University of Alberta

Food Safety in the Alberta Food Industry: Industry Assessments

by

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Dedication

I would like to dedicate this thesis to Jesus Christ, my Lord and Saviour

To my four girls: Jamie, Amanda, Chloe and Rachael. I will never know what this cost you and I love you all dearly.

And to Violet, my motivation.

Abstract

The objective of this thesis study is to identify factors that influence Alberta food processors' food safety decisions. Data for this study were collected in a 2008 survey of Alberta food processors. It is hypothesized that pressures from government, industry, and consumers influence firms' food safety decisions. Data on respondent firms' perceptions, attitudes and characteristics are analyzed using nonparametric statistical approaches; logit models are estimated. Analysis indicates that firms perceive their consumers as viewing potential hazards to be more dangerous to food safety than the firms themselves consider these hazards. Firms' responses associated good manufacturing practices with both improved food safety and improved business performance. Only minimal support is found for government, industry and consumer pressures as influencers of HACCP adoption in Alberta. Structural issues are identified which may impact policy implementation. The conclusions provide insights into Alberta food processors' food safety strategies and may contribute to food safety policy.

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1.0 Introduction

1.1 Background

Food safety is a significant issue for the firms in the Alberta food processing industry. Alberta food processors form a significant portion of the national food processing industry which is, in turn, a significant contributor to the Canadian economy. The Alberta food processing industry has recently been affected by a number of biological, economic and atmospheric influences including instances of Bovine Spongiform Encephalopathy (BSE), changes in the value of the Canadian dollar, and drought (Government of Alberta 2007). Some animal diseases are capable of crossing the species barrier and have the potential to affect food safety and threaten human health. Codex Alimentarius defines food safety as "assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use" (Codex Alimentarius 2003, p5). Food hazards, whether microbial, chemical or physical, detract from the safety of food by exposing the consumer to harm. Food safety errors or incidents can impact firms financially and damage their reputations. The potential financial and reputational losses can lead to food safety assurance becoming an important business practice.

Food safety perceptions and concerns can differ within different local, national and international contexts. Firms which sell into different markets may be faced with these different concerns and may also face differing regulations. Additionally, at the international level, different interpretations of standard production principles can lead to the creation of competitive advantage, trade

disputes, and loss of market access (Bungay 1999). In light of these challenges, exporters have occasionally responded to international concerns rather than to local or national concerns (Tanaka 2005). When firms choose not to respond to domestic concerns, both consumers and their elected officials may be motivated to influence firm decisions. Food safety is important to all industry stakeholders.

Alberta food processors are influenced by various internal and external forces (Holleran et al. 1999, Ali and Fischer 2005, and Starbird and Amanor-Boadu 2007), referred to as "drivers". Common external drivers affecting individual firms are the government and legal system (Starbird and Amanor-Boadu 2007, Holleran et al. 1999), pressure from other areas of the value chain (i.e. retailers, buyers and suppliers) (Ali and Fischer 2005), and the end consumer. Each driver can affect a food processor differently. Government is capable of altering the costs facing processors, customers with market power can affect the prices processors receive, and consumers decide whether or not to purchase the product. These external drivers can arise from different motivations and objectives. For example, government and the food industry typically view risk objectively/quantitatively (Shepherd et al. 2006); while for members of the public, subjective measures of food risk and food safety are important (Slovic et al. 2004). Internal drivers (Herath and Henson 2006) also affect firms' decision making and these may vary among firms. External and internal drivers may interact, leading to different forms of business, different business strategies, and differences in safety and quality decisions.

Food quality is multifaceted. It can be seen as a combination of attributes, just as conventional goods can be viewed as bundles of attributes (Hobbs and Kerr 2006). Food safety is a significant food quality attribute. Other attributes may include process attributes (Hobbs and Kerr 2006), sensory attributes (Müller and Steinhart 2007) and reputational attributes (Starbird and Amanor-Boadu 2007). Even when other quality attributes are present, a perceived lack of safety will often deter consumers from purchasing the product (Holleran et al. 1999). Improved information and changing technologies may affect consumers' perceptions of food safety and quality and thus change their preferences and purchase decisions (Müller and Steinhart 2007). Food safety and quality perceptions may, therefore, be dynamic, with consumer concerns potentially altering government regulations and the financial situation of food processors.

1.2 Objectives

The purpose of this thesis study was to identify the nature of influences on food safety strategies and related decisions of Alberta food processors. A survey of Alberta food processors was used to assess how Alberta food processors rank and respond to food safety issues relative to: their perceptions of consumers' concerns, their value chains, whether formal or informal; and government regulations and guidelines. We will try to assess whether differences between quantitative and qualitative/subjective risk perceptions influence Alberta food processors.

Three different factors may influence food processors' food quality strategies: the incentives that influence stakeholders; the increasing regulatory

emphasis on objective/quantitative risk analysis; and consumers' subjective/qualitative risk perceptions. In the light of these influences, which may sometimes conflict, it is not clear how firms decide on what qualifies as a food safety issue or a food quality issue. Do firms respond to and control for objective, quantitatively identified risks as their food safety controls and leave subjective consumer risk assessment for quality niche market segmentation, or do they include subjective concerns in their risk management systems? Are subjective consumers' concerns or uncertainties issues of food safety or marketing opportunities? This study seeks to identify food processing firm's motivations for adoption of food safety standards and also attempts to better understand how firms identify food hazards.

The specific objectives of this research study are:

- To investigate whether Alberta food processors' food safety systems are primarily a response to consumer concerns, value chain/industry demands, government regulations or internal drivers.
- To contribute to understanding of how these various drivers impact on processors' decisions regarding food safety versus food quality and market differentiation.
- To assess how firms attempt to control for food safety issues before and after they occur.

The data for this study are from a 2007-2008 survey of Alberta food processors that process meat (excluding seafood and shellfish), dairy, grain, and/or fruits and vegetables. For purposes of comparability some questions for

this survey are based upon some from a study by Herath and Henson (2006) of Ontario food processors; the researcher will compare the results for Alberta and Ontario firms where this is possible.

1.3 Thesis Organization

This thesis is organized as follows: Chapter Two provides three concise literature reviews of relevant background topics. These include literature on external drivers of food safety and food quality. Chapter Three includes an overview of different bodies of relevant theory as well as a discussion of three current issues facing Alberta food processors. These three issues are quality assurance systems, international trade and genetic modification. Chapter Four provides an overview of the Canadian and Albertan food processing industry and a qualitative analysis of the data, including a description of the survey of Alberta food processors. Chapter Five includes the non-parametric and principal component analyses, including some comparisons of these with results from Herath and Henson's (2006) assessment of Ontario food processors. Chapter Six includes a discussion of a principal component analysis and two binary logit models tested with respect to varying respondent characteristics. Chapter Seven concludes this thesis with a discussion of the results and outlines the conclusions and implications of the results; limitations of the study and suggestions for further research are noted.

2.0 Chapter Two: Literature Review

2.1 Overview

This chapter examines the food safety and quality literature on drivers of food safety investment. The chapter begins with a broad summary of some of the literature on food safety and quality. Topics introduced in the quality and safety summary are examined in closer detail in the following sections. The following sections include discussions regarding government, the food industry and the role of consumers in influencing private firm investment in food safety or food safety systems.

The interactions among food industry stakeholders can be complex. For example, governments attempt to influence private firms, the food industry, and consumers through the development and application of public policy. Government efforts may be in response to the concerns of food industry stakeholders such as consumers or the food industry itself. The food industry attempts to lobby the government for or against various public policies as well as attempts to influence firms within the industry and consumers. Consumers attempt to pressure individual firms and value chains and influence the government. Thus, firm food safety and investment decisions are complex and may occur in a highly interconnected environment.

Firm safety and investment decisions have been examined from multiple perspectives including government, industry and consumers. Food safety responsibilities are dynamic and shift between stakeholders (Halkier and Holm 2006). Today, food distribution networks and value chains often fill the role of

consumer gatekeepers and are highly important to processors. For example, Alberta exporters that produce non-genetically modified products must rely on European importers and distributers not to act as protective gatekeepers and penalize their products based on Canada's status as a genetically modified crop producer (Knight, Mather and Holdsworth 2005, Flynn, Marsden, and Smith 2003). Issues such as genetic modification and other consumer-driven food safety concerns will also be examined in this and later chapters.

2.2 Overview of the Food Quality and Safety Literature

It is impossible for any food to be guaranteed to be "100% safe". For this reason, Stringer (2005) reiterates that there must be an acceptable level of food risk. It is logical that there be an acceptable level of risk due to cost effectiveness of food safety controls, and limits to food safety controls. The literature on food safety and quality is extensive and has been contributed to by numerous authors, including many of those mentioned above. Safety can be directly affected by value chain members, their employees, consumers and the food production system itself. Burlingame and Pineiro (2007) hypothesized that increases in food production intensity are likely to be positively correlated with the risk of chemical and antibiotic residues. To mitigate the negative impact of increased risks or wide-scale food safety scares, firms may invest in reputational capital (Giraud-Héraud, Rouached and Soler 2006) to help build consumer trust.

The importance of food safety and quality to food industry stakeholders is illustrated by the prevalence of literature on these topics. The importance of food quality and reputation was studied by Carriquiry and Babcock (2007), who

observed that quality assurance schemes are one method of changing firm reputation and positioning a firm in the market. Davis (1990), concluded that retailers attempting to position themselves as 'high quality' must change consumer's perceptions to achieve price premiums. The change in consumer perceptions could be accomplished through investments in quality assurance schemes or in reputational capital. Investments in firm reputations can benefit firms and consumers; however, such investments can also be used to mislead consumers. Codron, Giraud-Heraud, and Soler (2005) observed that reputation protection is one incentive retailers have not to inform the public about the dangers of pesticide residues. Although important attributes, food quality is not limited to food safety and flavour.

A number of researchers have examined the costs of lapses in food safety. Loader and Hobbs (1999) discussed the 1993 Jack-in-the-Box hamburger contamination by *Escherichia coli* O157:H7 (*E.coli* O157:H7) and the costs of this. The health costs of the *E.coli* O157:H7 contamination included 300 people falling ill (Loader and Hobbs 1999), while the legal costs of a lapse can include civil liability, and the economic costs can include reputational damage, reduced sales and reduced value of the firm as seen by share prices. Loader and Hobbs (1999) noted that reputational losses may lead to significant financial losses.

One recent example of a food safety lapse was seen in the Canadian Maple Leaf Foods Inc. recall of processed meat products from the company's Toronto plant. As of 17:00 hours August 25, 2008, a *Listeria* outbreak had cost Maple Leaf an estimated $20 million dollars (CBC News 2008a). Fifty-seven people

died as a result of the outbreak (PHAC 2009). Reuters (2008) reported that the recall had pushed Maple Leaf stock to a record low on the Toronto Stock Exchange. Maple Leaf CEO Michael McCain acknowledged that the recall had affected consumer confidence (McCain 2008). Additionally, a class action lawsuit was filed against Maple Leaf by Merchant Law Group LLP. (Merchant Law Group 2008). The suit sought damages for those consumers who suffered physical illness from consuming contaminated food, suffered financial losses, or suffered mental anguish over concerns of potentially having consumed contaminated food (Merchant Law Group LLP. 2008); the lawsuit settled for $27 million dollars (CBC 2008b, CBC 2009). The Maple Leaf recall clearly demonstrates the varied effects of a food safety incident. Sporleder and Goldsmith (2001) noted that national food safety scares, such as with those seen in the UK in the 1990s, have led to decreases in tourism. Not all food safety costs are equivalent. Martinez et al. (2007) pointed out that firms of different sizes may feel the impacts of food lapses differently, with large firms feeling the loss of reputational capital more than expected financial losses. Losses associated with food safety are borne by firms as well as by consumers and by society as a whole.

Avoiding the costs associated with safety lapses, improving food quality and improved reputational capital are not the only benefits of improved food safety. Food quality and safety assurance can improve information transfer between members of the value chain (Carriquiry and Babcock 2007). Traceability systems are often associated with modern food quality assurance and can help value chain members avoid a number of financial and legal problems (Lupien

2005). Although they did not study food safety exclusively, Ahmed, Ahmed and Salman (2005) drew attention to benefits of food safety standards including: consumer assurance and protection and decreased costs within the value chain. Unnevehr, Roberts, and Custer (2004) effectively summarize the economic value of information to food safety provision, stating that *"[f]ood safety information has several different kinds of economic value to food producers, including avoidance of loss, capturing price premiums, increasing sales or reduced production costs. (Unnevehr, Roberts and Custer 2004, 215)"* The business aspect of food safety and quality may act as an internal driver of firm decision making, although the market itself will influence how internal drivers affect decision making.

As noted in the previous section, information is an important aspect of food safety within the value chain and Unnevehr, Roberts, and Custer (2004), identified information as an input at every level of the value chain. Information is important for ensuring trust among government, industry and consumers, and it is important for maintaining trust among members of a value chain. Food safety in the context of trust has been studied by Giraud-Heraud, Rouached, and Soler (2006), Lobb, Mazzocchi, and Traill (2007), and Frewer and Miles (2003). Frewer and Miles (2003) examined European consumers' trust and concluded that medical personnel were trusted sources of food safety information while government and industry were not. Their findings are indicative of the importance of maintaining trust rather than trying to rebuild it.

Value chain governance is important to the provision of food safety, the sharing of information throughout the value chain and for improving product quality. Food safety has been described as a "non-negotiable product attribute" (Verbeke et al. 2007, page 2) that is influenced by value chain governance. A number of authors have examined food safety with respect to governance. Raynaud, Sauvee, and Valceschini (2005), concluded that the less observable is an economic agent's actions, the less effective is value chain governance. Due to the credence nature of food safety, improving transparency is one method to protect food safety. While this is one possible role for government legislation, Tanaka (2005) noted that increasingly government has made industry responsible for food safety. Making industry responsible, i.e. liable, for food safety ought to increase the costs associated with free riding or shirking and decrease moral hazard. However, in spite of increased firm responsibility, governments are still taking an active role in food safety provision. Government involvement in food safety protection is evident in a variety of areas. Martinez et al. (2007) suggested that governments' desires to protect consumers has led to food quality regulations with respect to country of origin labelling, organics, genetic modification and other production technologies.

Consumer research includes many streams of literature. Food safety and quality issues have been examined from economic, sociological, and marketing perspectives. Selected theory and literature relating to sociological and marketing perspectives will be discussed in Chapter Three. From an economic perspective, food safety relative to consumers was studied by Andersen, Oksbjerg, and

Therkildsen (2005) who found that there is often a trade-off between consumer quality attributes and increased food safety. Consumers may not be willing to sacrifice flavour or texture in exchange for added safety, therefore firms must balance food safety provision with demanded attributes. Andrée (2006) found that consumers demand combinations of food attributes often taking into account other sensory attributes not related to flavour.

2.3 Factors Affecting Firms' Decisions

2.3.1 Government Regulations

There are a number of perspectives from which government regulations can be examined. This section is divided into three topics with respect to government regulations. The importance of government regulations is the first topic. The importance of regulations has been discussed by authors such as Unnevehr and Jensen (1999), Buzby and Mitchell (2006) and Hennessy, Roosen, and Jensen (2003). Studies by Antle (2000), Flynn, Marsden and Smith (2003), and Griffith (2005) are also considered in this discussion. The second topic with respect to government regulations is types of regulations. Studies by Holleran, Bredahl, and Zaibet (1999), Loader and Hobbs (1999) and Starbird (2005) as well as Havinga (2006), Giraud-Héraud, Rouached and Soler (2006), Martinez et al. (2007) and McGinnis (2007) are all discussed in the literature review on types of government regulation. The final topic included with respect to public regulations is the effects of regulation. Some of the authors whose studies are included in this section of the literature review are Holleran, Bredahl, and Zaibet (1999), Hennessy, Roosen, and Miranowski (2001), Gilliland and Manning (2002), and

Elbasha and Riggs (2003). Work by Halkier and Holm (2006), Havinga (2006), Tanaka (2006), and Hutter and Jones (2007) is also considered.

2.3.1.1 Importance of Government Regulations

Various streams of literature focus on different drivers of firms' decision making, one of which is government. Government regulations are important for mitigating market failure within the food industry and for maximizing citizens' social welfare. Government regulation of the food sector falls under its institutional responsibility; however, regulations must be dynamic and responsive to stakeholders, to the market and to political conditions. Unnevehr and Jensen (1999) explain the presence of governments' food sector regulations as twofold: first, to mitigate market failure and second, due to the experience or credence nature of food safety. They argue that market failure in the food industry occurs because the optimal level of food safety of private firms is generally below the social optimum. The presence of credence attributes can lead to asymmetric information between producers and consumers. Market failure, in the form of food safety lapses, can result from asymmetric information and differences in optimal levels of food safety as viewed by industry and society (Buzby and Mitchell 2006). The combination of asymmetric information and different optimal levels of food safety results in moral hazard situations between producers and consumers. In the food safety literature, Hennessy, Roosen, and Jensen (2003) discuss how, in the absence of regulation (and transparency) and in the presence of moral hazard, game theory dictates that firms within a value chain

will under-invest in food safety – leading to poor outcomes for consumers. The moral hazard situation between the food industry and consumers is one area where government involvement can mitigate market failure and improve social welfare.

Governments regulate food safety due to food safety's experience or credence nature (Unnevehr and Jensen 1999). The unobservable (credence) nature of quality and safety, with the resulting information asymmetries, create opportunities and incentives for firms to provide less food safety than under perfect information (Buzby and Mitchell 2006). Lack of information in complex market situations can contribute to a range of market failures from food safety lapses to an over-investment in safety. Under asymmetric information, consumers may demand the government institute minimum levels of food safety above the social optimum.

Food safety regulations may be legislated either pre-emptively to prevent market failure, or as a reaction to it. Regulations can be important for preventing food safety lapses; indicated by the focus of food safety regulations recently shifting from correction to prevention (Buzby and Mitchell 2006). To achieve food safety lapse prevention, government regulators have a variety of methods at their disposal. At a basic level, governments affect firm behaviours through changing the incentives firms face; including encouraging firms to observe or internalize some of the costs of the negative externalities they generate. Depending on the market situation and structure, regulations can be applied in different ways to generate different incentives for firms within an industry. For

example, during the 1990s BSE crisis, the British government had a focus on the beef industry; however, their mishandling of the crisis has been attributed to the governments' focus on the economic aspects of the beef industry rather than on social welfare overall (Flynn, Marsden and Smith 2003). Appropriate government regulations are important to optimizing social welfare.

It is important for governments attempting to maximize social welfare to regulate the food industry to ensure that the social costs of food safety provision do not exceed the social benefits of food safety provision. Basic microeconomic and welfare theories can demonstrate that suboptimal levels of food safety are associated with marginal social costs which do not equal the marginal social benefits of food safety. It is also possible for food safety costs to exceed the benefits of increased food safety (Antle 2000). In Canada, the social cost of food safety failures are borne by the public health system (Griffith 2005) and other social safety nets, as well as being borne directly by consumers. Following a lapse in food safety, the costs of the lapse could likely be extracted from the food industry by consumers and the government through legal action; however, to reduce the need for legal action the Canadian government can pre-emptively regulate the food industry to help prevent lapses in safety.

2.3.1.2 Types of Government Regulations

Depending on the hazard, the type of food, and the costs and benefits of regulation, governments may vary from the extremes of choosing not to regulate through to outright prohibition of the food technology or practice in question (Martinez et al. 2007). Between these two extremes, there are a variety of

different types of policies available to correct market failure. Government legislation and regulation properly applied to the food industry can be viewed as a series of incentives for firms to implement food safety standards (Holleran, Bredahl, and Zaibet 1999) or to mitigate risk in the food chain. Regulations have been defined as enforceable methods for responding to incentive problems within a value chain or for improving social welfare (Havinga 2006). Governments may choose to institute standards or use tort and liability law to encourage food safety (Loader and Hobbs 1999). Other tools that governments may use include national certification programs or mandates which improve food safety or risk management. Mandated traceability in the meat sector is one example of a policy that could improve food safety and help manage risk. The North American BSE incidents demonstrated the importance of having a system which can efficiently identify food hazards and quickly and accurately trace contaminated product back to its source (McGinnis 2007). McGinnis (2007) noted that identity preservation of foodstuffs is critical for keeping hazards out of the food chain and for disease control.

The institution of public quality standards is another type of food safety assurance regulation available to governments. Giraud-Héraud, Rouached and Soler (2006) examined public quality standards and private labels as a means of restoring damaged public trust in food in Europe. Giraud-Héraud, Rouached and Soler (2006) concluded that high quality public standards transformed the costs of quality assurance into costs of market access; this effect is highly beneficial for retailers.

Government regulations are important in situations with asymmetric information. Consumers' inability to observe food processors' food safety investments and practices leads to moral hazard situations with outcomes like BSE. In considering the issue of moral hazard between industry and consumers, Starbird (2005) discussed regulatory tools such as fines, sanctions, or legal actions, to ensure firms' compliance with regulation. Although firms have economic incentives to provide safe food, effective penalties are essential to ensure firms comply with regulations because private safety standards are not sufficient for ensuring compliance with public regulations (Havinga 2006). Thus there is interdependence between government and the food industry to ensure the credible provision of safe food, since food safety is essentially a credence attribute. In Canada, monetary fines for non-compliance with regulation may be quite low, leading to reputation damage being used as the incentive firms have to motivate compliance (Martinez et al. 2007). This has led to concerns that the Canadian incentives for ensuring federal compliance are too low and has been used to explain variations in compliance (Martinez et al. 2007). In Canada the possibility of public-private partnerships to encourage food safety was acknowledged by Martinez et al. (2007) who examined the potential for co-regulation by government and industry. An example of co-regulation is government encouraging industry to develop voluntary codes of practice.

Information is another aspect of government regulations. The more market based an economy is, the more consumers can be charged with being primarily responsible for their own health; thus there is pressure to reduce

information asymmetry and allow consumers to be more informed decision makers. If information asymmetry can be reduced, some of the market failures that exist relative to food consumption may also be reduced. Buzby and Mitchell (2006) point out that, to reduce consumer uncertainty, governments may require that firms teach consumers how to safely handle their products or reduce information asymmetry through information regulation and implementation. The effectiveness of information and labelling schemes can be questioned given that focus groups conducted by Health Canada found that Canadians lacked the nutritional knowledge to understand health claims on foods (Jones and Bourque 2003).

2.3.1.3 Effects of Government Regulations

Government regulations may lead to a variety of outcomes, some of which will be discussed in this portion of the literature review. This section generally assumes that government regulations are enacted to improve food safety and social welfare. Fulton and Giannakas (2004) argue that governments have a significant role to play in calculating and enforcing socially optimal levels of information. More generally, government actions are necessary for improving social welfare with respect to the optimal level of food safety. However, such actions require both citizen and industry support to be effective and credible. Government policy has a significant impact on the food industry. Some of the regulatory effects which will be discussed in this section are leadership within the

value chain, benefits to firms, cost effectiveness and costs of production, and regulations which are ineffective with respect to food safety.

Various studies have reported that regulations can encourage leadership within the food chain wherein leaders encourage the development of quality standards. Holleran, Bredahl, and Zaibet (1999) observed that liability laws and other food regulations may lead firms to demand traceability from their suppliers as a means of identifying points of contamination, i.e. from food mixing or temperature spikes. Liability legislation in the UK is one example (Hennessy, Roosen, and Miranowski 2001); by making retailers liable for food safety, retailers were forced to become value chain leaders, demanding quality assurance from their upstream suppliers. Tanaka (2006) found that post-BSE European legislation made retailers and the food production industry responsible for food safety. Being held liable for the safety of food products provided retailers with the incentive to manage their supply chain and helped internalize the negative externality of the costs of a food safety lapse. However, in spite of internalizing extra costs, the net returns of complying with government regulations are not always negative. For example, government institution of high minimum quality standards is beneficial for retailers because low quality public standards require retailers to invest in quality upstream in their supply chains (Rouached and Soler 2006). The institution of high minimum quality standards shifts the responsibility and costs of ensuring quality from retailers to producers, thereby providing retailers with incentives to lobby government for higher minimum quality standards (Rouached and Soler 2006).

Regulations that improve food safety may also provide food processors with other benefits. Elbasha and Riggs (2003) observed that government regulations and certification schemes can turn credence attributes into search goods that achieve price premiums, making regulations potentially beneficial for firms. In some cases, as with European retailers, regulations may not go far enough in spite of providing benefits to firms. Havinga (2006) pointed out that the protection of reputational capital may lead firms to exceed public regulations; such that the more valuable is social capital, the less likely are firms to ignore regulations. This is of interest because if regulations are intended to change the incentives faced by firms, they may be ineffective due to internal drivers. Loader and Hobbs (1999) noted that Canadian governments generally rely on market pressure to ensure regulatory compliance. Since Loader and Hobbs made their observation, Canada has experienced a series of food safety incidents including BSE. These incidents may have contributed to the food industry seeking to reassure consumers through government regulations. Rather than reacting to regulations *ex post*, there have been instances where the Canadian food industry has acted to improve food safety; looking to regulators to coordinate private food safety programs or to introduce industry-agreed upon regulations (Martinez et al. 2007). Industry cooperation to develop and adopt new regulations, guidelines and practices may reflect industry concern regarding free-riding by some and/or to avoid overly burdensome regulations. Providing reassurance to consumers would be an added benefit.

In spite of the potential benefits that may accrue to society (and in many instances to business itself) not all firms choose to comply with government regulations. In these cases regulations may have little impact on food safety. Government regulations may increase the costs facing firms or force firms to internalize social costs (Holleran, Bredahl, and Zaibet 1999) and have been ignored by the food industry (Martinez et al. 2007). Gilliland and Manning (2002) examined firms' compliance with regulation and cited such reasons as ideological differences between the regulator and the regulated bodies, opportunistic behaviour, and high compliance costs as motivators for non compliance. Hence, if firms do not feel that the costs of regulatory compliance will be cost-effective they may choose to ignore the regulation. Additionally, if the costs associated with non-compliance are low, firms may acknowledge a financial benefit from non-compliance (Starbird and Amanor-Boadu 2007). Regulation is not always the most cost effective method of achieving food safety goals and may pose particular challenges for some, i.e. for small or medium-sized firms (Martinez et al. 2007), thus encouraging their non-compliance and reducing the effect of regulations on food safety.

In spite of some firms choosing not to comply with regulations, the effects of regulations can be far-reaching as demonstrated by recent European developments. As of January 1, 2002 European regulations require each cow to have an identification number, in a central data base, to be used to track the animal from birth to final retail sale(s) (Martinez et al. 2007). This regulation requires investment at every level of the value chain. However, the effects of

government regulations are not one-sided given that governments must also respond to the effects of their regulations. Following European food safety incidents, the role of government itself changed within the EU, particularly with respect to food safety. New institutions and departments were formed to improve consumer trust and prevent similar market failures (Halkier and Holm 2006).

Following British and European food scares, British government departments were restructured and new regulatory bodies were created (Hutter and Jones 2007). One example is the Food Standards Agency (FSA). The FSA is an independent government department created by an Act of Parliament in 2000 to protect public health and consumer interests with respect to food and is responsible for much of the UK's BSE oversight (FSA 2008). It has been argued that it was government policy that led to the 1990s BSE crisis (Flynn, Marsden and Smith 2003) and in response to outcomes of those policies the government restructured. Such reactionary measures are not confined to Britain, and various studies have examined new institutions and their impacts on the food industry.

Interestingly, rather than increasing welfare for their own citizens, government officials may choose to design legislation to protect or facilitate international trade (Henson and Reardon 2005). With respect to international trade, government food policy and food safety regulations can easily impact trade relations. If food policies, regulations or incentives are inconsistent with the Sanitary and Phytosanitary provisions of the World Trade Organization, trade disputes may arise and result in damaged international relations. Three selected areas where government regulations have had a significant impact on the food

industry are: Hazard Analysis Critical Control Point (HACCP) implementation, international trade and genetically modified foods. Each will be discussed in Chapter Three.

2.3.1.4 Conclusions Regarding Government Regulations

Government regulations are important for correcting market failure and reducing information asymmetries. While a major purpose of government as an institution is to correct market failure, elected representatives may be motivated by more individualistic and political factors. Therefore, it is important to remember that government regulators must consider differences between quantitative risk assessment and socio-political risk management (Burlingame and Pineiro 2007). It can be argued that risk management should be based on risk assessment; however, there are differences between quantitative assessments, the subjective/qualitative risk assessments of members of the public, and political rationales. Both quantitative and qualitative types of assessments are important to elected government legislators and to policy makers, both for risk communication and public policy formation.

Governments attempt to protect society through risk analysis-based regulation (Martinez et al. 2007). Regulations can include a variety of policy tools that governments use to alter the incentives firms face. Recently, governments' implementation of minimum due diligence standards (e.g. HACCP and international organization for standardization (ISO) programs), have tended to change the focus of food safety regulation from correction to prevention (Buzby

and Mitchell 2006). ISO is an internationally recognized standards body which develops a variety of standards including standards for food production (West 2006, Surak 2005, Efstratiadis, Karirti and Arvanitoyannis 2000). The tendency to shift regulatory focus from correction to prevention is also seen internationally. European Union legislation introduced during the past decade has emphasised that food producers are responsible for food safety (Havinga 2006). Canada has tended to mandate food safety (Griffith 2005); a logical measure given that public expenditures on health problems resulting from unsafe food are reactionary expenses whereas mandating safety is a preventative public measure.

The speed at which changes occur in agricultural and food technologies have raised concerns of some members of the public relative to these changes. Government regulations may be capable of reducing these concerns to the benefit of both the food industry and social welfare. Andersen, Oksbjerg and Therkildsen (2005) pointed out that media attention to food safety issues can contribute both to consumer concerns and subsequent political action and new regulations. This observation was supported by Beulens et al. (2005). For example, it has been argued that if consumers perceive food risks differently than scientists, and governments have both the responsibility to protect consumers and the incentive to please them, mandated safety may misallocate resources (Cenci Goga and Clementi 2002). In Europe, and other markets, consumers and activists desire to limit consumption of foods derived from biotechnology has led to increased government regulation and standards implementation (Lupien 2005). In general,

the occurrence and publication of food scares tend to create incentives for governments to regulate.

2.3.2 Value Chains, Retailers and Firm Market Power

There is a considerable body of literature focused on the impacts of value chains and retailers on firms. A single food safety incident has the potential to hurt all players within that industry or sector regardless of the source (Havinga 2006). This can affect how individual firms, value chains and the wider industry as a whole react to food safety. Value chains and the food industry are made up of separate private firms, with varying degrees of market power, size, and expertise. Individual firms will both influence and be influenced by the value chain and by the industry.

This portion of the literature review includes assessments of the role and effects of market power within value chains. Flynn, Marsden, and Smith (2003) concluded that government not only regulates the food industry but also relies heavily on the retail sector to act as a food quality gatekeeper. Therefore, the influence of the value chain and the industry on individual private firms is important in optimizing the level of food safety provided. The selected literature review for market players, value chains, and retailers focuses on studies from North America and Europe. Three topics are examined within the context of the value chain: the individual private firm, value chains and vertically coordinated firms, and quality assurance schemes.

2.3.2.1 The Individual Private Firm

Individual private firms form the building blocks of the food industry and every value chain. Each firm interacts with other firms as suppliers, buyers, and competitors and these interactions can help dictate the level of food safety provided to end consumers. Private firm's food safety decisions may be motivated by a number of factors including laws and public or private regulations (Caswell and Jensen 2007). Firms can operate independently within a value chain or as a contracted or wholly owned member of a formally coordinated value chain.

In the previous discussion of government, differences between the firm's optimal level of food safety and consumers' optimal level of food safety were noted, as was the difference between quantitative science-based risk assessment and subjective risk assessment. Firms conduct risk assessments to optimize their food safety investment, maximize profit and protect themselves from the costs of a food safety lapse (Shepherd et al. 2006). The food safety technologies available may not match all the possible hazard sources, therefore firms must make trade-offs between broad but expensive preventative measures, or focus on critical control points and allow for the occurrence of less likely hazards (Hennessy, Roosen, and Jensen 2003). As demand for safe food increases, the potential for financial benefits from food safety innovation also increases; thus firms' desire to provide a product is expected to be positively correlated with consumers' demand for it (Buzby and Mitchell 2006). Unnevehr, Roberts, and Custer (2004 page 215) state that *"Food safety information has several different kinds of economic value*

to food producers, including avoidance of loss, capturing price premiums, increasing sales or reduced production costs."

The financial benefits from the provision of safe food may lead to investments in brand, reputational or social capital. This investment can take multiple forms including public marketing campaigns or investing in value chain quality assurance schemes. Brand or reputational capital is an asset typically requiring time and monetary investment (Collins and Burt 2006, Rundh 2005). Food scares can damage brand or reputational capital (Hennessy, Roosen, and Jensen 2003) and protection of reputational capital may lead firms to exceed public regulations (Havinga 2006). The more valuable reputational or social capital is, the less likely firms are to ignore regulations (Havinga 2006); although the more brand capital a firm holds prior to a shock the easier it may be to recover (Hennessy, Roosen, and Jensen 2003).

Managing the supply chain as a means of increasing social capital can also be effective. Gorris (2005) studied food and value chain management and observed food safety protection as one of the incentives for formal value chain emergence. The more market power a firm possesses, the more power it has to be the external motivation for its suppliers to adopt a quality assurance scheme (Holleran, Bredahl, and Zaibet 1999). Therefore the larger the firm's brand, the more incentive it may have to encourage upstream suppliers to help raise the value of the brand's social capital.

As demand for safe food increases, so does the food industry's incentive to produce this. Holleran, Bredahl, and Zaibet (1999) discuss how external customer

enforcement and the regulatory climate are significant adoption motivators for firm adoption of quality assurance standards. However, in spite of risk management along the supply chain, it is also important to include consumers in the design of risk management schemes: if consumers are the weakest link in the food chain, then industry may provide few social benefits with respect to healthcare expenditure (Halkier and Holm 2006).

2.3.2.2 Value Chains and Vertically Coordinated Firms

Value chains are being developed by industry members for a variety of reasons. For example, a value chain decision to adopt private regulations may be rooted in the current industry climate (such as instances of BSE, Foot and Mouth, or *E.coli* O157:H7) (Havinga 2006) or in the threat of new public regulations being brought forward. The literature identifies the protection of food safety and quality (Berdegué et al. 2005, Buzby and Mitchell 2006), maximizing profitability (Sporleder, Jackson and Bolling 2005), and high transaction costs (Holleran, Bredahl and Zaibet 1999) as motivators of value chain formation.

Transaction costs for achievement of known quality foods have the potential to be significantly lower than when goods are of unknown quality. Transaction costs include search, negotiation and monitoring (or moral hazard reduction) costs (Holleran, Bredahl, and Zaibet 1999). High transactions costs are a driver of vertical alignment and quality assurance systems as these systems seek to guarantee, *ex ante,* an agreed upon level of quality (Holleran, Bredahl, and Zaibet 1999). Vertical alignment, referred to in this study as formal value chains,

of a value chain can range from use of loose contracts, to specific joint investments by chain members, and to formal means of vertical integration through ownership.

Buzby and Mitchell (2006) claimed that, in an effort to protect food safety, private industry is moving away from spot market transactions toward coordinated value chains. Their finding was supported by Berdegué et al. (2005) who found that retailers were responsible for driving the development of value chains in Central America as a means of raising the quality of produce beyond what was typically available in spot market transactions. Central American retailers clearly found it was in their best interests to protect quality and safety through value chain coordination. The observations of Berdegué et al. (2005) provide general support for those of Sporleder, Jackson and Bolling (2005) who observed that vertical value chains often form as a means of maximizing chain profitability. Retailers, as market power holding firms and as gatekeepers of the foods which are commonly available to consumers, benefit from the formation of value chains.

Wrigley (2002) concluded that mergers and supply chain management allowed retailers to capture economies of scale. The literature on the role of retailers has examined retailer supply chain management in many different countries. The retail level of the value chain interacts most often with end consumers and is generally the final food gatekeeper. Consumers' demands for food safety and quality are being met by retailers who pass these demands onto their suppliers (Fulponi 2006). Safety of fresh produce is a particular issue for

retailers, which has motivated them to control their supply chains, inform consumers via private labels and encourage production segmentation and/or reduced opportunities for cross contamination (Codron, Giraud-Héraud, and Soler 2005). Within a country, where there exists an industry-wide private food safety standard, at the retail level, costs of compliance will tend to be borne by other levels of the industry as a cost of market access (Havinga 2006).

Britain is one country where retailers are taking more control of value chains and placing more responsibility on up-stream manufacturers (Ahmed, Ahmed and Salman 2005). Wrigley (2002) observed the early stages of this to be occurring in the United States. He noted that during the late 1990s market power began shifting from food manufacturers to food retailers. In Europe, the use of public food quality standards and private food quality standards have increased. Mora and Menozzi (2005) studied Italian food chains following the European BSE crisis, observing retailers' efforts to ensure safe food and the resulting development of retailer-led, multipartite supply contracts. Flynn, Marsden, and Smith (2003) also identified increasing retailer market power within the EU and discussed the implications of this with respect to government regulations. European retailers have increased their private quality standards through new procedures and used new labels to demonstrate this quality, while the European Union has also tightened up minimum quality standards (Giraud-Héraud, Rouached, and Soler 2006). Retailers are becoming more involved in upstream production as a means of establishing control and ensuring quality (Giraud-Héraud, Rouached, and Soler 2006). Jonas and Roosen (2005) observed that in

Germany, private label foods have evolved from no-name low quality goods to their current status as high quality products. Jonas and Roosen found that private labels currently compete with national brands and can improve a firm's reputational capital. From a business perspective, private labels are a logical investment for retailers given that these can be provided at lower costs than national brand products, can increase product safety and quality, and can protect retailer reputations through customer assurance (Giraud-Héraud, Rouached, and Soler 2006). Havinga (2006) found that within the European food industry, the balance of power is shifting toward retailers due to their market share and purchasing power and that retailer safety demands put pressure on the food chain ranging from producers to consumers. This author also noted that private and public food institutions have a common incentive to provide safe food; however, these institutions would tend to provide different levels of safety.

Retailer quality assurance statements require visible value chain support to be considered credible and thus provide retailers an incentive for involvement in upstream production practices and processes (Giraud-Héraud, Rouached, and Soler 2006). To ensure quality, and to be able reassure consumers of this, retailers will require their suppliers to use and document specific production processes, and be subject to monitoring (Codron, Giraud-Héraud, and Soler 2005). This retailer control has the potential to impact all Albertan processors who retail their products in external outlets and internationally.

Despite the pressure from downstream retailers to produce safe and credible products, value chains and quality assurance programs may also be

developed by upstream producers and processors. Upstream food safety precautions are effectively useless unless they are maintained throughout downstream processes and transactions (Caswell and Jensen 2007). Therefore, upstream producers and processors have an interest in assuring that their product does not become less safe downstream; while downstream processors can benefit from the efforts and precautions previously taken within the chain. Given the interconnectivity of the food industry, the safety and integrity of the industry is only as strong as the weakest point (Halkier and Holm 2006) and branded producers have an incentive to strengthen weak sections. When brand reputation depends on the reputational capital of a single firm, that firm has an incentive to increase vertical integration in effort to control quality throughout the chain (Raynaud, Sauvee and Valceschini 2005). Brand reputation can include the brand of the primary producer, the processor, or the private retailer. Firms that are seen as the weak link may therefore find themselves pressured to improve their safety systems. In value chains, firms' interdependence is both a strength and a weakness because a failure at any point may hurt all the value chain members (Hennessy, Roosen, and Jensen 2003).

2.3.2.3 Quality Assurance Schemes

Three types of quality assurance (QA) programs may be adopted by firms (Holleran, Bredahl, and Zaibet 1999). The three types of QA discussed by Holleran, Bredahl, and Zaibet (1999) are (1) internationally recognized, (2) national programs, and (3) internal private firm schemes; however, these may be

structured such that one system may satisfy the requirements of all three. All quality assurance programs rely on process documentation, third-party auditing, and certification to provide transparency and credibility to both customers and consumers (Holleran, Bredahl, and Zaibet 1999). Some firms use QA programs as a means of conducting transactions within the supply chain, thereby allowing the retailer to claim high food safety standards (Starbird and Amanor-Boadu 2007). Quality assurance schemes may span complete supply chains, whereby vertical coordination allows for or provides ex ante requirements for suppliers to adhere to (Buzby and Mitchell 2006).

Assurances that change the amount of available information to both buyers and sellers also change, and often decrease, transaction costs. Factors that tend to increase transaction costs include regulations (whether government, industry, value chain, or internal), changing liability laws (a firm found guilty of a safety failure may be required to pay all court costs of the injured regardless of the outcomes), and changing downstream demand (Holleran, Bredahl, and Zaibet 1999). The adoption of a value chain QA system may decrease costs for many firms as they improve efficiency, decrease search costs, and reduce transaction costs and risks (Holleran, Bredahl, and Zaibet 1999, Henson and Reardon 2005). Techniques used to monitor transaction costs can include laboratory tests, legal advice, product inspections and recall systems (Holleran, Bredahl, and Zaibet 1999). All of these measures may be included in QA systems.

Standardized control systems that may be adopted by firms include HACCP and ISO. HACCP is a useful system for firms wishing to implement

food safety schemes given its flexibly and ease of customization (Buzby and Mitchell 2006). As in government and public health, the emphasis on food safety within the food industry is shifting to prevention – through good agricultural practices and QA system adoption – rather than control of contaminated product (Burlingame and Pineiro 2007).

Adoption of QA systems, such as HACCP or ISO, may be seen as a quality signal for other firms, the retailer or the final seller; however QA systems tend not to be used as a quality signal to end consumers (Holleran, Bredahl, and Zaibet 1999, Raynaud, Sauvee and Valceschini 2005). ISO certification requires firms to be independently audited by a third party, which may help tighten firm production systems, increase efficiency and reduce costs (Holleran, Bredahl, and Zaibet 1999). The adoption of ISO standards may also help achieve new markets. Some firms may choose only to source products from nationally or internationally accredited suppliers (Holleran, Bredahl, and Zaibet 1999). Along with improving market access, ISO certification helps decrease transaction costs, reduces the number of audits firms must complete on their suppliers, and helps reduce the expected external losses from a food safety failure (Holleran, Bredahl, and Zaibet 1999).

Private regulations, quality assurance systems and food safety systems can originate from various sources within the food chain. Once formal value chains are established with *ex ante* standards or requirements, members of the value chain will be expected to operate by those standards or face penalties. This has

the potential to pressure firms who may have to choose among achieving new standards, increasing search costs for a buyer or going out of business.

2.3.2.4 Industry Conclusion

One common theme from this literature was that firms with market power, often retailers, apply that power to create credible value chains and consumer-focused risk management (Flynn, Marsden, and Smith 2003, Konefal, Mascarenhas, and Hatanaka 2005). Hennessy, Roosen, and Jensen (2003) noted that failure of quality and safety systems can have broad and varied consequences. Safety lapses are capable of causing both serious financial and reputational losses (Martinez et al. 2007) and given that firms within a value chain are highly interconnected a loss at one level can impact the entire chain. Hennessy, Roosen, and Miranowski (2001), in their study of leadership and safe food provision, point out that firms holding liability may be forced to become chain leaders. Jaffee and Masakure (2005) found that UK retailers put pressure onto producers and processors to absorb both more risk and higher costs; this conclusion was supported by Ahmed, Ahmed, and Salman (2005), Berdegué et al. (2005), and Fulponi (2006) as being applicable both within Europe and in other regions. Havinga (2006) and Codron, Giraud-Heraud, and Soler (2005) point out that the safety demands of retailers increasingly put pressure on the global food chain that extends to the level of consumers.

2.3.3 The Impacts of Consumers' Preferences

This section of the literature review demonstrates that consumer perceptions are subjective, complex, and multifaceted. Understanding consumers' preferences is critical to the success of firms. A large body of economic literature examines consumer perceptions, preferences, and effective demand. Food purchasers make choices, in their purchases of their preferred price and quality attribute bundles. This responsibility may help explain why concerns about food are so personal and emotionally charged (Cenci Goga and Clementi 2002). Demographics can provide insight into general concerns with respect to food; however, culture, and various personal attributes, such as locus of control, also plays a role in determining food concerns (McCarthey et al. 2007, Veeman and Li 2007, Knight and Warland 2004, Lindquist and Sirgy 2003, and Cowan 1998). These factors can contribute to fears and concerns about food. Food processors and retailers need to be aware of these concerns. When safety lapses occur the food industry must transparently communicate this, recognise the risks, and maintain consumer trust if it wants to remain credible. This section deals with consumer demand for food safety; the effects of lapses in food safety and the role of information.

2.3.3.1 Consumer Demand

2.3.3.1.1 Demand for Food Safety

Globally, numerous studies have examined foods and technologies considered by consumers to be safe, dangerous or trusted. These studies have

ranged from assessments based on small populations or regional studies to national studies and through to international comparisons (Traill et al. 2006, Siegrist, Keller, and Kiers 2006, Lobb, Mazzocchi, and Traill 2007, McCarthy et al. 2007, Roe and Teisl 2007). Consumers' perceptions of and behaviour towards food safety is currently a stand alone area of research (Starbird 2005) and is beyond the scope of this study. However, recognition of this is necessary because of consumers' role as a driver of food safety and quality.

Information about food production and consumption systems becomes more asymmetric and uncertain as populations urbanize and move away from food production areas (Goodman and DuPuis 2002). There is significant evidence from the literature that consumers lack much knowledge regarding food. For example, in their survey of Irish consumers, McCarthey et al. (2007) found that: 62% of respondents believed that organic food was the healthiest food they could eat; 51% were certain that not all processed foods were made from genetically modified ingredients; and only 36% knew with certainty that they ate DNA every day. Lack of knowledge about food highlights some of the potential difficulties the food industry faces as technology advances and the knowledge gap between consumers and industry expands. Consumers unaware of the presence of DNA in food cannot be expected to make rational choices about technologies such as genetically modified foods.

It should be noted that consumer uncertainty about food and food technology reflects only one of many areas of asymmetric information. Most consumers also have a limited understanding of common food safety science and

technologies. In his examination of an *E. coli* O157:H7 outbreak in Scotland, Pennington (2003) observed that consumers did not understand either food risk or science's ability to identify and prevent lapses in food safety; consequently consumers lacked understanding regarding why officials did not respond to and 'cure' outbreaks immediately upon discovery.

Coinciding with the decrease in common knowledge surrounding food production is an increase in purchasing power. As purchasing power has increased, consumer demand for food quality has also risen. Views of food quality vary. In Europe, quality attributes include attributes associated with production and process (location, animal density, feed, style, health, and traceability) individually or in combination (Andersen, Oksbjerg, and Therkildsen 2005). Overall, however, food safety is a large component of food quality. Consumers are unlikely to purchase a visually appealing product suspected to be contaminated with *E. coli* O157:H7, as seen in recent bacterial contamination incidents in North America. Increasing reports of food safety scares have lead to an increase in consumer concern regarding conventional food safety (Andersen, Oksbjerg, and Therkildsen 2005). This concern has been reinforced by media coverage (Lobb, Mazzocchi and Traill 2007, McCarthy et al. 2006, Lusk et al. 2002) and media may dramatise incidents to increase sales (Beulens et al. 2005). Mass media has run a number of anti-GM food news stories in North America and anti-GM food activists have often used fear campaigns as a means of influencing the public (West and Larue 2005).

To be successful, food processors must understand and respond to consumer concerns and demand for quality. However, consumers generally rely on retailers to act as food safety gatekeepers and on government to enforce this. Consumers, as members of the public, have purchasing power to motivate firms and electoral power to influence governments, although it can be argued made that the industry lobby is more effective than the consumer lobby. In spite differences in lobby power and group coordination, consumers have the potential to significantly impact the food industry.

2.3.3.1.2 Consumer Demographics and Demand for Food Safety

Consumer demographics and socioeconomic characteristics can be highly indicative of consumers' food safety concerns. For example, with respect to demographics, both Knight and Warland (2005) and McCarthy et al. (2007) examined the effects of demographics on risk perception and food safety. Gender (Knight and Warland 2004, McCarthy et al. 2007, Veeman and Li 2007) and age (Knight and Warland 2004, McCarthy et al. 2007) were associated with consumer food risk perceptions in North America and in Ireland. Other demographic factors found to influence food risk perceptions were race (Knight and Warland 2004), culture (Veeman and Li 2007), marital status and level of education (McCarthy et al. 2007). In the United States, the elderly were most concerned about food safety hazards; and with an aging population, food safety issues may become of increasing concern (Knight and Warland 2004). Knight and Warland also

identified the number of children in the home as a significant factor in influencing food risk perceptions.

Culture, as expressed by nationality, has an impact on consumers' perceptions of food risk, safety and quality. Cowan, in Sheridan, O'Keeffe, and Rogers (1998), concluded that consumers in different countries perceived food risks differently and that perceptions varied according to the product. For example, in studying European consumers, Cowan concluded that consumers differed by country in their risk perceptions of hormones in beef versus hormones in pork. His conclusion of consumer heterogeneity is consistent with the results of other studies. Another example of heterogeneous responses is the consumer response to new food technologies such as genetic modification (Hu, Veeman and Adamowicz 2004). In Europe and Asia, consumers' responses to genetically modified foods have differed drastically (Chen and Li 2007, Cauduff and Bernauer 2006).

The impacts of socioeconomic characteristics on risk perceptions are demonstrated by two studies of Canadian consumers; one by Magnusson and Cranfield (2005) and the other by Veeman and Li (2007). Magnusson and Cranfield (2005) found that consumers interested in pesticide free crops were: under 36 years of age, educated below the graduate level, concerned about the environment and their own health, and made a higher than average income. This is consistent with results reported by Veeman and Li (2007) which concluded that university graduates were more likely to perceive pesticide residues and

antibiotics as high risk issues. Levels of education were also found to impact Irish risk perceptions (McCarthy et al. 2007).

From a sociological perspective, Knight and Warland (2004) indicate that concern about food safety relies upon consumer perceptions, which are known to be heterogeneous. For example, French consumers were found to be more risk averse about genetically modified foods than Texan consumers were (Traill et al. 2006). These differences in consumers' perception can pose a problem for the food industry and for consumers' peace of mind. In addition, considering the speed at which agricultural technology changes, the gap between consumers' understanding and industry understanding can only be expected to grow. Jaenicke and Chikasada (2006) reported that new technologies may lead to negative feelings or consumer concerns. The larger the gap in consumer information, the more negative the response to new technologies may be. One new technology about which consumer concerns have been demonstrated and examined by numbers of authors is genetic modification. Johnson and Lin (2005) reported that consumers' concern over biotechnology was leading to a demand for food testing. West and Larue (2005) reported that Canadians who believed that the food they consumed would impact their household's cancer risks were more likely to become anti-genetic modification activists than those who were not concerned. However, it is necessary to remember that consumers are heterogeneous. This is highlighted by studies like Hu, Veeman and Adamowicz (2004), who found that while an appreciable group of Canadian consumers preferred non-genetically modified bread to genetically modified bread, many were indifferent.

2.3.3.1.3 Food Quality and the Effects of Lapses in Food Safety

To consumers, food quality traditionally generally includes a number of different attributes such as healthfulness, sensory characteristics, and consumer protection. For some, desired characteristics may also encompass religious aspects as well as including social or political issues such as worker or environmental welfare (Burlingame and Pineiro 2007). Consumers' perceptions of quality, safety, and reputation can also be affected by external stimuli which are under the control of food processors. For example, Ahmed, Ahmed, and Salman (2005) concluded that British consumers do not differentiate food from its packaging: these consumers tended to perceive quality from food packaging itself. It was concluded that this association can be misleading and highlights the need for accurate food information. North American studies such as by Lusk et al. (2002) suggested that although (American) media raised consumer awareness and concern over genetically modified products, consumer acceptance of genetically modified foods may be influenced by brand equity or the level of trust that consumers place in the brand.

It can be argued that consumers have increasing concerns over food safety which food processors and manufacturers will need to respond to in a transparent and credible manner. Andersen, Oksbjerg, and Therkildsen (2005) observed that, in Europe, food scares had led to a general increase in consumer concerns and that food marketing was dependent on consumers' perceptions about food quality and reputation. Burlingame and Pineiro (2007) claimed that food safety concern seemed to increase, or be positively correlated, with time. Burlingame and

Pineiro observed that with increasing concentration of food processing and manufacturing and the widening of distributional areas, food contamination can have wide and long lasting effects.

Food processing firms must respond to effects of lapses in food safety on consumers. The effects of food safety lapses in Europe have been temporally and geographically widespread and European consumers have been faced with food safety issues which range from disease to technology concerns. Disease examples include BSE, Foot and Mouth disease and the threat of avian flu. On the technological side, Europeans have expressed concerns over the safety of genetically modified food. In the UK, the effects of national food safety scares have ranged from increased concern over the food supply to decreases in tourism (Sporleder and Goldsmith 2001). In recent years a large number of studies have assessed these impacts.

There is a body of literature on the implications of trust on risk assessment which is beyond the scope of this study; however trust is critical to the food industry with respect to credence attributes (Holleran, Bredahl, and Zaibet 1999). Given that food safety is a credence attribute, if a lapse in food safety decreases consumer trust in the food production system, the repercussions could be highly negative. Consumer mistrust may damage the value chain from producers to consumers (Hennessy, Roosen, and Jensen 2003). Hennessy, Roosen, and Jensen (2003) found that [American] citizens are concerned about self-regulation and governance and if they do not trust regulators they will not be willing to pay price premiums. Price premiums act as incentives for firms to invest in food safety so

that if consumers are not willing to pay these, firms will have less of an incentive to produce food to higher than minimum public standards. Quality assurance systems are also seen to be ineffective when consumers do not trust the certifiers (Hennessy, Roosen, and Jensen 2003). Rather than having multiple markets differentiated by food quality attributes, consumers' mistrust of quality assurance and safety schemes may create a dysfunctional food market operating as "market for lemons" (Akerlof 1970). Low consumer willingness to pay for quality assurance could lead to firms discontinuing high quality production. As explained by Akerloff, low quality and consequent consumer mistrust has the potential to further decrease the quality and safety supplied by food processors.

2.3.3.1.4 The Impacts of Information on Food Safety Perceptions

Experience with food safety issues can affect consumers' concerns and preferences. Differing levels of concern and expectations have cost implications for firms that are supplying various markets but also offer niche market opportunities. Consumer differences between quantitative risk assessments and subjective/qualitative consumer risk assessments may be recognised by firms. Such differences are documented by a variety of authors, including Cenci Goga and Clementi (2002), Slovic et al. (2004), and Bruhn (2005). Cenci Goga and Clementi (2002) examined safety assurance and risk management with respect to consumers, industry and government, and concluded that that these three groups perceived and responded to risks differently. Coupled with the subjective and emotional nature of human risk perceptions observed by Slovic et al. (2004) and

Bruhn (2005), this can pose challenges for common understanding among government, industry and consumers.

Within the literature there is recognition of the importance of information on consumer responses to food and food technologies; however, this impact is still not fully understood. Kornelis et al. (2007) noted that not all consumers desire the same level of information and that individuals will use different sources of information; they identified five groups of consumers who differ in the type of food safety information sources used. Additionally, when government and industry is attempting to provide consumers with information they must consider the information quantity and form which are important for preventing information overload and consumer apathy (Verbeke et al. 2007). Bruhn (2005) observed that information is effective in reducing consumer concerns and noted that European information schemes have influenced target consumers in favour of genetic modification.

Consumers' risk perceptions are important to firms' success in sales of their products. It is expected that if consumers perceive a product to be risky or very risky, they will be less likely to purchase it. Slovic et al. (2004) discuss risk perceptions and note that people generally base their views of risk on intuition rather than on an objective measure, responding automatically to assess risk rather than conducting a systematic analysis. These authors point out that automatic risk responses tend to be based on heuristics and hypothesize that heuristics may be faster and easier than conducting an information search and becoming fully informed. The authors suggest that a "gut feeling" may help frame new

knowledge or information (Slovic et al. 2004). Subjective influences on consumers' risk assessments include outrage factors, primarily related to feelings of protectiveness, fairness and control (Bruhn 2005). Thus, consumers who do not feel in control of various attributes may perceive these as more risky or dangerous. Some credence attributes are subjectively considered to be food safety issues by some; GM food is one example, recombinant Bovine somatotropin (rBST) milk is another. A 1994 study by Fox et al. found that U.S. University students were generally opposed to rBST milk, (milk produced by cows injected with synthetic recombinant Bovine somatotropin), until presented with favourable information about this. These authors found that after receiving such information, approximately 60% of their sampled respondents were willing to purchase rBST milk at the same price as rBST-free milk.

Information is important to consumers and the methods used to convey information are also important. Bruhn (2005) discusses the need in risk communication for balanced information, acknowledging both the scientifically identified risk and any benefits from a new technology. She points out that it would also be helpful if the body informing the consumers understood consumers' perceptions and fears of the issues beforehand.

Much of the literature discussed in Chapter Two revolved around Europe while the current study focuses on Alberta, Canada. While European consumer concerns cannot be expected to translate to Canadian consumers, some overarching similarities, differences or themes may apply. The role of demographic influences may be similar and Canadian food processors can learn

from their European counterparts with respect to how they have responded to consumers. Canadian food processors can look at their consumers, identify their concerns, and respond to these on a regular basis rather then simply when a safety lapse occurs. Consumers' subjective (qualitative) perceptions of risk are heterogeneous and differ from objective perceptions of risk, as quantitatively calculated by scientific methods (Slovic et al. 2004). Müller and Steinhart (2007) noted that, due to changing consumer perceptions and new technologies, food quality is a dynamic term.

2.3.3.1.5 Summary of The Role of Consumers

Consumers are heterogeneous decision makers and vary by nationality, culture, age, level of education, marital status and the presence of small children in the household. Some consumers have very little knowledge of food production technologies. It has been argued that the more urbanized a population becomes, the wider the knowledge gap between consumers and food producers. Lack of information may lead consumers to mistrust available foods and may reduce consumers' willingness to pay price premiums for enhanced food quality Consumers' trust can influence sales and revenues of firms. Consumers' concerns over food safety can pose problems for the food production and processing industries. Where there are food safety lapses, correction of these needs to be undertaken and the principles of risk communication should be followed.

3.0 Chapter Three: Background Theory, HACCP, International Trade and Genetically Modified Foods

3.1 Overview

In Chapter Three, selected bodies of theory are discussed and literature on topics introduced in Chapter Two (HACCP, international trade and genetically modified foods) are explicitly assessed. While the general impacts of government, industry and consumers on the food industry were discussed in Chapter Two, in Chapter Three the impacts these three drivers have on HACCP, international trade and genetic modification are evaluated. HACCP is examined due to its growing importance in food safety lapse prevention, international trade is included due to its importance for improving the overall social welfare of a country, and genetic modification is examined due to its importance in addressing world hunger and because of its presence in the public eye. Genetic modification is discussed in the media and is a topic many consumers are aware of. The organization of this chapter is as follows: the chapter opens with a brief discussion of theories relevant to this thesis study, followed by discussions of HACCP, international trade and export, and of genetic modification.

3.2 Relevant Theories

A number of theories formed the basis for the literature review presented in Chapter Two. Many economic and behavioural theories can affect firms' stakeholders, industry drivers and firm decision making. These include the theory of the firm, moral hazard, agency and contract theories, as well as game theory, demand theory and organizational theory. These form the platform for studies of

the effects of government regulations, industry impacts and the effects of consumers on firms. For example, game theory has been used to predict sub-optimal firm food safety provision with respect to insufficient government regulation (Hennessy, Roosen, and Jensen 2003). In addition, externalities and social welfare are also important to the consideration of government as a food industry stakeholder and driver. Clearly, economic theory is important for understanding the interactions between the food industry and industry stakeholders but economics was not the only source of theory used in the consideration of the topics of this study. The discussion of consumer choice and its impact on firms' decision making is partially drawn from the marketing literature and the sociology literature.

Marketers specialize in understanding and manipulating consumers' perceptions and purchasing decisions. The tools they use are important to the food industry as a means of changing consumer perceptions and developing positive reputations. The two theories used from the marketing field include the locus of control theory (Lindquist and Sirgy 2003, page 40) and the theory of reasoned action (Lindquist and Sirgy 2003, page 280).

Locus of control theory is described by Lindquist and Sirgy (2003) as a categorization of consumers into external and internal categories. Externals are consumers who believe that outcomes are beyond their control, trust markets and tend not to conduct external information searches. Internals feel responsible for their actions and the outcomes of their decisions. They search for information as a basis for decision making (Lindquist and Sirgy 2003, page 40). Kornelis et al.

(2007) uses these concepts to help explain differences in consumers' information searches. Whether or not a firm perceives its consumers to be internals or externals may affect which characteristics firms use to convey product quality and may affect whether or not firms include consumer concerns in their risk analyses. This thesis study did not include a measure of firm perceptions about consumers' locus of control. However, the theory provided some of the basis for the hypothesis that firms recognize a difference between subjective/qualitative consumer concerns and hazards identified through quantitative scientific analysis, and then choose whether or not to respond to those concerns.

Lindquist and Sirgy (2003) describe the theory of reasoned action as: "*purchase results from intention to purchase, influenced by attitudes toward purchase and subjective norms.*" (Lindquist and Sirgy 2003, p 280). Under the theory of reasoned action, purchasing behaviour (*B*) is influenced by behavioural intent (*BI*). Behavioural intent is dependent on subjective norms (*SN*) and the sum of all the beliefs (A*act*) about the consequences from behaviour (*Bi*) and the evaluations of those consequences (*Ei*). Subjective norms are the sum of all the normative beliefs (*NBj*) from different sources (as from family, peers, and social pressure), with respect to the purchasing behaviour, and the consumers' motivation to act according to the subjective norms (*MCj*). Therefore, according to the theory of reasoned action, consumer purchasing behaviour can be defined as:

$$\sum_{i=1}^{m} BiEi = Aact \qquad (3.0)$$

$$\sum_{j=1}^{n} NBjMCj = SN \tag{3.1}$$

$$Aact + SN \rightarrow BI \rightarrow B \tag{3.2}$$

This theory is important to firms in predicting consumer purchases. If firms have a history of food safety lapses, the theory of reasoned action could logically be applied to predict that consumers would choose to reduce purchases of their products. The theory of reasoned action, with respect to food safety, can motivate food processors to produce safe food products. The United Nations and World Health Organizations, through the Codex Alimentarius, define food safety as "assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use" (Codex Alimentarius 2003, page 5). That is, food should not physically harm or damage the person consuming the food product when used as intended. Harm could potentially arise from microbial, chemical (Burlingame and Pineiro 2007), or physical hazards associated with the food.

Factors affecting food safety provision have been examined in the literature by multiple economic theories, including the theory of consumer behaviour, agency, and contract theories. Consumer demand, locus of control and reasoned action theories all help explain consumers' food safety concerns in North America. Following numerous food safety lapses in North America, Europe, and Asia, and in the context of the globalized markets for food, North American consumers have become increasingly concerned about food safety (Burlingame and Pineiro 2007). Consuming unsafe food decreases consumer

utility and repeated incidents may lead consumers to choose not to purchase a product in the long term. Consumers' concerns are complicated by interacting forces such as the availability of information (moral hazard and agency theories), trust in regulatory bodies and the food production industry (locus of control and reasoned action theories), and local culture (Lindquist and Sirgy 2003, Lang and Hallman, 2005, Lobb, Mazzocchi and Traill, 2007, and McCarthy et al. 2006, Bergeaud-Blacklet and Ferretti 2006). Martinez et al. (2007) concluded that consumers may expect firms to be short term profit maximizers who shirk as a means of increasing profits. Expectations of shirking could lead to heightened consumer concerns. Recall that, from a social welfare standpoint it has been argued that lapses in food safety are market failures that result from industry and society having different optimal levels of food safety (Buzby and Mitchell 2006) and that food safety problems may also arise from asymmetric information and the resulting moral hazard problem (Starbird 2005), as well as a lack of accurate information *per se*. The moral hazard problem, which results from asymmetric information between consumers and the food production industry, has implications for all industry stakeholders.

3.3 Hazard Analysis Critical Control Points System

The Hazard Analysis Critical Control Points system is designed to protect food safety by controlling points where lapses are most likely to occur (Unnevehr and Jensen 1999). The system belongs to the trend of preventing lapses in food safety rather than responding to them. HACCP systems can be used to identify likely points where food safety hazards will enter the food production system. It

can be used to prevent such hazards from contaminating foods rather than relying only on testing manufactured food to determine whether or not contamination has occurred. HACCP systems have been implemented by firms for multiple reasons. Its use may be mandated by government or other value chain members or it may be adopted for internal, firm driven reasons. Governments may place command and control restrictions on an industry or modify the incentives faced by the industry, but HACCP can be described as a combination of the two methods (Unnevehr and Jensen 1999).

The HACCP system is dynamic and can be used to continually improve production systems when properly applied (Hepner, Wilcock and Aung 2004). Thus, HACCP is a useful system for firms wishing to implement a food safety scheme. Due to its flexibly, HACCP can be applied to any number of firms and customized to different production systems (Buzby and Mitchell 2006). Ouellette (1999) observed that having a HACCP system in place to assure food safety increased efficiency, thereby saving time and money for firms which implement the system.

Firms' implementation of HACCP systems can be significantly impacted by government regulations. Due to its effectiveness, HACCP has been mandated in multiple jurisdictions. By 2002 the United States had mandated HACCP requirements for plants processing seafood, meat and poultry and for juice production (Quinn and Marriott 2002). Canadian plants that export food products to the United States are required to conform to United States Department of Agriculture HACCP regulations (Nguyen, Wilcock and Aung 2004). The

Canadian government has made HACCP mandatory in all fish and seafood value chain chains, i.e. for all processors and transporters, as well as all federally inspected meat and poultry facilities (Jol et al. 2007). It is also mandatory within the EU (Bergeaud-Blacklet and Ferretti 2006, Glynn et al. 2006).

Unnevehr and Jensen (1999) discussed the implications of regulating or mandating HACCP systems within the food industry and observed benefits to the firm and to consumers. Unnevehr and Jensen concluded that mandating HACCP decreased monitoring costs and raised food safety provision toward the optimal level through controlling points where safety lapses were most likely to occur. In this instance, government legislation and regulation improved the welfare of both private firms and society. Herath and Henson (2006) considered whether or not HACCP should be mandated in Canada. They found that firm size affected the likelihood of independent HACCP system adoption and suggested that regulation might be necessary to encourage small and medium firms to adopt the system. This finding was consistent with the findings of Holleran, Bredahl, and Zaibet (1999) who found size to be a leading indicator of whether or not firms would adopt ISO, as discussed in Chapter Two Section 2.3.2.3. Small firms were identified as experiencing less of a cost saving from adoption, whereas large firms tended to see decreased costs as the primary benefit (Holleran, Bredahl, and Zaibet 1999).

To improve national food safety and to encourage firms of all sizes to adopt HACCP, governments may have to mandate HACCP system adoption. However, Motarjemi and Mortimore (2005) found that when HACCP is

mandated, it may be rigidly applied rather than being used as a dynamic, useful tool. Therefore, Motarjemi and Mortimore (2005) argue that although HACCP can be highly beneficial to both business and food safety, its effectiveness may be decreased if there are overly rigid government requirements. When government regulations are rigid, mandated implementation may decrease the potential benefit from HACCP systems and, depending on national and international HACCP interpretations, may contribute to trade disputes.

Jol et al. (2007) studied the Canadian food industry's commitment to food safety and coordination through the development of a HACCP based program spanning multiple levels of the food chain. Quality assurance schemes such as HACCP are one method of coordinating value chains. Such schemes are useful for informing downstream value chain members about product attributes and increasingly, downstream firms encourage their suppliers to use quality assurance schemes (Carriquiry and Babcock 2007). Upstream, quality assurance schemes ensure that downstream buyers are able to assure a certain level of quality to their consumers. Whether or not consumers are educated about the name or details of the quality assurance program will likely depend on the implementing firm or value chain.

If quality assurance ensures consumers a given level of quality, success must be measured by the difference between consumers' expectations and their perceptions of the final product (Manning, Baines and Chadd 2006). HACCP programs, if they are to be marketed to consumers, must take into account the safety aspects of the system rather than some of the other attributes that indicate

quality to consumers. For food consumers, HACCP systems clearly provide benefits through food safety protection. Unfortunately and regardless of the benefits from HACCP, the system is likely unfamiliar to most consumers making HACCP itself less effective as a marketing tool beyond the value chain. Within the food industry HACCP may be a very effective marketing tool which can impact the industry positively in multiple ways. HACCP systems can increase overall industry efficiency, decrease the probability of a food safety lapse occurring and decrease costs (Hepner, Wilcock and Aung 2004, Holleran, Bredahl, and Zaibet 1999, Unnevehr and Jensen 1999). Unfortunately, in spite of benefits that accrue to consumers, firms and social welfare, HACCP still has the potential to cause problems internationally in that differing interpretations of HACCP principles between countries, or products, may lead to international trade disputes, loss of market access, or creation of a competitive advantage (Bungay 1999).

3.4 International Trade

Three food industry drivers noted in the literature review, specifically, government, the food industry, and consumers, are discussed with respect to international trade in this section. The focus in Section 3.4 will be on government regulation, noting interactions between the industry and consumers relative to trade. Government regulations are often a response intended to improve social welfare where there are negative externalities. Regulations will vary according to the structures of heterogeneous national governments. Due to national

heterogeneity, different governments may also perceive different optimal levels of public provision of food safety as well as identifying different methods to achieve those levels. Different nations face different levels of food safety risk related to cultural practices (e.g. eating raw meats or fish), standard production practices, and environmental factors (Buzby and Mitchell 2006). These differences can pose challenges for food processors wishing to export their product from one country to another. For example, in nation A the risks associated with raw meats and unpasteurized products may be considered to be within acceptable limits while in nation B, the government may decide to protect the weakest members of society, instilling stricter processing and labelling standards. Production in nation A may be less expensive. However, consumers in the more risk-averse nation B may prefer to avoid those products and may ask for government support in minimizing their availability. Such a situation could result in a trade conflict.

With the formation of trade agreements, countries typically open themselves up to increased trade. Although market access is generally viewed as being beneficial for consumers, at the level of food production there can be significant opposition to increased competition from imports. International bodies such as Codex Alimentarius, which develop consensus international food standards, may be successful in reducing differences in standards between nations. Resolutions of international trade conflicts are generally limited to three outcomes: cessation of trade, compromise between standards, or adoption of international standards (Buzby and Mitchell 2006), such as those developed by Codex. For example, Codex has developed standards for best before dates, and

defines food related terminology (Burlingame and Pineiro 2007). Unfortunately, the guidance on best practices provided by Codex may not keep pace fully with modern food technologies. Terms and concepts that have not been internationally defined may cause trade problems as each country may have a unique definition and different breadth, depth and accuracy requirements (Hobbs et al. 2005).

The European Union market, where there exists a free trade zone within the Union, is an example of the benefits of free trade among nations and the challenges of unifying food safety and quality systems across multiple countries (Halkier and Holm 2006). Free markets make it easier to buy and sell goods across international borders and should improve production efficiency and overall social welfare. However, it has been suggested that, within the European Union, varying national food safety standards may still be contributing to consumers' food safety concerns (Caduff and Bernauer 2006). While nations often base domestic food regulations on generally agreed to international standards, they do not always apply the regulations at the same level (Kuiper et al. 2001). This inconsistency may lead to consumer concerns and trade disputes.

Health care funding questions may also change national perspectives of food safety and the optimal public level of food safety governments ought to provide (Buzby and Mitchell 2006). For example, based on the argument by these authors it can be concluded that in Canada, where the health system is publically funded, the government may have more motivation to institute high safety processing standards. Following their argument further, in the United States, the consumer may have more incentive to look for highly safe products and provide

an incentive for their production given that the consumer will be covering the immediate health care costs of a lapse in food safety. National and international regulations may alter firms' ability to engage in international trade.

Value chain and food industry pressures can directly affect exporting firms. The effects of direct industry pressure can be considered in agency and contracting theory, and indirectly in organizational theory. The food industry lobby can affect government regulations (Flynn, Marsden and Smith 2003) thereby potentially indirectly impacting exporting firms. When value chains span national boundaries, not only do firms need to respond to government regulations, they may also need to respond to the issues and concerns of their downstream chain members (Codron, Giraud-Heraud, and Soler 2005). Exporting firms may face indirect pressure from the food industry in nations they export to through the import country's industry lobby. Flynn, Marsden and Smith (2003) noted that the producer lobby will work to orient policy in the producer's interest. For example, if competitor firms in the import country feel threatened by international exporters, they may ask their national governments to put in place regulations or restrictions on imported products (for recent examples, refer to R-Calf asking for restrictions on Canadian beef and American pork producers requesting protection from BSE-affected Canadian pork prices). Being able to respond to international issues can create a competitive advantage for firms. Transnational food corporations are increasingly creating international standards, bypassing local or national standards (Konefal, Mascarenhas, and Hatanaka 2005). Firms which meet these international, or potentially transnational, safety standards can compete

with other internationally standardized firms rather than local or national ones (Buzby and Mitchell 2006).

Consumers are generally perceived to benefit from international trade through lower cost products and more choice. Trade restrictions tend to reduce choice, but can be complex, as in the dispute over genetically modified foods which have been deemed safe in one country but which consumers in another do not want to consume. This issue is discussed in more depth in the following discussion of genetic modification.

3.5 Genetically Modified Foods

Genetically modified foods are the final selected example where government regulations, the value chain and consumers may have significant impacts on food industry operations. From the government perspective, history, culture and political pressures lead to heterogeneous governments with divergent regulatory techniques and applications in their efforts to achieve food safety. Alberta food processors that sell into international markets must abide by domestic food safety regulations as well as the relevant international food safety regulations. To complicate the issue for exporters, governments may draft food regulations for either or both scientific and political reasons. Bergeaud-Blackler and Ferretti (2006) found that governments in the EU have had to make decisions whether or not to use policy to protect subjective/qualitative consumer concerns; limiting genetically modified foods to ease consumer concerns is one example.

Genetic modification can provide a number of production attributes which may be beneficial to food producers and processors. Through increased yields the marginal cost of production may decrease. Genetic modification can allow crops with less pesticides applied and higher crop uniformity. In Canada, regulations apply to novel foods and plants, including genetically modified (GM) foods or foods derived from genetically modified organisms. Those which have been shown to be equivalent to their parent organism are generally accepted as safe, whereas in Europe such organisms are viewed with more suspicion (Lang and Hallman 2005). Health Canada (2006a) defines genetic modification as "*any change to the heritable traits of an organism achieved by intentional manipulation*" and regulates the products as novel foods. According to the Canadian definition, novel foods, are: "*products that have never been used as a food; foods which result from a process that has not previously been used for food; or, foods that have been modified by genetic manipulation*." (Health Canada 2006b). Within Canada regulations do not require labelling identification of approved GM food products; instead, there are national voluntary labelling standards which provide for products to be voluntarily labelled with "does/does not contain…" statements if the claim is factual and verifiable (Health Canada 2006c). Labels communicate potential dangers and benefits to consumers; for example, allergen or residue warnings and phrases such as "may contain GMO" or "contains trans-fat" are seen as a warning and may therefore be undesirable (Müller and Steinhart 2007).

The lack of Canadian labelling of GM-derived content may cause transparency problems and confuse some consumers. The domestic regulations can differ from those in international markets to which Albertan firms may want to export. One well known example of different standards is the difference between North American and European standards regarding GM food labelling. North America and Europe have different methods for regulating GM foods (Andrée 2006). In Europe and elsewhere the desire to limit consumption of foods characterised as GM foods (which includes foods derived from modern agricultural biotechnology) has led to regulations for traceability and labelling standards (Lupien 2005). Alberta exporters to Europe that handle genetically modified organisms, and ingredients derived from them, must comply with both the Canadian manufacturing standards and with European Union labelling and traceability regulations (Davies 2005).

In the previous literature review of Chapter Two, the potential role of consumer demographics on food risk perceptions and assessment was noted. This section notes drivers of consumer demand for genetically modified (GM) food and the effects of consumer demand. To this point, it has been assumed that producers' benefits of GM food tend to exceed benefits to consumers; however, Roe and Teisl (2007) note that consumers' attitudes ultimately dictate market development. If the consumers' benefits from GM food do not exceed consumers' fear or dread, the net effect will be negative (Lusk et al. 2002). Examining Canadian attitudes and responses to GM is challenging. The Canadian market for food is considerably smaller than the European or American markets

and the number of Canadian studies is correspondingly smaller but does include several studies [see Hu, Veeman and Adamowicz 2004]. It has been argued that many Canadian consumers are confused about the definition of genetically modified food, therefore labelling products as being or containing genetically modified food may not really inform consumers (Hobbs and Kerr 2006).

Beyond more concrete demographic measures, religion, ethics, and other personal values are all potential influences on food choice. Cenci Goga and Clementi (2001), on the topic of genetic modification, commented that genetic modification may be an ethical issue for some consumers and an ethical discussion of food biotechnology may not exclude risk given the personal nature of food and individual's ethics. These authors listed three main areas of ethical concerns: "the transfer of human genes to animal[s] used as food, the transfer of genes from animals whose meat is forbidden by certain religions to animals whose meat is permitted as food, and the transfer of animal genes to crop plants, which may be unacceptable to some vegetarians (Cenci Goga and Clementi 2001). Chen and Li (2007) supported these arguments of Cenci Goga and Clementi, arguing that GM foods ought to be labelled for those individuals who would chose not to consume them for religious or other dietary reasons (e.g. Vegans).

It can also be argued that rather than regulating the food industry and requiring processors to label products according to their genetically modified status, voluntary labelling provides incentives for "not-GM" labelling if demand is sufficient. One issue that relates to the problem of GM labelling is whether or

not uninformed consumption of GM food by these groups could be classified as harmful by consumers. Can the consumption of GM foods be considered harmful to sensitive consumers i.e. vegans or those with religious sensitivities? Currently these individuals may avoid GM food by purchasing and consuming organic food. However, the Maple Leaf class action settlement referred to in Section 2.2 wherein claimants suffering psychological trauma (exceeding 60 days) due to the consumption of meat potentially contaminated with *Listeria* each received $4,000 (CBC News 2008b) provides some support for the hypothesis that psychological trauma could become a legally actionable food safety hazard.

Siegrist et al. (2006) found that consumers who prefer natural foods perceive new technologies as more dreadful or unobservable. Put differently, a preference for natural foods implies that a consumer will view risks of new technology differently from consumers who are indifferent to "naturalness". Genetic modification technologies are generally unfamiliar and may therefore be seen as risky to society at large; thus Myhr and Traavik (2003) claim that it falls to scientists to identify areas of the technology that are genuinely uncertain. These authors believe it is scientists' responsibility to educate both consumers and policy makers about the known and unknown aspects of genetic modification. This claim may be oversimplified and leads to a brief discussion of the role of trust with respect to genetic modification.

Trust is important for providing consumers with food safety assurances. Much of the European animosity towards GM food is believed to stem from a distrust of scientists and government (Lang and Hallman 2005). To mitigate the

emotional and subjective nature of food risk assessment it is generally held that policy must be transparent and that information on the risk issue must be available and credible to consumers. Accurate industry information is important to consumers. However, the information source affects the credibility of information to consumers (Motarjemi and Mortimore 2005). Lang and Hallman (2005) suggest that, in the United States, the four least trusted sources of genetically modified food information were: 1) the federal government, 2) the media, 3) grocers and grocery stores, and 4) industry. These authors also noted that scientists were the most trusted information sources (Lang and Hallman 2005). The Lang and Hallman study creates an interesting situation for GM food processors. If consumers must trust information sources to accept the information as credible but do not trust the developers and regulators how can consumers be effectively informed?

Thankfully, a lack of understanding is not always sufficient to cause consumer alarm. In Ireland, a lack of understanding was not sufficient to predict consumers' fear of GM food products (McCarthy et al. 2006). Most US consumers do not have the background to understand the genetic modification process or its risks and since GM food safety is a credence attribute, consumers must rely on GM stakeholders such as industry and government (Lang and Hallman 2005). Additionally, recalling that media is distrusted but has motives to dramatise food safety lapses, consumer food safety fear is understandable. With a lack of background knowledge and understanding, many consumers may be ill-equipped to evaluate the information they receive on genetically modified foods.

West and Larue (2005) observed that the less contact and understanding Canadian consumers had with the food production system, the more likely consumers were to be anti-GM food activists.

Consumers have limited ability to ensure safety from their individual purchasing power (Starbird 2005) but recent food safety incidents have put both political and economic pressures on food producers and government for better food safety systems (Martinez et al. 2007). Public perceptions of GM foods have influenced how it is regulated in a variety of countries. In Taiwan, public reaction to GM foods affects how they are regulated (Chen and Li 2007) as in Europe. Few GM foods are found in Taiwan or the European Union countries. In contrast, 60 to 70% of all American processed foods are believed to contain one or more GM ingredient (Lang and Hallman 2005). These international differences can cause problems for exporters. If their products are being sold domestically and internationally, more effort is required to maintain the production, certification, and labelling requirements for international markets. Additionally, exporters must be aware of product destinations and potentially conflicting regulations. Officially consumers' are the focus of political and industrial restructuring in the food industry; however, each country is different and each government has different motivators and end goals (Halkier and Holm 2006).

3.6 Summary

The examination of food safety can be undertaken in light of numbers of theories from different academic disciplines. These can be highly complementary

and can contribute to understanding the food industry and the interactions which take place in it. Food industry stakeholders include government, industry and consumers and interactions may vary between each of these three stakeholders and food processors. HACCP system adoption, international trade, and the use of genetically modified food ingredients can all be affected by government regulations, industry pressures and consumers' expectations and preferences. The use of GM ingredients can affect international trade as can the implementation of a HACCP system. In the following chapters some of these issues and interactions will be explored with respect to Alberta food processors.

4.0 Chapter Four: Food Processing Industry Summaries, the Data, and Descriptive Data Analysis

This chapter presents overviews of both the Canadian and Albertan food processing industries. The distribution of food processors by the type of food sector is compared to the distribution of food processors at both the national and provincial level, since the latter is the focus of this thesis study. Chapter Four also includes a discussion of the development and administration of the survey conducted for this study. It concludes with an outline and discussion of the descriptive data and a summary of the characteristics of respondent firms.

4.1 Summary of the Canadian Food Processing Industry

The Canadian food processing industry consists of the sum of all the provincial and territorial food processing industries. Overall, at the national level, the industry is dominated by meat processing in terms of the volume of international exports, level of employment, and wages (Statistics Canada 2004). According to the most recent complete set of national data on the Canadian food industry, in 2006 there were 7399 food processing establishments reported to be operating in Canada (Statistics Canada 2008). The number of establishments refers to a count of facilities that undertake food manufacturing but does not include facilities that support manufacturing such as distribution centers (Statistics Canada 2008). This count is likely to include a number of establishments that belong to a single firm.

Of the 7399 establishments reported, there were 5116 which could be described as a member of one of the four food type groups (sectors) of meat,

dairy, grain and oilseeds, and fruit and vegetables (as seen in Table 4-0). Table 4-0 provides the numbers and percentages of total Canadian food processing establishments in 2006. In terms of the numbers of establishments associated with the four food groups, and excluding seafood, in 2006, the majority of processors were bakery and tortilla manufacturers (30.8%, or 33.9% if bakery and tortilla manufacturers are grouped with grain and oilseed milling), followed by meat product manufacturers (15.2%), dairy processers (12.7%) and fruit and vegetable preserving and specialty food manufacturers (7.3%), as seen in Table 4-0.

Table 4-0: Establishments in the Canadian Food Processing Sector in 2006

Sector description	Number of establishments	Percent of establishments
Grain and oilseed milling	233	3.1%
Fruit and vegetable preserving and specialty food manufacturing	537	7.3%
Dairy product manufacturing	937	12.7%
Meat product manufacturing	1128	15.2%
Bakeries and tortilla manufacturing	2281	30.8%
Seafood product preparation and packaging	1069	14.4%
Sugar and confectionery product manufacturing	352	4.8%
Other food manufacturing	862	11.7%
Total food manufacturing	7399	100.0%
Adapted from E-STAT table 301-0006 Principal statistics for manufacturing industries, by North American Industry Classification System (NAICS), annual (dollars unless otherwise noted) (131398 series, Available from E-STAT online, http://estat.statcan.ca.		

4.1.1 Summary of Alberta Food Processing Industry Characteristics

In 2006, Alberta ranked third in provincial food and beverage shipments to destinations outside the province, valued at $9.6 billion dollars (Government of

Alberta 2008), when total Canadian food exports were valued at $28 billion or 3.5% of global agri-food exports (Agriculture and Agri-food Canada 2008). International exports from Alberta were second in value only to those from Ontario (Government of Alberta 2008). The Alberta food processing industry is officially comprised of the following eight sectors, listed from largest to smallest by number of establishments: meat, dairy, grain and oilseeds, beverages, animal foods (includes feed), other food (includes snack foods), confectionary, fruit/vegetable preserving, specialty foods, and bakery (Government of Alberta 2008).

For the purposes of this thesis study and the survey undertaken for this purpose (referred to as the Alberta Food Processor Survey), the sample was drawn from the complete population of food industry processors as listed in two publically available sources. These sources were the Alberta Agricultural Processing Industry Directory (Alberta Agriculture and Rural Development 2008) and the list of food processors maintained by the Alberta Food Processors Association (AFPA) (AFPA 2007). Processors listed in either source were invited to participate in the survey for the current study.

In spite of the two lists it was difficult to compile a completely up-to-date food processor listing. Not all the processors listed were still in business and some processors were listed twice under different names. A distribution of food establishments amongst eight sectoral groups of Alberta food processors is reported in the Government of Alberta's agri-food "Industry Facts" webpage (Government of Alberta 2008). However, this differs somewhat from the

distribution which can be calculated from the current Agricultural Processing Industry Directory (2008) (see Tables 4-1 and 4-2). This difference may be due to the data available at the particular time of calculation and/or differences in definitions reported in the two sources. For example, not all of the food processors listed in the directory were still in business, therefore the distribution that can be calculated may be inaccurate. This study is motivated by questions of food safety focused on human foods rather than animal feeds or specialty products therefore five of the eight sectors were chosen as the focus of this study. Reflecting data availability, these five chosen sectors were condensed into four sectors for analysis. The bakery sector was combined with the grain and oilseed sector under the name "grain and oilseeds" and was used as one of the sectors of focus for this study. The other three sectors focussed on were: fruit and vegetable, meat, and dairy. Some snack foods may be included in these sectors; for example, potato chip processors were included in the "fruit and vegetable" sector while companies producing flavoured sunflower seeds were classified as grain and oilseed processors. Based on the Industry Directory, the researcher considered fruit and vegetable processors to be those processors that primarily dealt with fruit and/or vegetables, while the provincial description presented in the 2008 "Industry Facts" agri-food industry summary describes the fruit and vegetable sector as "confectionary, fruit/vegetable preserving, specialty foods". In this instance, following the definition used in this study, fruit and vegetable processors include firms that prepare fresh, ready-to-eat salads or vegetable

blends in addition to canning, freezing, processing or preserving fruit and vegetables.

The processor population sampled included 375 firms that comprised the bulk of the processors readily categorized into the four food groups outlined above. Some 148 firms listed in the Alberta Agricultural Processing Industry Directory were not included since they did not produce human food products but rather animal feeds, animal products (such as leather, wool, and yarns). Thirty-three speciality firms producing neutraceuticals and beverages or ice were also excluded.

Table 4-1: 2008 Distribution of Alberta Food Processing Establishments by Sector, Based on Data from the 2008 "Industry Facts" Webpage

Category	Percentage of total food processors	Percentage of total food processing establishments adjusted into sectors focussed upon for thesis study
Meat products	49.0%	60.5%
Dairy products	17.0%	21.0%
Bakery	3.0%	-
Confectionary, fruit/vegetable preserving, specialty foods	4.0%	4.9%
Other food (inc. snack foods)	5.0%	-
Animal foods (inc. feed)	7.0%	-
Beverages	7.0%	-
Grain and oilseeds	8.0%	13.6%*
Total	100.0%	100.0%
* Sum of Bakery and Grain and oilseed categories		
Adapted from Alberta Agriculture and Rural Development 2008, Available from: http://www.albertacanada.com/industries/890.html		

Alberta food processors can be categorised by size as small firms (for those firms with ≤ 25 employees), as medium-size firms (where there are 26-100

employees), or as large firms (in the case of >100 employees) (Government of Alberta, 2008). This characterisation slightly differs from the definitions of size used by Herath and Henson (2006) for Ontario food industry firms[1].

Table 4-2: Description of Albertan Food Processors by Sector, Classified by Number of Establishments and Percentage of Total Targeted Respondents Based Upon the Categories of the Alberta Processing Industry Directory and Alberta Industry Profiles

Sector Description	Number of establishments	Percentage of establishments
Fruit and vegetable processing and specialty food	89	24.3%
Dairy products	27	7.4%
Meat products	158	43.1%
Grain and oilseed products	93	25.3%
Total	367	100.0%

Adapted from Government of Alberta Industry Profiles and the Alberta Processing Industry Directory, Alberta Agriculture and Rural Development 2008 Available from: http://www.agric.gov.ab.ca/app68/foodindustry and http://www.albertacanada.com/industries/890.html

4.2 The Alberta Food Processor Survey

Data for this study are from a survey of Alberta food processors that sought to assess the general relevance, to the firms and their industry, of the drivers of food safety and risk management decisions discussed in the literature review. A complete copy of the survey is in Appendix A. The survey was developed, in Fall 2007, based upon observations and questions arising from a review of literature and background theory. The survey includes a number of questions applied by Herath and Henson (2007) in their study of Ontario food processors, in which these authors sought to assess whether or not HACCP should

[1] Herath and Henson described Ontario firm sizes as small if they had ≤ 20 employees, medium (if there were 21-100 employees), or large in the case where there were >100 employees.

be mandated in Canada. In addition to testing hypotheses identified for the current study, this section of the current survey may help to identify similarities and differences between the food processing industries in the two provinces.

The survey includes four parts. The first, Part A, consisted of a series of questions that indicate the major characteristics of different firms. Table 4-3 indicates the nature of the characteristics of firms queried in Part A of the survey. Some 18 characteristics are identified and used as variables to help classify respondents and to identify the characteristics of different types of firms. The characteristics of responding firms are summarised in Tables 4-8 to 4-14. Part B, the "Attitudinal" section of the survey included scaled questions that examined in turn, firm's food safety perceptions and firms' attitudes and opinions relative to food quality, business activities, genetic modification, and food safety. The third section of the survey, Part C, "Export" is specific to exporting firms and includes one question. Part D, "HACCP", includes questions relating to motivators of HACCP adoption and non-adoption used by Herath and Henson.

Table 4-3: Summary of Characteristics of Survey Respondent Firms by Variable Name, Description and Specification

Variable name	Variable description	Variable specification
SIZE	number of employees employed	0 = 1-25 employees, 1 = 26-100 employees, 2 = $\geq$ 101 employees
YEARS	number of years firm has been in business	number of years
EXP	the firm exports beyond provincial or national borders	0 = the firm does not export, 1 = the firm does export
EXP2	location(s) to which the firm exports	0 = The United States, 1 = Europe, 2 = Asia, 3 = Latin America, 4 = Africa, 5 = other country, 6 = another province, 7 = does not apply
Table 4-3: Summary of survey respondent characteristics by variable name, variable description and variable specification, continued on next page		

Table 4-3: Summary characteristics of respondent survey firms by variable name, description and specification, continued from previous page		
HACCP	the firm has implemented HACCP	0 = the firm has not implemented HACCP, 1 = the firm has implemented HACCP
HAC2	the firm intends to implement HACCP within the next six months	0 = the firm has does not intend to implement HACCP within the next six months, 1 = the firm intends to implement HACCP within the next six months
ISO	the firm is ISO certified	0 = the firm is not ISO certified, 1 = the firm is ISO certified
ISO2	the firm intends to become ISO certified within the next six months	0 = the firm has does not intend to become ISO certified within the next six months,1 = the firm intends to become ISO certified within the next six months
EMP	the firm has one or more employees dedicated to food safety on a full time basis	0 = the firm does not have one or more employees dedicated to food safety on a full time basis, 1 = the firm has one or more employees dedicated to food safety on a full time basis
HOWMANY	the number of employees a firm has dedicated full time to food safety	the number of employees dedicated to food safety on a full time basis
RECALL	whether or not the firm has had any recalls in the past three years	0 = the firm has not had any recalls in the past three years, 1 = the firm has had at least one recall in the past three years
RECAL2	number of recalls the firm has had in the past three years	the number of recalls the firm has had in the past three years
SECTOR	sector that a firm belongs to	0 = meat, 1 = dairy, 2 = grain and oilseeds, 3 = fruit and vegetables
CHAIN	the firm is a member of a formally coordinated value chain	0 = the firm is not a member of a formally coordinated value chain, 1 = the firm is a member of a formally coordinated value chain
INSPECT	customers inspect the firms' facilities	0 = customers do not inspect the firms' facilities, 1 = customers inspect the firms' facilities
CFIA	how often CFIA inspectors inspect respondents' facilities	0 = other, 1 = daily, 2 = weekly, 3 = monthly, 4 = bi-annually, 5 = annually, 6 = does not apply
CFIA2	frequency of CFIA inspections	0 = never, 1 = infrequently (quarterly or less often), 2 = frequently (daily to monthly)
ENDCONS	the firm includes end consumer concerns in the design stage of its risk management	0 = the firm does not include end consumer concerns in the design stage of its risk management 1 = the firm includes end consumer concerns in the design stage of its risk management
GOVT	perception of government standards	0 = too low, 1 = adequate, 2 = too high

Scaled questions were worded in one of three ways. Tables 4-4, 4-5, and 4-6 provide examples of the three different types of scales, i.e. level of danger, level of importance, and level of agreement, that were queried throughout the survey. Tables 4-4 through 4-6 also depict how the scales were coded for statistical analysis. In each case, the number "three" codes for neutral responses. The neutral code is expected to accommodate different potential types of respondents; 1) respondent firms to which the question did not apply, 2) respondents embarrassed or afraid to state their opinion, or 3) respondents who did not have an opinion.

Table 4-4: Example of Questions in which Food Processor Respondents were Queried on Their Level of Agreement with a Series of Statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Any media attention to your industry is positive	1	2	3	4	5

Table 4-5: Example of Questions in which Food Processor Respondents were Requested to Indicate the Importance of Various Signals to the End Consumer.

	Very unimportant	Unimportant	Neither important nor unimportant	Important	Very important
What are your main signals of food quality to the end consumer:					
Brand Reputation	1	2	3	4	5

Table 4-6: Example of Questions in which Food Processor Respondents were Queried on Their Assessment of the Danger or Safety of Various Food Safety Issues.

	Very dangerous	Dangerous	Neither dangerous nor safe	Safe	Very safe
Indicate how your facility ranks the relative hazard of these food safety issues:					
Chemical residues / contamination (process based, cleaners or disinfectants, etc.)	1	2	3	4	5

Pre-tests of the draft survey were conducted with the aid of several knowledgeable individuals specializing in various aspects of food safety in Alberta. This included pre-testing by a Safe Food Systems Specialist involved in the administration of the provincial government's HACCP adoption program and assessment by a manager at the Government of Alberta Food Processing Development Centre. In addition, the survey was examined by an Alberta Food Processors' Association representative and its content was subsequently expanded upon her recommendation. The adjusted expanded survey was also evaluated by a University of Alberta food microbiologist. These pre-tests were conducted as one-on-one interviews of the researcher with these various experts.

The survey was provided in a number of formats and administered in two phases from November 2007 until June 2008. Phase one was based on an invitation to participate in the survey that was included in the ninth issue of the 2007 Alberta Food Processors Association newsletter, published in November 2007. The invitation was in the form of a one paragraph summary of the project and included the researcher's contact information. Interested parties were requested to contact the researcher; three interested participants responded. Three survey packages were administered with two completed packages returned. The first completed survey response revealed a possible misinterpretation of two questions and thus the response was included in the pre-test group rather than as a response. The questions were clarified with new wording and use of an example. The second survey was completed by a consulting firm specializing in Food Safety Management Systems. (Not all AFPA members are food processors,

therefore firms outside the target sample received the newsletter invitation to participate). The consulting firm's response is withheld from the overall analysis. The invitation to respond was repeated and a link to the online revised version of the survey were included in the December 2007 AFPA newsletter. This generated zero response.

In January 2008, phase two of respondent recruitment began in which individual firms were contacted by phone and a representative was personally requested to participate. The managers/owners of small firms were asked to complete the survey, while for medium and large firms the production manager or quality assurance manager was asked to respond. Initially, firms in Edmonton were contacted first by phone, followed up in some instances with in-person visits. AFPA members and other food processors were contacted by phone. The survey was available electronically and in paper format. Respondents selected their preferred format and method for completing the survey, i.e. by mail, fax, email, or via personal interview. Only one response was provided completely by interview.

As of June 16th, 2008, 344 of the targeted 375 firms included in the target sample had been phoned. Of these, three were found not to be food processors while five were no longer in business. This left a potential sample size of 367 firms. One firm agreed to respond but subsequently closed its doors as of January 2008. Responses for this firm are included. A representative of another firm agreed to respond but withdrew shortly after, due to an impending plant closure. No reasons for the closures were indicated. Excluding the potential respondents

of the initial pre-test from phase one, 116 firms agreed to complete the survey. Of these, 43 surveys (37.1% of the 116 firms) were returned, representing an 11.5% overall response rate. One of these responses was completely excluded due to missing data. One other respondent did not complete one page of the survey and is excluded from the quantitative analysis in Chapters Five and Six. The information from forty two respondents was included in the non-parametric and parametric analyses conducted in Chapters Five and Six. With such a small sample the analysis must be cautiously interpreted given the potential for response bias and strategic behaviour on the part of the respondents. Overall, of the 42 respondents included, there were a total of 76 missing responses to individual questions, which represented less than one per cent of all possible question responses from the respondents. Twenty of these missing responses were for questions relating to genetically modified food while the others tended to be randomly distributed throughout other sections of the questionnaire. In at least one case, non-response was due to questions not being applicable to the respondent firm, and the representative wrote "not applicable" into the scale. Missing data was dealt with by coding this neutrally, as "three". This allowed for responses to questions that did not apply to the respondent and accommodated respondents who did not have, or refused to give, an opinion on the particular question as well as those who simply missed the question.

For purposes of preliminary analysis, responses were categorised by firm size, as determined by the number of employees[2]. Responses were also

[2] Small sized firms had 1-25 employees, medium sized firms had 26-100 employees, while large sized firms had >100 employees (Alberta Agriculture and Rural Development 2008).

categorized by the primary food group of the firm. For those firms that produced a blended product, categorization was according to the primary product or ingredient. For example, a firm that specialized in producing fancy desserts including cheesecakes, mousse, and tiramisus was classified as "dairy" due to the predominance of dairy product ingredients relative to flour or fruit. Those firms with product blends that included meat were classified as "meat" processors. Sectors were characterized broadly to allow for inter-sector comparisons. (In a study with a larger population and sample, it would be possible to sub-categorize firms by the extent of value added and to undertake intra sectoral comparisons).

4.3 Descriptive Analysis and Summary of the Data

In total, responses were received from 45 firms. One was used in the pre-test, one was not from a processor and was therefore excluded from the analysis, and a third was dropped as an incomplete response. A fourth respondent omitted answers to the questions on one of the pages in the survey. The basic characteristics of this fourth respondent are included in the summary of respondent characteristics but other content of this response is excluded from the quantitative analysis of the data. The 42 firms included in the qualitative analysis are grouped by the primary type of food that they process and also by size. Table 4-7 summarizes the distribution of firms by size and sector. The largest number of respondents are small meat processors (35.7%), followed by small fruit and vegetable processors (23.8%). One large grain and oilseeds processor responded;

however, no large dairy processors responded; responses from firms in this sector are from small and medium-size firms, see Table 4-7.

Table 4-7: Summary of Respondent Food Industry Firms by Size and Sector (Numbers and Percentages of Respondents in Each Size/Sector) (n=42)

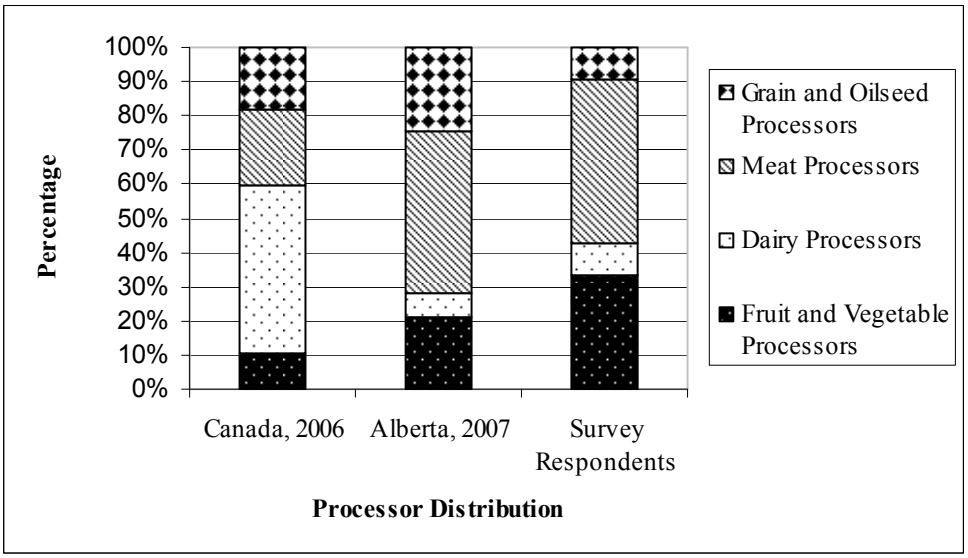
Size	Meat	Dairy	Grain and	Fruit and vegetables	Total respondents
Small (≤ 25 employees)	15 *35.7%*	2 *4.8%*	2 *4.8%*	10 *23.8%*	29 *69.0%*
Medium (26-100 employees)	3 *7.1%*	2 *4.8%*	1 *2.4%*	3 *7.1%*	9 *21.4%*
Large (≥ 100 employees)	2 *4.8%*	0 *0.0%*	1 *2.4%*	1 *2.4%*	4 *9.5%*
Total respondents	20 *47.6%*	4 *9.5%*	4 *9.5%*	14 *33.3%*	42 *100.0%*

As demonstrated in Figure 4-1 the sample is generally representative of the Alberta food processing industry. In terms of the numbers of firms, grain and oilseed processors are under represented, while fruit and vegetable processors, and dairy processors are over represented relative to the provincial distribution. Meat processors were accurately represented in term of the number of firms with respect to the provincial distribution but not in terms of their size. Overall, however, the sample is judged to be generally representative of the distribution by commodity sectors of the targeted Alberta food processors.

The distribution of firm sizes amongst respondent firms is reasonably representative of the distribution by size of the Alberta food processing industry overall, as depicted in Figure 4-2. Small firms in Alberta account for 65.8% of food processors (70.0% of survey respondent firms), while 23.7% of food processors (22.5% of the survey respondent firms) were medium size firms.

Large firms make up 10.5% of Alberta food processors (7.5% of the respondent firms).

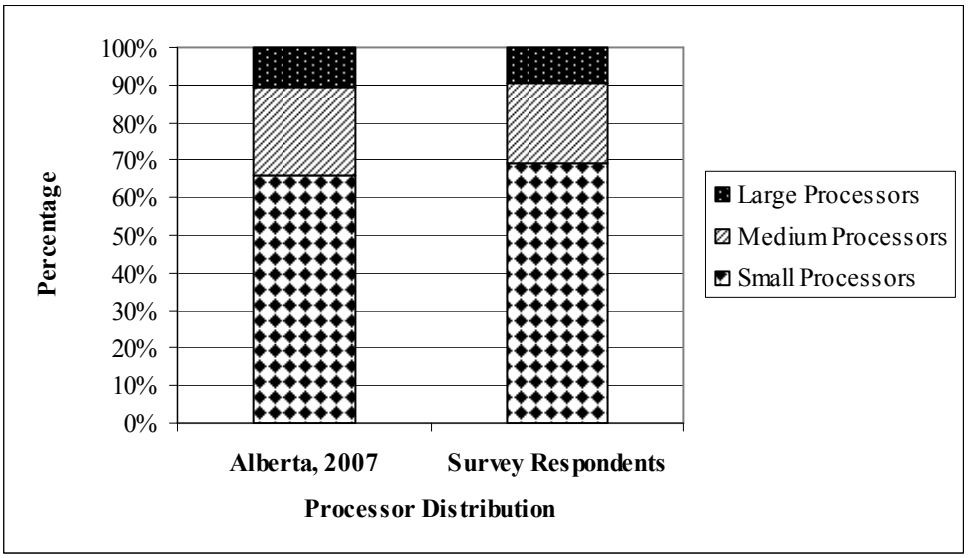
Figure 4-1: Comparison of the Distribution of the Percentages of Food Processing Establishments Belonging to Each of the Four Targeted Sectors in Canada, Alberta, and Among Survey Respondents.



Calculated from the Alberta Processing Industry Directory, Alberta Agriculture and Rural Development (2008), available from: http://www.agric.gov.ab.ca/app68/foodindustry and from E-STAT table 301-0006 (131398 series), Available from E-STAT online, http://estat.statcan.ca

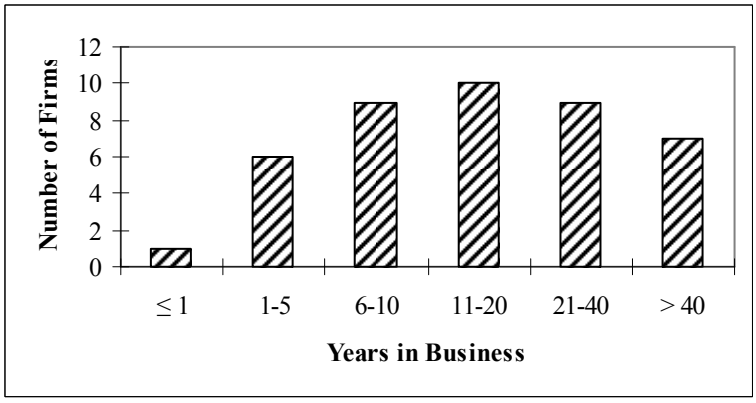
The respondent firms had varying levels of experience within the food industry, which ranged from less than one year in business to 70 years in business. Most of these firms had been in business for between six and forty years (see Figure 4-3). Surviving firms evidently require industry experience, which may enable them to respond to changing market conditions.

Figure 4-2: Comparison of the Size Distribution of Albertan Food Processing Firms[3] with the Size Distribution of Survey Respondents



Adapted from Alberta Agriculture and Rural Development Processing Industry Directory (2008) Available from: http://www.agric.gov.ab.ca/app68/foodindustry

Figure 4-3: Histogram of the Length of Years Responding Firms had Been in Business

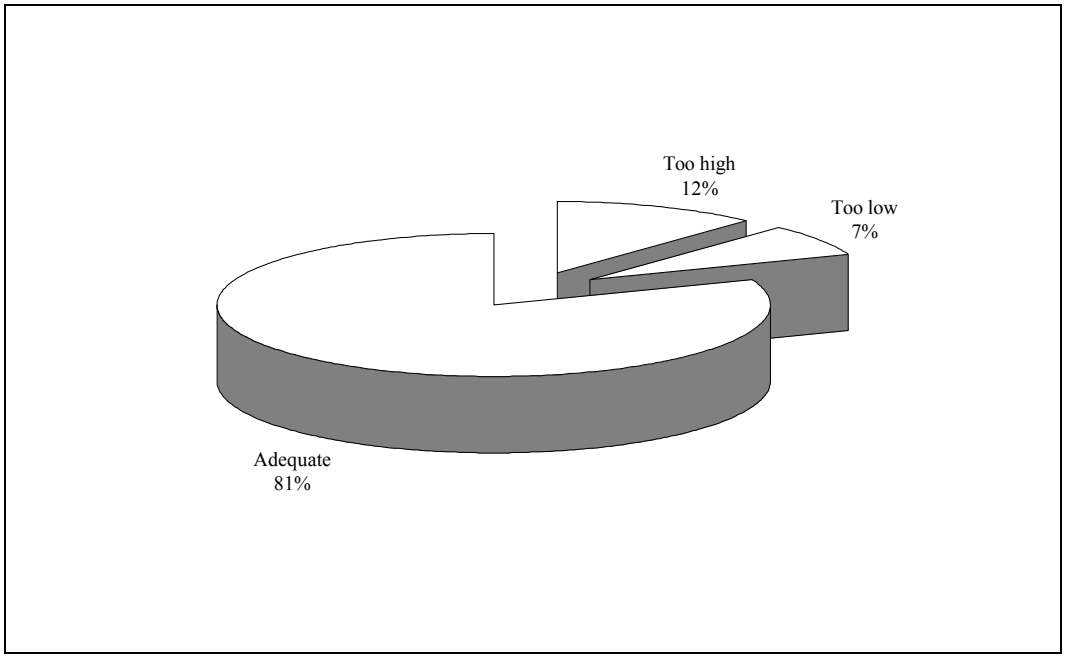


Respondents were asked to state whether government standards are "Too High," "Too Low," or "Adequate". Figure 4-4 depicts respondents' perceptions overall of government standards. The overwhelming majority of respondents, 81.0%, responded that the existing standards were adequate, while 11.9%

[3] Alberta percentages are calculated based upon the Alberta Processing Industry Directory, adjusted for firms' identified as no longer in business.

indicated that these were too high[4] and 7.1% responded that government standards were too low.

Figure 4-4: Pie Chart Depicting Aggregate of Respondents' Perceptions of Government Standards



This question regarding government standards was expanded upon in Part B of the survey. In addition to their perception of standards, respondents were also asked to indicate their level of agreement with five statements regarding compliance with government food safety regulations. For example, respondents were asked to indicate whether they "Strongly Disagree", "Disagree", "Neither Agree nor Disagree", "Agree" or "Strongly Agree", as in Table 4-4, with statements such as "Your internal safety standards are more stringent than the minimum relevant government guidelines for microbial levels." It had been pointed out by one of the pre-testers that unregulated guidelines may be more

[4] One firm chose to complete the survey expressly to demonstrate that government food safety regulations were too high. The owner of another firm strongly agreed with this view and commented that "Regulations are made by guys in suits who don't know what a knife looks like."

stringent than regulated requirements. Therefore the responses to this question are considered in conjunction with the responses to the perceived level of government standards. Figure 4-5 depicts the respondents' self reported compliance with government standards and guidelines. Firms tended to agree that they consistently met minimum safety standards. Chemical guidelines were met least consistently, but still ranked well above the neutral response (three). Respondents for the participating firms generally agreed that government regulations were adequate and self-reported meeting the guidelines.

Figure 4-5: Bar Graph Depicting Averages of Self-Reported Responses on Compliance with Government Food Safety Guidelines

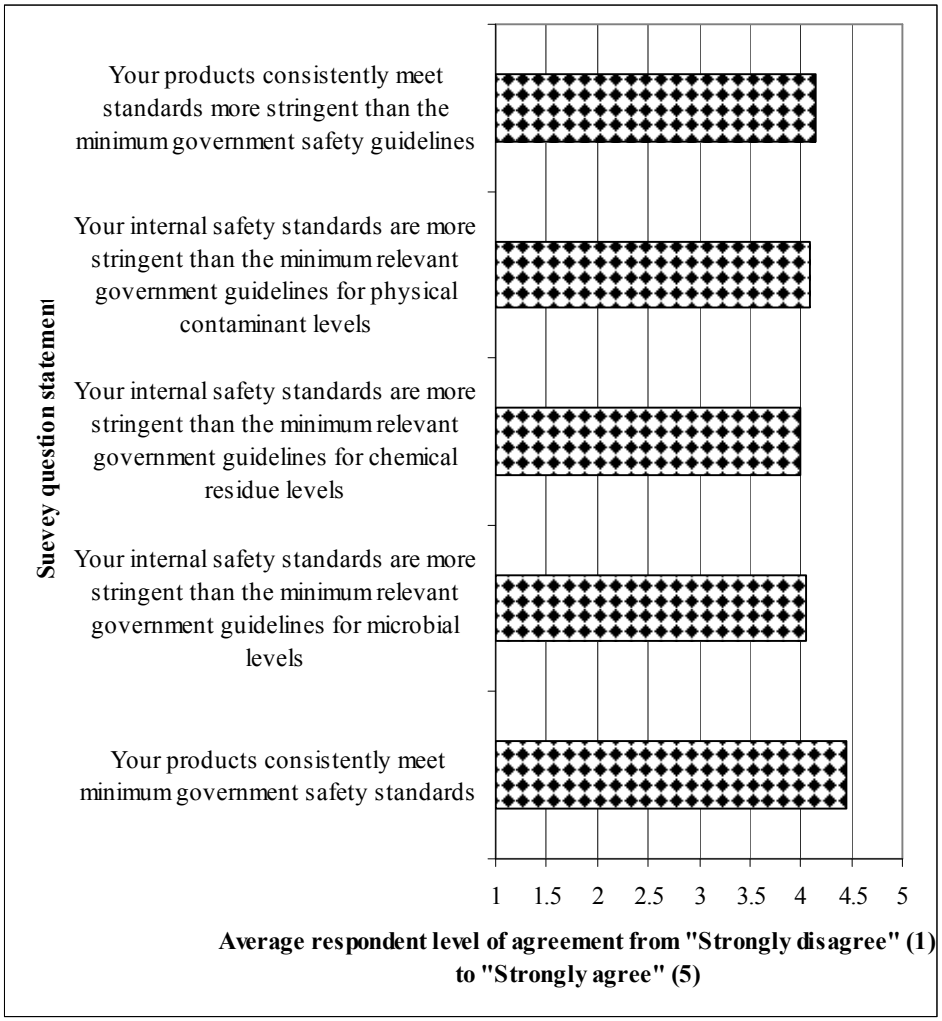


Table 4-8 depicts a summary of firm characteristics obtained from responses to Part A of the survey. Of the responding firms, 50.0% were exporters, 47.5% had implemented HACCP programs, and 60.0%[5] had employees dedicated full time to food safety, 12.5% had experienced a food recall within the past three years, 12.5% belonged to a coordinated value chain, 60.0% had customers who inspected their facilities, and 60.0% stated that their firm included end customer concerns in the design stage of their risk management programs, as indicated in Table 4-8. Where response numbers allow, the aggregate responses from firms in different food group sectors were examined separately.

Respondents were grouped based upon their primary common characteristics. Tables 4-9, 4-10, and 4-11 summarize firm characteristics according to firm size and industry sector. The majority of respondents, 29 of 42, were small, nine were of medium size and four were characterised as large. Less than half of the small respondents (37.9%) were exporters and less than half had implemented a HACCP program (34.5%), as seen in Table 4-9. About half of the respondents who had implemented a HACCP program (17.2% of the total respondents) were small meat processors. At least twenty-seven percent (27.6%) of small respondents claimed to have full time food safety employees but at least seven firms appear to have reported all employees as being dedicated to food safety on a full time basis. Only three small respondents (10.7% of small respondents) reported having a product recalled within the previous three years

[5] The percentage of respondents with dedicated food safety employees may be biased by instances in which up to seven small respondents evidently counted all employees as dedicated to food safety, i.e. seven small firms reported having between two and 20 employees dedicated full time to food safety. Excluding these seven responses, 42.3% of respondents had dedicated food safety employees.

and only four (13.8% of small respondents) indicated that they were part of an integrated value chain. Of the integrated value chain respondents, three (10.3% of small respondents) were meat processors while one was a dairy processor. Forty-four percent of small respondents had customers who inspected their facilities; over half of these respondents (27.6% of small respondents) belonged to the meat sector. The majority (58.6%) of small processors included end consumer concerns in their risk management.

Table 4-8: Summary Table of Numbers of Respondent Firms Exhibiting Selected Characteristics (n=42)

	Total	Meat	Dairy	Grains and oilseeds	Fruits and vegetables
	Numbers of firms *and percentages of total (%)*				
Export product	21 *50.0%*	8 *19.1%*	3 *7.1%*	3 *9.5%*	6 *14.3%*
Implemented HACCP	20 *47.6%*	10 *23.8%*	2 *4.8%*	2 *7.1%*	5 *11.9%*
Have dedicated food safety employees*	25 *59.5%*	10 *23.8%*	2 *7.1%*	2 *7.1%*	9 *21.4%*
Product recalls (in past 3yrs)	5 *11.9%*	0 *2.4%*	0 *0.0%*	2 *4.8%*	2 *4.8%*
Part of integrated value chain	6 *14.3%*	3 *7.1%*	2 *4.8%*	0 *2.4%*	0 *0.0%*
Customers inspect facilities	26 *61.9%*	12 *31.0%*	2 *4.8%*	2 *7.1%*	8 *19.1%*
Include end consumer concerns in risk management	23 *54.8%*	9 *21.4%*	2 *2.4%*	3 *7.1%*	10 *23.8%*

* These numbers of firms may be biased by instances in which up to seven small respondents evidently counted all employees as dedicated to food safety, i.e. seven small firms reported having between two and 20 employees dedicated full time to food safety. Excluding these seven responses, 42.3% of respondents reported having dedicated food safety employees. All of the large respondents and the majority (66.7%) of the medium respondents had at least one dedicated food safety employee.

There were nine medium sized food industry firm respondents. Table 4-10 depicts the summary of characteristics of these medium size respondent firms. The majority (66.7% of medium size firm respondents) exported product and the

majority (66.7% of medium size firm respondents) had implemented HACCP programs. Half of the medium size firm respondents that had implemented a HACCP program were in the meat sector (33.3% of medium size firm respondents) while only one of the responding medium size meat firms exported their products (11.1% of medium size firm respondents). Approximately sixty-six percent (66.7%) of medium size firm respondents indicated having dedicated food safety employees. The food safety employees were distributed among all four industry sectors. Only two, 22.2% of medium size firm respondents, had recalled one or more products within the past three years and only one respondent (11.1% of the medium size firm respondents) was part of an integrated value chain. All the medium size firm respondents had customers who inspected their facilities. Over half of these respondents (55.6% of medium size firm respondents) reported that they included end consumer concerns in the design stage of their risk management.

Table 4-9: Small Respondents' Characteristics: Summary by Industry Sector (n=29)

	Total	Meat	Dairy	Grain and oilseeds	Fruit and vegetables
	Numbers of firms *and percentages of small respondent firms (%)*				
Export product	11 *37.9%*	5 *17.2%*	1 *3.4%*	2 *6.9%*	3 *10.3%*
Implemented HACCP	10 *34.5%*	5 *17.2%*	1 *3.4%*	1 *3.4%*	3 *10.3%*
Have dedicated food safety employees*	8 *27.6%*	4 *13.8%*	1 *3.4%*	1 *3.4%*	2 *6.9%*
Product recalls (in past 3yrs)	3 *10.3%*	1 *3.4%*	0 *0.0%*	1 *3.4%*	1 *3.4%*
Part of integrated value chain	4 *13.8%*	3 *10.3%*	1 *3.4%*	0 *0.0%*	0 *0.0%*
Customers inspect facilities	13 *44.8%*	8 *27.6%*	0 *0.0%*	1 *3.4%*	4 *13.8%*
Include end consumer concerns in risk management	17 *58.6%*	8 *27.6%*	0 *0.0%*	2 *6.9%*	7 *24.1%*

* The number of firms that reported having dedicated food safety employees. This number excludes seven small firms that reported all employees as being full time dedicated to food safety in spite of employees having other duties.

Table 4-10: Medium Respondents' Characteristics: Summary by Industry Sector (n=9)

	Total	Meat	Dairy	Grain and oilseeds	Fruit and vegetables
	Numbers of firms *and percentages of medium size respondent firms (%)*				
Export product	6 *66.7%*	1 *11.1%*	2 *22.2%*	1 *11.1%*	2 *22.2%*
Implemented HACCP	6 *66.7%*	3 *33.3%*	1 *11.1%*	1 *11.1%*	1 *11.1%*
Have dedicated food safety employees	6 *66.7%*	2 *22.2%*	1 *11.1%*	1 *11.1%*	2 *22.2%*
Product recalls (in past 3yrs)	2 *22.2%*	0 *0.0%*	0 *0.0%*	1 *11.1%*	1 *11.1%*
Part of integrated value chain	1 *11.1%*	0 *0.0%*	1 *11.1%*	0 *0.0%*	0 *0.0%*
Customers inspect facilities	9 *100.0%*	3 *33.3%*	2 *22.2%*	1 *11.1%*	3 *33.3%*
Include end consumer concerns in risk management	5 *55.6%*	1 *11.1%*	1 *11.1%*	1 *11.1%*	2 *22.2%*

Only four large firms responded to the survey, see Table 4-11. Of these respondents, all four exported product, had implemented HACCP, had dedicated food safety employees, and had customers who inspected their facilities. None reported having had any product recalls or being part of an integrated value chain. Only one of the large size firm respondents, belonging to the fruit and vegetable sector, indicated including end consumer concerns in the design stage of their risk management plans.

Table 4-11: Large Respondents' Characteristics: Summary by Industry Sector (n=4)

	Total	Meat	Dairy	Grain and oilseeds	Fruit and vegetables
	Numbers of firms *and percentages of large respondent firms (%)*				
Export product	4 *100.0%*	2 *50.0%*	0 *0.0%*	1 *25.0%*	1 *25.0%*
Implemented HACCP	4 *100.0%*	2 *50.0%*	0 *0.0%*	1 *25.0%*	1 *25.0%*
Have dedicated food safety employees	4 *100.0%*	2 *50.0%*	0 *0.0%*	1 *25.0%*	1 *25.0%*
Product recalls (in past 3yrs)	0 *0.0%*	0 *0.0%*	0 *0.0%*	0 *0.0%*	0 *0.0%*
Part of integrated value chain	0 *0.0%*	0 *0.0%*	0 *0.0%*	0 *0.0%*	0 *0.0%*
Customers inspect facilities	4 *100.0%*	2 *50.0%*	0 *0.0%*	1 *25.0%*	1 *25.0%*
Include end consumer concerns in risk management	1 *25.0%*	0 *0.0%*	0 *0.0%*	0 *0.0%*	1 *25.0%*

To compare respondents' characteristics (e.g. to determine how many non-exporters had implemented a HACCP program or how many integrated value chain members also included end consumer concerns in the design stage of their risk management plans), respondents were categorised and cross-classified according to seven characteristic variables (as described in Table 4-3). These variable descriptions are: *EXP*, *HACCP*, *EMP*, *RECALL*, *CHAIN*, *INSPECT*, and *ENDCONS*.

Three cross-tabulations illustrate the three comparisons. Table 4-12 allows cross-comparisons of respondent firms that exhibit the following seven characteristics *EXP*, *HACCP*, *EMP*, *RECALL*, *CHAIN*, *INSPECT*, and *ENDCONS*. Thus this table allows cross comparison of respondents that have

implemented programs described by *EXP*, *HACCP*, *EMP*, *RECALL*, *CHAIN*, *INSPECT*, and *ENDCONS.* For example, this table illustrates the number of HACCP implementers that have experienced a recall in the past three years and the number that have had their facilities inspected by their customers[6]. In Table 4-13 respondent firms that have adopted the programs described by EXP, *HACCP*, *EMP*, *RECALL*, *CHAIN*, *INSPECT*, and *ENDCONS* can be compared with those firms that have not adopted these programs. Table 4-14 enables cross-comparisons of respondent firms that have not adopted the seven programs in question. For example, answering such questions as how many non-exporters are also not HACCP implementers or not part of an integrated value chain?

Twenty one respondents were exporters, while only 14 of these (66.7% of exporters) had implemented HACCP, see Table 4-12. This is interesting given that HACCP implementation can be a requirement for exportation of products to some markets. Seven exporters did not have HACCP programs. Three of the non-HACCP implementers exported to the United States, one of them exclusively. Four of the seven non-HACCP implementers sold their products across provincial boundaries. One of these exporting firms did not state the export destination for its products. Of the three exporters to the US, one was

[6] Each cell contains either two or three numbers. As the reader moves down a column, the uppermost number is the number of respondents characterised by both the column and row headings. Each row and each column contains one cell where a characteristic intersects itself, where the total number of firms described by that characteristic is given. (That is, these cells refer to 100.0% of the respondents that have that characteristic). All other cells contain two figures expressed as percentages. The upper italicized percentage is the percentage of respondents in the row described by the characteristic in the column, i.e. the number of respondents in the cell divided by the total number of respondents in the row. The lower bold type-face figure in the cell is the percentage of respondents in the particular column that are also described by the characteristic in the corresponding row, i.e. the number of respondents in the cell divided by the total number of respondents in the column. The emboldened percentage is calculated by dividing the number in the given row by the total number of respondents characterised by the column. This table format and calculation method was applied in Tables 4-12, and 4-14.

classified as a dairy processor while the other two were classified as fruit and vegetable processors. Only 70.0% of HACCP-implementing firms exported their products. Respondent firms that had conducted a product recall during the past three years were the most likely to report including end consumer concerns in risk management. Eighty (80.0%) percent of respondent firms that had conducted a recall within the past three years included end consumer concerns in risk management, whereas only 55.5% of HACCP implementing respondents reported including end consumer concerns.

Twenty-four firms, representing 59.0% of the total respondents, claimed to take end-consumers' concerns into account in the design stage of their risk management plans. If this is representative of the industry, consumer concerns may have a large impact on firms' risk management strategies. However, of the four responding firms classified as large, only one respondent indicated that consumer concerns were taken into account (as seen in Table 4-11), suggesting that small processors may be more concerned about the perceptions of their end-consumers. However, assessment of a larger sample would be desirable to draw firm conclusions on the implications of firm size with respect to consideration of consumers' concerns.

Respondent firms that had conducted product recalls were also characterised by having dedicated food safety employees (80.0% of respondent firms which had experienced a recall) and by not belonging to integrated value chains (0.0% of respondent firms that had experienced a product recall). In addition, respondent firms that had conducted a recall within the past three years

reported that their customers inspect their facilities (80.0% of respondent firms that had experienced a product recall). Respondents most likely to have customers inspect their facilities were those belonging to an integrated value chain (83.3% of value chain member respondents). Only 56.0% of HACCP program-implementing respondent firms had dedicated food safety employees, thus for some respondents, HACCP implementation must be a part time responsibility.

Table 4-12: Cross Tabulated Summary Table of Responding Firm Numbers and Percentages for Respondents Defined by Seven Characteristics (n=42)

	Export product	Implemented HACCP	Have dedicated food safety employees	Product recalls (in past 3yrs)	Part of integrated value chain	Customers inspect facilities	Include end consumer concerns in risk management
	Number of firms with each characteristic, *percentage of firms described by characteristic in row and characteristic in column (# in cell/ 100% total in row),* **(percentage of firms in column characterized by row (# in cell/ 100% total in column))**						
Export product	21	14	13	4	6	16	14
	100.0%	*66.7%* **(70.0%)**	*61.9%* **(52.0%)**	*19.0%* **(80.0%)**	*28.6%* **(100.0%)**	*76.2%* **(61.5%)**	*66.7%* **(58.3%)**
Implemented HACCP	14	20	14	3	6	15	11
	70.0% **(66.7%)**	***100.0%***	*70.0%* **(56.0%)**	*15.0%* **(60.0%)**	*30.0%* **(100.0%)**	*75.0%* **(57.7%)**	*55.0%* **(45.8%)**
Have dedicated food safety employees*	13	14	25	4	4	18	15
	52.0% **(61.9%)**	*56.0%* **(70.0%)**	***100.0%***	*16.0%* **(80.0%)**	*16.0%* **(66.7%)**	*72.0%* **(69.2%)**	*60.0%* **(66.7%)**
Product recalls (in past 3yrs)	4	3	4	5	0	4	4
	80.0% **(19.0%)**	*60.0%* **(15.0%)**	*80.0%* **(16.0%)**	***100.0%***	***0.00%***	*80.0%* **(15.4%)**	*80.0%* **(16.7%)**
Part of integrated value chain	6	6	4	0	6	5	4
	100.0% **(28.6%)**	*100.0%* **(30.0%)**	*66.7%* **(16.0%)**	***0.00%***	***100.0%***	*83.3%* **(19.2%)**	*66.7%* **(16.7%)**
Customers inspect facilities	16	15	18	4	5	26	16
	61.5% **(76.2%)**	*57.7%* **(75.0%)**	*69.2%* **(72.0%)**	*15.4%* **(80.0%)**	*19.2%* **(83.3%)**	***100.0%***	*61.5%* **(66.7%)**
Include end consumer concerns in risk management	14	11	16	4	4	16	24
	58.3% **(66.8%)**	*45.8%* **(55.0%)**	*66.7%* **(60.0%)**	*16.7%* **(80.0%)**	*16.7%* **(66.7%)**	*66.7%* **(61.5%)**	***100.0%***

* The number of firms may be biased by up to seven small respondents that reported all their employees were full time dedicated to food safety rather than only reporting those employees whose sole responsibility it is to monitor and control food safety.

Table 4-13 enables cross-comparison of respondents that engage in activities described by *EXP*, *HACCP*, *EMP*, *RECALL*, *CHAIN*, *INSPECT*, and

ENDCONS with those respondents that cannot be described by these characteristics. This cross-comparison allowed for further characterisation of firms and identifies common characteristics among different groups of respondents. For example, Table 4-13 depicts the number of HACCP implementers that can also be described as non-exporters. Table 4-13 highlights that the majority of exporters had not had any recalls in the past three years (81.0% of exporters) and were not part of an integrated value chain (71.4% of exporters). Respondent firms that were part of an integrated value chain had not had any product recalls during the past three years (100.0% of value chain member respondents). Belonging to an integrated value chain was one of the least common characteristics of respondents. The majority of respondent firms that included end consumer concerns in their risk management programs were not members of integrated value chains (83.3% of respondents included end consumer concerns in risk management). Respondents that had implemented HACCP tended to not be members of an integrated value chain (70.0% of HACCP implementers); similarly, respondents that had dedicated food safety employees tended to not be members of an integrated value chain (84.0% of respondents with dedicated food safety employees). Eighty percent of respondent firms that had customers inspect their facilities also tended not to be members of integrated value chains.

Table 4-14 depicts respondent firms that are not described by the seven characteristics in question, (*EXP*, *HACCP*, *EMP*, *RECALL*, *CHAIN*, *INSPECT*, and *ENDCONS*). A few interesting observations can be seen from Table 4-14.

Respondent firms that had not implemented HACCP were generally not exporters. Table 4-14 highlights that 68.2% of non-HACCP implementers did not export while 37.8% did export[7]. Unsurprisingly, 93.8% of respondent firms that were not subject to customer inspections were also not members of integrated value chains.

[7] Note that firms were asked whether they exported directly or indirectly across each of provincial or national borders. Only seven of the exporting respondent firms had not implemented HACCP and only three of these were exporting to the United States, see Table 4-12.

Table 4-13: Cross Tabulated Summary Table of Responding Firm Numbers and Percentages for Respondents Defined and Not Defined by Seven Characteristics (n=42)

		Export product	Implemented HACCP	Have dedicated food safety employees*	Have had product recalls (in past 3 yrs)	Part of integrated value chain	Customers inspect facilities	Include end consumer concerns in risk management
	Total no. of firms	21	20	25	5	6	26	24
	Number of firms with each characteristic, *percentage of firms described by characteristic in row and characteristic in column (# in row/ total in column),* **(percentage of firms in column characterized by row (# in column/ total in row))**							
Do not export product	21	0 ***0.0%***	6 *33.3%* **(30.0%)**	12 *38.1%* **(48.0%)**	1 *81.0%* **(20.0%)**	0 ***0.0%***	10 *47.6%* **(41.7%)**	9 *33.2%* **(42.7%)**
Have not implemented HACCP	22	7 *30.0%* **(33.3%)**	0 ***0.0%***	11 *30.0%* **(44.0%)**	2 *85.0%* **(40.0%)**	0 ***0.0%***	11 *50.0%* **(42.3%)**	13 *59.1%* **(54.2%)**
Do not have dedicated food safety employees	17	8 *48.0%* **(38.1%)**	6 *44.0%* **(30.0%)**	0 ***0.0%***	1 *84.0%* **(20.0%)**	2 *84.0%* **(33.3%)**	8 *47.1%* **(30.8%)**	9 *52.9%* **(37.5%)**
Have not had any product recalls within past 3yrs	37	17 *20.0%* **(81.0%)**	17 *40.0%* **(85.0%)**	21 *20.0%* **(84.0%)**	0 ***0.0%***	6 *16.2%* **(100.0%)**	22 *59.5%* **(84.6%)**	20 *54.5%* **(83.3%)**
Not part of integrated value chain	36	15 *41.7%* **(71.4%)**	14 *38.9%* **(70.0%)**	21 *33.3%* **(84.0%)**	5 ***100.0%***	0 ***0.0%***	21 *58.3%* **(80.8%)**	20 *55.6%* **(83.3%)**
Customers do not inspect facilities	16	5 *31.3%* **(23.8%)**	5 *31.3%* **(25.0%)**	7 *43.8%* **(28.0%)**	1 *6.3%* **(20.0%)**	1 *6.3%* **(16.7%)**	0 ***0.0%***	8 *50.0%* **(33.3%)**
Do not include end consumer concerns in risk management	18	7 *38.9%* **(33.3%)**	9 *50.0%* **(45.0%)**	10 *55.6%* **(40.0%)**	1 *5.6%* **(20.0%)**	2 *11.1%* **(33.3%)**	10 *55.6%* **(100.0%)**	0 ***0.0%***

* Number of firms may be biased by up to seven small respondents counting all employees as dedicated to food safety. Values were not adjusted.

Table 4-14: Cross Tabulated Summary Table of Responding Firm Numbers and Percentages for Respondents Not Defined by Seven Characteristics (n=42)

	Do not export product	Have not implemented HACCP	dedicated food safety employees	product recalls (in past 3 yrs)	integrated value chain	do not inspect facilities	end consumer concerns in risk management
	Number of firms with each characteristic, *percentage of firms described by characteristic in row and characteristic in column (# in cell/ 100% total in row)* , **(percentage of firms in column characterized by row (# in cell/ 100% total in column)**)						
Do not export product	21 ***100.0%***	15 *71.4%* **(68.2%)**	9 *42.9%* **(52.9%)**	20 *95.2%* **(54.1%)**	21 *100.0%* **(58.3%)**	11 *52.4%* **(68.8%)**	12 *57.1%* **(66.7%)**
Have not implemented HACCP	15 *68.2%* **(71.4%)**	22 ***100.0%***	11 *50.0%* **(68.8%)**	20 *90.9%* **(54.1%)**	17 *77.3%* **(47.2%)**	11 *50.0%* **(68.8%)**	9 *45.0%* **(50.0%)**
Do not have dedicated food safety employees	9 *52.9%* **(42.9%)**	11 *64.7%* **(50.0%)**	17 ***100.0%***	16 *94.1%* **(43.2%)**	15 *88.2%* **(41.7%)**	9 *52.9%* **(56.3%)**	8 *47.1%* **(44.4%)**
Have not had any product recalls within past 3yrs	20 *54.1%* **(95.2%)**	20 *54.1%* **(91.0%)**	16 *43.2%* **(94.1%)**	37 ***100.0%***	31 *83.8%* **(86.1%)**	15 *40.5%* **(93.8%)**	17 *45.9%* **(94.4%)**
Not part of integrated value chain	21 *58.3%* **(55.6%)**	22 *61.1%* **(100.0%)**	15 *41.7%* **(88.2%)**	31 *86.1%* **(83.8%)**	36 ***100.0%***	15 *48.4%* **(93.8%)**	16 *44.4%* **(88.9%)**
Customers do not inspect facilities	11 *68.8%* **(52.4%)**	11 *68.8%* **(50.0%)**	9 *56.3%* **(88.2%)**	15 *93.8%* **(40.5%)**	15 *41.7%* **(93.8%)**	16 ***100.0%***	8 50.0% **(44.4%)**
Do not include end consumer concerns in risk management	12 *66.7%* **(57.1%)**	9 *50.0%* **(40.9%)**	9 *50.0%* **(88.2%)**	17 *94.4%* **(45.9%)**	16 *88.9%* **(44.4%)**	8 *44.4%* **(50.0%)**	18 ***100.0%***

5.0 Chapter Five: Non-Parametric Quantitative Data Analysis

5.1 Hypotheses Examined Using Quantitative Data Analysis

Chapter Five includes non-parametric quantitative analyses which are used to examine a series of hypotheses. Two non-parametric tests are reported in Chapter Five that are used to assess several general hypotheses; principal component analysis and two econometric models are also applied and reported in Chapter Six. The hypotheses are based upon the literature review in Chapter Two and the background theory identified in Chapter Three. The general hypotheses tested in the quantitative analysis of this study are:

- There are no differences between food industry firms' internal perceptions of food safety risks and their views of their end consumers' perceptions of food safety risks
- Factors that affect food industry firms' views of food safety are perceived by these firms to equivalently affect their business performance
- The characteristics of food industry firms affect their perceptions of relative food safety hazards
- HACCP adoption by food industry firms is influenced by their views of government, value chains/industry and consumers

5.2 Quantitative Tests Used for Data Analysis

Two non-parametric tests were used to examine the survey data and to test hypotheses (Section 5.1) about firm behaviour. Summary statistics and

frequencies were calculated and the Wilcoxon signed rank test and the Kolmogorov-Smirnov (K-S) test were applied using SPSS 15.0.

The Wilcoxon signed rank test is a nonparametric test which can be used as an alternative to the one sample *t*-test; it tests paired data sets (Larsen and Marx 2001). When the samples meet the assumptions of the *t*-test, the Wilcoxon signed rank test tests for a significant difference between the means of the two groups; it tests for a difference in the distributions when the assumptions are not met (Winkler and Hays 1970, page 857). In this case the Wilcoxon signed rank test was used to assess differences in the distributions of Alberta food industry firms' responses in order to test 1) whether or not respondent firms themselves rank food safety issues similarly to how they perceive their consumers to rank food safety issues, 2) whether or not firms view food safety factors to be similar to business improvement factors, and 3) whether or not food safety hazards are regarded by firms as business hazards.

The tests were applied to the aggregate Alberta food processor respondents (41 observations) as well as to groups of respondents characterised by their firm's sector, size and export status. The application of the Wilcoxon signed rank test and the K-S test to the aggregate sample as well as to respondents divided into identified sizable sectors [specifically: meat (20 observations) and fruit and vegetable (14 observations)] and by other characteristics [small (28 observations) versus medium/large (13 observations) firms and exporters (21 observations) versus non-exporters (20 observations)] enabled tests of overall industry trends as well as differences and similarities across these various

groupings. For example, following the Wilcoxon signed rank test of the aggregate respondent group the Wilcoxon signed rank test results generated by testing particular responses from meat sector respondents were compared to the Wilcoxon signed rank test results generated from the responses of fruit and vegetable sector respondents. The comparison between the aggregate sample and the characteristic groupings allows for the possible identification of groups of firms which hold attitudes or perspectives that differ from the industry average. Not all categories could be compared due to the limited sample size in some groups. Due to their relatively small sample size, the medium size (n=9) and large size (n=4) respondent samples were combined and particular sets of their responses were compared with those from small firm respondents. Additionally, the dairy sector and grain and oilseed sector samples were of insufficient size to generate meaningful results thus these sectors were examined as part of the aggregate group of Alberta food processor respondents.

Through pair-wise analysis, the Wilcoxon signed rank test allows the following two thesis objectives to be met: to learn whether or not firms within the food industry recognise differences between quantitative risk assessments required by governments (or the firms themselves) in order to protect food safety, and subjective/qualitative risk assessments as conducted or perceived by members of the public, including consumers; and to identify whether or not practices which can protect food safety were also perceived by firms to be good business practices. To achieve these objectives the Wilcoxon signed rank test was used to compare responses to paired treatments, each containing a set of questions. The

term "initial treatment" refers to the Alberta food industry respondents' answers to a particular set of questions in which the respondents were requested to rank multiple subjects of consideration, whereas the "second treatment" refers to these respondents' answers to an identical set of questions with respect to a different context. For example, one set of treatments includes the set of questions: "How does *your facility* rank the relative hazard of: [chemical residues, pathogen contamination, etc]" and "How do *your end consumers* rank the relative hazard of: [chemical residues, pathogen contamination, etc]." Each question within these two treatments asked respondents to indicate their responses on a five-level rating scale from "very dangerous" to "very safe." The noted three different sets of treatments (on food safety issues; benefits to business; and hazards to business) included six, eight or ten specific questions, respectively. These are referred to here as factors, risks or issues, depending upon the set of questions being examined. The Wilcoxon signed rank test identified whether the distributions of responses to each question between the two treatments were equivalent or statistically significantly different from each other.

Additionally, it was a goal of the thesis study to identify the opinions and the strength of respondent's attitudes toward government regulations and to food quality and safety, including possible concerns relating to genetic modification of food. The Kolmogorov-Smirnov (K-S) test is the second non-parametric test used here to determine if there are significant differences in distributions of datasets that consist of responses to questions on these issues. In this study, the one sample K-S test was applied to questions from the latter three parts of the survey,

that is, the Attitudinal, Export, and HACCP queries. Rather than testing differences or similarities between paired questions, as with the Wilcoxon signed rank test, one sample K-S tests were used to assess if the distributions of survey responses were significantly different from a normal distribution. If the null hypothesis of responses following a normal distribution was rejected, respondents tended to declare an attitude toward or perception of each of the issues under consideration in each question. For example, respondents were asked to indicate whether "*The presence of GM or GM-derived ingredients is an issue of risk communication relative to your consumers,*" on a five-point rating scale from "strongly disagree" to "strongly agree." The more strongly the majority of respondents agreed or disagreed with the statement, the closer the average rank was to the tails of the rating scale, rather than being distributed normally about the mean rank of three, which indicated neither agreement nor disagreement with such a statement. Where the null hypothesis was rejected, the distribution of responses was examined to qualitatively determine the strength of respondent's attitudes and perceptions.

5.2.1 The Wilcoxon Signed Rank Test

The Wilcoxon signed rank test was used to analyze responses to matched questions within three pairs of treatments. The three pairs of treatments examined relate to alternate perspectives on: 1) relative food safety hazards, i.e. residues, contaminants and allergens, 2) the perceived importance of selected practices (i.e. good manufacturing practices, ISO, and HACCP) to food safety provision and to

improving business performance, and 3) potential risks to food safety provision and business performance (such as employee hygiene, pesticides and spoilage, etc.). These treatments involved sets of questions that asked firms to consider the issues from alternative perspectives and to rank their responses on a rating scale from one to five (see tables 4-3 to 4-5 for examples of the three types of rating scales and their coding). The first pair of treatments involve question sets that asked firms to characterise the hazards posed by various food safety issues from the firm's perspective and then their consumers' perspective: "*Indicate how your facility ranks the relative hazard of these food safety issue?*" (treatment one) and "*Indicate how your end consumers perceive the relative hazard of these food safety issues?*" (treatment two). With respect to the first pair of treatments it was hypothesized that firms are aware of the existence of subjective-objective differences between their end consumers' risk perceptions relative to quantitative risk analysis conducted by government and industry. It was also hypothesized that firm's characteristics affected whether or not subjective concerns of end consumers were taken into account in the design stage of a firms' food safety risk management procedures. The interpretation of these differences can be based upon one of two lines of reasoning. First, since there are often differences between consumers' perceived (qualitative or subjective) concerns and scientific-based (quantitative or objective) risk assessments (Slovic et al. 2004), those firms aware of this may be taking consumer concerns into account. Alternatively, it may be reasoned that firms that perceive few differences between consumers' subjective concerns and their own objective risk assessments are not aware of

potential differences between subjective and objective risk assessments. If the first reasoning applies in the interpretation of the results, groups of firms whose responses generated higher numbers that indicate statistically significant differences between their own risk assessments and their end consumers' perceived assessments might be better able to respond to those subjective concerns than those that noted no differences. Specifically, awareness of perceptions of end consumers' concerns may reflect a firm's ability to prepare for or respond to those concerns.

Differences in paired responses to two other sets of treatments were also assessed with the Wilcoxon signed rank test. The second application of the Wilcoxon signed rank test considered the second pair of treatments. The second pair of treatments involve question sets that asked firms to state the importance of various factors to both the provision of food safety and to improvement of business performance: *"State the importance of each of these factors to the provision of food safety"* (treatment one) and *"State the importance of each of these factors on improving firm business performance"* (treatment two). The third pair of treatments that are assessed included a set of questions which asked firms to state the levels of risk that various factors posed to food safety and to business performance: *"State the risk each of the following poses to the provision of food safety?"* (treatment one) and *"State the risk each of the following poses to business performance?"* (treatment two). It was hypothesized that there are differences between the perceived importance of the cited factors to food safety provision, as versus the importance of the same set of factors for business

performance. Theoretical concepts discussed in Section 2.3 hold that lack of food safety has negative effects on business performance, therefore it was hypothesized that risks to food safety will also be perceived as risks to business performance. Specifically, the Wilcoxon signed rank test was used to compare the responses to the sets of questions within the latter pairs of treatments (i.e. "*State the importance of each of these factors to the provision of food safety*," versus "*State the importance of each of these factors on improving firm business performance*," and "*State the risk each of the following poses to the provision of food safety*," versus "*State the risk each of the following poses to business performance*") in order to determine if 1.) firms consider factors that are likely to influence provision and protection of food safety also to be factors likely to improve or protect business performance; or 2.) whether there are differences between food safety practices and factors which improve or protect business performance.

5.2.2 Application of the Wilcoxon Signed Rank Test

The Wilcoxon signed rank test is effective and produces significant results even when applied to small samples (Larsen and Marx 2001). Samples where $n > 12$, are considered to be a large sample size and the test statistic W' becomes normalized, because, *"as n gets large, the distribution of W' converges to the standard normal. Furthermore, for n even as small as 13,* $f_{w'}(w')$ *and* $f_z(z)$ *are remarkably similar."* Larsen and Marx 2001 p. 700.

For $n > 12$, the normalized test statistic is:

$$W' = \frac{W - E(W)}{\sqrt{VAR(W)}} \tag{5.0}$$

where "*E(W) and VAR(W) are the expected value and variance of W when* H_0 *is true.*" [Larsen and Marx 2001 p. 700]:

$$E(W) = \frac{N(n+1)}{4} \tag{5.1}$$

$$VAR(W) = \frac{[n(n+1)(2n+1)]}{24} \tag{5.2}$$

The normalized distribution of W is:

$$W' = \frac{W - [n(n+1)/4]}{\sqrt{[n(n+1)(2n+1)]/24}} \tag{5.3}$$

Thus to test:

$$H_0 : \tilde{\mu} = \tilde{\mu}_0 \tag{5.4}$$

versus

$$H_1 : \tilde{\mu} \neq \tilde{\mu}_0 \tag{5.5}$$

when $n > 12$, reject H_0 when $W' \geq 1.96$ or when $W' \leq -1.96$. Samples sizes where $4 \leq n \leq 12$ can be compared to the W statistic table (Larsen and Marx 2001).

The strength of the Wilcoxon signed rank test applied to small samples made it possible to test for differences in the data between groups of firms according to characteristics (i.e. firms' size, sector, and export status) as well as in aggregate. Recall that, due sample size limitations for some sector groups, only the responses from firms in the meat sector and the fruit and vegetable sector were tested with the Wilcoxon signed rank test. Additionally, due to differences in the

sample sizes when respondents are grouped according to common characteristics it is challenging to compare the groups directly. Applying the Wilcoxon signed rank test according to respondents' characteristics allows comparisons to be made between responses of groups of food firms based on firms' characteristics. The Wilcoxon signed rank test was used to examine the hypothesis that firms' characteristics affect their perceptions of relative food safety hazards, the perceived importance or risk of various factors to food safety provision and business performance (Section 5.1). For example, larger firms may be better able than small firms to invest in research on hazards and the development of new methods and processes to counter these. For this reason small firms may regard hazards differently than larger firms.

5.2.3 Results of the Pair-wise Tests of Responses Regarding Relative Food Safety

The set of questions that query food safety hazards relate to the second general hypothesis, i.e. that firms' characteristics could alter their perceptions of relative food safety hazards (Section 5.1). This pair of treatments is found in tabular form in Appendix A and is designated as Att3 (treatment one) and Att4 (treatment two). Table 5-0 summarizes the responses to each question within the treatments. This table indicates the average of responses and significant differences in the distributions of responses to each of the ten food safety issues that respondents were asked to consider in the first pair of treatments. The rating scale in these two treatments was anchored between the ranks of "very dangerous" and "very safe". The null hypothesis for the Wilcoxon signed rank

test was that the risk perception of the firm shown in the distribution of responses to an issue, e.g., allergens, is the same as the firm's perceived risk ranking of its end-consumers. From testing for differences in the distribution of survey responses, the null hypothesis was rejected at the $\alpha = 5\%$ level of significance for four of the ten issues queried. These four issues were "GMO sourced ingredients," "allergens," "animal disease," and "pesticide residue." That is, for each of these four issues, the distribution of respondents' rankings relative to their own interests differed from the distribution of their responses to the same issues in the context of how these firms perceived their consumers to rank the issue.

In each case where the response distribution differed, the respondent firms perceived their consumers to rank the issue, on average, as being more dangerous to food safety than the respondent firms themselves ranked these issues. The response distributions were statistically significant with respect to "allergens" and the average hazard ranking fell into the dangerous category for both treatments. However, qualitatively, respondents generally perceived their end consumers to rank "allergens" as more dangerous than the respondents themselves did, as seen in Table 5-0. The expectation in this case appears to be logical given the personal nature of food allergies. The average rank calculated from respondent firms' rankings of the danger of "GMO sourced ingredients" to food safety was neither dangerous nor safe, as seen in Table 5-0. The distribution of firm responses regarding the risk of "GMO sourced ingredients" was statistically significantly different from the distribution of responses that end consumers' were perceived to have, (even though the average of the rank distributions consumers' were

perceived to apply was also neither dangerous nor safe). That is, firm's own assessments of the danger to food safety of "GMO sourced ingredients" and their views of their customers' assessments of this feature both generated average rank values within the neither dangerous nor safe category. Consumers were perceived to rank GMO sourced ingredients as being less safe than do the industry respondents.

"Animal disease" was the risk issue with significantly different distributions of risk rankings where there was the largest discrepancy between the average of respondent firms' rankings of the risk to the firm and the perceived risk ratings that they ascribed to their customers, is "animal disease." Respondent firms, on average, perceived animal disease to be neither dangerous nor safe, while, on average, they perceived their consumers' to rank animal disease as dangerous, as seen in Table 5-0. The average rank applied to "pesticide residues" by industry respondents was neither dangerous nor safe to the food safety of their operations but firms perceived their end consumers' to view "pesticide residues" as generally dangerous to food safety, as seen in Table 5-0.

Table 5-0: Industry Average Risk Rankings and Perceptions of Consumers' Risk Rankings (n=41)

Survey question Food safety issue	How does your facility rank the relative hazard of these food safety issues [1]:	How do your end consumers' rank the relative hazard of these food safety issues [2]:
Chemical residues / contamination (process based, cleaners or disinfectants, etc.)	2.5^{a}	2.4^{go}
Pathogen contamination	2.3^{b}	2.2^{gh}
Physical contamination (broken needles, rubber gloves, chewing gum, hair, metal)	2.4^{ab}	2.1^{hi}
Allergens	2.6^{abc}***	2.2^{ghi}***
Trans fatty acids	3.3^{d}	3.0^{jk}
GMO sourced ingredients	3.5^{e}**	3.1^{jlm}**
Animal disease (BSE, Foot and Mouth)	3.2^{e}***	2.7^{ko}***
Pesticide residues	3.0^{cdf}**	2.6^{n}**
Food origin (foreign vs. domestic or local)	3.3^{e}	3.1^{ln}
Trust (lack of consumer trust)	3.1^{f}	3.1^{m}

[1,2] Average score from a scale of 1("Very dangerous") to 5 ("Very safe")

*, **, ***: indicates a significant difference between the distribution of responses to the variable in each column at 10%, 5%, or 1% level respectively.

Notes: The distribution of responses for each factor was compared between the treatments. Thus for "allergens" the distribution of responses within treatment one (in this case: the hazard level respondent firms assign to each food safety issue), indicated in the center column, was compared to the distribution of responses for treatment two (which in this case is the hazard level respondent firms perceive this customers to apply to each food safety issue), indicated in the right hand column. Asterisks indicate a significant difference between the distribution of responses under treatment one versus under treatment two. The distribution of responses about factors under consideration were also compared to other factors within each treatment, using the Wilcoxon signed rank test. Within each treatment, responses to each factor were compared to responses for each other factor within the treatment to evaluate if different factors posed different levels of risk.

Superscripts a to m refer to the results, at the $\alpha = 5\%$ level, of the Wilcoxon Signed Rank tests conducted within each column. Factors with the same superscript did not have significantly different response distributions at the $\alpha = 5\%$ level when tested by the Wilcoxon Signed Rank Test. Many of these results

show that these responses had similar (i.e. not statistically significantly different) response distributions.

To assess relative differences in firms' perceptions of safety amongst the various cited food safety issues, rather than between the different treatment applications outlined above, the different issues within each treatment were also matched and evaluated using the Wilcoxon signed rank test, i.e. firms' response distributions to "allergens" were individually compared to their response distributions to the other issues (i.e. "GMO sourced ingredients" and "pesticide residues"). Table 5-0 illustrates the statistically significant differences among the ten food safety issues that resulted from this assessment. For example, the distribution of responses by industry respondents to "chemical residues" was significantly different at the $\alpha = 5\%$ level of significance from the response distributions for "pathogen contamination," "trans fatty acids," "GMO sourced ingredients," "animal disease," "pesticide residue," "food origin," and "[lack of] trust." The average rank calculated for "pathogen contamination" was perceived to be more dangerous than that calculated for "chemical residues[8]" while the other six issues were identified as having average ranks which were less dangerous than "chemical residues" to food safety. Respondents' perceptions of end consumers' risk rankings for different food hazards demonstrated a significant difference in the distribution of responses to "chemical residues" relative to the five other cited issues. The average rank calculated for "chemical residues" was more dangerous than the average ranks calculated for: "physical contamination," "trans fatty acids," "GMO sourced ingredients," "food origin" and "[lack of]

[8] Chemical residues were defined as being process based and included cleaners and sanitizers.

trust". While respondent firms' risk rankings indicate a significant difference between the distributions of the risk to their operations from chemicals, ranked as dangerous on average, relative to pesticide residues, which were ranked as neither dangerous nor safe on average, respondent firms did not perceive a difference between the distributions of perceived risk rankings by their end consumers for these two issues. Respondent firms, on average, ranked consumers' perceptions of both "chemical residues" and "pesticide residues" as dangerous to food safety.

To test the hypothesis that firm size influences firms' response to subjective consumer concerns, the Wilcoxon signed rank test was applied to sub-groups of responses from respondent firms according to the two size categories of small versus grouped medium/large firms. The Wilcoxon signed rank test of the small size respondent group rejected the null hypothesis of the responses being equally distributed between the two treatments for the following four issues: "allergens," "GMO sourced ingredients," "animal disease," and "pesticide residue." With respect to "animal disease" and "pesticide residues" the null hypothesis was rejected at the $\alpha = 10\%$ level of significance while for "allergens and "GMO sourced ingredients" the null hypothesis was rejected at the $\alpha = 5\%$ level of significance. The Wilcoxon signed rank test applied to the assessments of firms in the medium/large size respondent group rejected the null hypothesis of the responses being equally distributed between the two treatments for only three of these issues: "allergens," "animal disease," and "pesticide residue." The issue of "GMO sourced ingredients" was not identified as a significant risk issue from medium/large size firm responses. For medium/large size respondents, the null

hypothesis was rejected at the $\alpha = 10\%$ level of significance with respect to "allergens" and "pesticide residues" and at the $\alpha = 5\%$ level of significance with respect to "animal disease".

Both the responses from small size respondents and medium/large respondents generated average ranks which indicate that for each issue which rejected the null hypothesis of equally distributed risk rankings, the average perceived consumer rank was more dangerous than the average respondent ranking. For example, with respect to the issue "allergens," both the medium/large size respondents and small respondents gave risk rankings that were less risky than they perceived to be the case for consumers, i.e. respondent firms ranked this food safety issue as less dangerous, on average for their facilities, than they perceived consumers' assessments to be. Table B-1 in Appendix B gives the average numerical ranks from both small size and medium/large size firms on the rating scale from "very dangerous" (1) to "very safe" (5). This table also gives the level of significance, if any, of differences in the ranking distributions for each of the ten food safety issues queried.

The null hypothesis of equally distributed risk rankings was rejected for the issues "allergens," "animal disease," and "pesticide residues" within both the small size respondent firm category and the medium/large size respondent firm category. In comparing the average rank for small size respondent firms in treatment one to the average rank for medium/large size firms in treatment one (i.e. the risk that cited food issues pose to the food safety in the firm's own operations), the small size respondents generally viewed "animal disease," and

"pesticide residues" as more dangerous and "allergens" as less dangerous to food safety than did the medium/large size respondent firms. (Statistical tests to compare the distribution of rankings between the small size respondents and the medium/large respondents were not undertaken given that the Wilcoxon signed rank test requires an equal number of observations in each group). Differences between the average ranks may suggest that a firm's size may affect its risk perceptions. However, given that the null hypothesis of equally distributed risk rankings was rejected for three of the same issues in both groups, there is no evidence that the two groups differ in their understanding of end consumer concerns for the ten queried food safety issues.

To test the hypothesis that the type of food sector in which a firm operates may influence its assessments of subjective concerns of end consumers, it was possible to apply the Wilcoxon signed rank test to different pairs of responses given by respondents in the meat processing versus the fruit and vegetable processing sectors. The null hypothesis for the Wilcoxon signed rank test in this case was that the risk ranking responses to each question are equally distributed. Group responses by meat processors and those of fruit and vegetable processors were each tested using the Wilcoxon signed rank test. In testing the perceptions of meat processors, the null hypothesis of equally distributed risk rankings between the distribution of meat processors' response and the distribution of meat consumers' perceived responses was rejected with respect to only one food risk issue, "GMO sourced ingredients", at $\alpha = 10\%$. Meat processing firms responded that their consumers considered "GMO sourced ingredients" to be more

dangerous than the firms themselves considered them to be. The average of respondents' rankings for the risk posed by "GMO sourced ingredients" to meat sector firms' food safety was neither dangerous nor safe while the average perceived risk ranking by meat consumers seen by these firms was dangerous, (as seen in Appendix B Table B-2).

The analysis of the distributions of responses by fruit and vegetable sector firms rejected the null hypothesis of equally distributed risk rankings for the three food safety issues, "allergens", "pesticide residues" and "animal disease". See Appendix B, Table B-2 for the average ranks, degree of significance and relative differences among all the food safety issues: "chemical residues", "pathogen contamination", "physical contamination", "allergens", "trans fatty acids", "GMO sourced ingredients", "animal disease", "pesticide residues", "food origin" and "(lack of) trust". End consumers were perceived to rank "allergens" and "pesticide residues" as more dangerous to food safety than did the respondent fruit and vegetable firms themselves. With respect to "animal disease", there was a significant difference between the firms' response distributions for the effect of the risk on food safety within firms' operations and their perceptions of end consumers' responses; however, the average ranks applied to each treatment fell within the neither dangerous nor safe category, which appears logical given that animal disease should generally not pose a risk to fruit and vegetable processor operations.

To summarize the differences between the meat sector respondents and the fruit and vegetable sector respondents, recall that respondents characterized by

sector of production were questioned about ten food safety issues in two treatments. The first treatment included questions that asked respondents to consider risks to food safety within their facilities such as, "*Indicate how your facility ranks the relative hazard of these food safety issues*" while the second treatment queried respondents about their perceptions of their end consumers, and included questions such as "*Indicate how your end consumers perceive the relative hazard of these food safety issues*". The issues queried were the same in each treatment and the Wilcoxon signed rank test was applied to test whether or not the distribution of responses differed from treatment one to treatment two for each of the ten issues cited. This test was applied to the aggregate industry sample, as well as to data grouped by specified characteristics of firms. The tests applied to groups of data indicate that meat sector respondents rejected the null hypothesis of equally distributed risk rankings only once out of ten possible cases (i.e. for "GMO sourced ingredients"). Fruit and vegetable processor respondents rejected the null hypothesis of equally distributed risk ranking for three out of ten issues (i.e. for "allergens", "animal disease" and "pesticide residues"). These applications of the Wilcoxon signed rank tests indicate some differences between sectors.

To test the hypothesis that the characteristic of being either an exporter or a non-exporter alters whether or not a firm is more likely to include subjective end consumer concern in its risk assessments, respondents were separated into groups according to their export status, either as an exporter or a non-exporter. Given that food safety laws and regulations often differ between countries, it is possible

that the regulations faced by exporting firms will vary from those faced by non-exporting firms[9]. The Wilcoxon signed rank test was applied to assess differences between the two groups with respect to the ten cited food safety issues of "chemical residues", "pathogen contamination", "physical contamination", "allergens", "trans fatty acids", "GMO sourced ingredients", "animal disease", "pesticide residues", "food origin" and "[lack of] trust". Table B-3 in Appendix B contains the results of the Wilcoxon signed rank tests for the responses of firms that are exporters and non-exporters.

The null hypothesis for the Wilcoxon signed rank test, depicted in equation 5.4, hypothesizes equally distributed risk rankings between paired questions in the two treatments that firms were asked to consider, i.e. "*Indicate how your facility ranks the relative hazard of these food safety issues*" and "*Indicate how your end consumers perceive the relative hazard of these food safety issues*". In testing exporting firms' responses, it was found that for two food safety issues the null hypothesis of equally distributed risk rankings was rejected at the $\alpha = 10\%$ level of significance, specifically, for "animal disease" and "pesticide residue". In both cases, the exporting firms responded that their consumers considered the hazards to be more dangerous than the exporters themselves ranked the hazards to be. The average of the ranks that exporting respondents applied to the hazards was neither dangerous nor safe while the average of the ranks exporting respondents perceived consumers to assign was dangerous, as seen in Appendix B Table B-3. The neither dangerous nor safe

[9] There was no test for differences in the level of regulations faced by exporters or non exporters; a study of regulatory requirements in the destinations Alberta food processors export their products to could provide that information.

food risk rank for animal disease assigned by exporting firms is interesting given the highly negative international response to animal diseases such as BSE and foot and mouth disease.

The responses of non-exporting respondents were also tested with the Wilcoxon signed rank test. The null hypothesis for the Wilcoxon signed rank test is that risk rankings were equally distributed between the two treatments. In testing the responses of non-exporting respondents there were five factors where the null hypothesis was rejected at at least the $\alpha = 10\%$ level of significance: "physical contamination", "allergens", "GMO sourced ingredients", "animal disease", and "pesticide residue". In each case non-exporting respondents indicated the average perceived consumers' risk rank to be more dangerous than the hazard posed to food safety in their own facilities. In four of the five cases, "animal disease" being the exception, the average ranks for each treatment fell into the same numerical category although the Wilcoxon signed rank test indicates that the distributions generating those averages differ significantly, as seen in Appendix B Table B-3. For example, with respect to the risks of "physical contamination", "pesticide residues" and "allergens" to food safety, the average risk ranks assigned by non-exporting respondent firms for their own firm's food safety and the average rank perceived to be held by end consumers fell into the numerical range of dangerous, while for "GMO sourced ingredients" the average ranks are neutral, i.e. neither dangerous nor safe. However, the Wilcoxon signed rank test does indicate a significant difference between the distributions of these responses, suggesting that non-exporting respondents believe that they perceive

these issues differently from their end consumers. "Animal disease" was ranked as neither dangerous nor safe to the level of food safety provided in non-exporting respondent firm's facilities, contrasting with the perceived average end consumer rank for animal disease of dangerous, as seen in Appendix B, Table B-3.

A set of Wilcoxon signed rank tests was also conducted within treatments to test if non-exporting respondents differentiated in their rankings among the food safety issues. Thus the Wilcoxon signed rank test was applied to a series of pairs of issues so that responses for each food safety issue were considered with respect to each of the other cited food safety issues. As before, "pathogen contamination" was compared to "allergens," "GMO sourced ingredients," "animal disease", and so on. The distribution of non-exporting firms' responses with respect to risks of "physical contamination" was statistically significantly different from the distribution of non-exporting firm responses to cited food risks, such as "allergens," "GMO sourced ingredients" and "animal disease." In looking at non-exporting firms' perceptions of their consumers, the distribution of perceived end consumer responses to the risks from possible "pesticide residue" was not significantly different from the distribution of perceived end consumer responses to "physical contamination," "allergens," "GMO sourced ingredients" or "animal disease," as seen in Appendix B Table B-3.

Comparing the responses of non-exporting firms to those from exporting firms, tests of exporting firms' responses indicated fewer issues for which the null hypothesis of equally distributed risk rankings was rejected. While the tests of non-exporting firms' responses rejected the null hypothesis for the five issues

cited above, exporting firms' responses only rejected the null hypothesis for two of these issues, specifically, "animal disease" and "pesticide residue". Like non-exporting respondents, exporting firms' responses indicate that exporting respondents perceived their consumers to rank "animal disease" and "pesticide residue" as more dangerous to food safety, on average, than the respondents themselves did, as seen in Appendix B Table B-3. Thus, unexpectedly, non-exporting respondents appeared to be more aware of the likelihood of differences between subjective consumer concerns and their own risk assessments.

5.2.3.1 Summary of Results of the Pair-wise Tests of Responses Regarding Relative Food Safety

The results of the Wilcoxon signed rank tests reported in Section 5.2.3 generated two main points of interest. The first is that Alberta food processors generally perceive their end consumers to view potential risks to food safety as more hazardous than the firms themselves do. This tends to support the general hypothesis of differences between firms' views of end consumer perceptions of food safety and firms' internal perceptions. Two exceptions to this tendency were: small processors, on average, ranked pathogen contamination as being more hazardous than their consumers were perceived to rank this; and fruit and vegetable processors, on average ranked trans fatty acids to be more hazardous than they perceived their end consumers to rank these Between the sub-group pairings (small versus medium/large, meat versus fruit and vegetable, exporters versus non-exporters) there is limited evidence of firm characteristics affecting perceptions of relative food safety hazards with respect to their consumers.

However, across all six sub-groups firms tended to indicate a difference between their internal risk perceptions and their view of consumers' perceptions for the same factors. Therefore, a conclusion which may be derived is that firms' perceptions of consumer concerns differed (qualitatively) among different sub-groupings of firms, suggesting that it may be of interest to further examine Alberta processor perceptions of consumers in future work with a larger sample.

5.2.4 Results of the Pair-wise Tests of Firms' Views of Factors Affecting Food Safety Provision and Improving Business Performance

Using similar methods to those applied in Section 5.2.3, this section compares the responses of firms to a pair of treatments that queried eight factors in two contexts. Specifically, respondents were asked to respond to the set of questions "*State the importance of each of these factors to the provision of food safety*" (treatment one/context found in tabular form in Appendix A as Att6) and "*State the importance of each of these factors on improving firm business performance*" (treatment two/context found in tabular form in Appendix A as Att7). Table 5-1 indicates responses to questions within these two treatments. These were compared in order to evaluate whether firms distinguish between practices such as good manufacturing practices (or GMPs), which may improve business performance and/or improve food safety. Firms were asked to rank each factor on five-part response rating scales which ranged from "very important" to "very unimportant", as was seen in Table 4-4. These treatments were applied to eight factors including "GMPs", "HACCP", "ISO", "product recall system", "product traceability", "supplier certification", "wastage record system", and

"reworking record system". The null hypothesis for these Wilcoxon signed rank tests was that, for each factor, the distribution of firms' responses to questions within the first treatment are equal to the distribution of firms' responses to questions within the second treatment. Testing the responses of the aggregated Alberta industry sample of respondents indicated two factors for which the null hypothesis of equally distributed rankings of importance was rejected at the α = 10% or higher level of significance: "GMPS" and "HACCP". Overall, the responses indicated that the most important factor seen for both food safety provision and improving firm business performance was "GMPs" followed by product traceability, and then by both a product recall system and HACCP (as seen in Table 5-1). The average ranked level of importance for "GMPs" indicated that "GMPs" are more important to food safety provision than to improving firm business performance. This is confirmed by the statistically significantly difference in the distribution of responses, (α = 1%), regarding the importance of "GMPs" to food safety provision relative to firm business improvement (as seen in Table 5-1). This analysis also indicated that HACCP systems are seen to provide multiple benefits, but to different degrees. The Wilcoxon signed rank test of distribution of responses between the two treatments (i.e. for food safety versus business performance) with respect to "HACCP" was statistically different. HACCP was ranked as important, on average, to food safety provision and to improving firm business performance. However, the average rank given HACCP's role with respect to improving firm business performance was less important than for improving the firms' food safety, as seen in Table 5-1. Both

GMPs and HACCP use were perceived to be more important for providing food safety than for improving business performance, (see Table 5-1 for average ranks and statistical differences). The distribution of responses to questions regarding "GMPs" were also statistically significantly different from those querying the cited seven other factors, both for food safety provision and for improving business performance, as seen in Table 5-1.

Table 5-1: Average Ratings Given to the Importance of Specific Food Safety Practices for Food Safety Provision and Their Impact on Improving Firm Business Performance (n=41)

Survey scale question Factor	State the importance of each of these factors to the provision of food safety [1]:	State the importance of each of these factors on improving firm business performance [2]:
Good Manufacturing Practices (GMPs)	4.7***	4.5***
Hazard Analysis Critical Control Points (HACCP)	4.2[ab]*	4.1[cde]*
ISO 22000	3.0	3.1[f]
Product recall system	4.2[a]	4.1[c]
Product traceability	4.4[a]	4.2[d]
Supplier certification	4.1[a]	4.0[e]
Wastage record system	3.3	3.5[f]
Reworking record system	3.5[b]	3.6[f]
[1,2] Average score from a scale of 1("Very unimportant") to 5("Very important")		

Notes: The distribution of responses for each factor was compared between the treatments. Thus for "GMPs" the distribution of responses within treatment one (in this case: the importance of each factor to the provision of food safety), indicated in the center column, was compared to the distribution of responses for treatment two (which in this case is the importance of each factor to improving firm business performance), indicated in the right hand column. Asterisks indicate a significant difference between the distribution of responses under treatment one versus under treatment two. The distribution of responses about factors under consideration were also compared to other factors within each treatment, using the Wilcoxon signed rank test. Within each treatment, responses to each factor were compared to responses for each other factor within the treatment to evaluate if different factors posed different levels of risk.
*, **, ***- indicates a significant difference at 10%, 5%, or 1% respectively between the distribution of responses to the variable in each column.

Superscripts a to f refer to the results, at the α = 5% level, of the Wilcoxon Signed Rank tests conducted within each column. Factors with the same superscript did not have significantly different response distributions at the α = 5% level when tested by the Wilcoxon Signed Rank Test. Many of these results show that these responses had similar (i.e. not statistically significantly different) response distributions.

To test specific hypotheses that a firm's characteristics affect whether practices that may be of importance to food safety provision are equivalently important to improving firm business performance, the Wilcoxon signed rank test was also applied to responses to this set of questions from groupings of respondents according to their characteristics of firm size, sector, and export status. To test the hypothesis that the characteristic of firm size affects how firms differentiate between factors affecting food safety provision and improving firm business performance, respondents were divided into two groups according to size: small and medium/large firms. The null hypothesis for this Wilcoxon signed rank test was that respondent firms' rankings of importance were equally distributed. In testing the responses of small sized respondents and medium/large sized respondents independently, the null hypothesis was rejected with respect to "GMPs". In testing small sized respondents the null hypothesis was rejected at the α = 5% level of significance and was rejected at the α = 10% level of significance for medium/large sized respondents. In each case "GMPs" were ranked, on average, as being more important to food safety provision than to improving firm business performance. Within each treatment and size category, the response distribution for "GMPs" was statistically significantly different than the response distributions for "ISO," "wastage record system" and a "rework

record system." Of the eight factors queried, "GMPs" also received the highest average rating of importance by each of small sized respondent group and medium/large size respondent group both for providing food safety and for improving firm business performance. With respect to small size respondents, the distribution of responses for "GMPs" was also significantly different from the small firms' response distributions for "HACCP" "product recall", "product traceability", and "supplier certification" for food safety provision (not for business improvement).

In addition to GMPs, the Wilcoxon signed rank test of medium/large firm responses also indicated a significant difference in the distribution of responses for the relative importance of "supplier certification" and the "wastage record system" to food safety provision versus firm business improvement. The average rank given for the importance of "supplier certifications" to food safety provision was important, while the average rank given to the importance of supplier certification to improving business was neither important nor unimportant, as seen in Appendix B, Table B-4. The average rank given to a "wastage record system" relative to its importance to food safety provision and relative to its importance for improving business performance was neither important nor unimportant, however, the distributions of medium/large firm responses regarding the "wastage record system" were statistically significantly different at $\alpha = 10\%$. On average, the "wastage record system" was ranked as more important to food safety provision than to improving business performance.

In comparing the responses of small size firm respondents with those from medium/large size firms, the null hypothesis of equally distributed responses was rejected only once with respect to small firm respondents, for "GMPs", (as seen in Appendix B, Table B-4) and three times with respect to medium/large size respondents for "GMPs", "supplier certification" and "wastage record system" (as seen in Appendix B, Table B-4). With respect to the eight factors cited in the each of these questions, there were also five instances where the difference between the average ranks ascribed by small size respondents and the medium/large size respondents exceeded 0.4 on the rating scale from one to five, which suggests differences in the distribution of responses. The factors with differences in averages over 0.4 are: "HACCP", with respect to both improving food safety and business performance, "rework record system" with respect to improving business performance, "product traceability" with respect to improving business performance and "product recall system" with respect to improving food safety. Significant differences in response distributions were indicated by the Wilcoxon signed rank test for issues where the average ranks differed by only 0.18, as seen in Appendix B, Table B-4. Overall, then, in assessing the effect of firm size on how firms differentiate between factors affecting food safety provision and factors which improve firm business performance, there appears to be some evidence supporting the hypothesis that firm size does affect how a firm perceives various factors affecting food safety provision relative to improving business performance. This difference in the number of instances suggest that medium/large size firms tended to differentiate more than did small size firms

between practices that improve food safety and those practices that improve business performance. One possible reason for this could be from medium/large firms being better equipped to calculate the financial costs and benefits associated with different practices that may be relevant to them. However, not all firms were aware of the cited practices; for example, in the one interview response, the representative for a small meat respondent firm asked what a re-work record system was[10]. Of course, if the small size respondent firms were unaware of any of the cited practices it would have been difficult for them to differentiate between the benefit the practice would provide to food safety and the benefit it would provide to business performance.

To test the hypothesis that the characteristic of a firm's sector of operation affects how firms differentiate between factors affecting food safety provision as versus improving firm business performance, responses from meat sector versus fruit and vegetable sector respondents were tested using the Wilcoxon signed rank test. Table B-5 in Appendix B contains the average ranks given by meat industry firms and fruit and vegetable processors to the eight factors queried and the results of the Wilcoxon signed rank tests of responses by meat industry firms and fruit and vegetable processors to these sets of questions within the treatments.

In testing ratings assigned by meat sector respondents there was only one factor where the null hypothesis of equally distributed rankings of importance was rejected. For the factor "GMPs" the null hypothesis of equally distributed risk rankings at the $\alpha = 1\%$ level of significance regarding its importance to food

[10] A rework system reworks safe, but incorrect, i.e. misshapen, foods back into the food system for reprocessing or reuse. Consider as an example finding French fry pieces in a package of frozen hash browns; this could be diverted for reuse by a rework system.

safety provision versus the distribution responses to the importance of "GMPs" to improving business performance for meat firms was rejected. "GMPs" were ranked more important to the provision of food safety than to improving business performance for these firms. Even so, in each case, the average of the ranks assigned to the importance of "GMPs" was important, as seen in Appendix B, Table B-4.

The Wilcoxon signed rank tests of the responses of fruit and vegetable sector firms demonstrated a significant difference between the distribution of responses for the importance of a "wastage record system" to food safety provision and the response distribution for the importance of a "wastage record system" to improving firm business performance, at $\alpha = 10\%$. Although the average response to each question was neither important nor unimportant, the wastage record system was seen as more important to improving business performance than to food safety provision. This finding is reasonable since, given the short shelf life of many fruits and vegetables, reducing wastage can cut costs. The Wilcoxon signed rank tests comparing the distributions of responses to the question set "*State the importance of each of these factors to the provision of food safety*" within the second pair of treatments indicated that the distributions of fruit and vegetable processor responses referring to the importance of "supplier certification" was statistically significantly different from "GMPs", a "product recall system" and "product traceability" (see Appendix B, Table B-5 for the average ranks and statistical test results). Good manufacturing practices were seen as the most important factor in the provision of food safety while ISO was the

least important. ISO was also the least important factor to fruit and vegetable processors for improving firm business performance.

To test the hypothesis that a firm's export status affects how firms differentiate between factors affecting food safety provision and improving firm business performance, respondents were divided into two groups according to their export status. The null hypothesis for the Wilcoxon signed rank test was that there was no difference between firms' rankings of the importance of cited factors affecting food safety and business performance. There were four factors for which the null hypothesis of equally distributed exporter rankings of importance was rejected at the $\alpha = 5\%$ level of significance. These factors are "GMPs", "HACCP," "supplier certification" and the "wastage record system." In each case, the average of the exporter respondent firms' ranking of the factor was more important to food safety provision than with respect to improving business performance. Although the distribution of responses between treatments differed for both "GMPs" and "HACCP" the average of the exporter respondent ranks was important for both food safety provision and improving business performance. Conversely, "supplier certification" and a "wastage record system" were both seen to be important for food safety provision, but neither important nor unimportant for improving firm business performance, as seen in Appendix B, Table B-6.

Thirty-five Wilcoxon signed rank tests were applied to compare the distributions of exporting firms' responses for each of the eight factors cited ("GMPs", "HACCP", "ISO", "product recall system", "product traceability",

"supplier certification", "wastage record system", and "reworking record system") to the distribution of exporting firm's responses to each of the other factors, i.e. "GMPs" were tested against "HACCP", "ISO" a "product recall system" etc. From these tests, the null hypothesis of equally distributed rankings of importance to food safety provision was rejected twenty times. Appendix B, Table B-6 reports the results of these thirty-five tests. For example, the null hypothesis of equally distributed rankings of importance to food safety was rejected with respect to a "wastage record system" and was seen as significantly different from "supplier certification", "HACCP" and "GMPs". Based upon the average of the risk rankings of exporting firms, a "wastage record system" was seen as more important than "supplier certification" for food safety provision, but less important than both "HACCP" and "GMPs".

To further test the hypothesis that the characteristic of a firms' export status affects how firms differentiate between factors affecting food safety provision and improving firm business performance, the Wilcoxon signed rank test was applied to non-exporting firms' responses to the treatments containing the sets of questions "*State the importance of each of these factors to the provision of food safety*" (treatment one) and "*State the importance of each of these factors on improving firm business performance*" (treatment two). The null hypothesis of equally distributed rankings of importance was rejected for one factor, "GMPs", at the $\alpha = 10\%$ level of significance. On average, non-exporting respondents ranked "GMPs" as more important to food safety provision than to improving business performance, as seen in Appendix B, Table B-6. The Wilcoxon signed

rank test was also applied to each of the eight factors in each treatment ("GMPs", "HACCP", "ISO", "product recall system", "product traceability", "supplier certification", "wastage record system", and "reworking record system") with respect to each other factor. The Wilcoxon signed rank test null hypothesis of equally distributed rankings of importance was rejected in five instances. The distribution of responses by non-exporting respondent firms was significantly different for "GMPs" compared to the response distributions of "HACCP", "ISO", "supplier certification", a "wastage record system" and a "rework record system" with respect to both food safety provision and improving business performance. "GMPs" were also ranked, on average, as more important than "HACCP", "ISO", "supplier certification", a "wastage record system" and a "rework record system" by non-exporting respondent firms with respect to both food safety provision and improving business performance.

To test the hypothesis that a firm's primary characteristics (sector of operation, export status or size) affects how firms differentiate between factors affecting food safety provision and improving firm business performance, Wilcoxon signed rank tests were used to test the responses of food processor respondents grouped by the selected major characteristics. Within each intergroup comparison, e.g. for small size respondents versus medium/large size respondents, the null hypothesis of equally distributed rankings of importance was rejected for at least some different factors, indicating that firms in these different groups view at least some business improvement factors differently from the systems and practices which aid in the provision of food safety.

Overall, “GMPs” were the most consistent factor of importance among the eight factors queried, in particular, “GMPs” were consistently seen as the most important factor to food safety provision, more so than to improving firm business performance for almost each group identified. For example, “GMPs” were seen as more important to food safety provision than to improving firm business performance for the aggregate industry sample and for every group examined, with the exception of the responding firms associated with fruit and vegetable processing. It is of interest that similar results were also generated in the analysis by Herath and Henson (2006) of attitudes of Ontario food processors, for which there was a larger sample. Herath and Henson reported that Ontario food processors identified, on average, a difference in the importance of “GMPs” to food safety provision as versus to improving firm business performance. However in this Alberta study a number of other practices were also identified which were assessed by Alberta firms to play different roles in food safety provision as versus improving firm business performance. For exporting respondents and medium/large size respondents, “supplier certification” and a “wastage record system” were also identified to play different roles in food safety provision as versus in improving firm business performance. The “wastage record system” was seen as more important to improving business performance for medium/large size firms and for fruit and vegetable processors.

5.2.4.1 Summary of Results of the Pair-wise Tests of Firms' Views of Factors Affecting Food Safety Provision and Improving Business Performance

The results of the Wilcoxon signed rank test of firms' views of factors affecting food safety provision and firm business performance generated two main points which ought to be considered. The first of these is that GMPs were seen as very important to both food safety provision and firm business performance but not in exactly the same way or to the same degree. The second point for consideration is that in general Alberta food processors did not perceive differences between food safety practices in terms of their role in improving food safety provision and in improving business performance. The latter feature supports the hypothesis, noted in Section 5.1, that there are no differences between food industry firms' internal perceptions of food safety risks and their views of their end consumers' perceptions of food safety risks. However, it is noted that this generalization, while valid for the entire sample, did not hold equally well when the views of various sub-groups were assessed separately. Firms in some sub-groups tended to view the effects of various food safety practices (HACCP, ISO, product recall system and wastage record system) differently with regards to food safety provision as versus improving firm business performance.

5.2.5 Results of the Pair-wise Tests of Firms' Views of Factors Affecting Food Safety Risks and Business Performance

Previously in this Chapter, in each of Sections 5.2.3 and 5.2.4, the results of Wilcoxon signed rank tests of Alberta food processor response distributions to

sets of treatments were discussed. In Section 5.2.5 the results are presented from analysis of the third pair of treatments which respondents were queried about, based on Wilcoxon signed rank tests. In this third pair of question sets, respondent firms were queried about the risks of six potential hazards, i.e. "employee hygiene", "GM sourced ingredients", pathogen contamination", "physical contaminants", "pesticides" and "spoilage", to the provision of each of food safety and to business performance. The Wilcoxon signed rank test of the distribution of responses of the aggregate of Alberta food processor responses applies to treatments based on the question sets of: "*State the risk each of the following poses to the provision of food safety*" (treatment one, designated as Att8 in Appendix A) and "S*tate the risk of each of the following to business performance*" (treatment two, designated as Att9 in Appendix A). These rejected the null hypothesis of no differences between the distribution of respondents' views of the risk to food safety and the distribution of respondents' views of the risk to business performance arising from four of the ten queried hazards at the α = 10% level of significance. Specifically these hazards are "pathogen contamination", "physical contaminants", "pesticides" and "spoilage", as seen in Table 5-2. Pathogen contamination was ranked, on average, as more dangerous to business performance than to food safety while "physical contaminants", "pesticides" and "spoilage".

To test the specific hypothesis that characteristics such as firm size, sector and export status affect whether or not the respondent firms view risks to food safety as also acting as risks to business performance, Alberta survey respondents

were again organized into the six (potentially overlapping) groups of respondents, i.e. small and medium/large size respondents, meat processors and fruit and vegetable processors, and exporting respondents versus non-exporting respondents. The small size respondents, meat sector respondents, and exporting respondents were the only groups of firms whose response distributions were tested with the Wilcoxon signed rank test for which the null hypothesis of equally distributed responses between paired questions from each treatment was rejected.

Table 5-2: Comparison of the Importance of Risks to Food Safety Provision on and Business Performance for the Aggregate Industry Sample (n=41)

Survey question / Factor	State the risk each of the following poses to the provision of food safety [1]:	State the risk of each of the following to business performance [2]:
Employee hygiene	2.63[a]	2.54[d]
GM sourced ingredients	3.42	3.22
Pathogen contamination	2.66[ab]**	2.27[e]**
Pesticides	2.98[c]*	2.63[df]*
Physical contaminant	2.59[b]**	1.24[ef]**
Spoilage	2.83[abc]**	2.44[def]**
[1,2] Average score per factor on a scale from "Very dangerous" (1) to "Very safe" (5)		

Notes: The distribution of responses for each factor was compared between the treatments. Thus for "employee hygiene" the distribution of responses within treatment one (in this case: the risk it poses to the provision of food safety.), indicated in the center column, was compared to the distribution of responses for treatment two (which in this case is the risk it poses to business performance), indicated in the right hand column. Asterisks indicate a significant difference between the distribution of responses under treatment one versus under treatment two. The distribution of responses about factors under consideration were also compared to other factors within each treatment, using the Wilcoxon signed rank test. Within each treatment, responses to each factor were compared to responses for each other factor within the treatment to evaluate if different factors posed different levels of risk.

*, **, ***- indicates a significant difference at 10%, 5%, or 1% between the distribution of responses to the variable in each column

Superscripts a to f refer to the results, at the $\alpha = 5\%$ level, of the Wilcoxon Signed Rank tests conducted within each column. Factors with the same superscript did not have significantly different response distributions at the $\alpha = 5\%$ level when tested by the Wilcoxon Signed Rank Test. Many of these results show that these

responses had similar (i.e. not statistically significantly different) response distributions.

The differences in distributions of responses from small size firms were tested with the Wilcoxon signed rank test and the null hypothesis of no difference in the distribution of small size firm responses among the cited risks "employee hygiene", "GM sourced ingredients", "pathogen contamination", "pesticides", "physical contaminants", and "spoilage" was rejected at the $\alpha = 10\%$ level of significance for three of the six potential risks cited above, as indicated in Appendix B, Table B-7. Specifically, the distributions of responses for the potential risks to food safety posed by "physical contamination", "spoilage", and "pathogen contamination" were significantly different from the distribution of responses for the risk they posed to the firms' business performance for the small size respondents. Each potential risk was ranked by small respondents as more dangerous to business performance than to food safety, as seen in Appendix B, Table B-7.

The Wilcoxon signed rank test of the responses from firms categorised as belonging to the meat sector also rejected the null hypothesis of equivalent response distributions between the risk to food safety and the risk to business performance posed by "pathogen contamination", "physical contaminants", and "spoilage". This result may reflect the overlap between small food processors and the respondent meat processors, many of whom are small meat processors. However, the average ranks calculated based on meat sector respondents were much more dangerous than those calculated from small processor respondents.

As was the case for the small size respondents, each potential risk was considered to be more dangerous to business performance than to food safety, as seen in Appendix B Table B-8.

The third group of respondents to reject the null hypothesis that firms' perceptions of risks to food safety are equivalently risks to business performance are the exporting firm respondents. The null hypothesis of no difference in the distribution of responses between the risk to food safety and the risk to business performance was rejected at the α=10% and α=5% levels for four of the six cited risk factors, as indicated in Appendix B Table B-9. These four factors are "pathogen contamination", "spoilage", "physical contamination" and "GMO sourced ingredients". The average rankings of exporting firms indicate that exporters consider "pathogen contamination" and "spoilage" to be greater risks to business performance than to food safety at the 5% level of significance. At the 10% level of significance the distributions of responses by exporting respondents were different for "physical contaminants" and "GMO-sourced ingredients"; both were ranked as more dangerous to business performance than food safety. Although "spoilage" received an average rank of "dangerous" from exporting respondents for both treatments, the distribution of responses around the averages were statistically significantly different (as seen in Appendix B, Table B-9).

With respect to medium/large firms, the null hypothesis of equally distributed rankings was not rejected for any of the factors ("employee hygiene", "GM sourced ingredients", pathogen contamination", "physical contaminants", "pesticides" and "spoilage"). This may indicate that medium/large size

respondents and fruit and vegetable sector respondents perceive risks to food safety provision equivalently as risks to their business performance. There were also few significant differences in the distributions of responses when factors were tested with the Wilcoxon signed rank test within treatments (i.e. "employee hygiene" versus "pesticides"). The one factor for which the null hypothesis was rejected was "GM sourced ingredients". The distributions of responses from both medium/large sized firms and meat firms regarding "GM sourced ingredients" were significantly different from the distributions of responses for every other factor. Additionally, there were no significant differences between the perceived risk of each factor to food safety provision and its risk to firm business performance when the distributions of responses were compared for firms grouped within the fruit and vegetable sector or the non-exporting group.

5.2.5.1 Summary of Results of the Pair-wise Tests of Firms' Views of Factors Affecting Food Safety Risks and Business Performance

Three general results generated from the pair-wise tests of firms' views of potential risk factors to food safety and firm business performance are of particular interest. The first is that physical contamination was generally considered the riskiest of the cited factors to both food safety provision and to food business performance. This is of interest given the localized nature of physical contamination and low risk of cross-contamination. The second is that although the means of the responses varied, the distribution of Alberta food processor respondents generally did not differ for the risks posed by employee hygiene or GM sourced ingredients with respect to both food safety and business

performance. However, exporters were the one exception to this tendency, responding that GM sourced ingredients posed a different risk to food safety than to business performance The findings do not refute the hypothesis that characteristics of food industry firms affect their perceptions of relative food safety hazards. Sub-groups of Alberta food processor respondents, grouped by firms' characteristics such as size, type of product and export status, are generally consistent in their differentiation between factors that are potentially risky to food safety and to firm business performance. However, three sub-groups differentiated between risks to food safety and risks to business performance, while three sub-groups did not. For each case where the null hypothesis of equally distributed risk rankings was rejected, the average of the respondents' ranks indicated that each of these hazards ("GM sourced ingredients", "pathogen contamination", "physical contaminants" and "spoilage") was seen as more dangerous to firm business performance than to food safety provision. That lapses in various hazards are seen as more dangerous to firm business performance tends to support the hypothesis that firms believe that consumers see the cited risks as more dangerous than do many of the respondents themselves. This may suggest that, should a lapse in one of these particular areas occur, respondents would tend to see food safety not to be overly compromised but perceive consumers as perceiving a higher safety lapse, with a resulting public backlash that might damage business performance. In general, risks to food safety are seen as risks to business performance regardless of the sector in question.

5.3 Results of the Kolmogorov-Smirnov Test

In Section 5.2 the tests of differences in the distributions of firms' responses within three sets of paired treatments were outlined and discussed. Respondents were grouped with respect to common characteristics such as the firms' size and sector of production. Rather than comparing these treatments, in the current section respondent's attitudes and opinions within individual sets of questions are evaluated using the Kolmogorov-Smirnov test. Like the Wilcoxon signed rank test, the Kolmogorov-Smirnov (K-S) test is a non-parametric test that can be used to determine if the distribution of two datasets differ significantly. For the purpose discussed in this section, the one sample K-S test is applied to distributions of firms' responses to test whether or not these distributions are significantly different from a normal distribution. Specifically, the one sample K-S test was applied to questions from the "Attitudinal" section of the survey to test whether or not firms' attitudes and responses were distributed normally around the neutral rating choice of "neither agree nor disagree", "neither dangerous nor safe" or "neither important nor unimportant," as indicated in Tables 4-3 to 4-5.

With respect to the rating scales with which respondents were asked to indicate their responses to the questions, the strongest attitudes and rankings are found at the tails of the rating scales. Thus the more skewed toward the tails are the respondents' responses, the stronger are respondents' attitudes to that topic. If firms' responses do not follow a standard distribution the responses are examined to identify firm's opinions about the subject in question. For example, firms were asked to rate their opinion on a rating scale from "strongly disagree" to "strongly

agree" whether or not "*Any media attention to your industry is a source of consumer distrust and lost revenue.*" The higher the number of respondents who either "strongly agreed" or "strongly disagreed", the stronger the rejection of the one sample K-S test, and the stronger were respondents' opinion considered to be. In cases where the distribution of responses did not follow the standard distribution, the response distribution was examined to identify the apparent nature of firms' attitudes and opinions. The K-S test was conducted using the statistical package SPSS 15.0. The results are discussed in Section 5.3.1.

In a discussion of the Kolmogorov-Smirnov test, Massey (1951) provides a description of this test: *Suppose that a population is thought to have some specified cumulative frequency distribution function, say F0(x) is the proportion of individuals in the population having measurements less than or equal to x. The cumulative step-function of a random sample of N observations is expected to be fairly close to this specified distribution is not the correct one. If* $F_0(x)$ *is the population cumulative distribution, and* $S_N(x)$ *the observed cumulative step-function of a sample (i.e.,* $S_N(x)=k/N$*, where k is the number of observations less than or equal to x), then the sampling distribution of d=maximum* $|F_0(x) - S_N(x)|$ *is known, and is independent of* $F_0(x)$ *if* $F_0(x)$ *is continuous. (Massey, 1951, p.69)*

In conducting the Kolmogorov-Smirnov test, it was hypothesized that the respondent firms had clear opinions and attitudes about the food safety factors in question. For example, with respect to the statement "*Your products are labeled "May contain GM ingredients'*"" it was expected that respondents would

"strongly disagree" given the Canadian policy of voluntary labelling of GM foods. The null hypothesis in each one sample K-S test is that the responses will follow a normal distribution. Not rejecting the null hypothesis would demonstrate that the distribution of responses followed a standard distribution around the neutral rating and that respondents generally ranked the statement or factor as "neither". If the null hypothesis is rejected the data does not follow a standard distribution and can be further assessed to indicate respondents' level of (dis)agreement with the statement.

5.3.1 Results from Application of the Kolmogorov-Smirnov Test

The Kolmogorov-Smirnov test was conducted on the responses to five blocks of questions from the "Attitudinal" part of the survey to test whether or not respondents had defined opinions about the factors cited in each question or whether the pattern of responses from one to five was distributed normally around the neutral rating scale mean of three. It was hypothesized that firms' characteristics such as their size and sector would alter their perceptions of the hazards of issues such as genetic modification, pesticides and pathogens. In order to test whether respondents' opinions are defined or not, the K-S test was conducted on the responses from the aggregate food processor sample and on responses from groups of firms grouped by characteristics of size and sector of production. The responses from dairy sector respondents were not tested due to small sample size; for this reason the responses from firms in the grain and oilseed sector were combined with those from the fruit and vegetable sector to

create a "plant" based group for some of these tests. Table 5-3 gives the results of these tests of the aggregated industry responses to the first block of attitudinal questions, designated as Att1 in Appendix A. This table includes the average numerical rank for each statement and the response distribution for each statement. Each statement was tested independently.

For the aggregate sample the null hypothesis of the distribution of responses following a standard distribution was rejected for all twelve statements at $\alpha = 10\%$ or higher levels of significance. At the $\alpha = 10\%$ level of significance the distribution of responses by the aggregate industry sample rejected the null hypotheses of a normal distribution for two statements, "*Any media attention to your industry is a source of consumer distrust and lost revenue,*" and "*Your food safety systems are sufficient for meeting customer demands*," as seen in Table 5-3. At $\alpha = 5\%$ level of significance the null hypothesis was rejected and the distribution of the responses suggest industry respondents do not have a similar, normally distributed pattern of opinions regarding the following ten statements: "*Any media attention to your industry is positive*," "*Your end retailers have the majority of the bargaining power in your value chain*," "*Your customers provide you with processing standards for purchasing your products*," "*Your food safety systems are sufficient for meeting consumer concerns*," "*Your food safety systems are sufficient for meeting customer demands*," "*Your food safety systems are effective*," "*The presence of GM or GM derived ingredients is an issue of risk communication relative to your consumers*," "*The presence of GM or GM derived ingredients is an issue of food safety*," "*Your products are labelled "May*

contain GM ingredients,"" and "*You would lose customers if your products were labelled "May contain GM ingredients,""* as seen in Table 5-3.

Respondents generally tended to disagree with the statement "*Any media attention to your industry is a source of consumer distrust and lost revenue*," and generally agreed with the statement "*Your food safety systems are sufficient for meeting consumer concerns*." The three statements which received the highest level of agreement were "*Your food safety systems are effective*," "*Your food safety systems are sufficient for meeting customer demands*," and "*Your food safety systems are sufficient for meeting consumer concerns*." The three statements most disagreed with were "*Your products are labelled "May contain GM ingredients,""* "*Any media attention to your industry is a source of consumer distrust and lost revenue*," and "*Any media attention to your industry is positive.*"

Table 5-3: Kolmogorov-Smirnov Test Results for Aggregate Survey Responses to Attitudinal Statements, Average Response and Response Distribution for Statements (n=41)

	Total	Average	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
	K-S Z statistic Asymp. Sig. (2-tailed)		Percent of respondents				
Any media attention to your industry is positive	1.371 0.047**	2.8	12.2%	29.3%	36.6%	9.8%	12.2%
Any media attention to your industry is a source of consumer distrust and lost revenue	1.300 0.068*	2.7	14.6%	31.7%	29.3%	19.5%	4.9%
Your end retailers have the majority of the bargaining power in your value chain	1.823 0.003***	3.4	7.3%	7.3%	36.6%	34.1%	14.6%
Your customers provide you with processing standards for purchasing your products	1.657 0.008***	3.3	9.8%	14.6%	19.5%	46.3%	9.8%
Your food safety systems are sufficient for meeting consumer concerns	2.135 0.000***	4.2	0.0%	4.9%	9.8%	46.3%	39.0%
Your food safety systems are sufficient for meeting customer demands	1.280 0.075*	4.3	0.0%	0.0%	7.3%	58.5%	34.1%
Your food safety systems are effective	2.793 0.003***	4.3	0.0%	0.0%	4.9%	56.1%	39.0%
Your value chain insists on identity preservation of all its raw ingredients	1.416 0.036**	3.8	0.0%	9.8%	31.7%	29.3%	29.3%
The presence of GM or GM derived ingredients is an issue of risk communication relative to your consumers	1.416 0.036**	2.9	12.2%	14.6%	51.2%	17.1%	4.9%
The presence of GM or GM derived ingredients is an issue of food safety	1.702 0.006***	2.9	12.2%	19.5%	43.9%	14.6%	9.8%
Your products are labelled "May contain GM ingredients"	1.794 0.003***	2.0	43.9%	22.0%	29.3%	2.4%	2.4%
You would lose customers if your products were labelled "May contain GM ingredients"	2.088 0.000***	3.2	9.8%	4.9%	53.7%	19.5%	12.2%

*, **, ***- indicates a significant difference between the distribution of responses and a normal distribution with 90%, 95%, or 99% confidence respectively. Average on a scale from Strongly disagree (1) to Strongly agree (5).

To test the general hypothesis that firm's characteristics may alter a firm's perceptions, the K-S test was conducted on the distribution of responses by firms which were grouped according to size and sector characteristics. The null hypothesis that the distribution of responses follows a standard distribution in the

fruit and vegetable sector was rejected for two statements at the α = 5% level of significance and rejected for one statement at the α = 10% level of significance, as seen in Appendix B, Table B-10. The two statements where the null hypothesis that the distribution of fruit and vegetable sector responses followed a standard distribution was rejected at the α = 5% level of significance are "*Your food safety systems are sufficient for meeting customer demands*" and "*Your food safety systems are effective*." In both cases fruit and vegetable processors generally agreed with these statements; see Appendix B Table B-10 for the average rank and response distribution. There was one statement for which the null hypothesis that the distribution of fruit and vegetable sector responses followed a standard distribution was rejected at the α = 10% level of significance, "*Your customers provide you with processing standards for purchasing your products*"; over half the fruit and vegetable processor respondents agreed.

For respondents from the meat sector, the null hypothesis of responses having a normal distribution was rejected at the α = 10% level of significance for three of the twelve statements in the first question of the "Attitudinal" section of the survey. These three statements were "*Your food safety systems are effective*," "*The presence of GM or GM derived ingredients is an issue of risk communication relative to your consumers*," and "*You would lose customers if your products were labelled "May contain GM ingredients."*" Meat processor respondents generally agreed that their food safety systems were effective and somewhat disagreed that the presence of GM or GM derived ingredients was an issue of risk communication relative to their consumers; however, they strongly

agreed that they would lose customers if their products were labelled "May contain GM ingredients," (see Appendix B Table B-11 for the response distribution).

To test firms' attitudes toward food safety issues, the distribution of firms' responses to a set of questions regarding issues of food safety and risk, (to which the Wilcoxon signed rank test had earlier been applied), was also examined using the K-S test. This set of questions is labelled as Att3 in Appendix A. Ten issues which may impact food safety or the perception of food safety are included: "chemical residues", "pathogen contamination", "physical contamination", "allergens", "trans fatty acids", "GMO sourced ingredients", "animal disease", "pesticide residues", "food origin" and "(lack of) trust". The Kolmogorov-Smirnov test was applied to responses from the entire sample to this question set and also to responses from firms in the size categories of small and medium/large firms.

In testing the responses from the aggregate group of responding food processors, the null hypothesis of normally distributed responses was rejected for six of the 10 issues at the $\alpha = 5\%$ level of significance, suggesting non neutral opinions for six issues. These were: "chemical residues", "physical contamination", "pathogen contamination", and "allergens", as well as "trans fatty acids" and "GMO sourced ingredients". The latter two issues were generally ranked as either very safe or neither dangerous nor safe while "chemical residues", "physical contamination", "pathogen contamination", and "allergens" were all ranked as dangerous. In addition, the null hypothesis was rejected with

respect to two other issues at the $\alpha = 10\%$ level of significance. These were "animal disease" and "food origin". Across the entire sample, the majority of respondents ranked these issues as neither dangerous nor safe, however a reasonable percentage (19.5%) ranked "animal disease" to be very dangerous; regardless, a number of respondents ranked both issues as very safe, as seen in Table 5-4.

In testing the effects of firm size on respondents' perceptions of issues relating to food safety, the industry sample was also divided into respondent firm size categories. The Kolmogorov-Smirnov test was used to examine the distribution of responses of firms in each size category to the queried food safety factors. Testing the responses of small size respondent firms resulted in the null hypothesis of normally distributed responses being rejected at the $\alpha = 5\%$ level of significance for four of the ten issues, as seen in Table B-12 in Appendix B. The four issues for which the null hypothesis was rejected were "pathogen contamination", "physical contamination", "trans fatty acids" and "GMO sourced ingredients". Both "pathogen contamination" and "physical contamination" received an average rank of dangerous from small respondents; see Table B-12 for the average ranks and distribution. Small size respondents ranked both "trans fatty acids" and "GMO sourced ingredients" as neither dangerous nor safe, however 25% of small respondents ranked each of these two issues as very safe, as seen in Appendix B, Table B-12.

Table 5-4: Kolmogorov-Smirnov Test Results for Aggregate Respondents' Ranking of Potential Food Safety Issues, Average Response and Response Distribution per Issue (n=41)

	Total	Average	Very dangerous	Dangerous	Neither dangerous nor safe	Safe	Very safe
	K-S Z statistic		Percent of respondents				
Factor	Asymp. Sig. (2-tailed test)						
Chemical residues / contamination (process based, cleaners or disinfectants, etc.)	1.473 0.026**	2.5	29.3%	29.3%	14.6%	14.6%	12.2%
Pathogen contamination	1.701 0.006***	2.3	39.0%	29.3%	4.9%	17.1%	9.8%
Physical contamination (broken needles, rubber gloves, chewing gum, hair, metal)	1.797 0.003***	2.4	36.6%	31.7%	7.3%	7.3%	17.1%
Allergens	1.656 0.001***	2.6	19.5%	39.0%	19.5%	7.3%	14.6%
Trans fatty acids	1.912 0.001***	3.3	4.9%	17.1%	48.8%	4.9%	24.4%
GMO sourced ingredients	2.339 0.000***	3.5	0.0%	9.8%	58.5%	7.3%	24.4%
Animal disease (BSE, Foot and Mouth)	1.277 0.077*	3.2	19.5%	7.3%	34.1%	7.3%	31.7%
Pesticide residues	1.171 0.129	3.0	14.6%	24.4%	29.3%	9.8%	22.0%
Food origin (foreign vs. domestic or local)	1.332 0.057*	3.3	12.2%	7.3%	41.5%	14.6%	24.4%
Trust (lack of consumer trust)	1.051 0.219	3.1	19.5%	17.1%	22.0%	22.0%	19.5%

*, **, ***- indicates a significant difference between the distribution of responses and a normal distribution with 90%, 95%, or 99% confidence respectively. Average on a scale from Very dangerous (1) to Very safe (5)

The Kolmogorov-Smirnov tests of responses by medium/large-size food processors rejected the null hypothesis of the distribution of responses following a standard distribution at the $\alpha = 5\%$ level of significance for two issues, "trans fatty acids" and "physical contamination". Twenty-three per cent (23.1%) of medium/large respondents ranked "trans fatty acids" as very safe, while 69.2% ranked "physical contamination" as dangerous, as seen in Appendix B, Table B-

13. The Kolmogorov-Smirnov tests of responses by medium/large-size food processors rejected the null hypothesis of the distribution of responses following a standard distribution at the 10% level of significance for one issue, "allergens", which 61.5% of medium/large respondents ranked as dangerous.

The scaled responses to a set of questions on the importance of common food safety issues from the "Attitudinal" section of the survey were also tested using the Kolmogorov-Smirnov test. These questions are found in the first ranking table, designated Att401, in the "Attitudinal" section of the survey and queried respondents regarding the importance of five practices in modern food safety provision: "risk analysis", "regulating food safety primarily to protect consumers' health," "using a "farm-to-table" approach to deal with potential hazards," "HACCP system adoption as a basis for risk management," and "the distribution of better information along [the] value chain to inform consumers and help them make more informed purchases". The responses rating the importance of these factors were tested for the entire industry sample, as were the responses of firms grouped according to firm size. Table 5-5 gives the results of the K-S tests of the aggregate industry sample, the average response and the response distribution for each practice. At the $\alpha = 5\%$ level of significance, the null hypothesis of a normal distribution was rejected for each of the five practices cited, with "risk analysis", "regulating food safety primarily to protect consumers' health," "using a "farm-to-table" approach to deal with potential hazards," "HACCP system adoption as a basis for risk management," and "the distribution of better information along [the] value chain to inform consumers and help them

make more informed purchases" all generally being ranked as important or very important (as seen in Table 5-5).

Table 5-5: Kolmogorov-Smirnov Test Results for Aggregate Respondents' Ranking of Important Trends in Modern Food Safety Provision, Average Response and Response Distribution per Trend (n=41)

	Total	Average	Very unimportant	Unimportant	Neither important nor unimportant	Important	Very important
	K-S Z statistic		Percent of respondents				
	Asymp. Sig. (2-tailed)						
Risk analysis	1.920 0.001***	3.9	2.4%	2.4%	22.0%	53.7%	19.5%
Regulating food safety primarily to protect consumers' health	1.848 0.002***	4.4	2.4%	0.0%	4.9%	41.5%	51.2%
Using a "farm-to-table" approach to deal with potential hazards	1.684 0.007***	3.9	0.0%	7.3%	22.0%	46.3%	24.4%
Hazard Analysis Critical Control Points (HACCP) system adoption as a basis for risk management	1.545 0.017**	4.0	2.4%	4.9%	22.0%	29.3%	41.5%
The distribution of better information along your value chain to inform consumers and help them make more informed purchases	1.654 0.017**	3.8	2.4%	2.4%	29.3%	46.3%	19.5%

*, **, ***- indicates a significant difference between the distribution of responses and a normal distribution with 90%, 95%, or 99% confidence

Average on a scale from Very unimportant (1) to Very important (5)

When respondents were grouped according to firms' size categories, not all groups rejected the null hypothesis that responses followed a standard distribution. The K-S test of small processors' responses rejected the null hypothesis of normal distribution at the $\alpha = 5\%$ level of significance for three of the five practices. The practices for which the null hypothesis was rejected were "risk analysis," "regulating food safety primarily to protect consumers' health," and "the distribution of better information along your value chain to inform consumers and help them make more informed purchases." These three food safety trends were generally ranked as important or very important. Additionally,

the null hypothesis for the statement "Using a "farm-to-table" approach to deal with potential hazards" was rejected at the α = 10% level of significance. For small respondents "using a "farm-to-table" approach to deal with potential hazards" received an average rank of neither important nor unimportant, however, over 63% of small respondents ranked "Using a "farm-to-table" approach to deal with potential hazards" as either important or very important, (see Appendix B Table B-14 for the distribution of small size firm responses).

Examining the responses from medium/large firms, the null hypothesis of responses being normally distributed was rejected at the α = 5% level with respect to "Hazard Analysis Critical Control Points (HACCP) system adoption as a basis for risk management" which 69.2% of medium/large respondents ranked as very important. The null hypothesis of responses being normally distributed was rejected at the α =10% level with respect to "Risk analysis" which 61.5% of medium/large respondents ranked as important. The small sample size (of 13 observations) of the medium/large respondent groups indicates that results should be interpreted cautiously.

The K-S test was also applied to examine responses to another set of questions in the "Attitudinal" section of the survey, which requested that respondents rank the importance of various practices that may serve as signals that firms may use to convey the quality of their products to their end consumers. The set of questions are in Appendix A, designated as Att5. Responses to these questions were assessed using the K-S test to evaluate which quality signals were ranked most highly by respondent firms. A principal component analysis was

also conducted on responses to this set of questions to determine any commonalities among the selected practices that might enable these quality signals to be grouped. The principal component analysis is discussed in Section 6.2. Respondents were requested to rank the perceived importance to their firms of fourteen possible signals of food quality. Responses to these questions were analysed for the aggregate sample and for groupings of meat sector respondents and the respondents from the combined fruit and vegetable and grain and oilseed processor firms.

The K-S test was initially applied to the responses from the aggregate Alberta industry sample. The null hypothesis of responses being normally distributed was rejected at the 10% level of significance in all of the fourteen cases, as seen in Table 5-6. From examining the response distribution, the most important signal of food quality was "consistent food safety," which the majority of respondents ranked as very important. Consistent food safety was followed in importance by "flavour", "appearance", and "smell". The fifth most important of the signals of food quality to the Alberta food processor respondents was "brand reputation". The least important signal of quality, with an average rank of neither important nor unimportant, was "GMO sourced ingredients", as seen in Table 5-6.

To test the hypothesis that the firms' food sector influences the attributes that they focus on to portray quality to their end consumers, K-S tests were used to identify which of the fourteen quality indicators ought to be further assessed regarding their relative importance. These K-S tests were applied to responses from two groupings of respondents, those processing plant-based foods (i.e. the

combined fruit and vegetable and grain and oilseed sectors), and meat sector processors. In testing responses from plant-based food processing firms, the null hypothesis that responses follow a normal distribution was rejected for seven indicators of food quality ("flavour", "appearance", "brand reputation", "consistent food safety" and "smell"). At the $\alpha = 5\%$ level of significance the most important signals of food quality among plant-based food processors were "flavour" and "appearance", followed by "brand reputation", "consistent food safety" and "smell" (see Appendix B Table B-16 for the average ranks and results of response distribution tests). At $\alpha = 10\%$ level of significance the more important signal of food quality was "packaging". The least important quality signal, according to the responses of plant-food processors was "GMO sourced ingredients", which was ranked as neutral on average.

Meat processors' ratings of the relative importance of different features of food quality were also examined. The null hypothesis of a normal distribution of responses from this group of food processors was rejected at the $\alpha = 5\%$ level of significance for three signals of quality. These are, in order of importance, "consistent food safety", "smell" and "flavour", as seen in Appendix B Table B-17. "GMO sourced ingredients" was rated as the least important signal of food quality and this issue was generally ranked as unimportant by meat processors.

Table 5-6: Kolmogorov-Smirnov Test Results for Aggregate Sample Responses Regarding Signals of Food Quality to the End Consumer, Average Response and Distribution per Signal (n=41)

	Total	Average	Very unimportant	Unimportant	Neither important nor unimportant	Important	Very important
	K-S Z statistic						
	Asymp. Sig. (2-tailed)		Percent of respondents				
Brand reputation	2.061	4.4	0.0%	2.4%	7.3%	36.6%	53.7%
	0.000***						
Certifications (Health Check, organic, etc.)	1.280	3.8	0.0%	9.8%	31.7%	29.3%	29.3%
	0.075*						
Consistent food safety	2.671	4.6	0.0%	2.4%	2.4%	24.4%	70.7%
	0.000***						
Food origin (foreign vs. domestic or local)	1.298	3.7	0.0%	12.2%	29.3%	34.1%	24.4%
	0.069*						
GM free	1.758	3.4	2.4%	9.8%	48.8%	22.0%	17.1%
	0.004***						
GMO sourced ingredients	1.772	3.1	9.8%	9.8%	53.7%	17.1%	9.8%
	0.004***						
Healthful ingredient lists	1.430	3.8	4.9%	2.4%	26.8%	36.6%	29.3%
	0.033**						
Internal quality assurances	1.615	3.9	0.0%	2.4%	39.0%	24.4%	34.1%
	0.011**						
Labels	1.512	4.1	0.0%	0.0%	26.8%	36.6%	36.6%
	0.021**						
Packaging	1.801	4.3	0.0%	0.0%	9.8%	46.3%	43.9%
	0.003***						
Smell	2.242	4.5	0.0%	0.0%	7.3%	36.6%	56.1%
	0.000***						
Texture	2.040	4.4	0.0%	0.0%	14.6%	34.1%	51.2%
	0.000***						
Flavour	2.516	4.6	0.0%	0.0%	4.9%	31.7%	63.4%
	0.000***						
Appearance (i.e. product colour, bruises)	2.433	4.6	0.0%	0.0%	4.9%	34.1%	61.0%
	0.000***						

*, **, ***- indicates a significant difference between the distribution of responses and a normal distribution with 90%, 95%, or 99% confidence respectively.

Average on a scale from Very unimportant (1) to Very important (5)

Responses for "GMO sourced ingredients" along with "internal quality assurances", "packaging", and "texture" all rejected the null hypothesis of a normal distribution at the $\alpha = 10\%$ level of significance. Meat sector respondents generally ranked "internal quality assurances", "packaging", and "texture" as

important or very important signals of food quality to the end consumer, as seen in Appendix B Table B-17.

The final set of responses to which the K-S test was applied were from the last set of questions in the "Attitudinal" section of the survey, designated Att10 in Appendix A. These questions queried respondents about the safety of eight features of the procedures, premises and equipment in their own facilities, specifically "manufacturing procedures", "personnel hygiene", "personnel training", "equipment", "packing materials", "the premises", "validated quality assurance procedures" and "raw materials". These questions allowed firms' respondents to express whether or not there were areas within their establishments which needed improvement to provide safe food. It was expected that firms would generally respond that their facilities were safe. Since the null hypothesis for the one sample K-S test is that the distribution of responses would follow a normal distribution it was expected that the null hypothesis would be rejected in every case. Responses to this question were tested for the entire sample of Alberta food processor survey respondents and for two groups of firms of different sizes. In testing the aggregate sample, the null hypothesis was rejected at the $\alpha = 1\%$ level of significance for all eight variables, as seen in Table 5-7. In general, "manufacturing procedures", "personnel hygiene", "personnel training", "equipment," "packing materials," "the premises", and "validated quality assurance procedures" were all regarded to be safe or very safe, while, interestingly, over thirty-four percent of respondents ranked their "raw materials"

as dangerous or very dangerous. See Table 5-7 for the distribution of firms' responses by percentage in each hazard category.

Table 5-7: Kolmogorov-Smirnov Test Results for Aggregate Sample Responses Regarding Potential Facility Hazards, Average Response and Distribution per Hazard (n=41)

	Total	Average	Very dangerous	Dangerous	Neither dangerous nor safe	Safe	Very safe
	K-S Z statistic		Percent of respondents				
	Asymp. Sig. (2-tailed)						
Manufacturing procedures	1.778	3.8	9.8%	14.6%	4.9%	31.7%	39.0%
	0.001***						
Personnel hygiene	1.953	3.6	14.6%	14.6%	0.0%	34.1%	36.6%
	0.001***						
Personnel training	1.929	3.6	12.2%	14.6%	4.9%	39.0%	29.3%
	0.001***						
Equipment used	1.736	3.6	7.3%	17.1%	9.8%	36.6%	29.3%
	0.005***						
Premises	1.627	3.7	7.3%	19.5%	4.9%	36.6%	31.7%
	0.003***						
Raw materials	1.808	3.5	12.2%	22.0%	0.0%	31.7%	34.1%
	0.003***						
Packing materials	1.67	3.8	4.9%	17.1%	9.8%	34.1%	34.1%
	0.008***						
Validated quality assurance procedures	1.772	3.8	7.3%	12.2%	9.8%	36.6%	34.1%
	0.004***						

*, **, ***- indicates a significant difference between the distribution of responses and a normal distribution with 90%, 95%, or 99% confidence respectively. Average on a scale from Very dangerous (1) to Very safe (5).

To test if a firm's size affects whether or not there are common areas within food processing establishments which need improvements to provide safe food, the K-S test was applied to the responses of firms in the two size groups. The distribution of small size firm responses rejected the null hypothesis that the distribution of responses followed a normal distribution at the $\alpha = 5\%$ level of significance for each of the eight variables queried. Table B-18 in Appendix B includes the Kolmogorov-Smirnov Z statistic and the asymptotic significance for small processors' responses, the average small processor response, results of the

test and the distribution of the responses. On average, "manufacturing procedures" were ranked as the safest, followed by "validated quality assurance procedures". The least safe factors as perceived by small firms were "personnel training" and "raw materials", as seen in Appendix B Table B-18. Each variable was classified as being very dangerous in their facility by at least one respondent. This may indicate different potential problems, a risk adverse attitude, misunderstanding of the questions or respondent fatigue. When the responses of medium/large size respondents were tested with the K-S test, the null hypotheses of normally distributed responses were rejected at the $\alpha = 5\%$ level of significance for only the variable "personnel hygiene" which 61.5% of respondents rated as safe.

5.4 Summary

Chapter five reported on specific quantitative analyses of data from the survey of Alberta food processing firms. Summary statistics of sampled firm's responses were presented and these responses were analysed using two non-parametric tests. The Wilcoxon signed rank test and the Kolmogorov-Smirnov test were applied using SPSS 15.0. Firms' responses were grouped according to common firm characteristics such as size and sector of production; the responses from each group were independently tested with the Wilcoxon signed rank test and the Kolmogorov-Smirnov test.

In the analysis reported in this Chapter a number of hypotheses outlined in Section 5.1 were tested. Section 5.2.3 tested the hypothesis that firms are aware

of the existence of subjective-objective, or qualitative-quantitative differences between public and consumer risk perceptions relative to scientific risk analysis conducted by industry or government. It was also hypothesized that firms' characteristics, i.e. size, sector, or export status, may influence firms' response to consumers' concerns. In Section 5.2.4 the hypothesis was tested that firm's characteristics affect whether practices that may be of importance to food safety provision are perceived to be equivalently important to improving firm business performance. In Section 5.2.5 the hypothesis that risks to food safety are also risks to business performance was tested, as was the hypothesis that firms' characteristics may influence whether risks to food safety are also perceived to be risks to business performance. These hypotheses were tested using Wilcoxon signed rank tests. The Kolmogorov-Smornov test was used in Section 5.3 to test whether or not respondent firms displayed defined attitudes and opinions toward various types of risk and/or signals of quality.

In testing firm awareness of the existence of differences between subjective and objective risk analysis and that firm's characteristics such as size, sector, or export status, influence firm responses to subjective consumer concerns, the Wilcoxon signed rank test was used to compare the responses of groups of Alberta food processors. For the aggregate sample, the largest differences were identified between firm rankings and perceived consumer rankings for "allergens" and "animal disease" at the $\alpha = 1\%$ level of significance. When Canadian food safety systems are working properly, diseased animals should be identified before they enter the food chain, while allergens pose risks to individual consumers

rather than consumers in aggregate. Other potential hazards for which there were differences in the response distributions were "GMO sourced ingredients" and "pesticide residues". In different subgroups of firms, there were some differences in rankings of importance of different food safety issues and perceptions of consumers assessments. Small processors and non-exporters tended to give similar distributions of rankings to the aggregate sample. Non-exporters differentiated between their rankings and their consumers' perceived rankings of "physical contamination". Medium/large firm and fruit and vegetable responses were also similar to the aggregate results, however the medium/large processors did not differentiate between risks to food safety and consumer perceptions of the hazard posed from "GMO sourced ingredients". Meat sector respondents rejected the null hypothesis of equally distributed risk rankings only once for "GMO sourced ingredients". Whether or not each potential hazard was perceived as more or less dangerous showed some differences between subgroups. Small food processors, medium/large size food processors, non-exporting respondents and exporting firms' responses all indicate that they perceived their consumers to rank the potential risks as more dangerous to food safety, on average, than they themselves do. Given the similarities in the rejection of the null hypothesis of equally distributed risk rankings among subgroups, there is little statistically significant evidence to suggest that these groups differ in their understanding of end consumer concerns for the ten cited food safety issues. However, given the differing levels of consumer concern indicated by the respondent sub-groups

further examination of processors' perceptions of consumer perceptions may be of interest.

In spite of the similarities in response distributions between treatments, some differences do exist between the groups. For five of the issues cited, the average of medium/large size firm responses indicates that medium/large size firms rank measurable risks such as "chemical residues," "pathogen contamination", "physical contamination", "allergens", and "food origin" to be more dangerous to food safety within their facilities than did small size food processors. The other five issues cited ("GMO sourced ingredients", "trans fatty acids", "animal disease", pesticide residuals and "[lack of] trust") tended to be considered more of a risk to food safety by small size processors. These differences are intriguing and lead to speculation as to whether smaller firms are more concerned than others about subjective or qualitative sources of risk. The Wilcoxon signed rank tests of the responses by different groups of Alberta food processing respondents suggest that small processors may be more aware of differences between their own internal risk assessments and consumers' concerns than are medium/large size respondent firms. Fruit and vegetable sector respondents appear to be more aware of possible differences between consumer's concerns and their own risk assessments than are respondent meat sector processors. Non-exporting respondents may also be more aware of the differences between consumer concerns with respect to exporting respondents.

While differences between sectors with respect to their attitudes about food hazards and the hazards they their perceive their consumers to identify were

expected, it is interesting to note similarities between subgroups of firms asked to differentiate between benefits and risks to food safety provision and to business performance. These similarities among groups may indicate that while subgroup perceptions of their consumers may vary, the food industry is comprised of profit-based businesses which rely on quantitative research to produce safe and profitable products. The results of the analysis from the second and third pairs of treatments (question sets) indicate how similar firms in different groups and sectors may be. "Good manufacturing practices" were ranked as the most important factor to food safety provision and to improving firm business performance by almost each group tested; "GMPs" were ranked as more important to food safety provision than to improving firm business performance by the aggregate of industry respondents. This result was consistent for the subgroups of non-exporters, exporters, meat processors, small size processors and medium/large size processors and is similar to results generated by Herath and Henson's (2006) survey of Ontario food processors. There are a number of other factors which are seen by the Alberta respondents as important to both food safety provision and food business performance not identified by Herath and Henson (2006).

For the aggregate industry sample, the second and third most important factors to improving food safety performance are: "product traceability" while a "product recall system" and "HACCP" tied for third; however, for the aggregate sample the response distributions regarding the importance of "product traceability", a "product recall system" and "HACCP" were not significantly

different from each other at the $\alpha = 5\%$ level. With respect to improving business performance, "GMPs" were the most important, followed by "product traceability", a "product recall system" and then "HACCP". In this instance, the response distributions regarding "HACCP" were also not significantly different than either "product traceability" or a "product recall system". These rankings vary somewhat between sub-groups, with "HACCP" being second most important to both medium/large firms and exporting firms with respect to both food safety provision and business performance; whereas "HACCP" is fifth most important for small firms and non-exporting firms with respect to both food safety provision and business performance. Firm's characteristics tend to influence which factors are important to food safety provision and which are important to improving firm business performance, although in aggregate "GMPs" and "product traceability" were both ranked as highly important to the Alberta food processing firms. In light of the effects of traceability on mitigating financial and legal problems (Lupien 2005) this is a logical and important result.

This chapter also used the Wilcoxon signed rank test to examine whether risks to food safety provision were also risks to firm business performance, and whether firms' characteristics tend to affect whether or not firms perceive risks to food safety also to be risks to firm business performance. In aggregate, the hazards which posed different risks to food safety provision relative to firm business performance were "pathogen contamination", "physical contamination", "pesticides" and "spoilage". These four were ranked as more hazardous to business performance than food safety. These results did not carry through all the

smaller subgroups to which the test was applied. However, again it is interesting to note the similarities between subgroups as well as the differences with respect to particular hazards. Meat processors, small size processors[11] and exporters generally indicated the same perceptions as the aggregate sample in differing in the risks that they saw for business performance and food safety provision. The only differences in these results were for "pesticides", which none of the three groups differentiated between business performance and food safety provision, and "GM sourced ingredients", which exporting firms indicated were different with respect to food safety provision and business performance. Wilcoxon signed rank tests of medium/large firms, non-exporters, and fruit and vegetable firms did not give identical results to those generated by the aggregate sample but did generate similar results to each other. The appreciable numbers of similarities between groups involved in different areas of the food industry is interesting. Even so, the results from Wilcoxon signed rank tests of processors' responses suggest that there are some differences between the perceptions of particular hazards held by different firms (in terms of their size, export status or sector) as risks to food safety, relative to risks to business performance.

Seven points of particular interest arise from the results of the Wilcoxon signed rank test results. These points of interest are as follows: 1) Alberta food processors generally perceive their end consumers to view potential risks to food safety as more hazardous than the firms themselves do; 2) firms' perceptions of

[11] One small meat processor commented that it produced a safe product but that consumers did not know how to handle it properly; therefore the consumers were responsible for unsafe meat. If this attitude is common, it could help account for the rejection of the null hypothesis by some small meat processors.

consumer concerns qualitatively differ among sub-groups (i.e. size, sector, or export status); 3) good manufacturing practices are seen as important to both food safety provision and improving business performance; 4) Alberta food processors generally tended not to differentiate between business improving practices and food safety provision practices; 5) physical contamination was seen as a danger to food safety provision and to firm business performance; 6) The distribution of risks as seen by Alberta food processors does not significantly differ between risks to food safety provision relative to business performance from employee hygiene and GM sourced ingredients; and 7) firm's characteristics can affect firm's perceptions of relative food safety hazards. Each of these would be interesting to examine in more detail with a larger sample.

In one focus of the analyses in this chapter, the responses to five blocks of questions were compared in order to assess firms' perceptions and attitudes about food safety. To assess whether these perceptions varied among groupings of firms with some similar characteristics, the one sample Kolmogorov-Smirnov (K-S) test which compares distributions of responses against a normal distribution, was applied to responses from groups of respondents according to selected characteristics. Where the K-S null hypothesis was rejected the distribution of firm responses was examined to identify common perceptions or attitudes. The results of the K-S test indicated interesting similarities and differences between various sub-groups. For example, meat processors strongly agreed they would lose customers if their products were labelled "may contain GM ingredients" while this null hypothesis was not rejected when the responses of fruit and

vegetable sector respondents were tested. Perhaps this reflects meat processors' awareness of controversy in Europe about labelling meat fed GM-derived animal feed, whereas fruit and vegetable processors may not be aware of any GM-derived fruits and vegetables in Canada. The K-S tests of responses from small sized processors and from medium/large sized processors also showed some variation. For example, responses of small sized processors indicate that "pathogen contamination" and "physical contamination" are generally very dangerous, while "trans fatty acids", and "GMO sourced ingredients" are generally very safe; however, medium/large size processors indicated that "trans fatty acids" were very safe or were neither dangerous nor safe while "physical contamination" and "allergens" were simply dangerous. Given the consistency in the rankings of most factors which impact business performance and food safety there is another interesting difference for "HACCP", which is seen as an important food safety issue for medium/large size respondents but not for small size respondents.

The tendency for some concerns to be more important for some groupings of firms suggests that the more customized regulations and guidelines are to a sector, the more likely these are to be relevant and adopted. Relevance and cost effectiveness are both likely to be important in encouraging the adoption of new regulations and guidelines, regardless of the regulations' origin. Due to structural issues within the food processing industry, comprehensive public information regarding various factors influencing food safety could be useful for educating firms. Such information could help firms prioritize food safety measures, understand the relevance of regulations and encourage compliance.

6.0 Chapter Six: Principal Component and Binary Logit Analyses of Adoption of Management Practices

6.1 Introduction to Principal Component Analysis and Binary Logit Model Applications

This chapter reports on two analytic components. The first of these involves principal component analyses conducted on responses to three questions from the survey. One such question asked respondents about the importance of fourteen signals of food quality; these are designated Att5 in Part B of the survey, "Attitudinal." This analysis also included responses to two questions in Part D of the survey, headed, "HACCP," which query HACCP adoption and non-adoption. In this examination of food quality assessments, factor analysis was conducted on the responses of the entire sample of Alberta respondents, as well as on sub-groups of respondents identified by specific characteristics, such as firm size and export status. The assessment of firms' responses regarding HACCP adoption and non-adoption categorized these into two groups according to adoption status, as discussed in the qualitative analysis of responses.

In the second analytic component of the chapter two logit models were postulated and tested to better understand the potential influences of postulated external motivating factors on the adoption, by respondent firms, of food safety systems and risk management practices. These models were used to test the relative impact of selected government, industry and consumer influences on respondents' food safety investment. The previous or intended adoption of a HACCP program was used as a proxy for food safety investment. The results of three estimations are discussed.

6.2 Principal Component Analysis

Following the K-S tests conducted in Section 5.3.1 and the Wilcoxon Signed Rank Tests conducted in Section 5.2.4, principal component analyses were conducted to more closely examine firms' emphasis on signals of food quality and motivations for HACCP adoption. In Section 5.3.1, the results of the K-S test indicated that food quality can include a number of different attributes. To identify which groups of food quality attributes are commonly used by firms, principal component analysis was also conducted on responses to Survey question Att5 which queried respondents regarding food quality (See Att5 Appendix A). This set of questions asked respondents "*What are your main signals of food quality to the end consumer?*" and queried respondents about fourteen potential signals of quality. Some possible signals were credence attributes but each signal could be perceived as directly affecting end-consumers. HACCP has been ranked as important for managing food safety risks (Section 5.2.4, Section 5.3.1) and for protecting business performance (Section 5.2.4). To assess motives for HACCP adoption and non-adoption, principal component analyses were conducted on responses to queried factors that may relate to this.

Principal component[12] analyses were conducted using SPSS 15.0. These summarize the correlations among variables to capture the commonalities which exist among them (STATISTICA 2008). Through principal component analysis,

[12] Principal component analyses are a form of data reduction, used to reduce multiple correlated variables into factors. Each factor includes the information for the correlated variables contained within it. Annotated SPSS Output: Principal component analysis. UCLA: Academic Technology Services, Statistical Consulting Group. From http://www.ats.ucla.edu/stat/SPSS/output/principal_components.htm (accessed December 19, 2008).

strongly correlated variables are grouped into common factors. The information in multiple variables can then be reduced into fewer factors which can also be used to identify structure in the relationship between the variables (STATISTICA 2008). Each factor has an associated eigenvalue, a number which explains the amount of variance which is explained by each factor (STATISTICA 2008). The greater the eigenvalue, the greater the explanatory power of the factor. Due to their explanatory value, factors with eigenvalues greater than one are included in this discussion.

The Alberta industry sample was separated into several groups, some of which overlap, based on common characteristics, i.e. firm size, sector of operation, or export status; respondent firms which claim to include end consumer concerns in the design stage of their risk management are also identified as a group defined by a common characteristic. Principal component analyses were conducted both for the aggregate sample and on these different groupings of firms' responses.

Identical factors were generated from analyses of some groupings of firms, therefore, for clarification, when factors are identified, the respondent groupings which generated those factors are also identified. This may help demonstrate where similarities and differences exist between the different groupings of respondent firms. The respondent groups discussed in this context are the entire group of Alberta food processor respondents, meat sector respondents, fruit and vegetable sector respondents and respondent firms which claim to include end consumer concerns in the design stage of their risk management. Factors were

extracted using a verimax, or variance maximizing (STATISTICA 2008), rotation.

The principal component analyses conducted on the set of questions which dealt with HACCP program adoption (found in the fourth section of the survey, "HACCP") were replicated from Herath and Henson's survey of Ontario food processors and the resulting components are directly compared to those reported in the Ontario study.

6.2.1 Signals of Food Quality

The first set of question responses assessed with principal component analysis included fourteen potential signals of food quality which food processors could use to signal product quality to their end consumers. When a principal component analysis was run on the food quality responses of the aggregate Alberta food processor sample, four factors were generated with eigenvalues greater than or equal to one. Table 6-0 indicates these. The same four factors were also generated by the principal component analysis of the responses of plant-based food processors, i.e. processors which process either fruit and vegetables or grain and oilseed products.

The first factor generated from the analysis of both the aggregate and the plant based samples can be described as *sensory based quality*. This factor describes 24.4% of the variation in choices of food quality signals for the aggregate sample. The food quality characteristics which make up this factor are sensory in nature and include "smell", "flavour", "appearance" and "texture". A

similar but not identical *sensory* factor was also generated by the principal component analysis of the responses from meat sector processors, medium/large sized food processors and both exporting and non-exporting processors. The second factor identified for the aggregate of responses is termed *control*. This factor appears to communicate quality control through signals such as "internal quality assurances", "certification" and "food origin". *Control* describes 17.4% of the variation in choices of food quality signals of the aggregate sample. The *control* factor was also the second factor generated in the principal component analysis conducted on responses from exporting processors and plant-food processors. The third principal component factor for the aggregate of responses is labelled *information;* this is also a factor identified in the analysis of exporters' responses. This factor describes 17.0% of the variation in choices of food quality signals of the aggregate sample. It includes the quality characteristics "labels", "healthful ingredient lists", "packaging", and "brand reputation". This factor seems to support the use of brand reputation as a proxy for food quality and is consistent with previous research in Britain, where consumers have been found to equate packaging quality with product quality (Ahmed, Ahmed and Salman 2005). The last factor generated from the principal component analysis of responses from the aggregate sample is termed *concern*. This factor included the characteristics "consistent food safety" (which was negatively loaded) and being undecided with respect to having "GM sourced ingredients" or being "GM ingredient free" are the characteristics which group in this factor. The factor

concern describes 11.5% of the variation in choices of food quality signals of the aggregate sample, as seen in Table 6-0.

Table 6-0: Mean Rank and Factor Loading from the Principal Component Analysis of Responses from the Aggregate Sample Regarding Signals of Food Quality to the End Consumer (n=41)

	Mean	Factor 1: sensory based quality	Factor 2: control	Factor 3: information	Factor 4: concern
Smell	4.5	**0.950**	-0.047	0.136	-0.022
Flavour	4.6	**0.922**	-0.054	0.194	0.010
Appearance (i.e. product colour, bruises)	4.6	**0.912**	0.044	0.069	-0.025
Texture	4.4	**0.694**	0.086	0.349	-0.242
Certifications (Health Check, organic, etc.)	3.8	0.000	**0.826**	0.066	-0.005
Internal quality assurances	3.9	0.045	**0.824**	0.018	-0.115
Food origin (foreign vs. domestic or local)	3.7	-0.061	**0.596**	0.150	0.148
Labels	4.1	0.235	0.065	**0.846**	-0.095
lists	3.8	-0.084	0.101	**0.780**	0.160
Packaging	4.3	0.313	0.210	**0.630**	-0.051
Brand Reputation	4.4	0.348	-0.053	**0.561**	-0.028
Consistent food safety	4.6	0.232	0.362	0.025	**-0.806**
GMO sourced ingredients	3.1	-0.016	0.499	-0.144	**0.665**
GM free	3.4	0.122	0.512	0.332	**0.618**
% of Variance Explained	-	24.4%	17.4%	17.0%	11.5%

The second factor analysis was conducted on the responses to the same set of questions by meat sector processors (most of which are relatively small size firms). Five factors were generated from this analysis. The same set of five factors was also generated from responses ranking food quality issues by the

grouping of medium/large firms (all sectors). Table B-20 in Appendix B summarises these results.

The first factor generated by the principal component analysis of responses from meat sector processors and medium/large size processors is termed *popular health*. This factor included the characteristics of having "healthful ingredient lists", being "GM free", "food origin", and "certifications (organic or having the Health Check symbol, etc.)". The factor also included "food texture". (In the case of meat, texture may be dependent on levels of fat and cooking style, raising the possibility that tradeoffs may be made between fat levels and texture). This factor explains 20.8% of the variation in meat firms' choice of signals of food quality. The second factor generated is labelled *sensory quality*. This factor explains 20.2% of the variation in meat firms' choice of signals of food quality. It included food quality characteristics which were sensory based, such as "smell", "flavour" and "appearance". The third factor generated from the responses of meat sector processors and medium/large size processors is named *functional* and includes "GMO sourced ingredients" and "packaging" as quality characteristics. This factor explains 16.3% of the variation in meat firms' choice of signals of food quality. The fourth factor is called *brand reputational quality* and includes two characteristics, "brand reputation" and "labels". This factor explains 13.5% of the variation in meat firms' choice of signals of food quality. The fifth and final factor is termed *historic food safety*. The only characteristic in this factor is "consistent food safety" and this factor explains 10.1% of the variation in meat firms' choice of signals of food quality.

Responses from the group of firms associated with the fruit and vegetable sector were also analysed using principal component analysis. The analysis of these responses generated four factors with eigenvalues greater than one. Table B-21 in Appendix B gives these. The first factor generated from the principal component analysis of fruit and vegetable producer quality signals is termed *branded sensory quality*. This includes quality characteristics such as "smell", "appearance", and "flavour", in addition to "brand reputation", "packaging" and "texture". This factor explains 33.1% of the variation in fruit and vegetable sector firms' choice of signals of food quality. The second factor generated is labelled *search and credence quality*. This includes "food origin" and being "GM free" while "labels" and "healthful ingredient lists" were not important. This factor explains 24.0% of the variation in fruit and vegetable firms' identification of signals of food quality. The third factor generated from this principal component analysis is termed *consistent food safety* which includes "consistent food safety"; inclusion of "GMO sourced ingredients" was highly negatively loaded and not important to this factor. This factor explains 15.1% of the variation in fruit and vegetable firms' choice of signals of food quality. The fourth factor is termed *certified quality*. This factor explains 13.6% of the variation in fruit and vegetable firms' choice of signals of food quality. It includes "certifications" and "internal quality assurances" as signals of food quality to end consumers.

The final principal component analysis was applied to the responses rating food quality signals and practices by the sub-group of firms whose responses had indicated that they included end consumer concerns in the design stage of their

risk management plans. This group of processors is expected to place emphasis on consumer satisfaction and was, therefore, identified for particular assessment. Table B-22 in Appendix B indicates the factors generated from the principal component analysis of members of this groups' responses. The first factor generated from the principal component analysis is labelled *informed credence and experience characteristics*. This factor explains 23.7% of the variation in consumer considering firms' choice of signals of food quality. The quality signals which are highly loaded in this factor are "smell", "flavour", and "appearance", along with "labels" and being "GM free". The second factor includes two signals of quality and is characterized as *external quality*. This factor explains 15.7% of the variation in consumer considering firms' choice of signals of food quality. The signals which make up this factor are "packaging" and "healthful ingredient lists". The third factor generated by the factor analysis is termed *safe characteristics*. This factor explains 15.1% of the variation in consumer considering firms' choice of signals of food quality. The quality characteristics which make up the third factor are "consistent food safety", not having "GMO sourced ingredients", and "texture". Thus the third factor includes both credence and experience goods and appears to rely on firms having historically produced safe food products as a means to currently communicate quality. In addition to being firms that include end consumer concerns in the design stage of their risk management, fifty eight percent of the firms which demonstrated this factor were exporters; however there were few other consistent characteristics. The fourth factor generated by the principal component analysis of responses from firms that

include end consumer concerns in the design stage of their risk management is labelled *non-branded certifications*. This factor explains 14.1% of the variation in consumer considering firms' choice of signals of food quality. The factor includes "internal quality assurance" and "certifications" while "brand reputation" was negatively loaded. The fifth and final factor generated is termed *food origin* which included one quality characteristic, "food origin". This factor explains 9.9% of the variation in firms' choice of signals of food quality. The signal "food origin" may be seen by firms as important to consumers looking for local food products or those concerned about standards in particular countries.

6.2.2 Motivations that may Influence HACCP Program Adoption

Responses to two sets of questions querying HACCP program adoption and non-adoption were also examined with principal component analysis to better understand firms' motivations for HACCP adoption and non-adoption implied from the analysis in Sections 5.2.4 and 5.3.1. Table 6-1 indicates proposed motivators of HACCP adoption while Table 6-2 focuses on selected barriers to HACCP system adoption. In order to analyse responses to these two sets of questions, survey respondents were divided into two groups, one being HACCP adopters with the other being non-adopters. The principal component analysis of responses to questions on reasons for HACCP adoption generated five factors with eigenvalues exceeding one. Again, factors were extracted using a verimax rotation.

The first factor generated by the principal component analysis of HACCP adopters is labelled r*esponsive* p*roduct* q*uality*. This includes "Expected impact on product quality", "Expected impact on product traceability," and "Expected impact on shelf life of products," in addition to "Expected impact on ability to retain existing customers," "Expected impact on risk of product recalls," "Expected impact on customer complaints," and "Expected impact on ability to deal with customer complaints." This factor explains 22.4% of the variation in firms' HACCP adoptions. Respondents with motivations for adopting HACCP that are described by the first factor operate in each of the four food sub-sectors and are generally exporters. The majority of HACCP adopters described by the first factor are small size firms.

Factor two is termed *regulation motivated* and includes "Expected ability to meet anticipated regulatory requirements," "Expected ability to meet existing regulatory requirements," and "Expected ability to attract new customers;" along with "Wish to apply good practice," "Expected impact on product safety," and "Expected ability to meet anticipated future customer requirements." This factor explains 17.7% of the variation in firms' reasons for HACCP adoption. Respondents motivated by the second factor to adopt HACCP included firms of all sizes and sectors. All the respondents that were members of a value chain were motivated by this factor to adopt HACCP. Numbers of the other respondents motivated by this factor had customers who inspected their facilities.

The third factor generated by the principal component analysis of motivators of HACCP adoption is termed *external drivers.* This includes

"Expected impact on ability to access new markets," "Expected ability to comply with government recommendation," "Industry/trade organization recommendations," and "Expected impact on need for customers to inspect plant." This factor describes firms which seem to strive to comply with industry, value chain and government requirements and is similar to the third of three principal component factors reported for Ontario food processors[13] (Herath and Henson 2006), suggesting some similarities in HACCP adoption motivators across regions within Canada. All respondents motivated by the third factor to adopt HACCP had their facilities inspected by their customers and most included end consumer concerns in the design stage of their risk management. Half of the respondents motivated by factor three to adopt HACCP were medium/large in size and all but one respondent motivated by factor three were exporters. The third factor explains 15.5% of the variation in motivations to adopt HACCP.

Factor four is termed *financially driven* and includes "Expected ability to get a higher price for the products," "Expected impact on product wastage" and "Expected ability to reduce costs of production." Respondents motivated by factor four to adopt HACCP were generally small exporters that reported taking end consumer concerns into consideration in the design stage of their risk management. The respondents motivated by factor four did not generally belong to a formally coordinated value chain but had their facilities inspected by their

[13] However, Herath and Henson (2006) only reported three factors explaining HACCP adoption in Ontario. The first factor explained 52.0% of the variation in HACCP adoption in Ontario and displayed a market oriented focus. Their second factor was *improvements to internal efficiency* and explained 10.8% of the variation. Factor three, *external drivers*, only explained 5.4% of the variation in Ontario HACCP adoption.

customers. Factor four explains 12.9% in the variation in motivations to adopt HACCP.

Factor five is named *customer focus* and includes "Expected ability to meet existing customer requirements," and "Expected impact on ability to gain greater share of existing markets." Factor five explains 10.9% of the variation in motivations to adopt HACCP. The respondents motivated by factor five to adopt HACCP belong to all four food group sectors and include all respondent firm sizes. Most of the respondents motivated by factor five are exporters that have their facilities inspected by their customers.

Table 6-1: Mean Scores and Factor Loadings for Motivations to Adopt HACCP

Motivational Factors	Mean	1st Factor	2nd Factor	3rd Factor	4th Factor	5th Factor
Expected impact on ability to deal with customer complaints	4.3	**0.900**	0.191	0.163	0.152	0.066
Expected impact on product traceability	4.3	**0.898**	0.097	0.145	-0.131	0.020
Expected impact on shelf life of products	4.0	**0.831**	0.195	-0.006	0.003	0.078
Expected impact on risk of product recalls	4.4	**0.759**	0.130	0.122	0.227	0.114
Expected impact on product quality	4.3	**0.631**	0.131	0.053	0.266	0.197
Expected impact on ability to retain existing customers	4.3	**0.631**	0.139	0.196	0.244	0.494
Expected impact on customer complaints	4.0	**0.594**	0.062	-0.082	0.031	0.506
Expected ability to meet anticipated regulatory requirements	4.6	0.187	**0.885**	0.075	-0.206	-0.010
Expected ability to meet existing regulatory requirements	4.5	0.240	**0.837**	0.048	-0.179	0.130
Expected ability to meet anticipated future customer requirements	4.7	-0.019	**0.788**	0.222	0.200	0.305
Expected impact on product safety	4.5	0.116	**0.767**	-0.010	0.229	0.257
Wish to apply good practice	4.6	0.214	**0.758**	-0.121	-0.334	-0.105
Expected impact on ability to attract new customers	4.6	0.457	**0.534**	0.197	-0.112	0.364
Expected ability to comply with government recommendation	4.3	0.023	0.122	**0.947**	0.022	-0.030
Expected impact on ability to access new markets	4.2	0.110	-0.016	**0.927**	0.020	0.187
Industry/trade organization recommendations	3.8	0.248	0.177	**0.841**	-0.037	-0.121
Expected impact on need for customers to inspect plant	3.6	0.113	-0.117	**0.667**	-0.308	0.495
Expected impact on product wastage	3.4	0.240	0.012	-0.153	**0.927**	0.035
Expected ability to reduce costs of production	3.2	0.001	-0.172	0.422	**0.833**	-0.140
Expected ability to get a higher price for the products	3.4	0.224	-0.155	-0.249	**0.803**	0.072
Expected impact on ability to gain greater share of existing markets	4.2	0.194	0.132	-0.027	0.065	**0.817**
Expected ability to meet existing customer requirements	4.5	0.118	0.257	0.111	-0.068	**0.723**
Percent of Variation Explained	-	22.4%	17.7%	15.5%	12.9%	10.9%

6.2.3 Barriers to HACCP Adoption

The principal component analysis of responses relating to issues that may be barriers to adoption, based on responses by HACCP non-adopters, led to five factors which are described in Table 6-2. The first factor, termed *constraints* includes the variables "Internal budgetary constraints," "Difficulty in obtaining external funding," and "Overwhelmed by things to be done to adopt HACCP," in addition to "Scale and scope of changes to existing food controls" and "Difficulty in getting help and advice." This factor explains 20.8% of the variation in reasons given for why respondents had not adopted HACCP. Respondents described by the first factor as reasons for non-adoption of HACCP were generally small meat sector processors that reported having their facilities inspected by their customers.

The second factor, *HACCP concerns*, describes firms that do not know how HACCP will affect their businesses and so choose not to adopt it. This factor explains 18.4% of the variation in non-adoption and includes the barriers "Perception that firm's scale of operation is too small for HACCP," "Uncertainty about potential benefits from HACCP," and "Tendency to wait and see from other's experience before implementing ourselves." The second factor also includes "Not sure whether implementation of HACCP would meet our customer requirements," "Perception that HACCP would reduce the flexibility of operations," and "Perception that HACCP is not suitable for the firm." Respondents persuaded not to adopt HACCP based upon the second factor had full time food safety employees and had not experienced a recall within the past

three years. There were no other consistent respondent characteristics for firms prevented by factor two from adopting HACCP.

Factor three, termed *internal factors*, explains 16.8% of the variation in HACCP non-adoption and includes the factors "Perception that current food safety controls are sufficient," "Food safety issues not considered sufficiently important to warrant the investment," and "Perception that HACCP goes against our traditional methods" as well as "Perception that cost of HACCP adoption would be cheaper over time." Respondents that chose not to adopt HACCP due to the third factor were small firms that reported not considering end consumer concerns in the design stage of their risk management, generally did not undergo customer inspections and did not belong to a formally integrated value chain.

Factor four, termed *scale of change* is similar to Herath and Henson's second of four factors for non-HACCP adopting Ontario food processors and is given the same name, although *scale of change* explains more of the variation in Alberta non-adoption (15.3% of variation explained) than was reported in Ontario (9.2% of variation explained)[14]. For Alberta, this factor includes the variables "Scale and scope of changes needed prior to adopting HACCP," "Relative importance of other investments," "Wide scale facility upgrading required for HACCP implementation," "Relative importance of other investments" and "Uncertainty about whether future regulatory requirements met by HACCP."

[14] Herath and Henson (2006) reported one less factor generated by the principal component analysis of barriers to HACCP adoption. The first factor they reported explained 39.24% of the variation in non-adoption and was termed *questionable appropriateness*. It more closely reflected the second factor generated by the Alberta analysis and in Alberta this factor explained less of the variation in reasons for non-adoption. The factor analysis of Ontario food processor barriers to HACCP adoption explained less (61.1%) of the total variation than the Alberta analysis (79.9%).

This factor explains 15.3% of the variation in Alberta firms' non-adoption of HACCP. Respondents that opted not to adopt HACCP because of the perceived scale of change that adoption would require were generally small meat sector processors that did not report taking end consumer concerns into consideration in their risk plans.

The fifth factor generated by the principal component analysis of barriers to HACCP adoption in Alberta is termed *disinterest.* This factor explained 8.5% of the variation in barriers to adopt HACCP and included the barriers "HACCP difficult to implement because of internal organization of the company" (the factor loading was negative) and "Greater priority given to other issues than enhancing our food safety controls." This factor appears to describe firms which could implement HACCP but would rather focus on other areas of their business than this facet of food safety. Generally, the respondents for which HACCP adoption was hindered by the fifth factor were small, non-exporting meat sector processors. Overall, "internal budgetary constraints" and a stated belief that current systems are effective were the two most important variables to non-adoption of HACCP by the aggregate Alberta industry sample, as seen in Table 6-2. This finding is consistent with the conclusion from a study of Ontario food processors that finance was a significant barrier to HACCP adoption (Herath and Henson 2006).

Table 6-2: Mean Scores and Factor Loadings for Cited Barriers to HACCP Adoption

	Mean	1st Factor	2nd Factor	3rd Factor	4th Factor	5th Factor
Internal budgetary constraints	4.1	**0.831**	-0.170	0.079	0.035	-0.171
Difficulty in getting help and advice	3.5	**0.813**	-0.159	0.235	0.174	-0.021
Overwhelmed by things to be done to adopt HACCP	3.6	**0.802**	0.307	-0.062	0.237	0.140
Difficulty in obtaining external funding	3.7	**0.801**	0.059	0.191	0.059	-0.263
Scale and scope of changes to existing food safety controls	3.7	**0.652**	0.219	0.149	0.401	0.362
Perception that firm's scale of operation is too small for HACCP	4.0	-0.171	**0.858**	0.090	0.183	0.103
Uncertainty about potential benefits from HACCP	3.6	-0.017	**0.816**	0.172	-0.006	-0.144
Perception that HACCP is not suitable for the firm	3.5	0.168	**0.692**	0.521	-0.271	-0.105
Perception that HACCP would reduce the flexibility of operations	3.2	0.562	**0.675**	0.185	0.129	0.063
Not sure whether implementation of HACCP would meet our customer requirements	3.3	0.192	**0.612**	0.610	-0.085	0.107
Tendency to wait and see from other's experience before implementing ourselves	3.0	0.056	**0.466**	0.348	0.439	0.020
Perception that HACCP goes against our traditional methods	2.3	0.171	0.106	**0.857**	-0.093	0.262
Perception that cost of HACCP adoption would be cheaper over time	3.3	0.329	0.160	**0.790**	0.046	-0.305
Food safety issues not considered sufficiently important to warrant the investment	3.0	0.392	0.137	**0.732**	0.131	0.443
Perception that current food safety controls are sufficient	4.0	-0.237	0.322	**0.704**	0.104	-0.268
Scale and scope of changes needed prior to adopting HACCP	4.0	0.338	-0.030	-0.056	**0.866**	0.100
Wide scale facility upgrading required for HACCP implementation	3.7	0.208	0.188	-0.223	**0.839**	-0.256
Relative importance of other investments	3.3	-0.108	-0.466	0.225	**0.755**	0.212
Uncertainty about whether future regulatory requirements met by HACCP	3.4	0.523	0.313	0.054	**0.635**	0.119
HACCP difficult to implement because of internal organization of the company	3.3	0.319	0.302	0.130	0.113	**-0.722**
Greater priority given to other issues that enhancing our food safety controls	3.2	0.077	0.373	0.226	0.396	**0.636**
Percent of Variation Explained	-	20.8%	18.4%	16.8%	15.3%	8.6%

6.2.4 Summary of Principal Component Analyses

Principal component analyses were conducted to better understand the results generated by the Wilcoxon signed rank test and the K-S test in the earlier Sections 5.2.4 and 5.3.1. The principal component analyses of signals of food quality were conducted for the aggregate Alberta sample and for a number of subgroups identified by common firm characteristics. Four principal components were identified for the aggregate Alberta sample. As with the K-S and principal component tests it was interesting to note that in spite of some differences, there were also similarities in the factors generated among the groups, suggesting that regardless of firm's characteristics there are similar groupings of quality signals which may by used for marketing or competitive purposes.

The analysis of motivators of HACCP adoption and reasons for non-adoption were conducted on the responses to questions on this issue by firms grouped according to whether they are HACCP adopters or non-adopters. While the questions regarding HACCP adoption did not differentiate between value chain customers and end consumers, the factor analysis did provide some support for the hypothesis that adoption may be affected by government or value chain/consumers. This hypothesis will be further examined in Section 6.3.1. Finances, perceptions of size barriers and the level of change necessary to implement HACCP were identified as common barriers to HACCP adoption among non-adopting Alberta food processors. Based on Alberta firms' responses, if government or industry wants to encourage HACCP adoption among smaller

firms it may be helpful to provide multiple models or examples of small firms which have implemented HACCP to demonstrate the feasibility of adoption.

6.3 Binary Logit Model Estimation

Two binary logit models were postulated to assess factors that may explain investment in food safety, proxied by HACCP adoption/non-adoption. The binary logit model is the most basic of probability models in that there are only two response options – event A or non-A (Liao 1994). The occurrence of the outcome, in this case HACCP adoption/non-adoption, is characterized by a 0-1 dummy variable. Firms that had adopted HACCP or intended to adopt HACCP within the next six months, were specified by "1" while firms that had not adopted and did not intend to adopt HACCP were specified as "0". Liao explains that there are two forms of binary logit models, the logit form and the probability form. The logit model is specified as:

$$\log\left[\frac{P(y=1)}{1-P(y=1)}\right] = \sum_{k=1}^{K} B_k x_k \qquad (6.0)$$

Liao points out that because the logit model predicts the probability of event A occurring, Prob(y=1), "μ becomes the expected probability that y equals [one]" (Liao 1994 p. 12). The logit model in equation 6.0 can be transformed into the event probability function "by replacing the general CDF, F, with a specific CDF, L, representing the logistic distribution:" (Liao 1994, page 12)

$$\text{Prob}\,(y=1) = 1 - L\left(-\sum_{k=1}^{K} B_k x_k\right) = L\left(\sum_{k=1}^{K} B_k x_k\right) = \frac{e^{\sum_{k=1}^{K} B_k x_k}}{1+e^{\sum_{k=1}^{K} B_k x_k}} \qquad (6.1)$$

Equation 6.1 represents the probability that event A will occur, therefore the probability of event A not occurring is one minus expression 6.1 or:

$$\text{Prob}(y=0) = L\left(-\sum_{k=1}^{K} B_k x_k\right) = \frac{1}{1+e^{\sum_{k=1}^{K} B_k x_k}} \qquad (6.2)$$

The logit models specified below were estimated using the statistical program SPSS 17.0.

HACCP1 was used as a proxy for food safety investment in the form of HACCP adoption. *HACCP1* was created by summing *HACCP* and *HAC2,* (see Table 6-4 for variable specifications), such that firms were specified as HACCP implementers if they had already implemented HACCP or intended to implement HACCP within the next six months. The first binary logit model is postulated to assess influences on the probability of HACCP adoption of drivers associated with both government, industry and consumers, and firms' characteristics. Due to sample size these were estimated only on the aggregate data. The second binary logit model is also postulated to assess influences on the probability of HACCP adoption of drivers associated with government, industry and consumers, firms' characteristics and firms' attitudes. To examine whether or not government regulations, value chain controls or end consumers' considerations are significant influencers of HACCP adoption within Alberta, proxies for these three variables (*GOVT, INSPECT,* and *ENDCONS*) were included as explanatory variables in each case. To examine whether other firm characteristic variables were more important to HACCP than the three proxies identified above, other versions of Model One were tested with different explanatory characteristic variables. The

model version with best explanatory capacity is reported. The firms' characteristics postulated for the two models (and associated codings of all variables assessed) are listed in Table 6-3 and the characteristic variables which best explain HACCP adoption for the aggregate grouping of firm data are outlined in Table 6-4.

The postulated explanatory variables in Models One and Two were chosen based on the literature-based identification of potential influences on HACCP adoption. *INSPECT* represents pressure from other value chain members by identifying those firms for which facilities are inspected by customers. If these firms wish to maintain contracts they may be required to meet standards which are checked during customer inspections.

Table 6-3: Logit Model Variable Names, Descriptions and Coding

Variable type/name Characteristic Variables Variable name	Variable description	Variable specification
HACCP1	firms which have implemented HACCP or will implement HACCP within the next six months	0 = the firm has not implemented HACCP and will not implement HACCP within the next six months, 1 = the firm has implemented HACCP or will implement HACCP within the next six months
SIZE	number of employees employed	0 = 1-25 employees, 1 = 26-100 employees, 2 = ≥ 101 employees
INSPECT	customers inspect the firms' facilities	0 = customers do not inspect the firms' facilities, 1 = customers inspect the firms' facilities
ENDCONS	the firm includes end consumer concerns in the design stage of its risk management	0 = the firm does not include end consumer concerns in the design stage of its risk management 1 = the firm includes end consumer concerns in the design stage of its risk management
GOVT	perception of government standards	0 = too low, 1 = adequate, 2 = too high
RECALL	whether or not the firm has had any recalls in the past three years	0 = the firm has not had any recalls in the past three years, 1 = the firm has had at least one recall in the past three years
EXP	whether or not the firm is an exporter	0 = the firm does not export, 1 = the firm does export
YEARS	the number of years the firm has been in business	the number of years the firm has been in business
FUND	whether or not the firm has funding available to help implement HACCP	0 = no funding is available, 1 = funding is available
Attitudinal variables		
Variable name	Variable description	Variable specification
Media	“Any media attention to your industry is a source of consumer distrust and lost revenue.”	0 = strongly disagree, disagree, neither disagree nor agree, 1 = agree, strongly agree
RepCap	"Rank the relative value of your firm's reputational capital"	0 = strongly disagree, disagree, neither disagree nor agree, 1 = agree, strongly agree
ProSt	"Your customers provide you with processing standards for purchasing your products"	0 = strongly disagree, disagree, neither disagree nor agree, 1 = agree, strongly agree
ExGvt	"Your products consistently meet standards more stringent than the minimum government safety guidelines"	0 = strongly disagree, disagree, neither disagree nor agree, 1 = agree, strongly agree

Table 6-4: The Binary Logit Models and Associated Variables

Model applied	No. of Observations	Dependent Variable	Independent Variables
Model one	41	*HACCP1*	*SIZE, INSPECT, GOVT, ENDCONS*
Model one, version two	41	*HACCP1*	*SIZE, YEARS, EXP, RECALL, FUND*
Model two	41	*HACCP1*	*SIZE, INSPECT, GOVT, ENDCONS, Media, ProSt, RepCap, ExGvt*
Model two, version two	41	*HACCP1*	*SIZE, YEARS, EXP,RECALL, FUND, Media, ExGvt*
Model two, version three	41	*HACCP1*	*SIZE, EXP, Media*

Notes: See Table 6-3 for variable specification.

As HACCP adoption may also be a contract condition, it is expected that firms which are inspected by their customers may also be required to adopt HACCP to either keep or maintain the contract. The variable *GOVT* (which asks respondents about their perceptions of government regulations) is included as a proxy for government pressure to adhere to regulations. Firms which ranked government regulations as "too high" are assumed to feel pressure from government regulations and potentially to struggle to meet these. This variable reflects that HACCP adoption may either be required by government or adopted pre-emptively if HACCP regulation is expected. *ENDCONS* is also included based on the expectation of pressures from consumers. Consumer pressure is proxied through asking respondents whether or not they include end consumer concerns in the design stage of their risk management. Firms which responded that they did include end consumer concerns are considered to be responding to such concerns and under pressure from consumers.

Other postulated explanatory variables to predict HACCP adoption include *RECALL, YEARS* and *FUND*. *RECALL* was included based on the hypothesis that if a firm had experienced one or more recalls in the recent past they would be more likely to adopt HACCP as a means of reducing the chances of repeating the problem. *FUND* was chosen as a variable based on the hypothesis that if firms are aware of funding to help them implement HACCP they may be more likely to implement it. *YEARS* was included as a variable as a proxy for industry experience.

The attitudinal variables, chosen as to capture the relative importance of various other issues, include *Media* to identify the importance of media attention to HACCP adoption while *RepCap* was chosen to assess whether or not the value of a firm's reputational capital is a significant motivator of HACCP adoption, i.e. relative to the question of whether firms who considered reputational capital highly important were more likely to adopt HACCP that those which did not.

6.3.1 Application of Models One and Two to Data from the Aggregate Sample of Alberta Food Processors

SPSS 17.0 was used to calculate parameter estimates for the postulated independent variables outlined in Table 6-3. The model was estimated on data for the aggregate sample which includes the 41 respondent firms. The variables *CHAIN*, *ENDCONS, GOVT* and *SIZE* were postulated as explanatory variables, as was a constant, based on literature outlining the impact of government, value chains and consumers on food safety system implementation and given that the principal component analysis indicating that Albertan HACCP adoption is

motivated by the positive impact it is expected to have on regulation compliance, value chain relationships and customer (consumer) concerns. However, none of the three influencers proxied by *INSPECT*, *ENDCONS* and *GOVT* appear to be motivating HACCP adoption within Alberta. In contrast, firm size is of importance. The estimated coefficients for the models applied to the aggregate data set for Model One are in Table 6-5. The model accurately predicted HACCP adoption in 65.9% of the cases. Firm size was the only variable which was a significant indicator of HACCP adoption at the 10% level of significance. As respondent firm size increases so does the likelihood of HACCP adoption.

Table 6-5: Logit Model One (Version 1): Results for Aggregate Sample

Variables	Coefficient	Standard error	Wald Chi-Square statistic	Wald Chi degrees of freedom	Significance	Odds ratio
SIZE	1.291	0.746	2.993	1	0.084	3.637
INSPECT	0.465	0.824	0.318	1	0.573	1.592
GOVT	-0.095	0.791	0.015	1	0.904	0.909
ENDCONS	-0.169	0.729	0.053	1	0.817	0.845
Constant	-0.508	1.105	0.211	1	0.646	0.602

Estimation included 41 observations and correctly predicted HACCP adoption in 65.9% of cases. Cox & Snell R square statistic is 0.165

Several different versions of the two models were postulated to identify a model which best explained HACCP adoption based upon firms' characteristics. Significant explanators from the version of Model One which best predicted HACCP adoption for the aggregate industry sample based on firms' characteristics is presented in Table 6-6. Model One version two included *SIZE*, *EXP, RECALL, YEARS* and *FUND* as explanatory variables. Model One version two accurately predicted HACCP adoption in 70.7% of cases. At the 10% level of significance, being an exporter increased the likelihood of HACCP adoption.

SIZE was also significant with increasing firm size increasing HACCP adoption. This version of Model One has limitations, as seen by a low Cox & Snell R squared (.303), however it was the best version of Model One estimated.

Table 6-6: Logit Model One (Version 2): Results for Aggregate Sample

Variables	Coefficient	Standard error	Wald Chi-Square statistic	Wald Chi degrees of freedom	Significance	Odds ratio
SIZE	1.564	0.868	3.251	1	0.071	4.779
YEARS	0.019	0.023	0.732	1	0.392	1.020
EXP	1.306	0.782	2.790	1	0.095	3.692
RECALL	1.830	1.382	1.755	1	0.185	6.237
FUND	-1.136	0.742	2.343	1	0.126	0.321
Constant	-0.994	0.719	1.914	1	0.167	0.370

Estimation included 41 observations and correctly predicted HACCP adoption in 70.7% of cases. Cox & Snell R square statistic is 0.303

In addition to the explanatory variables in Model One, version one, Model Two versions included selected attitudinal variables from the Attitudinal section of the survey, as indicated in Table 6-4. Results for Model Two, version one are in Table 6-7. Model Two version one accurately predicted HACCP adoption in 82.5% of cases. Responses to questions *SIZE*, *Media* and *EXP* (see the definitions in Table 6-3), included as explanatory variables, are significant at the 10% level of significance (for these results see Table 6-7). Agreement with the Media statement that "Any media attention to your industry is a source of consumer distrust and lost revenue", increased the likelihood that the respondent would implement HACCP. An increase in firm size also increased the likelihood of HACCP adoption. The other variables are not significant.

Table 6-7: Logit Model Two (Version 1): Results for Responses of Aggregate Sample

Variables	Coefficient	Standard error	Wald Chi-Square statistic	Wald Chi degrees of freedom	Significance	Odds ratio
SIZE	2.160	1.000	4.663	1	0.031	8.675
INSPECT	0.414	1.064	0.151	1	0.697	1.512
ENDCONS	0.518	0.934	0.308	1	0.579	1.679
GOVT	-0.474	0.921	0.265	1	0.607	0.623
Media	1.769	0.973	3.304	1	0.069	5.866
ProSt	-1.229	0.971	1.602	1	0.206	0.293
RepCap	1.543	1.581	0.953	1	0.329	4.680
ExGvt	0.588	1.268	0.215	1	0.643	1.800
Constant	-2.454	2.610	0.881	1	0.347	0.086

Estimation included observations and correctly predicted HACCP adoption in 82.5% of cases. Cox & Snell R square statistic is 0.286.

Numbers of versions of Model Two were postulated and tested. Model Two version two (results in Table 6-8) accurately predicted HACCP adoption in 73.5% of the cases estimated; the Cox & Snell R squared statistic for this model was 0.372, higher than that of Model Two version one (0.286), which nonetheless had a higher level of correct predictions. These features may reflect lack of independence of explanatory variables or be related to inclusion of explantors which contribute to the model despite not being significant. Model Two version two combines the characteristic variables from Model One version two with attitudinal variables from Model Two version one. Responses to questions *SIZE*, *Media* and *EXP* (see Table 6-3), included as explanatory variables, are significant at the 10% level of significance (see Table 6-8). Agreement with "Any media attention to your industry is a source of consumer distrust and lost revenue" increased the likelihood that the respondent would implement HACCP. Being an exporter increased the likelihood of HACCP adoption. *SIZE* was also significant,

thus Model Two indicates that the larger a firm, the more likely it is to implement HACCP. Results for Model Two version two are presented in Table 6-8.

Table 6-8: Logit Model Two (Version 2): Results for Responses of Aggregate Sample

Variables	Coefficient	Standard error	Wald Chi-Square statistic	Wald Chi degrees of freedom	Significance	Odds ratio
SIZE	1.710	0.876	3.815	1	0.051	5.529
YEARS	0.026	0.026	1.058	1	0.304	1.027
EXP	1.493	0.874	2.920	1	0.087	4.449
RECALL	1.595	1.512	1.113	1	0.292	4.929
FUND	-1.252	0.827	2.291	1	0.130	0.286
Media	1.779	0.967	3.385	1	0.066	5.924
ExGvt	0.838	1.251	0.449	1	0.503	2.311
Constant	-2.383	1.475	2.611	1	0.106	0.092

Esimation included 41 observations and correctly predicted HACCP adoption in 73.2% of cases. Cox & Snell R square statistic is 0.372.

The final version of Model Two reported, version three, only includes variables previously found to be significant explantors of HACCP adoption in Alberta. All three variables, *SIZE*, *EXP* and *Media* as well as the constant are significant. The significance of the constant suggests some variables may be missing. The Cox & Snell R squared statistic is 0.313, lower than for Model Two version two and higher than the Cox & Snell R squared statistic for Model Two version one. The explanations of HACCP adoption are consistent with the previous model versions. Increasing firm size increased the likelihood of HACCP adoption, as does being an exporter. Agreement with the statement "Any media attention to your industry is a source of consumer distrust and lost revenue", increased the likelihood of HACCP adoption. These are not the only three motivators of HACCP adoption as indicated by the significant constant. The results for Model Two version three are given in Table 6-9.

Table 6-9: Logit Model Two (Version 3): Results for Responses of Aggregate Sample

Variables	Coefficient	Standard error	Wald Chi-Square statistic	Wald Chi degrees of freedom	Significance	Odds ratio
SIZE	1.394	0.751	3.442	1	0.064	4.030
EXP	1.682	0.821	4.199	1	0.040	5.376
Media	1.900	0.936	4.121	1	0.042	6.688
Constant	-1.783	0.698	6.530	1	0.011	0.168

Estimation included 41 observations and correctly predicted HACCP adoption in 75.6% of cases. Cox & Snell R square statistic is 0.313.

6.4 Principal Component Analysis and Logit Model Summary

Principal component analyses were used to examine firms' responses to three sets of survey questions. The first of these queried views of signals of food quality to the end consumer. Several principal component analyses were run; four are discussed. As with the non-parametric tests discussed in Chapter Five, the principal component analysis of food quality attributes demonstrated a surprising degree of homogeneity among subgroups of respondents. The analysis of data from the aggregate sample generated the same factors as from the combined fruit and vegetable and grain and oilseed sectors, while the analysis of meat processors' responses generated the same factors as the combined medium and large respondents. The principal component analysis for different groups of firms indicates common bundles of food quality signals which are used by different groups of firms. This commonality suggests that there are common groupings of quality characteristics which can be used to market food or to build competitive marketing plans.

Two other question sets tested using principal component analyses examined motivations for HACCP adoption and barriers to HACCP adoption.

The analyses of HACCP adoption and non-adoption complements the analyses from the K-S test in Section 5.3.1 and the Wilcoxon Signed Rank Test in Section 5.2.4. The principal components were extracted using a verimax rotation. In each case at least four factors were generated with eigenvalues exceeding one. These factors suggest that motivation to adopt HACCP may be product based, influenced by regulation or externally driven; they provide some general support for the hypothesis that HACCP adoption is motivated by government and customers/consumers. The analyses suggest that HACCP adoption may be a business decision as well as being considered by firms to be important for food safety. Reductions in costs and the requirements of firms' customers may be factors which motivate firms to adopt HACCP. Barriers to HACCP adoption included: constraints, uncertainty about the effects of HACCP, internal barriers, scale of change and a lack of interest. If government wishes to encourage, but not mandate, HACCP adoption, the analysis of identified barriers suggest that programs that educate firms regarding the effects and usefulness of HACCP and providing sources of information and advice may help to reduce barriers to adoption.

Two binary logit models were tested on data for the aggregate group of Alberta food processor responses. Model One examined firms' characteristics as motivators of HACCP adoption while Model Two also included attitudinal variables. These models also examined the hypothesis that proxies for the three primary influencers of firm food safety system adoption discussed in the literature (i.e. pressure from government, the food industry (in the form of downstream

value chain members), and consumer concerns) influence HACCP adoption in Alberta. In spite of the suggestions, from the principal component analysis, that Albertan HACCP adoption is motivated by regulation compliance, value chain relationships and customers' (consumer) concerns, the results of the logit models indicate that none of the three proxies available explain HACCP adoption within Alberta. Increasing firm size increased the likelihood of HACCP adoption as did increasing a firm's expectation that media attention damages consumer trust and reduces revenue.

Firm size was a significant variable in both Model One and Model Two. In these cases, increasing firm size increased the likelihood of HACCP adoption and indicates a structural element in HACCP adoption. Being an exporter also increased the likelihood of HACCP adoption as did expressed agreement with the statement "Any media attention to your industry is a source of consumer distrust and lost revenue". Due to the size of the samples the results should be cautiously interpreted. A larger sample would give the basis for a more in-depth analysis; although it can be generally concluded that there are a number of motivators of HACCP adoption. These may be external factors such as regulatory or customer based or can be internally based factors which improve internal controls and may improve business management.

7.0 Chapter Seven: Conclusions and Limitations

7.1 Introduction

This chapter summarizes the results of the thesis study and outlines some conclusions and implications. The limitations of the study and areas for further research are also discussed.

7.2 Summary of Results

This thesis research study focussed on Albertan food processors and their decision-making with respect to food safety. The data for this study were from a survey of Albertan food processors, conducted in 2008. Although the aggregate group of 41 respondent firms are reasonably representative of the Alberta food industry in terms of their commodity sector association and range of sizes, as a group the responding firms are less representative of the Canadian food processing industry. Food safety decisions may be seen as either or both food quality or business decisions. The literature identifies a number of drivers of firm and industry actions, both internal and external, which are expected to impact firms' decision making. It was hypothesized that government regulations and guidelines, pressure from value chains and consumers' concerns drive Alberta food processors' risk decisions, leading these to be the focus of the survey. Three other general hypotheses are outlined in Section 5.1. The survey included fifteen questions in which respondents were asked to give responses on five-point scales. Responses to these questions enable assessments of differences in the ratings given by different firms relative to various practices and assessments of the

importance of issues to both food safety and firm business decisions. The responses also enable evaluation of the relative importance to firms of different quality attributes.

The Wilcoxon signed rank test was used to test pair-wise responses to question sets. These question sets acted as treatments for respondent firms, with three pairs of treatments tested. The first pair of treatments examined firms' perceptions of potential food safety hazards within their facility, relative to their view of their end consumers' perceptions of those same potential hazards. Two main points were generated by this analysis. The first is that Alberta food processors generally perceive their end consumers to view potential risks to food safety as more hazardous than the firms themselves do. This finding tends to support the general hypothesis of differences between firms' views of end consumer perceptions of food safety and firms' internal perceptions. It also implies that firms may be aware of the potential for major consumer reaction to food safety incidents, such as seen by consumers who suffered physical and psychological trauma from eating actual or potentially contaminated Maple Leaf products in 2008, as indicated in the lawsuit against Maple Leaf (CBC 2008b). Two unexpected exceptions to the tendency for Alberta food processors to perceive their end consumers to view potential risks to food safety as more hazardous than the firms themselves do were: small processors, which on average ranked pathogen contamination as being more hazardous to food safety in their facilities than their consumers were perceived to rank this; and the fruit and vegetable processor group, which on average ranked trans fatty acids to be more

hazardous than they perceived their end consumers to rank these. It would be interesting to know the level of trans fatty acids used by fruit and vegetable processors to better understand the latter result. The responses of the two noted subgroups of firms generally indicated a statistically significant difference between their internal risk perceptions and their view of consumers' perceptions for the same potential food safety hazards. Therefore, a related conclusion is that, in spite of the similarity in the perceptions of potential hazards, firms' perceptions of consumer concerns differed (qualitatively) among different sub-groupings of firms. This difference suggests that it may be of interest to further examine Alberta processors' perceptions of consumers in future work with a larger sample.

With respect to the second pair of treatments tested with the Wilcoxon signed rank test which relate to perceptions of the role of various food safety practices, two points of interest are also evident. The first of these is that GMPs are regarded as very important to both food safety provision and firm business performance. However, GMPs are not seen as important in the same way or to the same degree in these two contexts. The second is that, in general, for the aggregate sample, Alberta food processors did not perceive differences between potential food safety provision practices and the role of these in improving business performance. However, it is noted that this generalization, while valid for the aggregate sample, did not hold equally well for the separately assessed responses from various sub-groups. Firms in some sub-groups tended to view the effects of HACCP, ISO, a product recall system and a wastage record system differently with regards to food safety provision as versus improving firm

business performance. Thus, from a policy perspective, when government is attempting to implement new food safety standards or regulations, it may be helpful to present the business effects to different groupings of firms individually rather than at an aggregate industry level.

Further general points of note were generated from the pair-wise tests of firms' views of the final pair of treatments tested with the Wilcoxon signed rank test. The third set of pair-wise testing examined potential risk factors to food safety and firm business performance. The first of the three is that physical contamination was generally considered the riskiest of the cited factors to both food business performance and to food safety provision. This is of interest given the localized nature of physical contamination and low risk of cross-contamination. A second feature is that the distribution of responses rating risks was not significantly different for two of the cited factors with respect to both food safety and business performance. This was the case for each of employee hygiene and GM sourced ingredients although exporters were the one exception to this. This exception was expected given the negative international response to GM foods as discussed in the literature review (Lang and Hallman 2005). A third observation relates to the hypothesis that characteristics of food industry firms affect their perceptions of relative food safety hazards. Three of the six sub-groups of Alberta food processor respondents, grouped by firms' characteristics such as size, type of product and export status, are generally consistent in their reactions to factors that are potentially risky to food safety and to firm business performance. In general, risks to food safety are seen as risks to business

performance regardless of the sector in question. This is not, however, as evident for the aggregate sample, as seen in the pair-wise analyses in Section 5.2.4. These seem to indicate that while the Alberta food processor respondents are aware that risks to food safety will also be risky to business performance, they did not demonstrate with equal conviction that benefits to food safety provision will improve business performance. This could be indicative of processors' being aware that there may be diminishing marginal returns to food safety investment in the context of business performance. Food safety investment may be characterized as process attributes (Hobbs and Kerr 2006) and may therefore be challenging to communicate to consumers. This result could also reflect processors' expectation that a decrease in consumer's willingness to purchase a food following a food safety incident is likely to be greater than that consumer's increased willingness to purchase following food safety investments. This appears to be a reasonable expectation given communication issues and consumer awareness of food safety measures and incidents.

The one sample Kolmogorov-Smirnov (K-S) test, which was used to compare distributions of responses against a normal distribution, was applied to responses from groups of respondents according to selected characteristics to help assess whether the perceptions identified in the Wilcoxon signed rank test varied among groupings of firms. Clearly, some variation was expected between sectors as some hazards are sector specific, however there were a few differences, which allow for unexpected and interesting conclusions to be drawn. Some differences worth noting were meat processors' indication that they would lose customers if

their products were labelled "may contain GM ingredients" while fruit and vegetable sector firms' responses relative to this feature did not demonstrate an expectation one way or the other. This may reflect meat processors' awareness of controversy in Europe (Lang and Hallman 2005) about labelling meat fed GM-derived animal feed whereas fruit and vegetable processors may not be aware of the presence of any GM-derived fruits and vegetables in Canada. The number of similarities between responses of subgroups is also noteworthy.

The K-S tests of responses between processors of different sizes also showed some variation. Responses of small size processors differed from medium/large size processors regarding the hazard posed by various factors potentially affecting food safety (i.e. pathogen contamination, physical contamination, trans fatty acids, and GMO sourced ingredients). As well, HACCP was ranked as an important food safety issue by medium/large size respondents but not by small size respondents. This difference between small and medium/large hazard rankings may indicate a place for government or industry associations to provide education regarding the relative hazard levels of various types of contamination and a standardized risk guide for food processors. Comprehensive public information regarding various factors influencing food safety may help overcome structural issues within the food industry and through helping firms understand the relevance of regulations and encourage compliance. This may also help firms prioritize food safety measures within their facilities.

Although there are numbers of instances from the applications of the Wilcoxon signed rank test and the K-S tests in which comparisons of responses

from the different groupings of firms were more homogeneous than expected, the tendency for some concerns to be more important for some groupings of firms still suggests that the more customized that regulations and guidelines are to a sector, the more likely these are to be relevant and adopted. Relevance and cost effectiveness are both likely to be important in encouraging the adoption of new regulations and guidelines, whether the regulations originate from government or industry.

In Chapter Six, principal component analyses were conducted to better understand the results generated by the Wilcoxon signed rank test and the K-S test in Sections 5.2.4 and 5.3.1. The principal component analyses of signals of food quality were conducted for the aggregate Alberta sample and for some subgroups identified by common firm characteristics. As with the results of the K-S and Wilcoxon signed rank tests, it was interesting to note that in spite of some differences, there were also similarities in the factors generated among the groups, suggesting that regardless of firm's characteristics there are similar groupings of quality signals which may be used by firms. The analyses of data from the aggregate sample generated the same factors as from the combined fruit and vegetable and grain and oilseed sectors, while the analyses of meat processors' responses generated the same factors as from the combined group of medium/large respondents. Both features are somewhat surprising as 36.6% of the aggregate respondent sample were small meat processors. The third factor generated by the analysis of the aggregate sample, *information*, is of interest due to its potential support of a British result that found consumers to equate package

quality with product quality (Ahmed, Ahmed and Salman 2005). The importance of packaging and related provision of product information as a proxy for quality may indicate an importance of investment in packaging and/or related communication to communicate quality to consumers.

Principal component analyses were also conducted on hypothesised motivators of HACCP adoption and reasons for non-adoption, based on the survey responses for two groups of firms, HACCP adopters and non-adopters. Unlike in the previous sections of the survey, the questions regarding HACCP adoption did not differentiate between value chain customers and end consumers, which limits interpretation of the results with respect to three main hypothesized drivers of food safety investment (government, value chain/industry and consumers (Starbird and Amanor-Boadu 2007, Ali and Fischer 2005, Holleran et al. 1999) and HACCP adoption. In spite of this omission, the factor analysis did provide some support for the hypothesis that adoption may be affected by government or value chain/consumers. Results from the principal component analysis suggested that common barriers to HACCP adoption for Alberta food processors include: constraints, uncertainty about the effects of HACCP, internal barriers, scale of change and a lack of interest. If government wishes to encourage, but not mandate, HACCP adoption, specifically among small firms, the analysis of identified barriers suggest that programs that educate firms regarding the effects and usefulness of HACCP and that provide sources of information and advice may help to reduce barriers to adoption. It may also be

useful to provide several case models of small firm HACCP adoption as a means of demonstrating the feasibility of adoption.

Factors generated by the analysis of motivators of HACCP adoption suggest that motivation to adopt HACCP may be product based, influenced by regulation or externally driven and provide some general support for the hypothesis that HACCP adoption is motivated by government and customers/consumers. HACCP adoption may be a business decision as well as a food safety issue for firms, however, based on the results of the Wilcoxon signed rank test and the principal component analysis, HACCP adoption may be a business decision within the value chain, rather than a food production attribute which is or could be marketed to consumers. Reductions in costs and the requirements of firms' customers may be factors which motivate firms to adopt HACCP, as demonstrated in the factor loadings in the principal component analysis of HACCP adoption motivators. This conclusion is also supported by the discussion of HACCP within the literature review presented in Chapter Three (Holleran, Bredahl, and Zaibet 1999) and the general discussion of costs and value chain requirements presented in Chapter Two.

Two binary logit models to predict adoption of food safety practices (proxied by HACCP adoption) were tested on the data for the aggregate sample of Alberta food processors' responses. Data sub-sets were not used due to sample size limitations. Model One examined firm's characteristics as motivators of HACCP adoption while Model Two included both characteristic and attitudinal variables as explanators. These models examined the hypothesis that the three

influencers of firm food safety system adoption discussed in the literature review (i.e. pressure from government, from the value chain/food industry, and from consumer concerns) influence Alberta food processors' HACCP adoption. However, the results of the logit models indicate that none of the available proxies for the three hypothesised drivers explain HACCP adoption within Alberta. Increasing the size of the firm is a motivator of HACCP adoption, as is being an exporter. The finding regarding firm size is consistent with results published by Holleran, Bredhal and Zaibet (1999) regarding the impact of firm size on ISO adoption. This finding also provides support for the existence of a structural element to HACCP adoption. This may influence the type of policy that may be most successful in encouraging HACCP adoption. Expressed concern regarding the effects of media attention appears to be an important firm motivator of HACCP adoption. A larger sample would give the basis for a more in-depth analysis. However, it can be concluded that in general there are a number of motivators of HACCP adoption. These may include factors external to the firm (such as regulation or customer expectation). There may also be internally based motivators such as a firm's size and desire to improve internal controls and improve business management.

Overall, the results of this thesis study suggest that the perceptions and motivations regarding food safety issues and practices of food industry firms are more homogeneous than expected. In some aspects the results supported the literature, however with respect to concerns surrounding genetic modification and issues related to international trade, the results supported the reviewed literature

less than expected. The hypotheses of HACCP adoption being based on motivation by government, value chain and consumers was somewhat supported by the principal component analysis but not supported by the logit analysis, which used available but not ideal proxies of these motivations. Respondents generally acknowledged that risks to food safety also posed risks to business performance, however their responses appear to demonstrate less of an expectation that food safety provision would also improve business performance. There does appear to be a role for government to play in encouraging HACCP adoption and removing barriers to adoption.

7.3 Limitations of the Study and Further Research

The study is limited by the relatively small size of the sample and by associated under-representation of some sectors. Relative to the distribution by sector of Alberta food processors, both the grain sector and the dairy sector were underrepresented while the fruit and vegetable sector was over represented. Although this might have been mitigated by further targeted phoning and sampling, considerable effort was expended to obtain wider representation and the target sample size of 10% of the firms in the industry was just achieved with a completed response rate of 11%. Given that survey participation was voluntary, there may be response bias from those respondents which chose to participate. It is also important to note that respondents were aware that potential policy implications could result from such studies which may have encouraged respondent strategic behaviour in replying. Some firms ranked both being GM

ingredient free and using GM sourced ingredients as signals of their food quality. This appears contradictory and may indicate some inconsistencies in interpretation of the survey or possible respondent fatigue. The responses to the question on whether firms have full time food safety staff may also have been misinterpreted. Seven small firms evidently considered all their employees to be dedicated to food safety, in effect making a statement that food safety is a responsibility shared by all food handlers. Grouping respondents according to selected common characteristics, i.e. by their relative size, product sector or export status, led to relatively small samples and reduced the capacity to draw valid conclusions from some sub-sets of the data. In future studies respondents could be asked to rank the hazard or benefit levels relative to the various factors queried. For example, rather than being able to rank both chemical contamination and pathogen contamination as dangerous, it could be of interest for respondents to indicate which they believe is more or less dangerous. Similarly, with respect to signals of food quality, asking firms to define an exact order of importance for each potential signal of quality might help define core quality strengths of the Alberta industry. It may also be useful for industry organizations to help their members to differentiate between federal and provincially inspected facilities and inspections. Some respondents were evidently confused regarding which jurisdiction they belonged to. At least two firms visited by the researchers fell into provincial or municipal jurisdiction and originally responded that they were inspected by CFIA inspectors, indicating possible confusion surrounding

jurisdiction. If there is confusion surrounding jurisdictions then respondents for firms may also be confused about the regulations which apply to them.

In addition, any future studies of Alberta food processors may want to include a question allowing firms to differentiate whether or not they are organic processors or whether they knowingly deal with genetically modified products. The survey conducted for this thesis study did not provide processors the explicit opportunity to identify themselves as organic processors. This omission forced organic processors to be evaluated with non-organic processors; therefore the data analysis could not differentiate between the genetic modification concerns of organic and non-organic processors.

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Appendix A

Survey

Below is a list of multiple choice questions. Please respond as accurately as possible

Part A:

Introductory questions: The following are a series of firm demographic questions designed to help characterize the firm.

1.) How many employees does the firm currently employ? Please check one.

Less than or equal to 25 _____

26 – 100 _____

Greater than or equal to 101 _____

2.) How many years has your firm been in business?

_____

3.) Does your firm export product directly or indirectly, i.e. are your products exported (across either provincial or national borders) by another firm further downstream?

a) Yes _____ or No _____

- If YES, does your firm export to: Please check one or more.

b) United States _____ Europe _____

Asia _____ Latin America _____

Africa _____ Other country _____

Another Province _____ Does not Apply _____

4.) Has your firm implemented HACCP? Please check one.

a) Yes _____ or No _____

- If NO, is your firm planning to implement HACCP within the next six months? Please check one.

b) Yes _____ or No _____ Does not Apply _____

5.) Is your firm ISO certified? Please check one.

a) Yes _____ or No _____

- If NO, is your firm planning to become ISO certified within the next six months? Please check one.

b) Yes _____ or No _____ Does not Apply _____

6.) Does your firm have one or more employees dedicated to food safety on a full time basis? Please check one.

Yes _____ or No _____

- If yes, then how many employees are dedicated to food safety? _____

7.) Has your firm had any recalls in the past three years? Please check one.

Yes _____ or No _____

- If YES, how many recalls has your firm had in the past three years? _____

8.) What sector does your firm primarily belong to? Please check one.

Meat _____
Dairy _____
Grains _____
Fruit and Vegetable _____
Other (Please Specify) _____

9.) Is your firm a member of a formally coordinated value chain?

a) Yes _____ or No _____

10.) Do your customers inspect your facilities?

a) Yes _____ or No _____

11.) How often do CFIA Inspectors inspect your facility?

a) Daily _____ Bi- Annually _____
Weekly _____ Annually _____
Monthly _____ Other (please specify) _____
Does not Apply _____

12.) Does your firm include end-consumer* concerns in the design stage of their risk management?

a) Yes _____ or No _____

13.) Government standards are: Please check one.

Too high _____
Too low _____
Adequate _____

14.) There is external funding available to improve your facility's food safety system?

a) Yes _____ or No _____

* consumer – individual purchasing products at a retail outlet

Part B: Attitudinal

Attitudinal Scale: For each statement, please indicate whether you strongly disagree, disagree, neither agree nor disagree, agree or strongly agree.					
Att1	**Strongly Disagree**	**Disagree**	**Neither agree nor disagree**	**Agree**	**Strongly Agree**
Any media attention to your industry is positive					
Any media attention to your industry is a source of consumer distrust and lost revenue					
Your end retailers have the majority of the bargaining power in your value chain					
Your customers provide you with processing standards for purchasing your products					
Your food safety systems are sufficient for meeting consumer concerns					
Your food safety systems are sufficient for meeting customer demands					
Your food safety systems are effective					
Your value chain insists on identity preservation of all its raw ingredients					
The presence of GM* or GM derived ingredients is an issue of risk communication relative to your consumers					
The presence of GM or GM derived ingredients is an issue of food safety					
Your products are labeled "May contain GM ingredients"					
You would lose customers if your products were labeled "May contain GM ingredients"					

*GM- Genetically modified

Att2	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Your products consistently meet minimum government safety standards					
Your internal safety standards are more stringent than the minimum relevant government guidelines for microbial levels					
Your internal safety standards are more stringent than the minimum required government guidelines for chemical residue levels					
Your internal safety standards are more stringent than the minimum required government guidelines for physical contaminants					
Your products consistently meet standards more stringent than the minimum government safety					

Att3	Very Dangerous	Dangerous	Neither Dangerous nor Safe	Safe	Very Safe
Indicate how your facility ranks the relative hazard of these food safety issues: i.e. when managing risk for your firm which issues require the most attention to ensure safety?					
Chemical residues / contamination (process based, cleaners or disinfectants, etc.)					
Pathogen contamination					
Physical contamination (broken needles, rubber gloves, chewing gum, hair, metal)					
Allergens					
Trans fatty acids					
GMO sourced ingredients					
Animal disease (BSE, Foot and Mouth)					
Pesticide residues					
Food origin (foreign vs. domestic or local)					
Trust (lack of consumer					

Att4	Very Dangerous	Dangerous	Neither Dangerous nor Safe	Safe	Very Safe
Indicate how your end consumers perceive the relative hazard of these food safety issues: i.e. which issues do end consumers believe require the most management to ensure food safety					
Chemical residues / contamination (process based, cleaners or disinfectants, etc.)					
Pathogen contamination					
Physical contamination (broken needles, rubber gloves, chewing gum, hair, metal)					
Allergens					
Trans fatty acids					
GMO sourced ingredients					
Animal disease (BSE, Foot and Mouth)					
Pesticide residues					
Food origin (foreign vs. domestic or local)					
Trust (lack of consumer					

Rankings: Att401	1	2	3	4	5
Rank the relative value of your firms assets. (1) being the least important, (5) being the most important. Each rank (number) can only be used once:					
Risk analysis					
Regulating food safety primarily to protect consumers' health					
Using a "farm-to-table" approach to deal with potential hazards					
Hazard Analysis Critical Control Points (HACCP) system adoption as a basis for risk management					
The distribution of better information along your value chain to inform consumers and help them make more informed purchases					

Rankings: Att402	1	2	3	4	5
Rank the relative value of your firms assets. (1) being the least important, (5) being the most important. Each rank (number) can only be used once:					
Capital (Physical) Assets					
Input (Ingredient) Contracts					
Management and staff experience					
Reputational Capital (Brand name, Goodwill)					
Accounts Receivable					

Att5	Very Unimportant	Unimportant	Neither Important nor Unimportant	Important	Very Important
What are your main signals of food quality to the end consumer:					
Brand Reputation					
Certifications (Health Check, organic, etc.)					
Consistent food safety					
Food origin (foreign vs. domestic or local)					
GM free					
GMO sourced ingredients					
Healthful ingredient lists					
Internal quality assurances*					
Labels					
Packaging					
Smell					
Texture					
Flavor					
Appearance (i.e. product colour, bruises)					

* If your firm has internal quality assurances which are only made public to reassure end consumers in the event of a food scare.

State the importance of each of these factors to the provision of food safety:					
Att6	**Very Unimportant**	**Unimportant**	**Neither Important nor Unimportant**	**Important**	**Very Important**
Good Manufacturing Practices (GMPs)					
Hazard Analysis Critical Control Points (HACCP)					
ISO					
Product recall system					
Product traceability					
Supplier Certification					
Wastage record system					
Reworking record system					

State the importance of each of these factors on improving firm business performance:					
Att7	**Very Unimportant**	**Unimportant**	**Neither Important nor Unimportant**	**Important**	**Very Important**
Good Manufacturing Practices (GMPs)					
Hazard Analysis Critical Control Points (HACCP)					
ISO					
Product recall system					
Product traceability					
Supplier Certification					
Wastage record system					
Reworking record system					

State the risk of each of the following to the provision of food safety: i.e. when managing risk for your firm which require attention to ensure safety?					
Att8	**Very Dangerous**	**Dangerous**	**Neither Dangerous nor Safe**	**Safe**	**Very Safe**
Employee hygiene					
GM sourced ingredients					
Pathogen contamination					
Pesticides					
Physical contaminant					
Spoilage					

State the risk of each of the following to business performance: i.e. should a lapse occur would it affect business performance?					
Att9	**Very Dangerous**	**Dangerous**	**Neither Dangerous nor Safe**	**Safe**	**Very Safe**
Employee hygiene					
GM sourced ingredients					
Pathogen contamination					
Pesticides					
Physical contaminant					
Spoilage					

State the risk that each of these factors poses to the food safety of the products you produce in your facility: i.e. are these factors safe or do they pose a risk to the safety of your products?					
Att10	**Very Dangerous**	**Dangerous**	**Neither Dangerous nor Safe**	**Safe**	**Very Safe**
Manufacturing procedures					
Personnel hygiene					
Personnel training					
Equipment used					
Premises					
Raw materials					
Packing materials					
Validated quality assurance procedures					

Part C: Export

This scale is for those respondents who answered YES to question (3), i.e. firms who answered YES to the export question in Part A of the survey.

Att11	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
The majority of your products destined for international markets					
The majority of your products destined for domestic markets					
Your firm is concerned about international sanitary and phytosanitary guidelines					
Your firm is threatened by the level of international consumer concerns surrounding GM production					
Your firm is threatened by the level of GM production in Canada					
Your firm is threatened by the level of GM production in North America					

Part D: HACCP

This Scale is for firms who checked NO to question (4) part (a), i.e. firms who have NOT implemented HACCP and who are NOT intending to implement HACCP within the next six months.

Indicate whether the following were/are motivations for NOT adopting [a food safety system e.g. HACCP]					
	Very Unimportant	**Unimportant**	**Neither Important nor Unimportant**	**Important**	**Very Important**
Internal budgetary constraints					
Difficulty in obtaining external funding					
Perception that current food safety controls are sufficient					
Scale and scope of changes needed prior to adopting HACCP					
Relative importance of other investments					
Overwhelmed by things to be done to adopt HACCP					
Scale and scope of changes to existing food safety controls					
Wide scale facility upgrading required for HACCP implementation					
Perception that firm's scale of operation is too small for HACCP					
Uncertainty about whether future regulatory requirements met by HACCP					
Uncertainty about potential benefits from HACCP					
HACCP difficult to implement because of internal organization of the company					
Perception that HACCP would reduce the flexibility of operations					
Tendency to wait and see from other's experience before implementing ourselves					
Perception that HACCP is not suitable for the firm					
Not sure whether implementation of HACCP would meet our customer requirements					
Perception that cost of HACCP adoption would be cheaper over time					
Greater priority given to other issues that enhancing our food safety controls					
Difficulty in getting help and advice					
Food safety issues not considered sufficiently important to warrant the investment					
Perception that HACCP goes against our traditional methods					

This Scale is for firms who checked YES to question (4) part (a), i.e. firms who HAVE implemented HACCP or who intend to implement HACCP within the next six months.

Indicate whether the following were/are motivations for adoption [of a food safety system e.g. HACCP]					
	Very Unimportant	**Unimportant**	**Neither Important nor Unimportant**	**Important**	**Very Important**
Expected ability to meet anticipated regulatory requirements					
Expected ability to meet existing regulatory requirements					
Wish to apply good practice					
Expected impact on product safety					
Expected ability to meet anticipated future customer requirements					
Expected ability to meet existing customer requirements					
Expected impact on ability to access new markets					
Expected ability to comply with government recommendation					
Expected impact on product quality					
Expected impact on ability to retain existing customers					
Expected impact on ability to attract new customers					
Expected impact on ability to gain greater share of existing markets					
Expected impact on product traceability					
Expected impact on risk of product recalls					
Industry/trade organization recommendations					
Expected impact on ability to deal with customer complaints					
Expected impact on need for customers to inspect plant					
Expected impact on customer complaints					
Expected impact on shelf life of products					
Expected ability to get a higher price for the products					
Expected ability to reduce costs of production					
Expected impact on product wastage					

Appendix B:

Table B-1: Average Risk Rankings From Two Sets of Questions by Firm Size (Small Respondents, n=28, Medium/Large Respondents, n=13)

Survey question:	How does your facility rank the relative hazard of these food safety issues[1]:		How do your end consumers' rank the relative hazard of these food safety issues[2]:	
	Firm characteristic			
Food safety issue	Small	**Medium/large**	Small	**Medium/large**
Chemical residues / contamination (process based, cleaners or disinfectants, etc.)	2.5[a]	**2.5[de]**	2.5[h]	**2.3[mnopr]**
Pathogen contamination	2.3[a]	**2.2[d]**	2.4[h]	**1.9[m]**
Physical contamination (broken needles, rubber gloves, chewing gum, hair, metal)	2.5[a]	**2.2[d]**	2.2[h]	**2.0[m]**
Allergens	2.7[ab]**	**2.4[df]***	2.2[h]**	**2.2[m]***
Trans fatty acids	3.3[c]	**3.3[e]**	2.9[ij]	**3.2[q]**
GMO sourced ingredients	3.4[c]**	**3.7[g]**	2.9[ik]**	**3.4[n]**
Animal disease (BSE, Foot and Mouth)	3.2[c]*	**3.4[f]****	2.8[jk]*	**2.5[o]****
Pesticide residues	3.0[b]*	**3.2[f]***	2.6[jl]*	**2.5[p]***
Food origin (foreign vs. domestic or local)	3.3	**3.3[e]**	3.1[jk]	**2.9[r]**
Trust (lack of consumer trust)	2.9	**3.3[f]**	3.0[jl]	**3.2[q]**

[1,2]Average score from a scale of very dangerous (1) to very safe (5)

Notes: The distribution of responses for each factor was compared between the treatments. Thus for "allergens" the distribution of responses within treatment one (in this case: the hazard level respondent firms assign to each food safety issue), indicated in the second and third columns from the left, was compared to the distribution of responses for treatment two (which in this case is the hazard level respondent firms perceive this customers to apply to each food safety issue), indicated in the right hand columns. Asterisks indicate a significant difference between the distribution of responses under treatment one versus under treatment two. The distribution of responses about factors under consideration were also compared to other factors within each treatment, using the Wilcoxon signed rank test. Within each treatment, responses to each factor were compared to responses for each other factor within the treatment to evaluate if different factors posed different levels of risk.

*, **, ***- indicates a significant difference at 10%, 5%, or 1%, respectively, between the distribution of responses to the variable in each column

Superscripts a to q refer to the results, at the $\alpha = 5\%$ level, of the Wilcoxon Signed Rank tests conducted within each column. Factors with the same superscript did not have significantly different response distributions at the $\alpha = 5\%$ level when

tested by the Wilcoxon Signed Rank Test. Many of these results show that these responses had similar (i.e. not statistically significantly different) response distributions.

Table B-2: Average Risk Rankings From Two Sets of Questions by Respondent Sector (Meat Respondents, n=20, Fruit and Vegetable Respondents, n=14)

Survey question	How does your facility rank the relative hazard of these food safety issues[1]:		How do your end consumers' rank the relative hazard of these food safety issues[2]:	
	Firm characteristic			
Food safety issue	Meat	**Fruit and vegetable**	Meat	**Fruit and vegetable**
Chemical residues / contamination (process based, cleaners or disinfectants, etc.)	2.5[ab]	**3.2[dg]**	2.4[hj]	**2.9[k]**
Pathogen contamination	2.2[a]	**2.9[e]**	2.2[h]	**1.6[k]**
Physical contamination (broken needles, rubber gloves, chewing gum, hair, metal)	2.5[a]	**2.8[de]**	2.2[h]	**2.5[kl]**
Allergens	2.9[b]	**2.8[d]****	2.4[h]	**2.1[l]****
Trans fatty acids	3.4[c]	**3.1[d]**	3.0[i]	**3.3[m]**
GMO sourced ingredients	3.4[c]*	**3.5[g]**	3.0[i]*	**3.4[m]**
Animal disease (BSE, Foot and Mouth)	2.7[a]	**3.8[fg]***	2.5[ij]	**3.2[km]***
Pesticide residues	2.6[a]	**3.7[fg]****	2.4[h]	**2.9[km]****
Food origin (foreign vs. domestic or local)	3.3[c]	**3.6[d]**	3.1[i]	**3.2[m]**
Trust (lack of consumer trust)	2.9[a]	**3.6[d]**	3.1[i]	**3.2[km]**
[1,2]Average score from a scale of very dangerous (1) to very safe (5)				

Notes: The distribution of responses for each factor was compared between the treatments. Thus for "allergens" the distribution of responses within treatment one (in this case: the hazard level respondent firms assign to each food safety issue), indicated in the second and third leftmost column, was compared to the distribution of responses for treatment two (which in this case is the hazard level respondent firms perceive this customers to apply to each food safety issue), indicated in the right hand columns. Asterisks indicate a significant difference between the distribution of responses under treatment one versus under treatment two. The distribution of responses about factors under consideration were also compared to other factors within each treatment, using the Wilcoxon signed rank test. Within each treatment, responses to each factor were compared to responses for each other factor within the treatment to evaluate if different factors posed different levels of risk.

*, **, ***- indicates a significant difference at 10%, 5%, or 1%, respectively, between the distribution of responses to the variable in each column
Superscripts a to m refer to the results, at the α = 5% level, of the Wilcoxon Signed Rank tests conducted within each column. Factors with the same superscript did not have significantly different response distributions at the α = 5% level when tested by the Wilcoxon Signed Rank Test. Many of these results show that these responses had similar (i.e. not statistically significantly different) response distributions.

Table B-3: Average Risk Rankings From Two Sets of Questions by Firm Export Status (Exporting Respondents, n=21, Non-exporting Respondents, n=20)

Survey question	How does your facility rank the relative hazard of these food safety issues[1]:		How do your end consumers' rank the relative hazard of these food safety issues[2]:	
	Firm characteristic			
Food safety issue	Export	**No export**	Export	**No export**
Chemical residues / contamination (process based, cleaners or disinfectants, etc.)	2.3[a]	**2.7[c]**	2.2[f]	**2.6[ij]**
Pathogen contamination	2.1[a]	**2.5[c]**	2.0[f]	**2.5[i]**
Physical contamination (broken needles, rubber gloves, chewing gum, hair, metal)	2.0[a]	**2.8[c]****	1.9[f]	**2.4[i]****
Allergens	2.3[a]	**2.9[d]****	2.0[f]	**2.4[i]****
Trans fatty acids	3.3[b]	**3.2[d]**	3.1[g]	**3.0[j]**
GMO sourced ingredients	3.5[b]	**3.4[e]***	3.1[g]	**3.0[j]***
Animal disease (BSE, Foot and Mouth)	3.2[b]**	**3.3[d]***	2.5[fh]**	**2.9[j]***
Pesticide residues	3.1[b]*	**3.0[cd]****	2.6[f]*	**2.6[i]****
Food origin (foreign vs. domestic or local)	3.3[b]	**3.3[e]**	3.0[gh]	**3.2[j]**
Trust (lack of consumer trust)	3.0[b]	**3.2[ce]**	3.0[g]	**3.1[j]**

[1,2]Average score from a scale of very dangerous (1) to very safe (5)

Notes: The distribution of responses for each factor was compared between the treatments. Thus for "allergens" the distribution of responses within treatment one (in this case: the hazard level respondent firms assign to each food safety issue), indicated in the second and third left hand column, was compared to the distribution of responses for treatment two (which in this case is the hazard level respondent firms perceive this customers to apply to each food safety issue), indicated in the right hand columns. Asterisks indicate a significant difference between the distribution of responses under treatment one versus under treatment

two. The distribution of responses about factors under consideration were also compared to other factors within each treatment, using the Wilcoxon signed rank test. Within each treatment, responses to each factor were compared to responses for each other factor within the treatment to evaluate if different factors posed different levels of risk.

*, **, ***- indicates a significant difference at 10%, 5%, or 1%, respectively, between the distribution of responses to the variable in each column

Superscripts a to j refer to the results, at the $\alpha = 5\%$ level, of the Wilcoxon Signed Rank tests conducted within each column. Factors with the same superscript did not have significantly different response distributions at the $\alpha = 5\%$ level when tested by the Wilcoxon Signed Rank Test. Many of these results show that these responses had similar (i.e. not statistically significantly different) response distributions.

Table B-4: Average Risk Rankings From Two Sets of Questions by Firm Size (Small Respondents, n=28, Medium/Large Respondents, n=13)

Survey scale question	State the importance of each of these factors to the provision of food safety[1]:		State the importance of each of these factors on improving firm business performance[2]:	
	Firm characteristic			
Food safety issue	Small	**Medium/large**	Small	**Medium/large**
Good Manufacturing Practices (GMPs)	4.6[a]**	**4.9[f]***	4.7[k]**	**4.6[n]***
Hazard Analysis Critical Control Points (HACCP)	4.0[b]	**4.7[fg]**	3.9[l]	**4.5[no]**
ISO	3.1[cd]	**2.9[h]**	3.1[m]	**3.0[q]**
Product recall system	4.1[b]	**4.5[gi]**	4.0[l]	**4.4[nop]**
Product traceability	4.3[abc]	**4.5[g]**	4.1[kl]	**4.5[no]**
Supplier Certification	4.1[bce]	**4.2[j]****	4.1[kl]	**3.7[q]****
Wastage record system	3.4[d]	**3.2[h]***	3.5[lm]	**3.7[p]***
Reworking record system	3.4[de]	**3.7[ij]**	3.4[m]	**3.9[pq]**
[1,2]Average score from a scale of very unimportant (1) to very important (5)				

Notes: The distribution of responses for each factor was compared between the treatments. Thus for "GMPs" the distribution of responses within treatment one (in this case: the importance of each factor to the provision of food safety), indicated in the second and third left hand columns, was compared to the distribution of responses for treatment two (which in this case is the importance of each factor to improving firm business performance), indicated in the right hand columns. Asterisks indicate a significant difference between the distribution of responses under treatment one versus under treatment two. The distribution of responses about factors under consideration were also compared to other factors within each treatment, using the Wilcoxon signed rank test. Within each treatment, responses to each factor were compared to responses for each other factor within the treatment to evaluate if different factors posed different levels of risk.

*, **, ***- indicates a significant difference at 10%, 5%, or 1%, respectively, between the distribution of responses to the variable in each column
Superscripts a to f refer to the results, at the α = 5% level, of the Wilcoxon Signed Rank tests conducted within each column. Factors with the same superscript did not have significantly different response distributions at the α = 5% level when tested by the Wilcoxon Signed Rank Test. Many of these results show that these responses had similar (i.e. not statistically significantly different) response distributions.

Table B-5: Average Risk Rankings From Two Sets of Questions by Firm Sector (Meat Respondents, n=20, Fruit and Vegetable Respondents, n=14)

Survey scale question	State the importance of each of these factors to the provision of food safety[1]:		State the importance of each of these factors on improving firm business performance[2]:	
	Firm characteristic			
Food safety issue	Meat	**Fruit and vegetable**	Meat	**Fruit and vegetable**
Good Manufacturing Practices (GMPs)	4.7[a]***	**4.6[d]**	4.4[i]***	**4.6[m]**
Hazard Analysis Critical Control Points (HACCP)	4.1[bd]	**4.1[e]**	4.0[j]	**4.0[n]**
ISO	2.9[c]	**3.1[f]**	2.8[k]	**3.4[o]**
Product recall system	4.1[ab]	**4.3[deg]**	3.9[ij]	**4.1[mnp]**
Product traceability	4.2[ab]	**4.7[deg]**	4.0[ijl]	**4.3[mnp]**
Supplier Certification	4.2[b]	**3.9[h]**	4.0[ij]	**3.9[nop]**
Wastage record system	3.0[c]	**3.5[efh]***	3.3[jkl]	**3.7[nop]***
Reworking record system	3.3[cd]	**3.5[efh]**	3.4[k]	**3.5[no]**
[1,2]Average score from a scale of very unimportant (1) to very important (5)				

Notes: The distribution of responses for each factor was compared between the treatments. Thus for "GMPs" the distribution of responses within treatment one (in this case: the importance of each factor to the provision of food safety), indicated in the second and third left hand columns, was compared to the distribution of responses for treatment two (which in this case is the importance of each factor to improving firm business performance), indicated in the right hand columns. Asterisks indicate a significant difference between the distribution of responses under treatment one versus under treatment two. The distribution of responses about factors under consideration were also compared to other factors within each treatment, using the Wilcoxon signed rank test. Within each treatment, responses to each factor were compared to responses for each other factor within the treatment to evaluate if different factors posed different levels of risk.
*, **, ***- indicates a significant difference at 10%, 5%, or 1%, respectively, between the distribution of responses to the variable in each column

Superscripts a to o refer to the results, at the α = 5% level, of the Wilcoxon Signed Rank tests conducted within each column. Factors with the same superscript did not have significantly different response distributions at the α = 5% level when tested by the Wilcoxon Signed Rank Test. Many of these results show that these responses had similar (i.e. not statistically significantly different) response distributions.

Table B-6: Average Risk Rankings From Two Sets of Questions by Firm Export Status (Exporting Respondents, n=21, Non-exporting Respondents, n=20)

Survey scale question	State the importance of each of these factors to the provision of food safety[1]:		State the importance of each of these factors on improving firm business performance[2]:	
	Firm characteristic			
Food safety issue	Export	**No export**	Export	**No export**
Good Manufacturing Practices (GMPs)	4.8**	**4.7^{e}***	4.5**	**4.5^{mn}***
Hazard Analysis Critical Control Points (HACCP)	4.6^{a}**	**3.9^{f}**	4.3^{j}**	**3.9^{opq}**
ISO	3.1^{c}	**2.9^{g}**	3.2^{k}	**3.0^{r}**
Product recall system	4.3^{abc}	**4.2^{efh}**	4.2^{kl}	**4.0^{mor}**
Product traceability	4.4^{a}	**4.3^{ef}**	4.3^{jk}	**4.2^{nps}**
Supplier Certification	4.1^{ab}**	**4.0^{fh}**	3.9^{jkl}**	**4.1^{pt}**
Wastage record system	4.2^{d}**	**3.4^{fgi}**	3.8^{k}**	**3.3^{qrt}**
Reworking record system	3.3^{ad}	**3.5^{i}**	3.6^{k}	**3.5^{qrs}**
[1,2]Average score from a scale of very unimportant (1) to very important (5)				

The distribution of responses for each factor was compared between the treatments. Thus for "GMPs" the distribution of responses within treatment one (in this case: the importance of each factor to the provision of food safety), indicated in the second and third left hand columns, was compared to the distribution of responses for treatment two (which in this case is the importance of each factor to improving firm business performance), indicated in the right hand columns. Asterisks indicate a significant difference between the distribution of responses under treatment one versus under treatment two. The distribution of responses about factors under consideration were also compared to other factors within each treatment, using the Wilcoxon signed rank test. Within each treatment, responses to each factor were compared to responses for each other factor within the treatment to evaluate if different factors posed different levels of risk.

*, **, ***- indicates a significant difference at 10%, 5%, or 1%, respectively, between the distribution of responses to the variable in each column

Superscripts a to s refer to the results, at the α = 5% level, of the Wilcoxon Signed Rank tests conducted within each column. Factors with the same superscript did not have significantly different response distributions at the α = 5% level when tested by the Wilcoxon Signed Rank Test. Many of these results show that these

responses had similar (i.e. not statistically significantly different) response distributions.

Table B-7: Average Risk Rankings From Two Sets of Questions by Firm Size (Small Respondents, n=28, Medium/Large Respondents, n=13)

Survey question	State the risk each of the following poses to the provision of food safety[1]:		State the risk of each of the following to business performance[2]:	
	Firm characteristic			
Food safety issue	Small	**Medium /Large**	Small	**Medium /Large**
Employee hygiene	2.9[a]	**2.1[b]**	2.6[d]	**2.3[gh]**
GM sourced ingredients	3.4[a]	**3.5**	3.2[e]	**3.3**
Pathogen contamination	2.9[a]*	**2.2[bc]**	2.5[f]*	**1.9[g]**
Pesticides	3.2[a]	**2.5[c]**	2.8[de]	**2.3[g]**
Physical contaminant	2.9[a]**	**1.9[bc]**	2.5[f]**	**1.8[hi]**
Spoilage	3.1[a]**	**2.3[bc]**	2.6[df]**	**2.1[gi]**
[1,2]Average score per factor on a scale from very dangerous (1) to very safe (5)				

Notes: The distribution of responses for each factor was compared between the treatments. Thus for "employee hygiene" the distribution of responses within treatment one (in this case: the risk it poses to the provision of food safety.), indicated in the center column, was compared to the distribution of responses for treatment two (which in this case is the risk it poses to business performance), indicated in the right hand column. Asterisks indicate a significant difference between the distribution of responses under treatment one versus under treatment two. The distribution of responses about factors under consideration were also compared to other factors within each treatment, using the Wilcoxon signed rank test. Within each treatment, responses to each factor were compared to responses for each other factor within the treatment to evaluate if different factors posed different levels of risk.

*, **, ***- indicates a significant difference at 10%, 5%, or 1%, respectively, between the distribution of responses to the variable in each column

Superscripts a to i refer to the results, at the $\alpha = 5\%$ level, of the Wilcoxon Signed Rank tests conducted within each column. Factors with the same superscript did not have significantly different response distributions at the $\alpha = 5\%$ level when tested by the Wilcoxon Signed Rank Test. Many of these results show that these responses had similar (i.e. not statistically significantly different) response distributions.

Table B-8: Average Risk Rankings From Two Sets of Questions by Firm Sector (Meat Respondents, n=20, Fruit and Vegetable Respondents, n=14)

Survey question	State the risk each of the following poses to the provision of food safety[1]:		State the risk of each of the following to business performance[2]:	
	Firm characteristic			
Food safety issue	Meat	**Fruit and vegetable**	Meat	**Fruit and vegetable**
Employee hygiene	2.6^{ab}	**3.1^{c}**	2.4^{de}	**3.1^{gh}**
GM sourced ingredients	3.3^{a}	**3.4^{c}**	3.3	**3.1^{g}**
Pathogen contamination	2.5^{b}**	**3.3^{c}**	2.0^{df}**	**3.2^{g}**
Pesticides	2.9^{a}	**3.4^{c}**	2.6^{d}	**3.2^{g}**
Physical contaminant	2.7^{a}**	**2.9^{c}**	2.1^{df}**	**3.1^{g}**
Spoilage	2.6^{ab}**	**3.5^{c}**	2.0^{df}**	**3.4^{h}**

[1,2]Average score per factor on a scale from very dangerous (1) to very safe (5)

The distribution of responses for each factor was compared between the treatments. Thus for "employee hygiene" the distribution of responses within treatment one (in this case: the risk it poses to the provision of food safety.), indicated in the center column, was compared to the distribution of responses for treatment two (which in this case is the risk it poses to business performance), indicated in the right hand column. Asterisks indicate a significant difference between the distribution of responses under treatment one versus under treatment two. The distribution of responses about factors under consideration were also compared to other factors within each treatment, using the Wilcoxon signed rank test. Within each treatment, responses to each factor were compared to responses for each other factor within the treatment to evaluate if different factors posed different levels of risk.

*, **, ***- indicates a significant difference at 10%, 5%, or 1%, respectively, between the distribution of responses to the variable in each column

Superscripts a to h refer to the results, at the $\alpha = 5\%$ level, of the Wilcoxon Signed Rank tests conducted within each column. Factors with the same superscript did not have significantly different response distributions at the $\alpha = 5\%$ level when tested by the Wilcoxon Signed Rank Test. Many of these results show that these responses had similar (i.e. not statistically significantly different) response distributions.

Table B-9: Average Risk Rankings From Two Sets of Questions by Firm Export Status (Exporting Respondents, n=21, Non-exporting Respondents, n=20)

Survey question	State the risk each of the following poses to the provision of food safety[1]:		State the risk of each of the following to business performance[2]:	
	Firm characteristic			
Food safety issue	Export	**No export**	Export	**No export**
Employee hygiene	2.3[a]	**3.0[cd]**	2.3[e]	**2.8[ghij]**
GM sourced ingredients	3.6*	**3.2[cd]**	3.2*	**3.3[h]**
Pathogen contamination	2.4[a]**	**2.9[cd]**	2.0[f]**	**2.6[g]**
Pesticides	2.9[b]	**3.1[cd]**	2.5[eh]	**2.8[i]**
Physical contaminant	2.2[a]*	**3.0[c]**	1.9[fh]*	**2.7[g]**
Spoilage	2.8[ab]**	**2.9[d]**	2.4[ef]**	**2.5[j]**

[1,2]Average score per factor on a scale from very dangerous (1) to very safe (5)

The distribution of responses for each factor was compared between the treatments. Thus for "employee hygiene" the distribution of responses within treatment one (in this case: the risk it poses to the provision of food safety.), indicated in the center column, was compared to the distribution of responses for treatment two (which in this case is the risk it poses to business performance), indicated in the right hand column. Asterisks indicate a significant difference between the distribution of responses under treatment one versus under treatment two. The distribution of responses about factors under consideration were also compared to other factors within each treatment, using the Wilcoxon signed rank test. Within each treatment, responses to each factor were compared to responses for each other factor within the treatment to evaluate if different factors posed different levels of risk.

*, **, ***- indicates a significant difference at 10%, 5%, or 1% between the distribution of responses to the variable in each column

Table B-10: Kolmogorov-Smirnov test results for Fruit and Vegetable Processor Survey Responses to Attitudinal Statements

	Fruit and vegetable	Average	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
	K-S Z statistic / Asymp. Sig. (2-tailed)		Percent of respondents				
Any media attention to your industry is positive	0.882 / 0.418	3.1	14.3%	14.3%	43.0%	7.1%	21.4%
Any media attention to your industry is a source of consumer distrust and lost revenue	0.721 / 0.677	2.6	21.4%	28.6%	21.4%	21.4%	7.1%
Your end retailers have the majority of the bargaining power in your value chain	1.069 / 0.204	3.2	14.3%	0.0%	50.0%	21.4%	14.3%
Your customers provide you with processing standards for purchasing your products	1.242 / 0.091*	3.4	14.3%	0.0%	21.4%	57.1%	7.1%
Your food safety systems are sufficient for meeting consumer concerns	0.995 / 0.276	4.3	0.0%	0.0%	14.3%	42.9%	42.9%
Your food safety systems are sufficient for meeting customer demands	1.521 / 0.020**	4.4	0.0%	0.0%	0.0%	64.3%	35.7%
Your food safety systems are effective	1.521 / 0.020**	4.4	0.0%	21.4%	35.7%	21.4%	21.4%
Your value chain insists on identity preservation of all its raw ingredients	0.840 / 0.481	3.4	21.4%	7.1%	35.7%	28.6%	7.1%
The presence of GM or GM derived ingredients is an issue of risk communication relative to your consumers	0.886 / 0.413	2.9	7.1%	21.4%	50.0%	7.1%	14.3%
The presence of GM or GM derived ingredients is an issue of food safety	1.069 / 0.203	3.0	50.0%	14.3%	28.6%	0.0%	7.1%
Your products are labelled “May contain GM ingredients”	1.085 / 0.190	2.0	7.1%	0.0%	50.0%	28.6%	14.3%
You would lose customers if your products were labelled “May contain GM ingredients”	0.992 / 0.278	3.4	0.0%	0.0%	7.1%	28.6%	64.3%

*, **, ***- indicates a significant difference between the distribution of responses and a normal distribution with 90%, 95%, or 99% confidence respectively. Average on a scale from Strongly disagree (1) to Strongly agree (5).

Table B-11: Kolmogorov-Smirnov test results for Meat Processor Survey Responses to Attitudinal Statements

	Meat	Average	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
	K-S Z statistic						
	Asymp. Sig. (2-tailed)		Percent of respondents				
Any media attention to your industry is positive	1.009	2.8	5.0%	40.0%	35.0%	10.0%	10.0%
	0.261						
Any media attention to your industry is a source of consumer distrust and lost revenue	0.918	2.9	5.0%	35.0%	35.0%	20.0%	5.0%
	0.369						
Your end retailers have the majority of the bargaining power in your value chain	1.001	3.6	5.0%	5.0%	35.0%	40.0%	15.0%
	0.269						
Your customers provide you with processing standards for purchasing your products	1.127	3.4	0.0%	10.0%	10.0%	40.0%	40.0%
	0.158						
Your food safety systems are sufficient for meeting consumer concerns	1.158	4.1	0.0%	0.0%	15.0%	50.0%	35.0%
	0.137						
Your food safety systems are sufficient for meeting customer demands	1.177	4.2	0.0%	0.0%	10.0%	50.0%	40.0%
	0.125						
Your food safety systems are effective	1.234	4.3	0.0%	5.0%	40.0%	30.0%	25.0%
	0.095*						
Your value chain insists on identity preservation of all its raw ingredients	1.095	3.8	5.0%	20.0%	55.0%	15.0%	5.0%
	0.181						
The presence of GM or GM derived ingredients is an issue of risk communication relative to your consumers	1.241	3.0	10.0%	20.0%	45.0%	15.0%	10.0%
	0.092*						
The presence of GM or GM derived ingredients is an issue of food safety	1.037	2.2	30.0%	25.0%	40.0%	5.0%	0.0%
	0.233						
Your products are labelled "May contain GM ingredients"	1.117	3.4	5.0%	5.0%	55.0%	20.0%	15.0%
	0.165						
You would lose customers if your products were labelled "May contain GM ingredients"	1.290	4.4	0.0%	10.0%	0.0%	35.0%	55.0%
	0.072*						

*, **, ***- indicates a significant difference at 10%, 5%, or 1% between a normal distribution and the distribution of responses in the row respectively. Average on a scale from Strongly disagree (1) to Strongly agree (5).

Table B-12: Kolmogorov-Smirnov Test Results for Small Respondents' Ranking of Potential Food Safety Issues

	Small	Average	Very dangerous	Dangerous	Neither dangerous nor safe	Safe	Very safe
	K-S Z statistic						
	Asymp. Sig. (2-tailed)		Percent of respondents				
Chemical residues / contamination (process based, cleaners or disinfectants, etc.)	1.139	2.5	32.1%	25.0%	14.3%	14.3%	14.3%
	0.149						
Pathogen contamination	1.389	2.3	42.9%	25.0%	3.6%	14.3%	14.3%
	0.042**						
Physical contamination (broken needles, rubber gloves, chewing gum, hair, metal)	1.453	2.5	46.4%	14.3%	7.1%	10.7%	21.4%
	0.029**						
Allergens	1.147	2.7	25.0%	28.6%	17.9%	10.7%	17.9%
	0.144						
Trans fatty acids	1.369	3.3	7.1%	17.9%	42.9%	7.1%	25.0%
	0.047**						
GMO sourced ingredients	2.043	3.4	0.0%	14.3%	60.7%	0.0%	25.0%
	0.000***						
Animal disease (BSE, Foot and Mouth)	1.073	3.2	21.4%	10.7%	28.6%	7.1%	32.1%
	0.200						
Pesticide residues	1.029	2.9	17.9%	25.0%	28.6%	3.6%	25.0%
	0.240						
Food origin (foreign vs. domestic or local)	1.092	3.3	10.7%	10.7%	39.3%	14.3%	25.0%
	0.184						
Trust (lack of consumer trust)	0.840	2.9	25.0%	17.9%	17.9%	17.9%	21.4%
	0.480						

*, **, ***- indicates a significant difference at 10%, 5%, or 1% between a normal distribution and the distribution of responses in the row
Average on a scale from Very dangerous (1) to Very safe (5)

Table B-13: Kolmogorov-Smirnov test results for Medium/Large Respondents' Rankings of Potential Food Safety Issues

	Medium/Large	Average	Very dangerous	Dangerous	Neither dangerous nor safe	Safe	Very safe
	K-S Z statistic						
	Asymp. Sig. (2-tailed)		Percent of respondents				
Chemical residues / contamination (process based, cleaners or disinfectants, etc.)	0.929	2.5	23.1%	38.5%	15.4%	15.4%	7.7%
	0.354						
Pathogen contamination	0.976	2.2	30.8%	38.5%	7.7%	23.1%	0.0%
	0.296						
Physical contamination (broken needles, rubber gloves, chewing gum, hair, metal)	1.471	2.2	15.4%	69.2%	7.7%	0.0%	7.7%
	0.026**						
Allergens	1.254	2.4	7.7%	61.5%	23.1%	0.0%	7.7%
	0.086*						
Trans fatty acids	1.393	3.3	0.0%	15.4%	61.5%	0.0%	23.1%
	0.041**						
GMO sourced ingredients	1.188	3.7	0.0%	0.0%	53.8%	23.1%	23.1%
	0.119						
Animal disease (BSE, Foot and Mouth)	0.854	3.4	15.4%	0.0%	46.2%	7.7%	30.8%
	0.459						
Pesticide residues	0.598	3.2	7.7%	23.1%	30.8%	23.1%	15.4%
	0.867						
Food origin (foreign vs. domestic or local)	0.915	3.3	15.4%	0.0%	46.2%	15.4%	23.1%
	0.373						
Trust (lack of consumer trust)	0.658	3.3	7.7%	15.4%	30.8%	30.8%	15.4%
	0.780						

*, **, ***- indicates a significant difference at 10%, 5%, or 1% between a normal distribution and the distribution of responses in the row

Average on a scale from Very dangerous (1) to Very safe (5)

Table B-14: Kolmogorov-Smirnov Test Results for Small Firm Responses Regarding Important Practices in Modern Food Safety Provision

	Small	Average	Very unimportant	Unimportant	Neither important nor unimportant	Important	Very important
	K-S Z statistic / Asymp. Sig. (2-tailed)		Percent of respondents				
Risk analysis	1.490 / 0.024**	3.9	3.6%	0.0%	21.4%	50.0%	25.0%
Regulating food safety primarily to protect consumers' health	1.527 / 0.019**	4.4	3.6%	0.0%	0.0%	42.9%	53.6%
Using a "farm-to-table" approach to deal with potential hazards	1.267 / 0.081*	3.8	0.0%	7.1%	28.6%	42.9%	21.4%
Hazard Analysis Critical Control Points (HACCP) system adoption as a basis for risk management	1.053 / 0.217	3.8	3.6%	7.1%	28.6%	32.1%	28.6%
The distribution of better information along your value chain to inform consumers and help them make more informed purchases	1.942 / 0.001***	3.7	3.6%	3.6%	21.4%	64.3%	7.1%

*, **, ***- indicates a significant difference at 10%, 5%, or 1% between a normal distribution and the distribution of responses in the row

Average on a scale from Very unimportant (1) to Very important (5)

Table B-15: Kolmogorov-Smirnov Test Results for Medium/Large Firm Responses Regarding Important Practices in Modern Food Safety Provision

	Medium/Large	Average	Very unimportant	Unimportant	Neither important nor unimportant	Important	Very important
	K-S Z statistic		Percent of respondents				
	Asymp. Sig. (2-tailed)						
Risk analysis	1.267	3.7	0.0%	7.7%	23.1%	61.5%	7.7%
	0.081*						
Regulating food safety primarily to protect consumers' health	1.021	4.3	0.0%	0.0%	15.4%	38.5%	46.2%
	0.248						
Using a "farm-to-table" approach to deal with potential hazards	1.120	4.1	0.0%	7.7%	7.7%	53.8%	30.8%
	0.163						
Hazard Analysis Critical Control Points (HACCP) system adoption as a basis for risk management	1.497	4.6	0.0%	0.0%	7.7%	23.1%	69.2%
	0.023**						
The distribution of better information along your value chain to inform consumers and help them make more informed purchases	1.092	4.0	0.0%	0.0%	46.2%	7.7%	46.2%
	0.184						

*, **, ***- indicates a significant difference at 10%, 5%, or 1% between a normal distribution and the distribution of responses in the row

Average on a scale from Very unimportant (1) to Very important (5)

Table B-16: Kolmogorov-Smirnov Test Results for Fruit and Vegetable and Grain and Oilseed Aggregated Processor Responses Regarding Signals of Food Quality to the End Consumer

	Aggregated fruit & vegetable, grain & oilseed	Average	Very unimportant	Unimportant	Neither important nor unimportant	Important	Very important
	K-S Z statistic		Percent of respondents				
	Asymp. Sig. (2-tailed)						
Brand reputation	1.451	4.6	0.0%	0.0%	11.1%	22.2%	66.7%
	0.030**						
Certifications (Health Check, organic, etc.)	1.147	3.9	0.0%	0.0%	44.4%	22.2%	33.3%
	0.144						
Consistent food safety	1.198	4.6	0.0%	5.6%	0.0%	28.7%	66.7%
	0.113						
Food origin (foreign vs. domestic or local)	1.145	3.8	0.0%	0.0%	38.9%	44.4%	16.7%
	0.145						
GM free	1.021	3.9	0.0%	0.0%	44.4%	22.2%	33.3%
	0.248						
GMO sourced ingredients	1.325	3.5	5.6%	0.0%	55.6%	16.7%	22.2%
	0.060*						
Healthful ingredient lists	1.143	4.1	5.6%	0.0%	16.7%	38.9%	38.9%
	0.147						
Internal quality assurances	0.802	4.2	0.0%	0.0%	22.2%	33.3%	44.4%
	0.541						
Labels	0.995	4.3	0.0%	0.0%	16.7%	38.9%	44.4%
	0.276						
Packaging	1.311	4.5	0.0%	0.0%	11.1%	27.8%	61.1%
	0.064*						
Smell	1.601	4.6	0.0%	0.0%	11.1%	22.2%	66.7%
	0.012**						
Texture	1.466	4.3	0.0%	0.0%	27.8%	11.1%	61.1%
	0.027**						
Flavour	1.742	4.6	0.0%	0.0%	11.1%	16.7%	72.2%
	0.005***						
Appearance (i.e. product colour, bruises)	1.601	4.6	0.0%	0.0%	11.1%	16.7%	72.2%
	0.012**						

*, **, ***- indicates a significant difference at 10%, 5%, or 1% between a normal distribution and the distribution of responses in the row
Average on a scale from Very unimportant (1) to Very important (5)

Table B-17: Kolmogorov-Smirnov Test Results for Meat Processor Responses Regarding Signals of Food Quality to the End Consumer

	Meat	Average	Very unimportant	Unimportant	Neither important nor unimportant	Important	Very important
	K-S Z statistic		Percent of respondents				
	Asymp. Sig. (2-tailed)						
Brand reputation	1.141	4.2	0.0%	5.0%	10.0%	45.0%	40.0%
	0.148						
Certifications (Health Check, organic, etc.)	0.861	3.6	0.0%	20.0%	25.0%	30.0%	25.0%
	0.449						
Consistent food safety	1.960	4.7	0.0%	0.0%	0.0%	30.0%	70.0%
	0.001***						
Food origin (foreign vs. domestic or local)	1.129	3.9	0.0%	20.0%	10.0%	35.0%	35.0%
	0.232						
GM free	1.146	3.1	5.0%	15.0%	50.0%	25.0%	5.0%
	0.144						
GMO sourced ingredients	1.351	2.8	15.0%	15.0%	50.0%	20.0%	0.0%
	0.052*						
Healthful ingredient lists	0.936	3.7	5.0%	5.0%	30.0%	35.0%	25.0%
	0.345						
Internal quality assurances	1.349	3.6	0.0%	5.0%	50.0%	25.0%	20.0%
	0.052*						
Labels	1.128	3.9	0.0%	0.0%	10.0%	55.0%	35.0%
	0.157						
Packaging	1.352	4.3	0.0%	0.0%	5.0%	55.0%	40.0%
	0.052*						
Smell	1.451	4.4	0.0%	0.0%	10.0%	55.0%	35.0%
	0.030**						
Texture	1.352	4.3	0.0%	0.0%	0.0%	50.0%	50.0%
	0.052*						
Flavour	1.499	4.5	0.0%	0.0%	0.0%	55.0%	45.0%
	0.022**						
Appearance (i.e. product colour, bruises)	1.141	4.5	0.0%	0.0%	5.0%	25.0%	70.0%
	0.148						

*, **, ***- indicates a significant difference at 10%, 5%, or 1% between a normal distribution and the distribution of responses in the row

Average on a scale from Very unimportant (1) to Very important (5)

Table B-18: Kolmogorov-Smirnov Test of Small Processor Sample Ranking of Potential Facility Hazards

	Small	Average	Very dangerous	Dangerous	Neither dangerous nor safe	Safe	Very safe
	K-S Z statistic		Percent of respondents				
	Asymp. Sig. (2-tailed)						
Manufacturing procedures	1.810	3.9	14.3%	3.6%	0.0%	39.3%	42.9%
	0.003***						
Personnel hygiene	1.614	3.8	17.9%	7.1%	0.0%	28.6%	46.4%
	0.011**						
Personnel training	1.756	3.7	14.3%	7.1%	3.6%	42.9%	32.1%
	0.004***						
Equipment used	1.522	3.8	10.7%	10.7%	7.1%	35.7%	35.7%
	0.019**						
Premises	1.599	3.8	10.7%	10.7%	3.6%	35.7%	39.3%
	0.012**						
Raw materials	1.719	3.7	17.9%	7.1%	0.0%	35.7%	39.3%
	0.005***						
Packing materials	1.761	3.9	7.1%	10.7%	3.6%	46.4%	32.1%
	0.004***						
Validated quality assurance procedures	1.498	3.9	10.7%	3.6%	10.7%	35.7%	39.3%
	0.022**						

*, **, ***- indicates a significant difference at 10%, 5%, or 1% between a normal distribution and the distribution of responses in the row
Average on a scale from Very dangerous (1) to Very safe (5)

Table B-19: Kolmogorov-Smirnov Test of Medium/Large Processor Sample Ranking of Potential Facility Hazards

	Medium/Large	Average	Very dangerous	Dangerous	Neither dangerous nor safe	Safe	Very safe
	K-S Z statistic		Percent of respondents				
	Asymp. Sig. (2-tailed)						
Manufacturing procedures	0.786	3.7	0.0%	23.1%	15.4%	30.8%	30.8%
	0.567						
Personnel hygiene	1.427	3.6	7.7%	15.4%	0.0%	61.5%	15.4%
	0.034**						
Personnel training	1.125	3.6	7.7%	15.4%	7.7%	46.2%	23.1%
	0.159						
Equipment used	1.028	3.5	0.0%	23.1%	15.4%	46.2%	15.4%
	0.241						
Premises	1.078	3.5	0.0%	30.8%	7.7%	46.2%	15.4%
	0.195						
Raw materials	1.010	3.5	0.0%	38.5%	0.0%	38.5%	23.1%
	0.260						
Packing materials	0.823	3.9	0.0%	15.4%	23.1%	23.1%	38.5%
	0.508						
Validated quality assurance procedures	1.087	3.7	0.0%	23.1%	7.7%	46.2%	23.1%
	0.188						

*, **, ***- indicates a significant difference at 10%, 5%, or 1% between a normal distribution and the distribution of responses in the row
Average on a scale from Very dangerous (1) to Very safe (5)

Table B-20: Mean Rank and Factor Loading From the Principal Component Analysis of Meat Processor Responses Regarding Signals of Food Quality to the End Consumer

	Mean	Factor 1: popular health	Factor 2: sensory quality	Factor 3: functional	Factor 4: brand reputational quality	Factor 5: historic food quality
Healthful ingredient lists	3.7	**0.836**	-0.096	0.230	0.280	-0.148
GM free	3.1	**0.780**	0.194	0.229	0.289	0.035
Food origin	3.9	**0.696**	-0.098	0.061	0.080	0.314
Certifications	3.6	**0.632**	0.038	0.625	-0.067	0.036
Texture	4.3	**0.598**	0.556	-0.258	0.052	0.042
Smell	4.4	0.106	**0.947**	-0.157	-0.045	0.059
Flavor	4.5	0.024	**0.847**	-0.016	0.189	0.294
Appearance	4.5	-0.149	**0.820**	0.248	0.278	0.005
GMO sourced ingredients	2.8	0.156	-0.029	**0.888**	-0.008	-0.095
Internal quality assurances	3.6	0.092	-0.022	**0.875**	-0.018	0.213
Brand Reputation	4.2	0.077	0.217	-0.185	**0.886**	0.053
Labels	3.9	0.428	0.052	0.092	**0.780**	0.039
Consistent food safety	4.7	0.025	0.163	0.040	0.008	**0.933**
Packaging	4.3	0.335	0.296	0.184	0.446	**0.525**
% of Variance Explained	-	20.8%	20.2%	16.3%	13.5%	10.1%

Table B-21: Mean Rank and Factor Loading From the Principal Component Analysis of Fruit and Vegetable Processor Responses Regarding Signals of Food Quality to the End Consumer

	Mean	Factor 1: branded sensory quality	Factor 2: search and credence quality	Factor 3: consistent food safety	Factor 4: certified quality
Smell	4.4	**0.941**	0.032	0.236	-0.021
Appearance	4.6	**0.941**	0.032	0.236	-0.021
Flavor	4.7	**0.937**	0.003	0.178	-0.102
Brand Reputation	4.5	**0.885**	-0.185	-0.088	0.025
Packaging	4.5	**0.742**	-0.420	-0.104	0.168
Texture	4.4	**0.655**	-0.063	0.622	0.280
Labels	4.3	0.388	**-0.863**	0.172	0.039
Food origin	3.6	0.020	**0.856**	-0.172	0.303
Healthful ingredient lists	4.1	-0.007	**-0.850**	-0.036	-0.091
GM free	3.9	-0.045	**0.660**	-0.582	0.259
Consistent food safety	4.4	0.152	-0.074	**0.873**	0.359
GMO sourced ingredients	3.7	-0.191	0.559	**-0.624**	0.313
Internal quality assurances	4.0	-0.049	0.083	0.090	**0.932**
Certifications	3.7	0.098	0.424	0.102	**0.718**
% of Variance Explained	-	33.1%	24.0%	15.1%	13.6%

Table B-22: Mean Rank and Factor Loading From the Principal Component Analysis of Processors Which Claim to Include End Consumer Concerns in the Design Stage of Their Risk Management Procedures Responses Regarding Signals of Food Quality to the End Consumer

	Mean	Factor 1: informed credence and experience characteristics	Factor 2: external quality	Factor 3: safe characteristics	Factor 4: non branded certifications	Factor 5: food origin
Smell	4.7	**0.909**	0.172	0.128	0.071	-0.052
Flavor	4.7	**0.882**	0.128	0.057	-0.084	-0.032
Appearance	4.7	**0.759**	-0.461	0.054	0.013	-0.033
Labels	4.4	**0.563**	0.521	0.382	-0.139	-0.254
GM free	3.7	**0.549**	0.341	-0.379	0.087	0.543
Packaging	4.4	0.238	**0.826**	0.020	-0.183	-0.098
ingredient lists	4.3	-0.100	**0.804**	0.076	-0.068	0.277
Consistent food safety	4.6	0.130	-0.077	**0.857**	0.323	0.042
GMO sourced ingredients	3.1	0.119	-0.075	**-0.735**	0.381	-0.294
Texture	4.5	0.449	0.347	**0.698**	0.042	-0.116
Internal quality assurances	4.0	0.076	-0.183	0.071	**0.820**	-0.058
Reputation	4.6	0.417	-0.112	0.056	**-0.730**	0.110
Certifications	3.8	0.141	-0.190	0.038	**0.666**	0.367
Food origin	3.9	-0.142	0.053	0.150	0.010	**0.827**
Variance Explained	-	23.7%	15.7%	15.1%	14.1%	9.9%