0.02 (0.02)
	English speaking	-0.26	0.33	-0.28	-0.27

		(0.05) ***	(0.54)	(0.06) ***	(0.09 ***
	Household head age	0.01 (0.001) ***	0.05 (0.02) **	0.01 (0.002) ***	0.002 (0.002)
	Household head educ.	-0.03 (0.01) ***	-0.11 (0.09)	-0.05 (0.01) ***	-0.04 (0.01) ***
	Live in urban area	-0.27 (0.04) ***	0.25 (0.66)	-0.03 (0.05)	-0.11 (0.06) *
	Risk perceptions	-0.02 (0.02)	-0.20 (0.22)	0.05 (0.03) *	0.08 (0.04) **
	Risk attitudes	0.03 (0.02)	0.78 (0.31) **	-0.01 (0.03)	0.10 (0.04) ***
	Regression Statistics				
	Scaled R^2	0.13	0.38	0.13	0.15
	LR (zero slopes)	888.2***	69.7***	747.6***	486.8***
	Schwarz B.I.C	2749.7	51.4	1917.1	1192.3
	Log Likelihood	-2709.9	-27.2	-1878.1	-1155.8
	Predictions	83%	96%	87%	85%
Chicken equation *(Dependent variable: buy chicken=1, do not buy chicken=0)*	Constant	0.90 (0.18) ***	-8.81 (23.0)	0.73 (0.24) ***	0.48 (0.30) *
	Total expenditure	0.01 (0.001) ***	0.02 (0.01) *	0.24 (0.01) ***	0.02 (0.001) ***
	Income	0.002 (0.01)	2.83 (2.66)	0.01 (0.01)	-0.02 (0.02)
	English speaking	-0.26 (0.05) ***	-10.19 (12.2)	-0.03 (0.06)	-0.19 (0.10) **
	Household head age	0.003 (0.002) **	-0.25 (0.18)	0.003 (0.002) *	-0.007 (0.003) ***
	Household head educ.	-0.01 (0.01)	0.37 (0.89)	-0.03 (0.01) ***	0.01 (0.01)
	Live in urban area	0.11 (0.04) **	-1.02 (3.40)	0.16 (0.05) ***	0.02 (0.07)
	Risk perceptions	-0.02 (0.02)	1.67 (2.68)	-0.004 (0.03)	0.06 (0.04)
	Risk attitudes	0.01 (0.02)	2.96 (3.36)	-0.01 (0.03)	0.11 (0.04) ***
	Regression Statistics				
	Scaled R^2	0.07	0.18	0.14	0.12
	LR (zero slopes)	503.0***	26.8***	805.5***	376.3***

	Schwarz B.I.C	2256.9	30.8	1620.3	966.7
	Log Likelihood	-2217.1	-6.55	-1581.2	-930.1
	Predictions	89%	99%	89%	90%
Turkey equation (*Dependent variable: buy turkey=1, do not buy turkey=0)*	Constant	-1.12 (0.13) ***	-2.49 (0.88) ***	-1.09 (0.16) ***	-1.08 (0.20) ***
	Total expenditure	0.05 (0.003) ***	0.04 (0.01) ***	0.41 (0.03) ***	0.04 (0.003) ***
	Income	0.07 (0.01) ***	0.20 (0.06) ***	0.06 (0.01) ***	0.06 (0.01) ***
	English speaking	0.29 (0.04) ***	0.49 (0.22) **	0.47 (0.04) ***	0.33 (0.06) ***
	Household head age	0.01 (0.001) ***	0.02 (0.008) ***	0.01 (0.001) ***	0.002 (0.002)
	Household head educ.	-0.008 (0.005) *	-0.08 (0.03) **	0.002 (0.01)	0.002 (0.01)
	Live in urban area	-0.08 (0.03) **	0.83 (0.21) ***	0.02 (0.03)	-0.01 (0.05)
	Risk perceptions	0.02 (0.01)	0.12 (0.09)	-0.03 (0.02)	0.04 (0.03)
	Risk attitudes	0.001 (0.02)	0.10 (0.11)	-0.05 (0.02) **	0.03 (0.03)
	Regression Statistics				
	Scaled R^2	0.09	0.17	0.08	0.07
	LR (zero slopes)	595.5***	37.9***	500.5***	252.1***
	Schwarz B.I.C	4526.1	155.4	3843.8	2235.4
	Log Likelihood	-4486.3	-131.2	-3804.8	-2198.9
	Predictions	64%	70%	64%	63%
Seafood equation (*Dependent variable: buy seafood=1, do not buy seafood=0)*	Constant	-0.13 (0.13)	-2.00 (0.96) **	0.24 (0.16)	0.60 (0.21) ***
	Total expenditure	0.03 (0.003) ***	0.05 (0.02) **	0.29 (0.03) ***	0.04 (0.005) ***
	Income	0.03 (0.01) ***	0.21 (0.07) ***	0.08 (0.01) ***	0.07 (0.01) ***
	English speaking	0.16 (0.04) ***	0.06 (0.25)	0.11 (0.04) ***	0.14 (0.06) **
	Household head age	0.002 (0.001) *	0.005 (0.008)	-0.002 (0.001)	-0.0004 (0.002)
	Household head educ.	0.007	-0.02	-0.01	-0.01

		(0.005)	(0.03)	(0.01)	(0.01)
	Live in urban area	0.07 (0.03) **	0.38 (0.22) *	0.01 (0.04)	-0.04 (0.05)
	Risk perceptions	-0.04 (0.01) ***	0.06 (0.09)	0.02 (0.02)	-0.05 (0.03) *
	Risk attitudes	0.004 (0.02)	0.29 (0.12) **	-0.06 (0.02) ***	-0.15 (0.03) ***
	Regression Statistics				
	Scaled R^2	0.03	0.15	0.04	0.06
	LR (zero slopes)	199.3***	32.7***	229.3***	204.3***
	Schwarz B.I.C	4385.6	134.8	3678.2	2039.4
	Log Likelihood	-4345.8	-110.6	-3639.1	-2002.8
	Predictions	66%	71%	66%	69%

Notes: All figures in parenthesis (…) are standard errors, *** = significant at 1%, ** = significant at 5%, * = significant at 10%.

Appendix 5 G. Marginal effects (*buy meat*$_i$ *=1*) of probit estimations

Equation	Variables	Group1	Group2	Group3	Grop4
Venison equation *(Dependent variable: buy venison=1, do not buy venison=0)*	Constant		-0.48		
	Total expenditure				
	Income				
	English speaking				
	Household head age				
	Household head educ.				
	Live in urban area				
	Risk perceptions				
	Risk attitudes				
Bison equation *(Dependent variable: buy bison=1, do not buy bison=0)*	Constant	-0.07	-0.48	-0.06	-0.123
	Total expenditure				0.00005
	Income		0.037		
	English speaking	-0.01	-0.106	-0.013	
	Household head age	0.0001			
	Household head educ.	0.001			
	Live in urban area				
	Risk perceptions	-0.003		-0.004	0.006
	Risk attitudes			-0.005	0.006
Beef equation *(Dependent variable: buy beef=1, do not buy beef=0)*	Constant	0.16	-0.47	0.16	0.095
	Total expenditure	0.0002	0.004	0.002	0.003
	Income	-0.003	0.031	0.006	
	English speaking	-0.06		-0.029	
	Household head age	0.001	0.006	0.001	
	Household head educ.	-0.002		-0.005	-0.005
	Live in urban area		0.197	0.029	0.016
	Risk perceptions				
	Risk attitudes	-0.009		-0.009	0.015
Pork equation *(Dependent variable:*	Constant	0.18	-0.308	0.17	0.158
	Total expenditure	0.003	0.003	0.003	0.003
	Income		0.024	0.011	
	English speaking	-0.06		-0.051	-0.053

buy pork=1, do not buy pork=0)	Household head age	0.002	0.003	0.001	
	Household head educ.	-0.007		-0.008	-0.008
	Live in urban area	-0.06			-0.022
	Risk perceptions			0.009	0.016
	Risk attitudes		0.057		0.021
Chicken equation	Constant	0.16		0.11	0.075
	Total expenditure	0.0002	0.003	0.003	0.003
(Dependent variable: buy chicken=1, do not buy chicken=0)	Income				
	English speaking	-0.046			-0.029
	Household head age	0.0006		0.0005	-0.001
	Household head educ.			-0.004	
	Live in urban area	0.019		0.024	
	Risk perceptions				
	Risk attitudes				0.017
Turkey equation	Constant	-0.42	-0.86	-0.408	-0.408
	Total expenditure	0.0002	0.001	0.002	0.002
(Dependent variable: buy turkey=1, do not buy turkey=0)	Income	0.027	0.068	0.024	0.024
	English speaking	0.109	0.168	0.177	0.126
	Household head age	0.003	0.007	0.003	
	Household head educ.	-0.003	-0.026		
	Live in urban area	0.031	0.284		
	Risk perceptions				
	Risk attitudes			-0.019	
Seafood equation	Constant		-0.574		0.203
	Total expenditure	0.002	0.001	0.001	0.001
(Dependent variable: buy seafood=1, do not buy seafood=0)	Income	0.009	0.061	0.028	0.024
	English speaking	0.059	0.018	0.039	0.049
	Household head age	0.001			
	Household head educ.		-0.005		
	Live in urban area	0.023	0.109		
	Risk perceptions	-0.014			-0.018
	Risk attitudes		0.083	-0.022	-0.050

Notes: All figures in parenthesis (…) are standard errors, *** = significant at 1%, ** = significant at 5%, * = significant at 10%.

Appendix 5 H. Estimates of the demand system

Equation	Variables	Group 1	Group 2	Group 3	Group 4
First Stage: Total Expenditure Equation *(Dependent variable: Log of total expenditure - LTEXP)*	Constant	3.42 (0.12) ***	-0.07 (0.43)	2.66 (0.14) ***	1.73 (0.16) ***
	Sum (share*log of price)	-1.56 (0.06) ***	0.01 (0.003) ***	-0.72 (0.06) ***	-0.35 (0.09) ***
	LTEXP (-1)	0.58 (0.02) ***	0.81 (0.05) ***	0.59 (0.03) ***	0.70 (0.03) ***
	Log of income	0.08 (0.01) ***	0.08 (0.05)	0.09 (0.01) ***	0.06 (0.01) ***
	Household head age	-0.0006 (0.0004)	-0.002 (0.001)	-0.001 (0.0005) **	-0.002 (0.001) ***
	Risk perceptions	0.005 (0.004) **	0.008 (0.01)	-0.003 (0.01)	0.006 (0.01)
	Risk attitudes	0.005 (0.004) *	-0.01 (0.02)	-0.02 (0.01)	0.003 (0.01)
Second Stage: Share Equations *(Dependent variables: Share of meat expenditure in total expenditure)*	**Constants:**				
	Venison		-0.15 (0.21)		
	Bison	-0.02 (0.01)	-1.86 (1.03) *	-0.02 (0.01) *	-0.01 (0.01)
	Beef	7.98 (8.00)	0.94 (1.57)	0.27 (2.75)	40.8 (33.8)
	Pork	0.24 (0.08) ***	-2.06 (1.26) *	-0.04 (0.10)	0.03 (0.04)
	Chicken	0.73 (0.19) ***	-1.04 (0.98)	0.37 (0.19) **	0.02 (0.03)
	Turkey	-0.09 (0.03) **	2.14 (1.50)	-0.17 (0.06) ***	-0.08 (0.03) ***
	Seafood	-9.84 (8.01)	1.02 (0.89)	-1.41 (2.81)	-42.8 (33.8)
	Prices:				
	Venison-Venison		-0.001 (0.002)		
	Venison-Bison		0.00003 (0.01)		
	Venison-Beef		0.00001		

			(0.01)		
	Venison-Pork		-0.0001 (0.01)		
	Venison-Chicken		0.001 (0.001)		
	Venison-Turkey		-0.003 (0.005)		
	Venison-Seafood		0.003 (0.01)		
	Bison-Bison	0.02 (0.01) **	0.03 (0.03)	0.06 (0.02) **	-0.001 (0.01)
	Bison-Beef	0.019 (0.016)	0.005 (0.016)	-0.07 (0.03) **	-0.015 (0.01)
	Bison-Pork	-0.02 (0.01)	-0.02 (0.02)	0.08 (0.03) ***	0.01 (0.007)
	Bison-Chicken	-0.004 (0.003) *	-0.001 (0.003)	-0.01 (0.003) **	-0.0002 (0.003)
	Bison-Turkey	0.002 (0.009)	-0.03 (0.03)	-0.03 (0.02) **	0.005 (0.008)
	Bison-Seafood	-0.01 (0.01) **	0.02 (0.01)	-0.02 (0.01) **	0.004 (0.01)
	Beef-Beef	0.54 (0.22) **	-0.15 (0.08) **	-0.02 (0.23)	0.25 (0.25)
	Beef-Pork	-0.57 (0.19) ***	0.05 (0.04)	0.21 (0.19)	-0.17 (0.14)
	Beef-Chicken	0.01 (0.05)	0.02 (0.01)	-0.15 (0.06) **	0.03 (0.06)
	Beef-Turkey	0.035 (0.078)	0.05 (0.02) **	0.10 (0.10)	-0.05 (0.08)
	Beef-Seafood	-0.15 (0.11)	0.03 (0.04)	-0.17 (0.18)	-0.06 (0.12)
	Pork-Pork	0.34 (0.20) *	-0.03 (0.03)	-0.31 (0.22)	-0.01 (0.13)
	Pork-Chicken	0.04 (0.038)	0.0005 (0.007)	0.09 (0.07)	0.05 (0.03) *
	Pork-Turkey	0.24 (0.09) ***	-0.034 (0.03)	0.12 (0.10)	0.05 (0.06)
	Pork-Seafood	-0.10 (0.06)	0.03 (0.02)	-0.23 (0.11)	0.06 (0.07)

			**	
Chicken-Chicken	-0.23 (0.06) ***	-0.01 (0.007)	-0.18 (0.06) ***	-0.06 (0.04) *
Chicken-Turkey	-0.03 (0.02) *	0.007 (0.01)	-0.05 (0.03) *	-0.002 (0.02)
Chicken-Seafood	-0.003 (0.04)	-0.02 (0.01) **	0.13 (0.04) ***	-0.03 (0.03)
Turkey-Turkey	-0.21 (0.08) ***	0.05 (0.04)	-0.28 (0.09) ***	-0.025 (0.05)
Turkey-Seafood	-0.04 (0.02) **	-0.03 (0.02) **	0.13 (0.05) ***	0.02 (0.04)
Seafood-Seafood	0.03 (0.08)	-0.02 (0.03)	-0.45 (0.22) **	-0.003 (0.09)
Log of total expenditure:				
Venison		-0.005 (0.01)		
Bison	0.003 (0.002) *	0.07 (0.05)	0.004 (0.002) *	0.002 (0.002)
Beef	-0.12 (0.03) ***	0.07 (0.29)	-0.09 (0.05) **	0.06 (0.01) ***
Pork	-0.07 (0.02) ***	-0.06 (0.10)	-0.05 (0.02) **	-0.04 (0.01) ***
Chicken	-0.22 (0.05) ***	0.31 (0.25)	-0.17 (0.05) ***	-0.06 (0.01) ***
Turkey	-0.008 (0.005) *	-0.07 (0.04) *	-0.005 (0.004)	0.003 (0.003)
Seafood	0.41 (0.08) ***	-0.32 (0.09) ***	0.31 (0.09) ***	0.03 (0.008) ***
Quantity (t-1):				
Venison		0.0005 (0.0003) **		
Bison	0.00003 (0.00002)	0.01 (0.001) ***	0.00003 (0.00005)	0.0003 (0.00006) ***
Beef	-0.00006 (0.00002) ***	-0.003 (0.0004) ***	-0.0001 (0.00004) ***	-0.0001 (0.00002) ***

	Pork	-0.00004 (0.00002) **	-0.001 (0.0003) ***	-0.00001 (0.00001)	-0.0001 (0.00001) ***
	Chicken	0.00001 (0.00001)	-0.001 (0.0002) ***	0.00001 (0.00001)	-0.00005 (0.00001) ***
	Turkey	0.000001 (0.000005)	-0.0003 (0.0001) **	-0.00004 (0.00001) ***	-0.00002 (0.00001) ***
	Seafood	0.00007 (0.00002) ***	-0.001 (0.0004) **	0.0001 (0.00005) ***	-0.000003 (0.00003)
	Inverse Mill Ratios:				
	Venison		-0.09 (0.03) ***		
	Bison	-0.02 (0.01) *	-0.60 (0.10) ***	-0.03 (0.01) ***	-0.02 (0.003) ***
	Beef	-0.24 (0.07) ***	0.95 (0.07) ***	-0.22 (0.07) ***	0.46 (0.01) ***
	Pork	-0.07 (0.02) ***	-0.15 (0.10)	-0.29 (0.09) ***	-0.10 (0.01) ***
	Chicken	-0.16 (0.05) ***	0.40 (0.09) ***	-0.23 (0.07) ***	-0.12 (0.01) ***
	Turkey	-0.09 (0.02) ***	-0.24 (0.04) ***	-0.10 (0.03) ***	-0.08 (0.005) ***
	Seafood	0.58 (0.14) ***	-0.27 (0.07) ***	0.87 (0.23) ***	-0.14 (0.007) ***
Demographics, BSE and CWD media coverage, risk perceptions and risk attitudes Variables	**Venison Equation:**				
	Constant		0.11 (0.22)		
	Household head age		-0.003 (0.001) **		
	Household head educ.		-0.007 (0.004) **		
	Household income		0.007 (0.007)		
	BSE media coverage		-0.0004 (0.0002) ***		
	CWD media coverage		0.03 (0.01)		

			***		
	Bison Equation:				
	Constant	-0.02 (0.01)	-1.94 (1.00) **	-0.02 (0.01) *	-0.009 (0.007)
	Household head age	-0.00001 (0.00002)	-0.0004 (0.002)	0.0001 (0.00004) *	-0.00001 (0.00001)
	Household head educ.	0.00001 (0.0001)	0.01 (0.01)	-0.0004 (0.0002) **	0.0001 (0.0001) *
	Household income	-0.0003 (0.0002)	-0.002 (0.02)	0.0003 (0.0002)	-0.0003 (0.0002) *
	BSE media coverage	-0.000004 (0.000003)	0.0003 (0.0005)	-0.00001 (0.00001)	-0.000005 (0.000003) *
	CWD media coverage	0.0006 (0.0002) ***	-0.01 (0.03)	0.001 (0.0004) **	0.0002 (0.0002)
	Beef Equation:				
	Constant	0.432 (5.41)	-0.16 (1.49)	-0.32 (2.74)	44.56 (35.9)
	Household head age	0.004 (0.02)	0.01 (0.01) *	0.007 (0.007)	-0.03 (0.04)
	Household head educ.	0.36 (0.31)	0.04 (0.03)	0.01 (0.03)	-0.02 (0.12)
	Household income	0.50 (0.45)	-0.07 (0.07)	-0.08 (0.06)	-0.30 (0.30)
	BSE media coverage	-0.005 (0.005)	0.003 (0.001) ***	0.002 (0.001) *	0.002 (0.004)
	CWD media coverage	0.25 (0.27)	-0.22 (0.06) ***	-0.06 (0.08)	0.08 (0.26)
	Pork Equation:				
	Constant	0.21 (0.08) **	-1.91 (1.29)	-0.19 (0.12)	-0.005 (0.05)
	Household head age	-0.001 (0.0004) ***	-0.005 (0.004)	-0.0003 (0.0004)	-0.0004 (0.0002)
	Household head educ.	0.005 (0.001) ***	0.0003 (0.02)	0.01 (0.004) ***	0.004 (0.001) ***
	Household income	0.008 (0.003) ***	-0.001 (0.04)	-0.002 (0.004)	0.0001 (0.002)

	BSE media coverage	-0.00002 (0.00004)	0.00003 (0.0003)	-0.00002 (0.00005)	-0.00003 (0.00003)
	CWD media coverage	0.001 (0.003)	0.04 (0.02) *	0.005 (0.004)	0.002 (0.002)
	Chicken Equation:				
	Constant	0.75 (0.20) ***	0.23 (0.95)	0.32 (0.18)	0.06 (0.04)
	Household head age	0.001 (0.0004) **	-0.01 (0.01)	0.001 (0.001)	0.0002 (0.0003)
	Household head educ.	-0.008 (0.002) ***	-0.03 (0.03)	0.0007 (0.002)	-0.005 (0.001) ***
	Household income	0.01 (0.004) ***	0.004 (0.06)	-0.0001 (0.004)	0.007 (0.002) ***
	BSE media coverage	-0.0001 (0.00004)	-0.002 (0.001) ***	-0.00003 (0.00004)	-0.00003 (0.00004)
	CWD media coverage	0.007 (0.004) **	0.13 (0.04) ***	0.002 (0.003)	0.001 (0.003)
	Turkey Equation:				
	Constant	-0.04 (0.03)	1.92 (1.46)	-0.10 (0.04) **	-0.03 (0.03)
	Household head age	-0.0007 (0.0002) ***	-0.0003 (0.002)	-0.001 (0.0002) ***	-0.0006 (0.0001) ***
	Household head educ.	0.002 (0.0006) **	0.005 (0.007)	-0.001 (0.001)	0.0002 (0.0005)
	Household income	-0.007 (0.002) ***	0.02 (0.02)	-0.0003 (0.001)	-0.004 (0.001) ***
	BSE media coverage	-0.00005 (0.00002) **	-0.0002 (0.0004)	-0.00005 (0.00004)	-0.00001 (0.00002)
	CWD media coverage	0.002 (0.002)	0.05 (0.03) *	0.003 (0.002)	0.001 (0.001)
	Seafood Equation:				
	Household head age	-0.002 (0.02)	0.005 (0.006)	-0.006 (0.007)	0.03 (0.04)
	Household head educ.	-0.36 (0.31)	-0.007 (0.02)	-0.02 (0.03)	0.02 (0.12)
	Household income	-0.51	0.03	0.08	0.29

		(0.45)	(0.04)	(0.06)	(0.30)
	BSE media coverage	0.005 (0.005)	-0.002 (0.003)	-0.002 (0.001) *	-0.002 (0.004)
	CWD media coverage	-0.26 (0.27)	-0.017 (0.027)	0.04 (0.08)	-0.09 (0.26)

Notes: All figures in parenthesis (…) are standard errors, *** = significant at 1%, ** = significant at 5%, * = significant at 10%.