AN ECONOMIC ANALYSIS OF HAZARD ANALYSIS CRITICAL CONTROL POINT-BASED RISK MANAGEMENT PROGRAMME IN THE NEW ZEALAND MEAT INDUSTRY

A thesis
submitted in partial fulfilment
of the requirements for the Degree
of
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at the
University of Waikato

by

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ABSTRACT

The replacement of the Meat Act 1981 by the Animal Products Act 1999 opened a new era for food safety management in New Zealand. Administering food legislation is now the sole responsibility of the New Zealand Food Safety Authority instead of being shared between the Ministry of Agriculture and Forestry and the Ministry of Health as previously. At the core of the legislative change is the requirement for Risk Management Programmes (RMP). Every single animal primary processing business is required to have an RMP for each type of product. An RMP is required to embrace the principles of Hazard Analysis and Critical Control Point (HACCP).

While there have been some studies considering the implementation of HACCP in food businesses worldwide, there has not been any study focusing on HACCP adoption in New Zealand. The mandating of RMP has also made the implementation process more complex. On the other hand, it also brings new experience in terms of food safety management.

This thesis examines the implementation process of HACCP/RMP in New Zealand. It also explores the interaction between food safety management and international competitiveness through an economic analysis of the impacts of the program on a New Zealand food processing industry. The meat industry was chosen as a case study as it is one of the first industries that had to comply with the first deadline of the implementation (July 2003). Also, being a significant export-oriented industry of New Zealand, the meat industry provides an ideal case for the purpose of this study.

The thesis consists of four parts.

Part I presents an introduction to the study including a review of international and national food safety issues, the relationship between food safety and trade and international competitiveness, and the HACCP economic literature. This background helps to shape the research objectives and methodology as described

in Chapter 3. Chapter 4 discusses the design of the survey to collect plant experience regarding the implementation of HACCP/RMP in New Zealand.

Part II analyses the experiences within the New Zealand meat industry regarding the implementation of HACCP/RMP. It discusses plant motivations to adopt the program and the implementation issues they are facing. Plant observations on the costs and benefits of the implementation are reported. Further, data gathered from the survey are used in a non-parametric analysis of the influences of the plant characteristics on the HACCP/RMP implementation process. The analysis provides implications for HACCP/RMP policy design.

Part III presents the modelling techniques to quantify the costs and benefits of HACCP/RMP implementation. In Chapter 8, a quality-adjusted cost function is used to estimate the change in variable cost of production due to HACCP/RMP. It shows that this type of cost can make up a significant proportion of the total implementation cost.

In Chapter 9, an export model is employed to analyse the impact of HACCP/RMP on meat industry export performance. The results show that the programme can bring a positive impact on exports. However, the magnitude of the impact depends on the status of existing food safety management before HACCP/RMP implementation.

In Chapter 10, the Global Trade Analysis Project (GTAP) model is used to simulate the scenarios where market accesses to significant export destinations are lost when HACCP/RMP is not adopted. The estimated costs of these losses signal the potential benefits of HACCP/RMP. The research results show that HACCP/RMP can deliver a net benefit to the New Zealand meat industry.

The thesis concludes with implications for policy design and future research directions. It signifies that the research findings, in addition to reporting an investigation into HACCP/RMP implementation process in New Zealand, provide an important foundation for future research on food safety and international competitiveness.

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LIST OF ABBREVIATIONS

ANZFA	Australia and New Zealand Food Authority
BSE	Bovine Spongiform Encephalopathy
Codex	Codex Alimentarius
ERS/USDA	Economic Research Service/United Sates Department of Agriculture
EU	European Union
FAO	Food and Agriculture Organisation
FDA	Food and Drug Administration
FSIS	Food Safety Inspection Service
FSANZ	Food Standard Australia New Zealand
GATT	General Agreement on Tariffs and Trade
GMO	Genetically Modified Organisms
GMP	Good Manufacturing Practices
GTAP	Global Trade Analysis Project
HACCP/RMP	Hazard Analysis Critical Control Point-based Risk Management Program
ISO	International Organization for Standardization
LA	Latin America
MAF	Ministry of Agriculture and Forestry
NA	North America
NACMCF	National Advisory Committee on Microbiological Criteria for Foods
NASA	National Aeronautics and Space Administration
NTB	Non-Tariff Barrier
NZFSA	New Zealand Food Safety Authority
OMAR	Overseas Market Access Requirements
QMS	Quality Management System
RCA	Revealed Comparative Advantage
SEA	South and East Asia
SPS	Sanitary and Phytosanitary Agreement
TME	Turkey and Middle East
TRQ	Tariff Rate Quota
UK	United Kingdom
USA	United States of America
WHO	World Health Organisation
WTO	World Trade Organisation

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LIST OF ABBREVIATIONS

ANZFA	Australia and New Zealand Food Authority
BSE	Bovine Spongiform Encephalopathy
Codex	Codex Alimentarius
ERS/USDA	Economic Research Service/United Sates Department of Agriculture
EU	European Union
FAO	Food and Agriculture Organisation
FDA	Food and Drug Administration
FSIS	Food Safety Inspection Service
FSANZ	Food Standard Australia New Zealand
GATT	General Agreement on Tariffs and Trade
GMO	Genetically Modified Organisms
GMP	Good Manufacturing Practices
GTAP	Global Trade Analysis Project
HACCP/RMP	Hazard Analysis Critical Control Point-based Risk Management Program
ISO	International Organization for Standardization
LA	Latin America
MAF	Ministry of Agriculture and Forestry
NA	North America
NACMCF	National Advisory Committee on Microbiological Criteria for Foods
NASA	National Aeronautics and Space Administration
NTB	Non-Tariff Barrier
NZFSA	New Zealand Food Safety Authority
OMAR	Overseas Market Access Requirements
QMS	Quality Management System
RCA	Revealed Comparative Advantage
SEA	South and East Asia
SPS	Sanitary and Phytosanitary Agreement
TME	Turkey and Middle East
TRQ	Tariff Rate Quota
UK	United Kingdom
USA	United States of America
WHO	World Health Organisation
WTO	World Trade Organisation

PART I

INTRODUCTION

Chapter 1: Food Safety and International Competitiveness – a Review of Contemporary Issues

Chapter 2: The Economics of HACCP: a Literature Review

Chapter 3: Research Problems and Methodology

Chapter 4: Data Collection

CHAPTER 1

FOOD SAFETY AND INTERNATIONAL COMPETITIVENESS – A REVIEW OF CONTEMPORARY ISSUES

"Today, food safety is one of the highest priority issues for consumers, producers, and governments alike…"

Gro Harlem Brundland
Director-General, World Health Organisation, 2001

This chapter reviews the issues associated with food safety concerns which come from different perspectives of different members of society, including the consumer, the industry and the regulator. The analysis also considers the effects of food safety issues on international trade and competitiveness. The chapter is intended to provide background information for the research presented in this thesis.

1.1. Food Safety – Concepts, Costs, and Economic Problems

1.1.1. Definition

Food safety is one among other food quality attributes. According to Caswell et al (1998), there are five categories of food quality attributes, namely food safety, nutrition, value, package, and process attributes. Table 1 shows these five categories and their subsets.

Food safety relates to the appearance of pathogenic bacteria (e.g. Campylobacter, E. coli O157:H7, Salmonella); parasites (e.g. worms); viruses (e.g. Hepatitis A); food additives (e.g. colouring, preservative); heavy metals (e.g. lead, mercury); naturally occurring toxins (e.g. aflatoxin in cereals and nuts); veterinary drug (e.g. antibiotics) and pesticide residues. In addition, recent food safety problems related to the appearance of persistent organic pollutants such as dioxin or unconventional agents such as prions associated with *bovine spongiform encephalopathy* (BSE) in cattle (WHO, 2001a). Also, emerging concerns about food safety include the use of growth promoters, contaminated feed, and genetically modified organisms.

Table 1. Food Quality Attributes

Food Quality Attributes	Quality Attribute Subsets
1. Food Safety Attributes	• Food-borne Pathogens • Heavy Metals • Pesticides Residues • Food Additives • Naturally Occurring Toxins • Veterinary Residues
2. Nutrition Attributes	• Fat Content • Calories • Fibre • Sodium • Vitamins • Minerals
3. Value Attributes	• Purity • Compositional Integrity • Size • Appearance • Taste • Convenience of Preparation
4. Package Attributes	• Package Materials • Labelling • Other Information Provided
5. Process Attributes	• Animal Welfare • Biotechnology • Environmental Impact • Pesticide Use • Worker Safety

Source: Caswell et al (1998)

Foods are not safe once they are contaminated with the above-mentioned micro-organisms and agents. Food contamination can occur at any point in the food chain, from production to consumption. Once these agents enter the human body through the ingestion of food, they cause food-borne illness (WHO, 2001b).

1.1.2. Food Safety Costs

Food-borne illnesses can range from mild to severe cases. While some people may show no symptoms at all, other may have gastrointestinal problems, vomiting, or diarrhoea. Moreover, some acute cases may develop secondary long-term illnesses, called ‘chronic sequellae’ (ERS/USDA, 2001a). Chronic sequellae of food-borne illness can occur in any part of the body and subsequently affect the joints, nervous system, kidneys, or heart. Examples of these are the Guillain-Barré syndrome (a major cause of paralysis) associated with Campylobacter infections or the variant Creutzfeldt-Jakob Disease (vCJD) which links to BSE in cattle.

In the year 2000, there were about 1.5 billion cases of diarrhoea worldwide, which led to about three million deaths of children under five. Approximately 70% of these cases were caused by food-borne pathogens (Buzby, 2001). A study in the USA estimated that each year food-borne diseases cause 76 million human illnesses (26% population), 325 000 serious illnesses resulting in hospitalisations, and 5 000 deaths (Crutchfield et al., 2000). The huge number of illnesses caused by food-borne diseases implies that the cost to society is enormous. The Economic Research Service (ERS) of the United State Department of Agriculture (USDA) estimated that the costs associated with five major pathogens (Escherichia coli O157:H7, other non-O157:H7 STECs (Shiga-like toxin producing E. coli), Campylobacter, Listeria monocytogenes, and Salmonella) amount to at least US$6.9 billion annually (ERS/USDA, 2001a). This is the cost made up of medical costs, productivity losses, and estimated values of premature deaths. Other costs such as travel costs and lost leisure time, etc (see Figure 1) are not included.

In New Zealand it was estimated that there are 119320 cases (3% of the population) of food-borne illnesses each year (NZFSA, 2002). The estimated total cost of these cases was $55.1 million ($462 per case) made up of direct medical costs of $2.1 million, direct non-medical costs of $0.2 million, indirect cost of lost productivity of $48.1 million, and intangible cost of loss of life of $4.7 million (Scott et al, 2000).

The above-mentioned costs are costs associated with the household sector. In the event of a food disease outbreak, costs are also borne by the food industry and the public health governance sector. The industry may incur costs of product recall, reduction in demand, or other cleanup costs. The public health sector will have to pay for investigation costs or other costs of food safety regulation administration. In other words, the whole economy is affected and costs are numerous and long lasting. The "Mad Cow Disease" outbreak in the UK in 1996[1] is one example. The outbreak not only seriously affected the UK beef export market but also had a long lasting impact on consumer perceptions of the safety of UK beef and other bovine products. It was estimated that, in the first year of the outbreak, total economic loss ranged from US$1.2 to US$1.6 billion. However, by March 2001, the cumulative gross budgetary cost was estimated to be US$6.4 billion (Buzby, 2001).

The exposures to food-borne diseases and the involved costs are summarized in Figure 1.

1.1.3. Why Food Safety is an Economic Problem?

The economic problem of food safety is one of the central issues in recent studies of food economics (for example, Antle, 1996; Caswell et al, 1998; Crutchfield et al, 1997; Segerson, 1998; and Crutchfield et al, 2000). It is widely agreed that the

[1] This is when the British government announced the link between BSE and the variant Creutzfeldt-Jakob Disease. BSE however has been discovered in the UK since 1986 (WHO, 2004a).

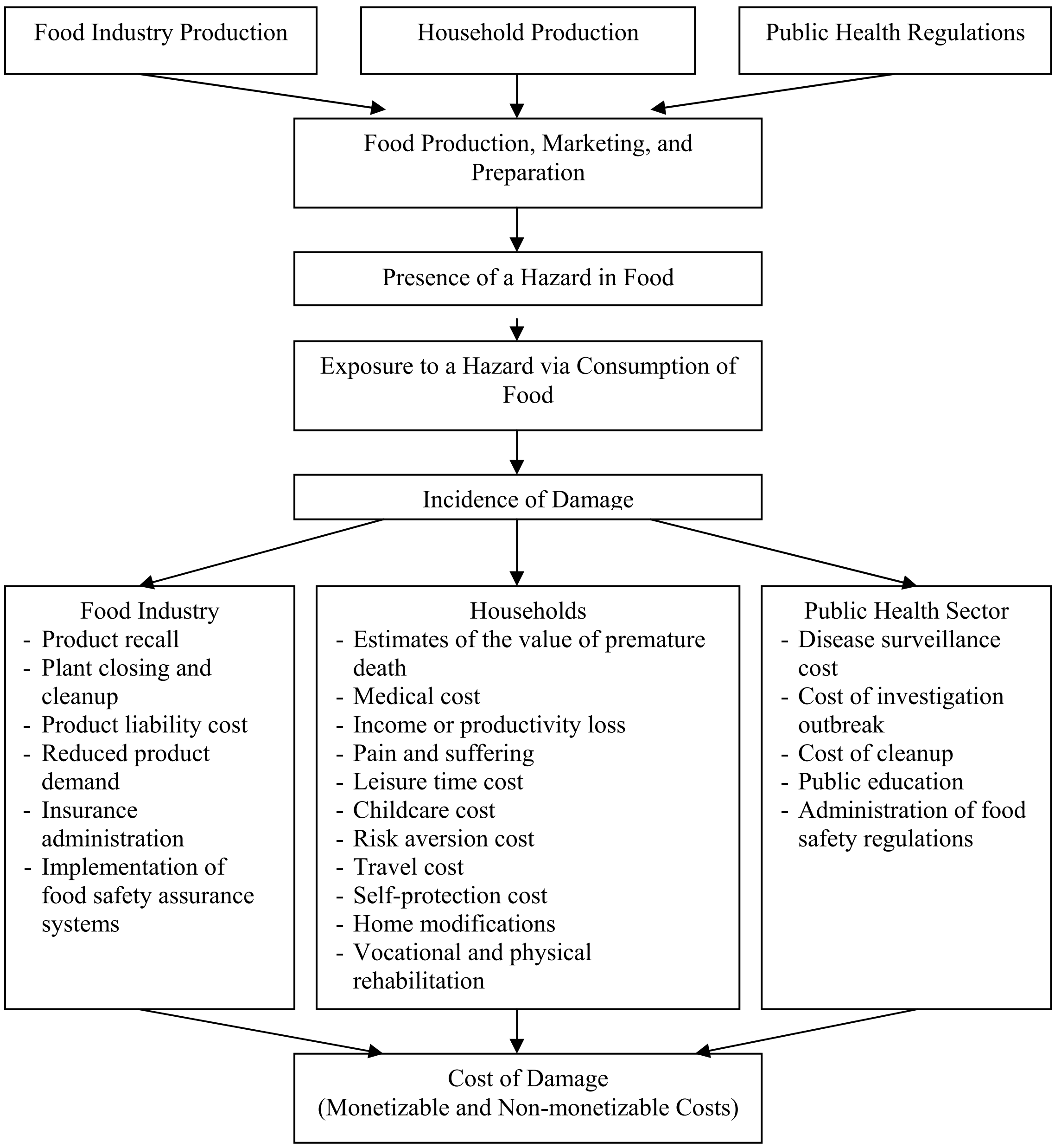
market for food safety has a problem of asymmetric information. Unlike other quality attributes, food safety is usually not discernible to consumers at the time of purchase. In a few cases, consumers might be able to discover the safety of the product before their purchases (search goods). In some other cases they are able to do so after consuming it (experience goods). However in many other cases, when the effects are delayed, consumers cannot trace back the source of problems, they have no information about the safety of the food either before or after purchase (the case of credence goods). This uncertainty about the safety of foods affects consumer response to changes in product safety and consequently will discourage firms from supplying higher quality foods. Then the Lemons problem occurs with low quality products driving the high quality ones out of the market and the market fails to achieve an efficient level of safety.

Firms however can signal the safety of food through certification and labelling, or by enhancing its reputation. Then the problem of asymmetric information may be overcome and firms might be able to achieve higher prices for higher quality products. In this case, an efficient level of food safety is achieved. Nevertheless, there are still cases (e.g. foods contaminated with pathogenic micro-organisms) when consumer knowledge is inadequate or information costs are sufficiently high to be a problem for both firms and consumers (see Antle, 1996). Hence there is sufficient justification for government intervention.

Another approach to the food safety problem is to ask whose role it is to ensure food safety. Should it be the industry, the government, the consumer or all? Spriggs and Isaac (2001) argued that none of these parties alone can provide an optimal food safety system. An optimal food safety system, as these authors argued, does not only protect public health but also at the same time maximises the food industry's international competitiveness.

Economic research helps to address food safety problems by aiding the choice of an optimal food safety system, or in other words, the choice of an efficient form of government intervention. Food safety regulations, as argued by Crutchfield et al (2000), change the costs of producing foods. These changes (often upward shifts) will then be distributed among consumers, producers, and other members of society. The role of economics is to measure how large these costs may be and to determine who bears what costs. The role of economics is also to measure the benefits of regulations, in this case, improvements in public health as well as international competitiveness. To an economist, the regulation is desirable if the benefits achieved are greater than the costs.

Figure 1. Food Safety Problems: Exposures and Types of Costs



Source: adapted from ERS/USDA (2001a)

1.2. Consumers and Food Safety Issues

1.2.1. Drivers of Food Safety Concerns

Consumers worldwide are increasingly concerned about food safety. This trend is particularly significant in developed countries. Moreover, the concern over food safety is one aspect of general consumer concerns of higher and more differentiated food quality (Senauer, 2000; Bredahl et al, 2001). Drivers for these concerns include:

- *Food scares and food-born illness outbreaks*. Examples of recent widely publicized incidents are: ground beef-related E. Coli O157:H7 in the US and Japan in 1996, Mad Cow Disease in the UK in 1996, contamination of feed by cancer-causing dioxin in Belgium in 1999, and recent notifications of BSE infected animal in Japan (2001), Canada (2002), and the USA (2003).

- *Changes in consumer characteristics that affect their behaviours*. The dominant factor is income growth. Consumers with higher income require a higher quality, healthier and safer food (Gehlhar and Coyle, 2001; Bredahl et al, 2001). Also, a consumption style favouring higher processed food has made consumers subject to less control over the safety of food. An aging population also means that more people are vulnerable to food-borne illness. Moreover, consumers have easier access to information, which makes them more aware of the risks associated with unsafe food; especially when these risks are involuntary and uncertain and could result in disastrous outcomes (Crutchfield et al, 2000).

- *The increasing globalisation of food*. A large volume of food is consumed a long distance away from its origin. This complexity of the food chain has led to more concerns over the safety of food.

- *The use of new technologies* such as biotechnology increased the anxiety about food safety for a significant number of consumers.

- *The threat of bio-terrorism.* The increasing number of terrorism attacks, particularly after the September 11 event in the USA, has led to more concerns over the safety of the food supplied.

1.2.2. Issues in Food Safety Demand

- *Priority of concerns*. Consumer food-safety concerns have changed over time. In the early 1980s, concerns were focused on food additives, chemicals, and preservatives. However, since the late 1980s, concerns have emphasized pesticides, animal drugs and germs (Roberts et al, 1997). Recently concerns were expressed about the use of growth promoters, feeding stuff, and GMOs. These changes imply that firms need to respond in a timely manner to satisfy consumer requirements.

- *Consumer preferences on how food safety should be dealt with*. Robert et al. (1997) emphasized that consumers can address food safety concerns by: avoiding or reducing consumption, changing forms of consumption, adopting hygiene handling and cooking practices, trusting in the industry to provide safe foods or government with efficient food safety regulation. A recent study in the USA showed that consumers have placed more responsibility on the government instead of relying on the industry and themselves (ERS/USDA, 2001b).

- *Consumer perceptions of food safety risks*. Food safety risk perceptions are determined by many factors, including consumers' experience with food safety incidents, their knowledge and acceptance of food technologies, and social factors such as culture and religion. Consumer perceptions vary across countries and also across different population groups. For example, consumers in Europe are more cautious about genetically modified foods than consumers in the USA. A study of consumers in the USA showed that men, consumers with no children, younger consumers and those with college education were less likely to rate food safety as very important (ERS/USDA, 2001c).

Consumer perceptions of risk influence their acceptance of food safety risks. Understanding consumer perceptions of food safety risk is important for food firms in marketing food safety. Emphasis on quality-differentiated strategies is necessary to satisfy different levels of risk acceptance.

- *Consumer willingness to pay for safer foods*. Consumer perceptions of food safety risks also affect their willingness to pay for safer foods. Research results have showed that consumers are willing to pay a premium for safety-improved products (Roberts et al, 1997; Loureiro and McCluskey, 2000). Foods that are perceived to be safe and healthy such as organic foods have experienced a steady increase in demand in recent decades (Lohr, 2001; ERS/USDA, 2001b). However consumers are still resistant to safety-improved food by new technology such as irradiation. Frenzen et al (2000) showed that not many (US) consumers are willing to pay a premium for irradiated meat products.

  Understanding consumer willingness to pay for food safety is important as (1) it suggests the appropriate strategies in marketing food safety; and (2) it is an alternative way of estimating the value of food safety.

1.3. Food Industry and Food Safety Issues

The food industry has responded to increasing consumer demand for food safety by adopting food safety management practices which are usually parts of a general Quality Management System (QMS). These food safety/QMSs can either be mandatory or voluntary. This section discusses the basic concept of QMS and firm motivation in adopting QMS. The ISO 9000 series and Hazard Analysis and Critical Control Points (HACCP) provide two examples of the common-used QMS.

1.3.1. Quality Management System - the Concept

QMSs are mentioned widely in food quality/safety literature recently. In the agri-food industry, they are often mentioned as food quality meta-systems (Caswell et al, 1998) or quality assurance schemes (Bredahl et al, 2001). A QMS seeks to control the overall mix of quality attributes (Hooker and Caswell, 1999a) of which safety attributes is just a subset. Hooker and Caswell (1999a) quoted an ISO definition of QMS as:

> …all activities of the overall management function that determine the quality policy, objectives and responsibilities, and implement them by means such as quality planning, quality control, quality assurance and quality improvement within the quality system.

Quality assurance schemes - according to Bredahl et al. (2001) - define a series of technical requirements for producing, processing, or transporting food, and may include standards of environmental and other management practices.

As mentioned above, food safety control is often a part of a QMS. Food safety management systems required by law are often referred to as food safety regulations or standards. Food safety management systems may also be adopted voluntarily. Additionally, they may be required by customers as part of the contract, which are called quasi-voluntary systems (Caswell et al., 1998).

QMS can be adopted at any stage of the supply chain: on farm, at processing, retailing, or transporting stage. Examples include: farm level quality assurance schemes, processor level quality assurance schemes, and proprietary quality assurance schemes (Bredahl et al, 2001).

1.3.2. Two Examples of QMS

1.3.2.1. The ISO 9000 Series

ISO 9000 is a series of standards such as ISO 9001, ISO 9002 and ISO 9003, of which ISO 9002 is most common in food processing industries. Recently these standards have been integrated into the new ISO 9001:2000 (International Organization for Standardization, 2004). The ISO 9000 series contains guidelines to maintain quality in product design, production, installation, and servicing. The series is a generic meta-system, and is applicable across industries. In addition, its standards are voluntary principles of good practice and not intended to replace product safety or other regulatory requirements (Zaibet and Bredahl, 1997). An example of ISO 9001/2 is provided in Table 2.

ISO 9000 certification involves a third party certifying that the firm's QMS is in compliance with the appropriate model. This third party is a registration/accreditation company appointed by ISO. Certification is maintained via a combination of internal and third party audit to ensure the QMS adheres to the ISO 9000 requirements. The registration company does not need to be from the same country where the plant is located. Inconsistencies in the accreditation process are targeted by a programme called quality system assessment recognition (QSAR).

The ISO 9000 series has been adopted widely across all industries. Nevertheless, the series by nature is a generic quality control, not specific to food safety. Therefore, to emphasize food safety management practices, food businesses need other systems such as HACCP.

Table 2. ISO 9001/2 Requirements

Clause	Title and Description
4.1	Management responsibility: Defines the firm's quality policy, organization, and management review. This step ties that part of management with the "executive responsibility" to the quality system
4.2	Quality system: Defined as the combination of organizational structure, procedures, process and resources, the quality system must be fully documented and maintained to meet all "specified requirements." This step involves the preparation of a quality manual.
4.3	Contract review: Addresses the capabilities of the firm to meet its contractual requirements.
4.4*	Design control: Review the design of the product to insure that all specified requirements can be met. This step follows each stage of the process through design review, verification, validation and changes.
4.5	Document and data control: Linking with other clauses, this is the commitment the firm makes to maintain all documents and data and guarantee these records reflect up-to-date practices.
4.6	Purchasing: Sets-up checks that all products purchased from subcontractor conform to their specified requirement.
4.7	Control of customer-supplied product: Firms that incorporate customer-supplied ingredients or packaging materials into their end-products should establish and maintain documented procedures for the verification, storage and maintenance of these products.
4.8	Product identification and traceability: A system that follows the product through each stage of production, delivery and installation should be implemented. This "trace-back" capability is essential for product recalls.
4.9	Process control: That all aspect of the production process (e.g. buildings, plants, equipments, personnel, etc) must be carried under controlled conditions. Further "where the results of processes cannot be fully verified by subsequent inspection and testing of the product and where, for example, processing deficiencies may become apparent only after the product is in use the processes shall be carried out by qualified operators and/or shall require continuous monitoring and control of process parameters to ensure that the specified requirements are met" (ISO 9001 1994, p. 6).
4.10	Inspection and testing: Procedures to verify that the specific requirements of the inputs, intermediate, and final product are being met should be initiated.
4.11	Control of inspection, measuring and test equipment: Those instruments required to comply with 4.10 should be periodically calibrated.
4.12	Inspection and test status: Some system of identification of the product that indicates if it is in compliance with the tests performed must be in place.
4.13	Control of nonconforming product: This is then followed-up with an assurance that nonconforming product is not inadvertent used (such may be reworked and then re-inspected depending upon the details of the quality system).
4.14	Corrective and preventative action: There must be an effective system that implements both corrective and preventative action when required.
4.15	Handling storage, packaging, presentation, and delivery: The quality of the product should be maintained during the post-production stage.
4.16	Control of quality records: All quality records should be readily available.
4.17	Internal quality audits: The quality system should undergo periodic internal reviews to determine its effectiveness.
4.18	Training: Training needs should be identified and addressed to ensure qualified personnel are performing those activities the effect the quality of the product
4.19	Servicing: Although unlikely to be appropriate for the agri-food industry, provisions for compliance with any after sales servicing requirements are included.
4.20	Statistical techniques: When statistical techniques are required to establish, control or verify the process capability or product attribute they should be documented.

Source: adapted from Hooker & Caswell (1999a)
* Not included in ISO 9002

1.3.2.2. Hazard Analysis and Critical Control Points (HACCP)

HACCP is a systematic approach to the identification, evaluation, and control of food safety hazards (National Advisory Committee on Microbiological Criteria for Foods (NACMCF), 1997). The approach was first started in 1959 with the Pillsbury Company's manufacture of food products for the NASA space program. Since then, HACCP has been strongly suggested as an effective approach to prevent food safety hazards by many national and international scientific groups, corporations, government agencies and academic organizations (Peirson, 1995). The joint FAO/WHO Codex Alimentarius Commission endorsed HACCP in 1993.

The concept of HACCP is to focus on preventing hazards that could cause food-born illnesses by applying science-based controls from raw materials to finished products. It involves seven principles:

1. Hazard analysis, which involves collecting and evaluating information on hazards associated with the food under consideration to decide the significant hazards to be addressed in the HACCP plan.

2. Determination of critical control points (CCPs), which are points where controls can be applied and are essential to prevent or eliminate or reduce a hazard to an acceptable level.

3. Establishing critical limits, which are maximum/minimum values to which a biological, chemical, or physical parameter must be controlled at a CCP.

4. Establishing monitoring procedures to assess whether a CCP is under control and create an accurate record for future use in verification.

5. Establishing corrective actions, in case there is a deviation from an established critical limit.

6. Establishing verification procedures to verify that the HACCP system is working correctly.

7. Establishing record-keeping and documentation procedures to document the HACCP system.

Each food processing establishment is required to have its own HACCP plan tailored to its individual products. Moreover, there are required prerequisite programs prior to the implementation of HACCP. Prerequisite programs such as Good Manufacturing Practices are an essential foundation for the success of a HACCP plan (NACMCF, 1997).

HACCP has been and is being mandated into law in many nations all over the world. In the EU, HACCP principles were adopted through the Directive 93/43 in 1993 (Ziggers, 2000). In the US, HACCP was mandated for seafood in 1995, for meat and poultry in 1998, and for the juice industry in 2001 (FDA, 2001). The Australian Food Standard Code required HACCP-based food safety programs from January 2003 onwards (Food Standards Australia New Zealand, 2002). In New Zealand, the Animal Products Act 1999 requires all primary animal product processing businesses to have a HACCP-based risk management program in place by November 2002 (MAF, 2001).

HACCP is a preferred approach to food safety hazards, especially microbiological hazards. However, HACCP is also criticized for its focus on reducing hazards over individual segments of the food chain rather than targeting the risk to consumers. Therefore its benefits might not be recognised as improvements made at one level may not be communicated or capitalized on in upstream and downstream markets (Caswell et al, 1998).

There are also concerns over the effectiveness of the programme in reducing food safety hazards. The US Food Safety and Inspection Service concluded that '...there is insufficient knowledge to predict with certainty the effectiveness of the rule, where effectiveness refers to the percentage of pathogens eliminated at the manufacturing stages' (Crutchfield et al, 1997). It is also argued that the effectiveness of HACCP relies on an effective understanding of key hazards and a systematic approach to implementation, including implementation of the relevant prerequisite programmes (Crawford, 2000).

The implementation of HACCP worldwide has involved the following issues:

- Should HACCP be voluntary or mandatory? Voluntary HACCP requires more responsibilities from the industry while mandatory HACCP requires the government to be involved. Segerson (1998) argued that the voluntary approach can work for the case of search and experience goods but not for credence goods (and food safety is credence goods). Spriggs and Isaac (2001), on the other hand, argued that mandatory HACCP negates one of the main benefits of HACCP (i.e. shifting responsibility to the industry), as the government ends up owning responsibility for food safety. Among the leading countries in the implementation of HACCP, the USA and New Zealand chose a mandatory approach while the UK and Canada opt for a voluntary basis. Australia, however, introduced mandatory HACCP in domestic plants but voluntary HACCP in export plants.

- Should HACCP be performance-based or process-based? A performance-based HACCP emphasises end-point testing while a process-based HACCP focuses on the prevention process. It has become common for HACCP systems to have both performance-based and process-based features. For example, the US HACCP regulation requires end-point testing for generic E.Coli and Samonella as well as being a process control system.

- Should HACCP target the whole supply chain or just an individual sector? HACCP at the start was designed for one individual segment in the food chain, either on farm or at the processing stage. Recently, the idea of an integrated HACCP system has been brought forward (see for example, Unnevehr and Jensen, 2001). Clearly an integrated system has more advantages than a single-sector HACCP. However it is harder to implement.

- Should HACCP be generic or specific? A generic HACCP system allows for the diversity among firms while a specific one assumes that there are critical control points relevant to all firms. Therefore a generic HACCP allows firms to be flexible in adopting principles and practices that maybe accepted as HACCP. However a specific HACCP can identify the best practices that must be employed. Spriggs and Isaac (2001) argued that a specific HACCP is more congruent with the objective of preventing food safety hazards.

1.3.3. Firm Motivation to Adopt QMS

The factors that affect firm motivation to adopt QMS are often classified into internal factors and external factors (Holleran et al, 1999). Internal factors or firm-driven motivations are those related to firm operational efficiency. Examples of this motivation are: improving product quality, improving control of production process, reducing product failure and wastage, reducing operating and transaction costs. External factors are those of customer's requirements, regulatory requirements, and the desire to gain market share.

A survey of 647 British firms in 1993 found that internal factors motivate ISO 9000 adoption more than external factors (Seddon et al cited in Caswell et al, 1998). The study also pointed out that firm size is an important factor affecting firm motivation. Large firms tend to adopt ISO 9000 for internal reasons such as cost reduction, while small firms tend to adopt ISO 9000 for external reasons such as to gain market share.

Henson and Holt (2000) studied motivation to implement HACCP in the UK dairy industry. The study surveyed 192 plants of which 72 already implemented HACCP. External factors such as to meet legal requirements and major customers' requirements were ranked the most important. Internal factors such as improvements in control of production process and product quality were also cited but were less important.

Yet another argument for firm investment in food safety is that food safety outbreaks could have disastrous consequences on the firm such as loss of reputation, loss of sale or even the threat of closing up (Ollinger, 2000; Worth, 2000). However, even when the benefits of having QMSs outweigh the costs, the free rider problem (when one bears the costs, but the others also get the benefits) may discourage firm willingness to invest in food safety. Then regulations either in terms of legal regulation or market regulation (quasi-voluntary QMSs) maybe needed to overcome this problem.

1.4. Government and Food Safety Issues

1.4.1. Rationale for Government Intervention

The problem of imperfect information has been discussed widely in the food safety economics literature (see for example, Unnevehr and Jensen, 1996; Antle, 1996; Henson and Caswell, 1999; Crutchfield et al, 2000). Consumers have little or no knowledge about the safety of foods, even after consuming. This uncertainty makes it difficult for food firms to charge higher prices for higher quality/safer products. This discourages firms from providing high quality products. Moreover, firms might not have adequate knowledge about product safety as contamination can occur at any point in the food chain. This prevents firms from signalling product quality to consumers. When there is lack or high cost of information about food safety (Unnevehr and Jensen, 1996; Antle, 1996), the market cannot work to achieve an efficient level of safety. Thus, there is justification for government intervention.

1.4.2. Forms of Intervention

Government intervention is divided into two groups: (1) direct command and control and (2) incentive-based intervention.

Direct interventions include performance standards, process standards, and mandatory disclosure of information. Performance standards impose the requirement that a firm must achieve a specified level of product quality, without specifying the technology that the firm must use to achieve the standard (Antle, 1999). Examples are Samonella standards and E. Coli standards for meat and poultry products. Process standards specify technology or procedures a firm must follow in production. Examples include specific product washing solutions or chill temperatures. Mandatory disclosure of information (or labelling) requires suppliers to disclose certain facts about their products (e.g. nutritional labelling) (Henson and Caswell, 1999).

Incentive-based interventions are designed to induce either producers or consumers to identify and practice cost effective methods that achieve improved food safety (Unnevehr and Jensen, 1996). This kind of intervention maybe in the form of providing information to consumers to allow them to evaluate and avoid hazards (e.g. through consumer education) or subsidizing development of new pathogen tests to reduce the cost of information, or providing public certification for products that meet a minimum safety standard.

Government intervention can also be categorized into *ex ante* and *ex post* regulations (Henson and Caswell, 1999). *Ex ante* regulations are those in the form of standards as discussed above. *Ex post* regulations are in the form of product liability that punishes companies that produce products of insufficient quality, through compensation to those harmed by their actions (Henson and Caswell, 1999).

1.4.3. Choice of Efficient Intervention

If government intervention is necessary, then the next question is which forms of intervention are efficient in ensuring food safety? Analyses of environmental regulation have shown that incentive-based intervention is more desirable than direct command and control approach (Unnevehr and Jensen, 1999). However, given the distinctive characteristics of the food safety market where quality information is costly and consumers have limited opportunities to utilize information, an incentive-based approach might not be an efficient approach.

Among direct command and control interventions, performance standards are arguably preferable to process standards (Antle, 1999; Unnevehr and Jensen, 1999). Performance standards allow firms to tailor quality control to fit their particular operation. Hence, the cost of performance standards is arguably less than the cost of process standards in achieving a given level of food safety (Antle, 1999). However, as performance standards involve end-product testing, process standards maybe more desirable when end-product testing is costly (e.g. tests for microbial pathogens). The use of HACCP provides an example of choosing process standards as food safety regulation.

The efficiency of food safety regulation can be assessed according to scientific and economic criteria. The scientific criterion requires regulation to have a science base and to be defended by a valid risk analysis. The economic criterion incorporates a benefit-cost analysis which requires the regulation to yield a positive net benefit. In practice, applying these criteria to evaluate food safety regulation is not an easy task as many of the scientific and economic variables related to food safety are hard to measure (Henson and Caswell, 1999). This provides challenges to food safety regulation assessment.

1.4.4. The Development of Food Safety Legislation

Countries have their own food safety legislation regimes. However, there is a common trend that governments have shifted more responsibility to the industry (Loader and Hobbs, 1999). The increasing use of mandated risk management programmes, HACCP, and HACCP-based systems reflects this change. In the USA, HACCP is mandated for seafood, meat, and poultry industry. There are also proposals to extend HACCP to other US food sectors (Loader and Hobbs, 1999). The UK regulatory system does not mandate the use of a full HACCP programme but requires all food business to adopt a risk management tool, based on the principles of HACCP. Moreover, in the UK, the ‘due diligence defence’ clause under the Food Safety Act 1990 requires all food handlers to take all reasonable precautions to ensure food safety. It therefore requires more responsibility from food handling firms. In New Zealand, the Animal Product Act 1999 also imposed more responsibility on food firms by mandating the use of HACCP-based risk management programmes.

Additionally, there have been institutional re-arrangement efforts to cope with food safety issues. The attempts to move toward a single food safety agency in countries such as the USA, Canada, and New Zealand recently provide examples of this trend. The creation of a single food safety agency is argued to be an efficient approach in response to food safety (Institute of Medicine and National Research Council, 1998).The New Zealand food safety legislation is discussed in more details in the next section.

1.5. The New Zealand Food Safety Legislation

1.5.1. The Establishment of the New Zealand Food Safety Authority

In New Zealand, before July 2002, administering food legislation was a shared responsibility between the Ministry of Agriculture and Forestry (MAF) and the Ministry of Health (MOH) whereby the MOH was responsible for food sold domestically and MAF was responsible for exported food. On 1 July 2002, the New Zealand Food Safety Authority (NZFSA) was established to combine the functions of MAF Food and MOH. The establishment of NZFSA is considered a significant step forward in the evolution of food regulation in New Zealand (NZFSA, 2004).

The key objectives of the NZFSA are: (1) to administer legislation covering food for sale on the domestic market and the primary processing of animal products, (2) to provide official assurances related to the exports of food and plant products, and (3) to administer the controls surrounding registration and use of agricultural compounds and veterinary medicines.

1.5.2. The Animal Products Act 1999

Also central to the reform of the New Zealand food safety legislation is the implementation of the Animal Products Act 1999. The new act replaced the Meat Act 1981 at the end of the transitional period (November 2002). The aims of this reform were (1) to manage associated risks, and (2) to facilitate overseas market access.

The Animal Products Act requires all animal products traded and used to be "fit for intended purpose". It therefore sets out a risk management system which could be applied anywhere in the value chain from production, through processing to the market.

The risk management system comprises the following main types of controls:

1. Risk management programmes;
2. Regulated control schemes; and
3. Controls relating to the export of animal material and animal products.

1.5.2.1. Risk Management Programmes (RMPs).

The Act requires that by November 2002[2] all animal product primary processing businesses (except those exempted) must have a risk management programme.

A risk management programme is a documented programme to identify and manage biological, chemical and physical hazards. The programme is to be based on the principles of HACCP: identifying the hazards, the systems of control, and demonstrating that the controls are effective.

It is the responsibility of each business to develop a risk management programme(s) and to maintain it. Risk management programmes are then to be registered with MAF. Independent evaluation of the programme is required prior to registration. Evaluators need to be accredited by MAF. Also, the operation of an RMP must be verified on an ongoing basis.

Business responsibilities required under RMP are summarised in Table 3.

1.5.2.2. Regulated Control Schemes

Regulated control schemes are special risk management measures used in cases where:

(a) It is inappropriate or impracticable to manage [risk factors] under risk management programmes; or

(b) [Risk factors] may need to be addressed in relation to the production of animal material or the processing of animal product that is not required by this Act to be covered by a registered risk management programme; or

(c) Special provision is required for the purposes of overseas market access requirements.

These schemes are expected to apply mostly to monitoring hazards at source, or for applying controls to certain parts of the production or processing chain.

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[2] The Animal Product Amendment Act 2002 has extended the transition period further to 2006. However, meat processing businesses are required to have RMP by July 2003.

Table 3. RMP Tasks

RMP Task	Responsibility	Description
Design & Development of RMP	Business Operator or Operator may hire External Consultants to do this task	Designing all the components of RMP which based on the 7 principles of HACCP
Validation of RMP	Business Operator	Required when RMP is first developed to verify that it complies with requirements and is capable of achieving its outcomes
Independent Evaluation of RMP	Operator must contract a MAF accredited evaluator	On-site assessment to recognising the validity of the developed RMP with the intent of recommending registration
Registration of RMP - Application for registration - Registration approval	 - Operator - MAF (NZFSA)	Business Operator to apply to the Director of Animal Products, NZFSA to register RMP
Operation of RMP - Specific operational duties (e.g. sampling/testing, record-keeping) - Ongoing verification activities - Independent verification - Application for amendments to RMP when there are major changes in the production process - Updates and notification of minor amendments to RMP - Re-registration of RMP after 3 years	 - Operator - Operator - Operator must contract an accredited verifier - Operator - Operator - Operator	Business operators in general are responsible for RMP operational tasks such as monitoring, testing or record-keeping. They are also in charge of ongoing verification activities such as internal audits or reviewing of monitoring records. When there are major changes in their production process (e.g. changes that modify product outcomes), operators must apply for the approval of RMP amendments. Minor changes do not need to be registered.
Cessation of RMP - Surrender of registration - Suspension of registration or Deregistration	 - Operator - MAF (NZFSA)	RMP are terminated when the operation does no longer exist or it is suspended by NZFSA due to unsatisfaction with APA requirements or deregistered due to failures.

Source: adapted from RMP Manual (MAF, 2000)

1.5.2.3. Export of Animal Material and Products

The aim of the Animal Products Act is to ensure that overseas market access requirements are consistently met, and to manage risks to the integrity and reputation of New Zealand's official assurances and systems.

Safeguards for export products include:

- the registration of exporters of animal products intended for human or animal consumption;

- placing duties on exporters, for example, to notify the Director General when their products do not fit for the intended purposes or overseas market requirements;

- provisions set by the Director General relating to the issuance and use of official assurances;

- New Zealand's interpretation of market access requirements;

- MAF provides and maintains information covering overseas market access requirements available to exporters and others with the need to know.

NZFSA is mainly responsible for administering food safety standards. Other aspects of food regulations such as food labelling and composition standards are covered under the Australia New Zealand Food Standards Code, which is administered by the Food Standards Australia New Zealand (FSANZ).

1.6. Food Safety and International Trade

Food safety concerns can have certain effects on international trade (see for example, Crutchfield et al, 2000; Buzby, 2001; Hooker and Caswell, 1996; Henson and Caswell, 1999b; Hooker, 1999). The two main effects argued are:

1. The disruption in international markets for food products due to food safety outbreaks; and

2. The creation of non-tariff barriers to trade due to the differences in countries' food safety regulations.

1.6.1. Food Scares Disrupt International Food Markets

Food safety outbreaks not only affect domestic markets but also international trade. The 'Mad Cow Disease' outbreak in the UK is one example. Immediately after the announcement in 1996, domestic sales of beef products fell 40 percent within a month (Buzby, 2001). The export market was hit much harder with the volume of beef trade reduced from 148,304 metric tonnes in 1995 to 269 metric tonnes in 1997 (reduced by 99.8%). Disruption happened not only within the export market of the country of origin but also within the international market of the product itself. For example, due to the Cyclospora outbreak in Guatemalan raspberry in 1996, there was a reduction in demand for raspberries as a whole regardless of the country of origin (Buzby, 2001). The reason was, given knowledge about the outbreak, consumers switched to other substitute products. It is also emphasized that consumer confidence in the products is often seriously affected and slow to recover (Crutchfield et al, 2000). Therefore, food safety outbreaks often have long lasting effects on international food markets.

1.6.2. Food Safety Regulations act as Non-tariff Barriers to Trade

Over recent years, traditional trade barriers such as tariffs have been reduced significantly through multilateral trade agreements. However, non-tariff barriers have proliferated. Food safety regulations, intentionally or unintentionally, can act as non-tariff barriers to trade. Studies have shown that food safety measures account for a significant portion of non-tariff barriers to trade of agricultural and food products. For example, it was estimated that food safety barriers alone accounted for 50 percent of the revenue losses in US agricultural exports due to non-tariff barriers (Crutchfield et al, 2000).

Unintentionally, the differences in food safety measures adopted by countries can have distorting effects on trade. These differences are results of the differences in countries' perceptions of food safety risks which in turn depend on many factors such as perception of science and risk assessments, knowledge and access to food technologies, and past experience with food safety incidents.

1.6.3. Regulatory Rapprochement

Attempts to manage the differences in food safety regulations are called rapprochement efforts. Strategies for rapprochement can be grouped into three categories: (1) harmonization, (2) mutual recognition, and (3) coordination (Hooker and Caswell, 1996; Henson and Caswell, 1999b; Hooker, 1999).

Harmonization involves the standardization of regulations in identical forms. Clearly, harmonization is the strongest effort. The bilateral agreement between Australia and New Zealand managed by the Australia New Zealand Food Authority (ANZFA) is often cited as one of this type (Hooker, 1999).

Mutual recognition involves the acceptance of regulatory diversity as meeting common goals or equivalency. An example of this type is the rapprochement effort of the European Union (Hooker and Caswell, 1996).

Coordination aims to gradually narrow the differences between regulatory systems, often based on voluntary international codes of practice. Examples of this type include those trade agreements of North American Free Trade Agreement (NAFTA) and World Trade Organization (WTO).

1.6.4. International Standards and Trade Agreements

International standards are set by the international standards organizations such as the Codex Alimentarius (Codex), the International Plant Protection Convention (IPPC) and the International Office of Epizotics (OIE). Codex is responsible for food safety issues, the IPPC is responsible for plant health (phytosanitary), and the OIE is for animal health and disease concerns.

The largest scale of coordination to target the impacts of food safety measures on trade in agri-food products has been shown through the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement). The SPS Agreement was implemented in 1994. It allows (food safety) measures that are necessary to protect human, animal or plant life and health but do not constitute disguised restrictions or create unnecessary trade barriers (Crutchfield et al, 2000). Therefore, countries' food safety regulations are under scrutiny within the framework of the SPS Agreement. To become legitimate, regulations must pass a two level process (Hooker and Caswell, 1999b). First, the science level requires a country to supply a valid risk analysis to defend its regulation if it chooses to adopt food safety standards other than internationally accepted standards (as set by Codex). Second, the policy level requires a minimal trade impact from the chosen regulation.

Although the SPS Agreement has solved a number of trade disputes since its implementation (Hooker, 1999), there is growing concern that the agreement may rule against the domestic demand for food safety protection (Henson and Caswell, 1999; Swinbank, 1999). In other words, the agreement may promote 'downward harmonization' of national standards to facilitate trade (Crutchfield et al, 2000). There was also concern that science-based risk assessment can conflict with those belonging to cultural factors (Echols, 2001). Recent disputes over the EU's ban on the use of growth hormones and requirements of GMO labelling provide examples of this conflict between facilitating trade and minimizing perceived human health risks.

With the increasing globalisation of food trade and increasing concerns about food safety, multilateral coordination mechanisms on food safety issues will become more important in facilitating international trade. There is also recognition of the role of private-sector approaches (e.g. HACCP, ISO 9000) and their coordination with multilateral mechanisms in reaching the dual target of minimizing food safety risks and facilitating trade (Hooker and Caswell, 1996; Crutchfield et al, 2000).

1.7. Food Safety and International Competitiveness

1.7.1. Competitiveness, Sources, Measurements, and Approaches in Agribusiness

1.7.1.1. Different Perspectives of Competitiveness

Competitiveness is regarded as one of the most misunderstood concepts of the 1990s (Waheeduzzaman et al, 1996). This conclusion is drawn from the fact that there is no unique definition of competitiveness. Competitiveness can be viewed from different perspectives, such as that of a firm, an industry, a nation, or a bloc of nations. Moreover, competitiveness is defined differently by different academic disciplines, for example, neoclassical economics, strategic management, and social-cultural disciplines.

From a macro perspective, competitiveness is defined as 'the degree to which a nation can, under free and fair market conditions, produce goods and services that meet the test of international markets while simultaneously maintaining or expanding the real incomes of its citizens' (The US President's Commission on

Industrial Competitiveness 1985 as quoted in Waheeduzzaman et al, 1996). The concept of competitiveness of a nation is said to have its roots in the classical Ricardian theory of comparative advantage (Harrison and Kennedy, 1997; Cho, 1998). The theory argues that a country's factor endowments determine its competitiveness vis-à-vis other countries. Together with the Heckscher-Ohlin's factor abundance theorem, it is stated that a country will export those goods and services in which it has comparative advantage in price and factor cost. International competitiveness is therefore traditionally viewed as price competitiveness. However, it was argued that the theory of comparative advantage does not reflect the real world very well. There are cases where countries have abundance resources but support a poor economy (Cho, 1998). Additionally, in a world where raw materials, capital, and labour move across borders, endowment resources alone do not determine a country's competitiveness. The existence of market distorting government policies also means that price competitiveness may not well reflect competitiveness.

The micro perspective on competitiveness focuses on firms. The arguments are that firms, not nations, are the entities that compete in international markets (Waheeduzzaman et al, 1996); and that the competitiveness of a nation stems from firms within that nation (Cho, 1998). It is at this micro level that the approach of the strategic management school is often used to define competitiveness. In general, firm competitiveness or competitive advantage is defined as 'the ability to deliver goods and services at the time, place, and form sought by buyers at prices as good as, or better than other suppliers while earning at least opportunity costs on resources employed (Cook and Bredahl, 1991 cited in Harrison and Kennedy, 1997). To emphasize the strategies to achieve competitiveness, the strategic management school also defines competitiveness as 'the ability to profitably create and deliver value through cost leadership or product differentiation' (Harrison and Kennedy, 1997). With emphasis on the indicators of competitiveness, competitiveness is defined as 'the sustained ability to profitably gain and maintain market share (Van Duren et al, 1991 cited in Harrison and Kennedy, 1997).

1.7.1.2. Sources of Competitiveness

The most widely cited framework in analysing sources of competitiveness is that of Porter (1990). Porter's model, also known as the 'dynamic diamond' suggested four major determinants of a nation's competitiveness: (1) factor conditions; (2) demand conditions; (3) related and supporting industries; and (4) firm strategy, structure, and rivalry. Factor conditions are the inputs necessary to compete in an industry, such as labour, land, natural resources, capital, and infrastructure. Demand conditions refer to the segment structure of domestic demand, its sophistication, and whether or not it anticipates foreign demand. Related industries are those that use the same technology, raw materials, distribution networks, or marketing activities. Support industries include financial, insurance, information, transportation, and other service sectors. Firm strategy, structure, and rivalry refers to the conditions in the nation governing how companies are created, organized, managed, and the nature of domestic rivalry. Porter's model also considers two factors outside the diamond, they are: chance and government policy.

Porter's model is considered as a very broad conceptual framework to combine strategic management and international economics in explaining the competitiveness of nations. However, there is also a critique that this framework is more applicable to the more advanced developed nations rather than to the less developed and developing countries (Waheeduzzaman et al, 1996; Cho, 1998). Porter's model is also criticized for not considering the dynamics aspects of the forces that are shaping the world, such as the phenomenon of foreign direct investment and globalisation (Dunning 1992 as quoted in Waheeduzzaman et al, 1996). Recent studies on competitiveness have tried to overcome these limitations by proposing a framework for developing countries (Cho, 1998) or by incorporating foreign direct investment into the measurement of international competitiveness (Trail and da Silva, 1996). The application of Porter's model to small net exporting countries has also been criticised. Cartwright (1993) showed that the offshore factors are as important as the home-based factors. However the significance of these factors is different between industries; for example, the offshore factors do not necessarily impact the New Zealand meat industry as much as they do the dairy industry.

1.7.1.3. Measures of Competitiveness

Market share and other trade-base measures are often used as measures of international competitiveness from industry or firm's perspective. Trail and da Silva (1996) presented three traditional trade-based measures of international competitiveness as follows:

1. Export market share (XMS_i)

$$XMS_i = 100(X_i/X_{iw})$$

where: X_i is the value of national exports of industry i; X_{iw} is the value of total world exports of industry i.

2. Balassa's index of revealed comparative advantage ($XRCA_i$)

$$XRCA_i = 100(X_i/X_{iw})/(X/X_w)$$

where X is the value of national exports for all industries; X_w is the value of total world exports in all industries.

3. Balassa and Bauwen's net export index (NX_i)

$$NX_i = 100(X_i - M_i)/Y_i$$

where M_i is the value of national imports of industry i; Y_i is the value of production of industry i.

1.7.1.4. Agribusiness Competitiveness

Studies on the competitiveness of agribusiness benefit from the micro approach to competitiveness. To emphasize strategies to achieve competitiveness and the effects of these strategies on the level of firm competitiveness, the concept of customer value is introduced (Kennedy et al, 1997). Customer value is determined by the relationship between the bundle of benefits that a product is perceived to provide a customer and the price that the customer must pay for that bundle of benefits (Allen and Pierson 1993 as quoted in Kennedy et al, 1997). Customer value is expressed as:

Customer Value Perception = Perceived Benefits/Price

With the introduction of customer value, competitiveness is defined as 'the ability of a firm or industry segment to offer products and services that meet or exceed the customer value currently or potentially offered by the products and services of rivals, substitutes, and possible market entrants' (Kennedy et al, 1997). Therefore, competitiveness means to create customer value by increasing the bundle of perceived benefits for a given cost or cutting down costs for a bundle of perceived benefits. This implies the two major competitive strategies for agri-food industries: (1) product differentiation (or value-added competitiveness) and (2) cost competitiveness (or cost leadership).

1.7.2. Food Safety and International Competitiveness: Implications for Research

The above discussion shows that firm competitiveness has two components: value-added competitiveness and cost competitiveness. Therefore, to assess the effects of any factors (in the case of food safety/quality management systems) on firm competitiveness requires consideration on the effects on each of these components. Obviously, effective quality management systems would enhance the safety and/or quality of products, hence would have a positive effect on value-added competitiveness. On the other hand, the extent of this effect on firm overall competitiveness would depend on consumer response to the improvement in product quality/safety. Thus, research on consumer response to enhanced food safety would be useful in considering the impacts of quality management systems on firm competitiveness.

Effects on cost competitiveness can be decomposed into effects on each cost component. The argument is that food safety/quality management systems would increase production costs and sunk costs but reduce transaction costs. Quantifying those effects requires careful analyses and applications of an appropriate model for each type of costs.

1.8. Chapter Conclusion

This chapter has discussed the concept of food safety and the significant issues associated with different member of society, namely the consumer, the industry, and the regulator. It also reviewed the effects of food safety concerns on international trade and competitiveness. In addition, the current New Zealand food safety legislation has been discussed. The chapter serves as a background of information and also a starting point for further research which is presented in the next chapters.

From the discussion in this chapter, HACCP has emerged as a preferable tool in food safety management worldwide. HACCP implementation has also claimed the central place in the food safety – international competitiveness dynamic. The next chapter will discuss the economic issues associated with the adoption of HACCP.

CHAPTER 2

THE ECONOMICS OF HACCP: A LITERATURE REVIEW

"It (HACCP) was perhaps the most revolutionary institutional innovation to ensure food safety of the 20th century."

J. Spriggs and G. Isaac (2001)

Chapter 1 has highlighted the food industry's adoption of HACCP as a food safety management practice in response to increasing consumer concerns about food safety. This chapter reviews the recent international literature on the economic impacts of HACCP implementation. The analysis emphasises the particular impacts of HACCP on the food industries. The impacts on other parties (e.g. consumers, and regulators) are not the focus of the analysis. For an introduction about the concept and principles of HACCP please refer to section 1.3.2.2 of Chapter 1.

2.1. HACCP as a Food Safety Regulation

Government intervention in the food market is justified by the lack of and high cost of information associated with food safety and the resulting consequences for public health (Unnevehr and Jensen, 1996). There are alternative interventions including consumer education, mandatory labelling, and statutory regulation. Statutory regulation is arguably a preferred approach. Statutory regulation is implemented in the form of either process standards or performance standards. A process standard specifies the technology or procedures a firm must follow in production while a performance standard imposes requirements on the final product. Process standards do not allow firms to choose an efficient production technology and are therefore believed to be less efficient than performance standards. However, performance standards involve end product testing, which may be very costly (for example, microbiological tests of meat products). This explains why HACCP is widely preferred as a process design to prevent food safety hazards. Moreover, HACCP can also permit more efficient and effective government oversight (FDA, 2001). Thus, HACCP could be an efficient regulatory tool regardless of being a command-and-control process standard (Unnevehr and Jensen, 1996).

There have been several studies on the benefits and costs of HACCP regulation (Crutchfield et al, 1997). In general, HACCP benefits to society are reductions in risks of morbidity and mortality associated with consuming unsafe foods (Antle, 1999). Costs associated with these risks are costs of treating foodborn illnesses, forgone income due to lost work time, costs of averting illnesses, and disutility of illnesses. Enhancing food safety would result in reductions of these costs and hence benefit society. On the other hand, HACCP regulation also involves costs which include: (1) costs of implementation; and (2) costs of HACCP maintenance. Examples of costs of implementation are costs of HACCP planning and training employees. Maintenance costs are costs of monitoring, sampling and testing, and costs associated with process modification.

The Food Safety Inspection Service (FSIS) of the US Department of Agriculture (USDA) used the cost-of-illness method to estimate the benefits of HACCP regulation for meat and poultry. The present value of medical costs and productivity losses due to foodborn illnesses associated with seven main pathogens was estimated to be in the range of US$1.9 to US$171.8 billion over 20 years (Crutchfield et al, 1997). The lower bound was estimated with 7% discount rate, 20% reduction in illnesses, and using a lower value of a statistical life. The upper bound was associated with 3% discount rate, 90% reduction in illnesses, and a higher value of life. The cost-of-illness approach is said to provide the lower-bound estimate of HACCP benefits as consumers would be willing to pay for risk reduction even if they are not actually ill (Unnevehr, 1996). FSIS also estimated the cost of HACCP using data from their pilot program. The cost estimates range from US$1 to US$1.2 billion over 20 years (Roberts et al, 1996; FSIS, 1996). It was concluded that HACCP results in positive net benefits in all scenarios.

The study by FSIS, however, has received criticisms. Firstly, FSIS estimated costs were criticized as being underestimated. Robert et al (1996) voiced scepticism about the low cost estimated by FSIS and argued that this may be due to the lack of data on process modification. Belzer (2000) also remarked that the estimate, based on a sample of nine establishments, maybe too small to represent the industry as a whole. Colatore and Caswell (2000), using an accounting approach to conduct an *ex post* estimate of the cost of HACCP in the US breaded fish industry, concluded that *ex ante* estimates are usually underestimated due to the diversity of HACCP applications. The study of Antle (2000), which was based on a quality-adjusted cost function, provided an estimate of the increase in variable cost of production, which ranges from $535 million to $4.8 billion. The upper limit of the estimate is four times as high as the FSIS estimate. However, Antle's study included costs not captured in a normal accounting approach. Secondly, FSIS estimates of HACCP benefits were based on debatable assumptions of HACCP effectiveness and the positive relationship between pathogen reduction and illness reduction. Further scientifically based research about these relationships is required to actually prove a strong correlation between both factors as assumed by FSIS.

Whether or not HACCP brings a net benefit still remains an unanswered question. As the cost-of-illness approach just provides a lower-bound estimate, the benefits of reducing food safety risks are considered potentially much higher (Unnevehr and Jensen, 1996). However, studies concerning the impacts of HACCP on food markets, industry structure, and distributional impacts are just emerging. It implies that careful consideration must be taken in measuring the benefits and costs of HACCP. As noted by Antle (2001), a short-run and static analysis could lead to misleading results.

Yet another important point in analysing the costs of HACCP is the existence of private incentives to adopt HACCP. Researchers argued that the costs of HACCP regulation could be reduced if firms, due to some private incentives, adopt HACCP in the absence of a regulation (Martin and Anderson, 2000). Firms could adopt HACCP due to customer requirements, their intention to gain improvements in operating efficiency, or under the threat of new regulations. It was also argued that firms have incentives for reducing sanitary deficiencies due to the threat of huge costs and loss of reputation incurring from the sale of contaminated products (Ollinger, 2000). In the event of an outbreak of a food safety related illness, firms may consider not just losses in sales, but also costs associated with tort liability, fines, potential future supply restrictions and stricter future government regulations (Worth, 2000). Hence, recognising the private incentives of adopting HACCP is also critical in a benefit cost analysis of HACCP regulation.

2.2. HACCP as a Business Management Tool

HACCP as a process design was argued to bring management benefits (Mazzocco, 1996; Cato, 2000). As a process control tool, HACCP is part of a total quality management system which generates benefits for firms, if properly implemented. These benefits include: (1) improvement in operational efficiency, (2) reduction of transaction costs, (3) reduction of marketing/sales costs and (4) product quality improvement.

Mazzocco (1996) claimed that HACCP, like other process management systems, can function as a method of process and product improvement, thus reducing output variations. As HACCP requires the identification of hazards and the establishments of critical limits and monitoring procedures, errors are corrected as soon as they are detected by the critical limits. This suggests that HACCP can help to improve operational efficiency by reducing product reworks and inefficiency in the use of inputs (Nganje and Mazzocco, 2000).

Transaction costs are costs of undertaking an exchange between customers and suppliers. They include informational search costs, negotiation costs, and monitoring and enforcement costs (Holleran et al, 1999). Informational search costs are also known as supplier identification costs. When supplier firms adopt quality assurance systems such as HACCP, it helps to identify themselves as competent suppliers. Contract negotiation often involves supplier site visits or audits. Contract verification and enforcement include laboratory testing and product inspection in addition to other legal procedures. By having a quality assurance system such as HACCP and being certified by a third party, these transaction costs can be reduced (Holleran et al, 1999). Mazzocco (1996) and Cato (2000) also argued that through HACCP systems installed in supplier's operations, manufacturing and processing firms are able to reduce costs of raw materials inspection, specification, inventory, and other costs associated with inputs. This phenomenon of ' upstream costs, downstream benefits' has recently become a common issue associated with food safety requirements.

It was also argued that transmitting HACCP system requirements to consumers can reduce marketing and sales costs (Cato, 2000). By adopting a food safety management system like HACCP and being able to signal it to consumers, firms can enjoy a marketing advantage. Bungay (1999) reported that Canadian HACCP-registered food businesses have requested permission to use HACCP in advertising materials, labelling claims, and promotional materials. Farina and Reardon (2000) in their study of agri-food grades and standards in the Mercosur countries also reported these marketing benefits among other management benefits generated by HACCP.

With the characteristics of a quality management system, HACCP can improve product quality. Being a food safety management system HACCP not only helps to achieve a safer product but also generates other quality enhancement benefits. The survey of Henson et al (2000) about HACCP adoption in the UK dairy industry has shown that by having HACCP firms can achieve other quality enhancement benefits such as improving product shelf life. Once this quality improvement is communicated to customers, firms may be able to achieve price premium for their products (Caswell, 2003).

To date there is limited number of studies that quantify the management benefits of HACCP. The shortage of the necessary data has somehow inhibited this task. When there is data available, a production economics framework is often employed to analyse these management benefits. Nganje and Mazzocco (2000) conducted an efficiency analysis of HACCP using data from their survey of the US meat industry. In their study, cost efficiency was estimated with elasticities of size from a system of cost share equations in which HACCP cost is considered an input together with other inputs. Technical efficiency was estimated with a corrected least square procedure using a Ray homothetic profit function. It was concluded that: (1) Firms have lower marginal cost of production compared with their marginal cost prior to HACCP implementation; (2) Firms with HACCP have greater technical efficiency and cost efficiency than firms without HACCP; and (3) Small firms may be more efficient with HACCP. In another study, Nganje et al (1999) through the use of a translog profit function have come to the conclusion that small firms were more profitable after HACCP implementation despite of the fact that their output prices did not increase significantly to compensate for HACCP expenses. The authors argued that the increase in firm profit was a result of the improvement in production efficiency.

Nganje's study was the first study that used survey data to analyse the economic efficiency of HACCP. The contribution of the study is that it has provided a general framework for analysing the efficiency impacts of HACCP. However, the study experienced a shortcoming in that their survey response rate is quite low. A total of 1050 questionnaires were sent out but there were only 98 responses, of which only 68 were useable. This pushed up the sampling error from 3% to 10%. To date there has not been any study on the other management benefits of HACCP. One reason is that these types of benefits are not easy to measure (Holleran et al, 1999). Further studies on the management benefits of HACCP should be able to shed more light on firm experiences with HACCP as a business management tool.

2.3. HACCP as an International Trade Standard

It was argued that the growing international use of HACCP can facilitate trade of food products once countries have adopted similar food safety assurance system (Caswell and Hooker, 1996). However, the degree to which HACCP could facilitate trade depends on the coordination efforts of nations. In other words, countries can benefit from reconciling the differences in their HACCP regimes.

The flexibility of HACCP is a challenge to this harmonization task. HACCP is said to be a combination of performance and process standards (Antle, 1999; Unnevehr and Jensen, 1999). It is a performance standard if governments require its implementation, but do not specify its details (Cato, 2000; Caswell and Hooker, 1996). On the other hand, it is a process standard if the details of implementation are specified. Due to these characteristics, HACCP as a performance standard can facilitate trade better than HACCP as a process standard.

Harmonising HACCP regimes also require the reconciliation of differences in pre-requisite requirements. According to NACMCF (1997), pre-requisite programs are the foundations for an effective HACCP implementation. These programs often cover in detail the requirements of the environment for the production process regarding product quality and safety. Examples are Standard Sanitary Operating Procedures (SSOPs) and Good Manufacturing Practices (GMPs). Caswell and Hooker (1996) argued that pre-requisite programs alone already create non-tariff barriers to trade, quoting as an example the differences in pre-requisite programs between the Canadian and the US HACCP regimes.

In practice, there have been different degrees of HACCP rapprochement. The EU has the strongest level of HACCP rapprochement, where HACCP-based regulatory regimes have been harmonised across countries through EU Directive 93/43 (Caswell and Hooker, 1996; Ziggers, 2000). WTO and North American approaches to rapprochement for HACCP are much weaker forms of coordination. The WTO encourages member countries to adopt the Codex HACCP standards.

However, Codex HACCP is just a set of minimum HACCP principles and does not provide detailed guidance on how it should be implemented (Caswell and Hooker, 1996). It is observed that countries usually implement programs which are stricter than Codex HACCP standards.

Once HACCP and pre-requisite programs are coordinated, trade can be facilitated. Recent studies have focused on the impacts of HACCP adoption on gains in trade (Zaibet, 2000; Alpay et al, 2001). These studies benefited from the use of trade models such as export performance models. Zaibet (2000) analysed the relationship between the compliance to HACCP and the competitiveness of Oman fish processing industry. He used an export model, in which firm export penetration index (measured as the proportion of export volume in total production) is a function of the status of HACCP adoption, sanitation requirements, labour (number of employees), and capital stock. Results showed a positive impact of HACCP adoption on export performance. Alpay et al (2001) studied the impacts of HACCP and other quality control systems on the export performance of Turkish food processing firms. Export value is specified as a function of the compliance with quality and safety standards, HACCP adoption levels, the compliance with environmental standards, the degree of vertical integration, and firm experience in the export markets. Results also revealed a positive relationship between HACCP adoption and export value.

The above-mentioned studies have provided analyses on the trade impacts of HACCP, with the use of firm level data. However, none of them has offered an estimate of the size of the gain which is an important input in a benefit cost analysis of HACCP.

2.4. Impacts of HACCP Implementation on Market Structure

There were concerns that small food processing plants may bear higher HACCP unit cost than large plants, given their smaller production scale (Unnevehr, 1996; Roberts et al, 1996). Therefore HACCP regulation could lead to small plants reducing their throughput or even exiting the market (Siebert et al, 2000; Muth et al, 2001). Using plant level data of firms under federal inspection, the study of Muth et al (2001) compared the rate of plant entry and exit prior to and during the implementation of HACCP regulation (1996-2000). It found that the rate of exit of meat slaughtering plants increased substantially during HACCP implementation (13% in 1993-1996 compared with 18% in 1996-2000). In particular, very small and small plants[3] had the highest rate (20%). Through interviewing industry representatives and HACCP experts, it was found that small slaughtering plants in fact made fewer changes to their production process than large plants. However, the authors argued that even if per unit costs are less for small plants, they may still exit at a faster rate than larger firms due to lack of expertise in HACCP implementation or because of revenues decreasing in a way that those businesses were no longer profitable. Small businesses generally have to cut down on the number of their products, especially on those that fetch a price premium in the market. The loss of higher product specialty, seasonal and ethnic product assortments significantly reduced the profitability of smaller firms. The authors went further to examine the factors that contribute to the probability of a plant exiting during HACCP implementation. Using a probit model, in which the probability of plant exit is a function of plant characteristics (e.g. slaughter volume, plant age, HACCP size), company characteristics (e.g. number of plants), regional characteristics (e.g. entry rate), and supply conditions (e.g. wage rate, cattle price), the study revealed that HACCP size designation significantly affects the probability of exit, with small plants being 55% more likely to exit than large plants. The contribution of the study is that it has pointed out the types of processing plants that are at high risk of exit and need more considerations in the process of HACCP implementation. Muth's study, however, used HACCP plan size as a HACCP variable. Although HACCP plan size is likely to have a positive correlation with HACCP implementation costs, it may also take into account other plant size effects.

[3] Very small plants: <10 employees; Small plants: 10-500 employees; Large plants: >500employees.

Siebert et al (2000) studied the impacts of HACCP upon small and very small meat processors, using data from their survey of Texas (US) meat plants. Three models were constructed, with the first model being concerned with the factors that affect the level of HACCP implementation costs (e.g. plant size, process complexity). The second model considered the probability of HACCP leading to products being withdrawn. The third model took into account the number of products withdrawn due to HACCP implementation. The authors concluded that: (1) Implementation costs are significantly related to the addition of new facilities, custom exempt status, and the starting date of required implementation; (2) The probability of product withdrawal is affected by the addition of new facility and employment due to HACCP and the required starting date; and (3) The number of product withdrawals is significantly related to the building or expansion of facilities due to HACCP and the number of items within a sales mix. The contribution of the study is that it has taken into account the implications of the complexity of the production process to the implementation of HACCP. It argued that there are diseconomies of scope in the implementation of HACCP, in other words, plants with a high number of products may be more likely to reduce the number of their products due to HACCP.

2.5. Distributional Impacts of HACCP Implementation

The welfare distribution of regulatory costs is also an important issue as it may affect future industry structure (Unnevehr et al, 1998). It is often considered a secondary impact and not included in regulatory impact assessments. However this type of impact may well be an important factor in assessing the economics of HACCP (Unnevehr et al, 1998; Goodwin and Shiptsova, 2000).

Unnevehr et al (1998) argued that production cost increase due to regulations would shift the supply curve upwards, thus increase product price. The increase in product price leads to a new equilibrium which takes into account the reduction in demand as well as the substitution effects among products. For example, higher beef prices would lead to consumers shifting to other meat products such as pork and poultry or other non-meat products. To measure changes in producer welfare due to the effect of the new regulation, Unnevehr et al (1998) employed a multi-market model, comparing the initial with the final equilibrium. The study found significant producer welfare losses due to HACCP regulation. When there are substitution effects among meat products, total meat producer welfare losses account for US$72 to US$733 million per year. Estimated losses for individual industries are at US$5 to US$52 million for poultry, US$24 to US$263 million for pork, and US$40 to US$426 million for beef producers. The magnitude of the loss depends on the initial estimate of HACCP implementation costs and the elasticities of substitution among meat products. Without substitution effects, producer welfare losses are even higher, with total losses estimated to be in the rage of $95 to $748 million. Poultry producers incur the lowest losses as demand elasticity estimates show that consumers are in favour of poultry when beef prices increase. The finding that producer welfare losses are reduced with substitution effects implies that the structure of demand has a significant influence on actual market outcomes following regulation. Additionally, there will also be consumer welfare losses as price increases, but according to Unnevehr et al (1998) these losses are insignificant compared to the benefits gained by reducing food safety risk.

Goodwin and Shiptsova (2000) studied producer welfare losses in the US poultry industry due to HACCP regulation. Although using a similar framework as Unnevehr et al (1998), this study utilized *ex post* estimates of HACCP costs. The study also found significant producer welfare losses, which range from US$4 to US$23 million without substitution effects, and from US$31 to US$63 million per year with substitution effects. Consumer welfare losses were estimated between US$49 to US$73 million with substitution effects, and from US$79 to US$93 million without substitution effects.

In general, studies on the distributional impacts of HACCP adoption have benefited from the use of multi-market equilibrium models and have provided an important input into HACCP impacts analysis. However, these studies require a careful design of the model as well as the applications of previously estimated values of HACCP implementation costs and substitution elasticities.

2.6. Chapter Conclusion

This chapter has discussed the issues associated with the implementation of HACCP as a food safety management system. Overall, HACCP brings benefits to society by reducing costs associated with food safety risks, but also imposes additional costs on the food industry. HACCP can also function as a business management tool and have a positive influence on firm export performance. However, in the long term, HACCP costs may affect market structure and reduce producer surplus. As HACCP has now been introduced into the New Zealand food legislation system, the time is right for a benefit-cost analysis of the implementation of the system. The analysis in this chapter provides the context for the research problems and methodology discussed in the next chapter.

CHAPTER 3

RESEARCH PROBLEM AND METHODOLOGY

This chapter sets out the research questions, research objectives and research method for each objective. The study was motivated by the recent changes in New Zealand legislation that impacted New Zealand experience in food safety management. It makes transparent the significance of the study given the benefits to New Zealand food exports from improved food safety practices.

3.1. Research Motivation

3.1.1. The New Zealand Experiences

The New Zealand Food Safety Authority (NZFSA) was established 1 July 2002 to administer food safety legislation covering food for sale on the domestic market and exported food. Prior to the establishment of the NZFSA, the Animal Products Act 1999 was implemented to eventually replace the Meat Act 1981. Significant drivers for this reform were growing consumer concerns about food safety and changes in food safety legislations in overseas markets. These are reflected clearly in the stated aims of the reform: (1) to manage associated risks; and (2) to facilitate overseas market access (NZFSA, 2004).

The Animal Products Act 1999 requires that all animal product primary processing businesses must have a risk management programme (RMP) based on the principles of HACCP. This is phased into four stages from July 2003 till July 2006. Most licensed red meat processors, export seafood processors and packing houses are required to have RMP by the end of the first period (July 2003).

Due to market access requirements, many primary food exporters have voluntarily adopted HACCP systems for food safety management since the 1990s. The Animal Products Act recognises these systems by allowing a roll-over for existing MAF approved HACCP. Moreover, a streamlined approach to RMP adoption developed in September 2002 also facilitates the move-over from HACCP to RMP. Nevertheless, the mandate of RMP does add some costs to the industries in terms of both time and money.

HACCP/RMP implementation may also bring benefits to the food industries. Arguably, the two major benefits are: to increase the safety of the products and to facilitate market access.

3.1.2. The Motivation

The transition from voluntary HACCP to mandatory RMP brings out the unique features of food safety management with the New Zealand food industries. This transition certainly adds to the complexity of the implementation process of food safety management practices. This research is the first since the introduction of HACCP in New Zealand to study the process of HACCP/RMP adoption and its impacts on the food industries. The meat industry was chosen as it is one of first industries which have to comply with the 2003 deadline. Also, being an export-oriented industry, the meat industry provides a typical case of the transition from voluntary HACCP to mandatory RMP. It is hoped that the study will provide a framework for analysing HACCP/RMP implementation processes and its impacts and provide research implications to further studies in other food processing industries in New Zealand.

3.2. Industry Structure and Theoretical Framework

New Zealand is a net exporter in meat products. In 2003, total beef production was 565,000 tonnes and total sheep meat production was 506,000 tonnes (MAF, 2003). Eighty five percent of total red meat production was exported. However, this made up only three percent of the global meat trade.

There are ninety meat processing plants throughout the country (Meat and Wool NZ, 2002). These comprise of local abattoirs, meat export slaughterhouses, and packing houses. Nearly 90 per cent of these plants export.

In 2003, meat products were exported to more than 70 overseas markets. Among these, the USA was the largest market for beef (55%) and the EU was the largest market for sheep meat (40%) (Statistics NZ, 2003). Meat exports often face quota restrictions and other non-tariff technical measures such as health and safety standards.

The New Zealand meat industry's experience with HACCP/RMP could be different from overseas experience. This is because the industry is highly dependent on exports and has to face a significant number of technical barriers. The following section sets out a theoretical framework for this study.

The discussion in chapter 2 has shown that there are costs associated with the adoption of HACCP. These are compliance costs which occur due to the implementation and operation of the programme. Overseas experience (Unnevehr et al, 1998; Goodwin and Shiptsova, 2000) showed that HACCP adoption increases production costs and thus shift the supply curve upwards. This results in a loss of producer welfare. However, this framework is only applicable to the case of a local firm. For an exporting firm, if HACCP is a market access requirement, the adoption of the programme is expected to maintain or even enhance market access.

Figure 2 below illustrates the case of the New Zealand meat industry in the international market. ES is the excess supply curve which shows the quantities that the country supplies to the international market at different world prices. As New Zealand is considered a small player (exporter) in the world meat market, it faces a horizontal demand curve (Houck, 1986). Changes in its export volume cannot affect the world price.

Two contrasting cases are presented. The first case is the ‘without HACCP’ case. In this case, the excess supply curve is at its original position ES_0 (assumed to be linear approximation of the curvilinear function). The world demand curve is positioned at ED_0. This is when the meat industry does not comply with HACCP and faces embargoes from other countries that require HACCP. The risk is quite obvious as if the industry does not meet the market requirements it cannot sell its products on that particular market. There is another type of risk that could happen in term of food safety outbreaks if HACCP or other good management practices are not in place. However this type of risk is less obvious (or of a lesser magnitude) than the case of market access requirements.

The second case is the ‘with HACCP’ case. In this case, the excess supply curve is at its position ES_1. ES_1 lies on the left of ES_0 as HACCP compliance costs shift the supply curve upwards (not shown here) hence affect the excess supply curve at the same magnitude. The world demand curve is at ED_1 which is positioned above ED_0. The reason is that world demand for NZ meat is expected to be higher than the ‘without HACCP’ case as the products satisfy market requirements. If the shift in demand happens at a larger magnitude than the shift in supply then it is expected that HACCP adoption can deliver net benefit to the meat industry. This is measured by an increase in producer welfare, which is the difference between area *abc* and *efg* (Figure 2).

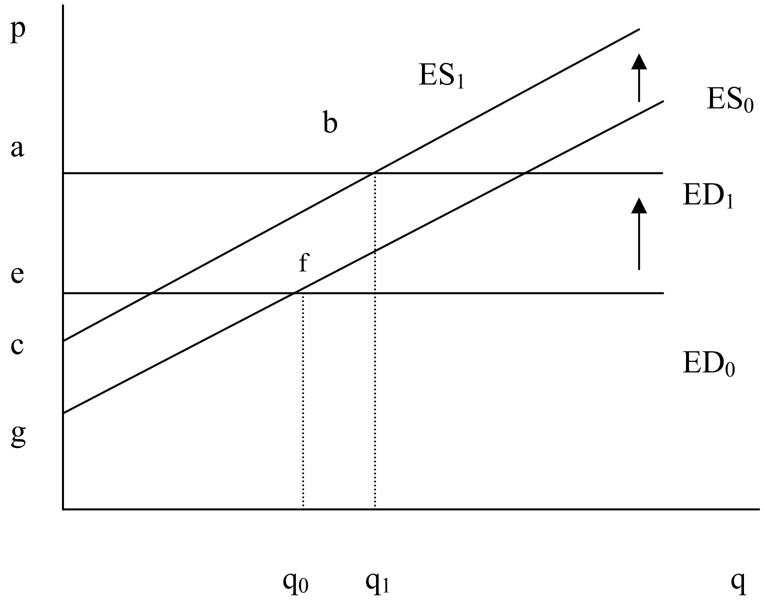


Figure 2. Theoretical Framework

The research objectives of the thesis will therefore focus on quantifying the costs and benefits of HACCP/RMP adoption. Costs are expected to be those of implementing and operating the programme. Benefits are expected to be the market access benefits. The following sections describe the research questions and objectives.

3.3. Research Questions

The purpose of this study is to analyse the economic impacts of HACCP/RMP implementation on the New Zealand Meat Industry. In particular, three main questions are asked:

(1) What are plant experiences with the implementation process of HACCP/RMP?

(2) What are the costs imposed on plants as a result of HACCP/RMP implementation?

(3) What are the benefits to plants that may result from HACCP/RMP implementation?

These research questions link to the research objectives presented in the next section. A summary of the research problems and the outline of the thesis are illustrated in Table 4.

3.4. Research Objectives

The research questions highlighted above will be dealt with in two separate parts of the thesis. The following set out the research objectives for each section:

Part 1: HACCP/RMP Adoption: Experiences from the New Zealand Meat Industry

Objective 1.1. To analyse the implementation process of HACCP/RMP. Issues addressed are implementation status, time spent on designing and implementation, time since HACCP/RMP is in place, motivations for HACCP/RMP adoption, and implementation problems.

Objective 1.2. To explore plant observations on HACCP/RMP costs and benefits.

Objective 1.3. To analyse the influences of plant characteristics on their implementation experiences and observations on HACCP/RMP costs and benefits.

Part 2: Modelling the Economic Impacts of HACCP/RMP adoption

Objective 2.1. To estimate the costs imposed on businesses as a result of HACCP/RMP adoption. Particular attention will be paid to the change in variable cost of production as this is the cost that difficult to observe by plants.

Objective 2.2. To estimate benefits to businesses that may result from HACCP/RMP adoption. Particular attention will be paid to the gain in market access as this is an important benefit to an export industry.

3.5. Research Methods

The recent literature on the economics of HACCP (e.g. Unnevehr, 2000) has helped to shape the research framework. Specific research methods for each of the above mentioned objectives are as follows:

Objectives 1.1 – 1.3 are performed by analysing information collected by a survey of New Zealand meat processing plants. The design of the survey was motivated by the existing literature analysing the process of HACCP adoption worldwide (e.g. Colatore and Caswell, 2000; Martin and Anderson, 2000; Henson et al., 2000). It also takes into account the unique features of the New Zealand experiences. Non-parametric methods are used to analyse the relationship between plant characteristics and the variables observed from the survey.

A production economics framework is employed for the estimation of changes in production costs as a result of HACCP/RMP adoption (Objective 2.1). Recent studies such as that of Antle (2000) have developed a useful framework for this task. In these models, a safety variable is introduced into traditional cost functions to estimate changes in variable cost due to the adoption of HACCP/RMP.

Objective 2.2 is performed by utilising an export model and a Global Trade Analysis Project (GTAP) model. Reduced form export models (also called gravity models) have been widely used in analysing international trade (e.g. Dascal et al, 2002; Tang, 2003). Recently these models were also employed in analysing the effects of food safety regulations on trade in food products (e.g.

Wilson et al, 2003). HACCP/RMP adoption will be included in this model as a dummy variable in order to analyse its impacts on export performance. The GTAP models, on the other hand, are useful in analysing impacts in a general equilibrium setting. These models are utilised in estimating the potential benefits of HACCP/RMP, for example the savings on costs of losing market access.

3.6. Significance of the Study

This study has two major contributions:

Firstly, it is the first study to analyse the implementation process of HACCP/RMP and its impacts on a New Zealand food industry. It makes a significant contribution by setting up the framework for analysing HACCP/RMP adoption in New Zealand and also providing implications for policy design and implementation.

Secondly, as an analysis of the benefits and costs of HACCP/RMP, the study also contributes to the development of the methods to evaluate HACCP as a food safety policy. How to model HACCP for marginal benefit-cost analysis is one of the yet unanswered questions which require further research (Unnevehr, 1996). Moreover, the impacts of HACCP as an international trade standard have been argued but not yet quantified. This study will also provide a quantitative assessment of the impacts of HACCP/RMP on the export performance of the meat industry.

3.7. Chapter Conclusion

This chapter set out the research problem, research objectives and the methodologies to carry out these objectives. Each research objective is treated separately in the following chapters (Chapter 5-11). Following Chapter 4 which sets out the survey methods, Chapter 5 reports the survey results on HACCP/RMP implementation process, adoption motivations, and implementation problems.

Chapter 6 presents plants' observations on the costs and benefits of HACCP/RMP. Chapter 7 analyses the influences of plant characteristics on their implementation processes and their observations on HACCP/RMP costs and benefits. Chapter 8 presents the estimates of changes in variable cost of production due to HACCP/RMP. Chapter 9 analyses the impacts of HACCP/RMP on export performance. Chapter 10 estimates the potential benefits of having HACCP/RMP or the costs of losing market access. Chapter 11 summarises the thesis findings.

Table 4. Research Problems, Objectives, Methodology, and Outline of Thesis

Problem	Objective	Method	Thesis Outline
1. Plant HACCP experience.	1.1. Plant experience with HACCP/RMP implementation process, including adoption motivations and implementation problems.	Survey	Chapter 5: HACCP/RMP implementation process, motivations and problems
	1.2. Plant observations on the costs and benefits of HACCP/RMP implementation.	Survey	Chapter 6: Plant observations on HACCP/RMP costs and benefits
	1.3. The influences of plant characteristics on HACCP/RMP implementation experiences, costs, and benefits.	Non-parametric method to analyse survey data	Chapter 7: Plant characteristics influences on adoption motivations, implementation problems, costs and benefits observations
2. Modelling costs and benefits of HACCP/RMP	2.1. HACCP/RMP cost estimation	Cost function framework	Chapter 8: Estimation of changes in variable cost of production due to HACCP/RMP
	2.2. HACCP/RMP benefits estimation	Export model and GTAP model	Chapter 9: HACCP/RMP and export performance Chapter 10: The cost of losing markets or the potential benefit of HACCP/RMP

CHAPTER 4

DATA COLLECTION

This chapter presents data collection methods, in particular, the design of the survey, the structure of the questionnaire and survey administration. It also provides a summary of the descriptive statistics of survey respondents and non-respondents.

4.1. Survey Design

The purpose of this survey is to gather information about the implementation process of HACCP/RMP in the New Zealand meat industry. Issues addressed include: implementation status, time spent on designing and implementation, time since HACCP/RMP in place, motivations for HACCP/RMP adoption, implementation problems, and plant observations on HACCP/RMP costs and benefits.

4.1.1. Survey Methods

There are four major methods in conducting a survey, namely, personal interviews, telephone interviews, self-administered questionnaires, and direct observation (Scheaffer et al, 1996).

Personal interviews or face-to-face interviews usually require the interviewers to ask prepared questions and to record the respondent's answers. The advantage of this method is that the interviewers can assist the interviewees with understanding and answering the survey questions and thus reducing survey errors. The disadvantage of the method is that it may be costly, especially when respondents are located over a large area. Leaving aside the cost issue, this method is appropriate for the purpose of this study.

Telephone interview method maybe less expensive than personal interviews as it does not require the interviewers to visit the respondents. However, it is not suggested for a lengthy and complicated questionnaire. As our purpose is to gather information about HACCP/RMP implementation which is rather a complicated process, telephone interviews may not be appropriate in this case.

A self-administered questionnaire method (or also called mail survey) does not require the presence of interviewers. It is therefore considered cheaper than the two methods above. However, it may have a low response rate and the accuracy of the answers may not as high as in interviews methods. With the assistance of other error reducing methods such as follow-up survey or providing incentives, mail survey is one of the appropriate approaches for this study.

Direct observation could be the most expensive method of all, as it requires the data collectors to observe the real process and record the data. Given the fact that HACCP/RMP implementation process is lengthy and complicated, this is not a suggested method.

A summary of the advantages and disadvantages of the two possible methods, face-to-face interviews and mail survey, is presented in Table 5 below.

Table 5. Possible Survey Methods

	Mail survey	Face-to-face interviews
Framework from literature	Henson et al (2000); Nganje and Mazzocco (2000); Siebert et al (2000)	Colatore and Caswell (2000)
Advantages	- Low survey cost	- Data accuracy higher
	- Can allow large-scale survey	- Responses known
Disadvantages	- Accuracy of data may not be high	- Often small survey sample
	- Uncertainty in responses	- Higher survey cost.

Given the limited resources for the data collection task, a mail survey was chosen. The targeted population is all the members of the New Zealand Meat Industry. According information from the Meat and Wool NZ (2002), there were 38 companies with 90 plants nationwide. As this is a rather small population size, the whole population is surveyed. Hence there is no need to determine a survey sample.

4.1.2. Questionnaire Design

The design of survey questionnaire was inspired by the existing literature studying the process of HACCP implementation worldwide (Martin and Anderson, 2000; Colatore and Caswell, 2000; Mortlock et al, 2000; Buchweitz and Salay, 2000; Nganje and Mozzocco, 2000; Siebert et al, 2000; and Henson et al, 2000). The unique characteristic of the New Zealand case as discussed earlier (see chapter 1.5 and 3.1) was incorporated in the design.

The purpose is to design a simple, easy to answer questionnaire, but able to gather all the necessary information related to the implementation of HACCP/RMP. Overall, the questionnaire consists of 25 questions which take about 15 minutes to answer. The structure and wording of the questionnaire were designed carefully to make it easy to understand. The pre-test stage (discussed in the next section) helps to shape the question form and wording suitable to the respondents' experiences. A copy of the questionnaire is available in the Appendix.

There are five sections in the questionnaire.

Section 1 asks about the process of RMP implementation such as how RMP was developed, the amount of time spent on plan design and implementation, also time since a completed RMP be in place. If an RMP has not been registered with MAF, respondents were asked about the time that has been spent on designing and the expected time to complete the implementation.

Section 2 asks about the process of HACCP implementation. This is similar to section 1. For example, respondents were asked about how their HACCP plan was developed, time spent on design and implementation and time since their HACCP plan became operational.

Section 3 considers motivations in adopting HACCP/RMP, difficulties faced, and expected benefits of having HACCP/RMP. For each category, a list of items that have been suggested from the literature were presented and respondents were asked to rank each item on a 7-point scale. This helps to assess firm observation for each category qualitatively.

Section 4 considers the costs associated with implementing and operating HACCP/RMP. Costs are categorised into various items such as costs of designing plan, training, sampling/testing, etc. Respondents were asked to give rank 1 for the highest cost, and thereafter. This ranking helps to estimate the weight of each cost item when specific data is not available.

Section 5 gathers other plant characteristics such as activities (e.g. slaughtering or processing), age, products (e.g. beef, lamb, veal), size (in terms of number of employees), volume of production, export markets and the adoption of other quality/safety management systems than HACCP/RMP. This is necessary as it helps to differentiate the impacts of HACCP/RMP implementation further according these characteristics.

4.1.3. Error Control Methods

4.1.3.1. Pre-test

The draft questionnaire was tested through visits to two nearby meat processing plants (AFFCO Horitiu and Greenlea Meats Hamilton) in July 2003. It was also sent to meat scientists at AgResearch (Ruakura, Hamilton) for their advice. This stage proved to be very helpful. For example, the draft of the questionnaire did ask for some specific costs associated with the implementation and other production costs. However, plant visits showed that these items were not available for collection. The draft then was amended to suit plants' experiences.

4.1.3.2. Incentives

The questionnaire has a cover page. In this page, the benefits to the meat industry through the knowledge gained from the survey and further analysis were specified. There was also a guarantee for the confidentiality of the information supplied. The contact addresses and telephone/facsimile numbers were displayed clearly in case respondents needed help. Moreover, respondents could win one of three Mitre10 gift vouchers if they replied before the specified date. The time consumed by completing the questionnaire was also mentioned. This page is also included with the questionnaire in the Appendix.

There was also an option at the end of the questionnaire offering a survey report to those respondents interested.

4.1.3.3. Survey procedures and follow-up survey

Eighty eight (88) questionnaires were sent out to meat plants operating in New Zealand in the first stage of the survey (23/07/03 – 29/08/03). Plants visited for pre-test were excluded. Contact addresses for the 88 plants are taken from the New Zealand Contacts in Agriculture 2002.

At the end of the first survey stage, there were 30 responses, of which 3 were non-usable: one plant was just involved in tannery, one was in liquidation, and one was no longer operating. Total usable responses in the first stage were 27.

Fifty eight (58) questionnaires were sent in the follow-up survey (01/10/03 – 14/11/03). There were 15 responses which are all usable. The total number of usable responses is 42. This represents a valid response rate of 48%.

4.2. Descriptive statistics

4.2.1. Plant Size

In this study, plant size is categorised as follows:

(1) Small plants are those employing from zero to 19 fulltime equivalent employees (FTEs);

(2) Medium plants are those employing from 20 to 99 FTEs; and

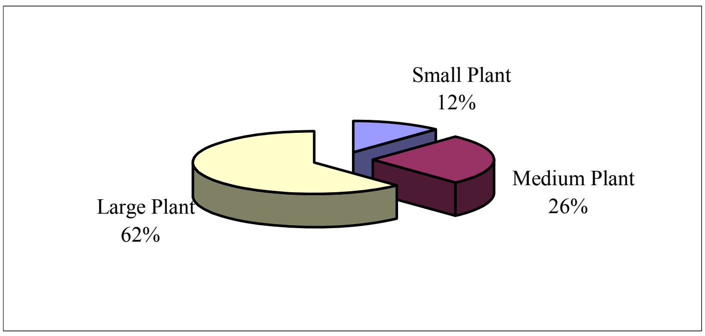
(3) Large plants are those employing 100 or more FTEs.

To calculate the number of FTEs, a part-time employee is treated as equal to 0.5 FTE. The numbers of responses for each group of plant size are reported in Table 6.

Table 6. Plant Size

Plant Size	Response	Percent
Small	5	12%
Medium	11	26%
Large	26	62%
Total	42	100%

Figure 3. Plant Size



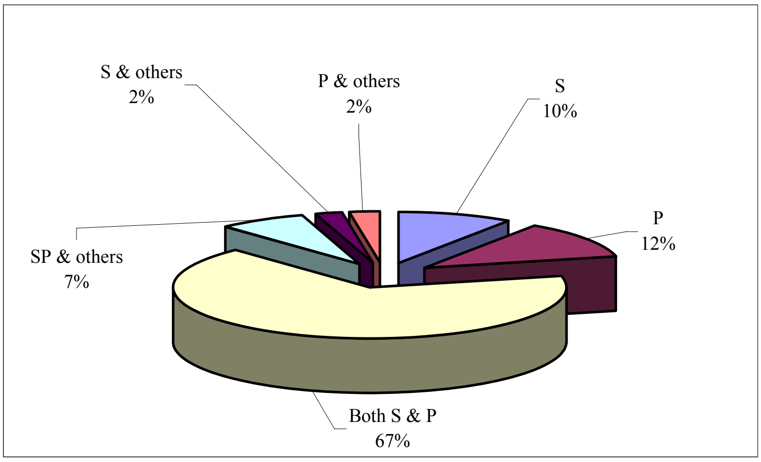
4.2.2. Plant Activity

Sixty seven percent (67%) of respondents are both slaughtering and processing. Among these, 76% are large, 24% are medium, none are small plants. About 12% of respondents include other activities other than slaughtering and processing (e.g. cold storage, butcher shops). Table 7 shows the distribution of plant activities.

Table 7. Plant Activity

Activity	Response	Percent
Slaughtering (S)	4	10%
Processing (P)	5	12%
Both S & P	28	67%
SP & others	3	7%
S & others	1	2%
P & others	1	2%
Total	42	100%

Figure 4. Plant Activity



Note: S – slaughtering; P - processing

4.2.3. Plant Type

In New Zealand, in general, there are 3 types of meat plants: abattoirs, packing houses, and meat export slaughterhouses (Meat and Wool New Zealand, 2004). Abattoirs are often premises that are licensed to process meat for the local market. Packing houses often engage in processing activities, and often for export. Meat export slaughterhouses are licensed to process meat for export and often engage in both slaughtering and processing. Tables 8 and 9 show the distribution of respondents according to plant types and the differentiation into plant sizes and activities.

Table 8. Response Plants by Plant Type and Size

	Small plant	Medium plant	Large plant	Total Row
Abattoir	2 (33.33%)	4 (66.67%)	0 (0.00%)	6 (100%)
Meat export	0 (0.00%)	3 (11.11%)	24 (88.89%)	27 (100%)
Packing house	3 (33.33%)	4 (44.44%)	2 (22.22%)	9 (100%)
Total Column	5	11	26	42

Table 9. Response Plants by Plant Type and Activity

	Slaughtering	Processing	Total
Abattoir	6 (100%)	3 50.00%	6 (100%)
Meat export	27 (100%)	25 92.59%	27 (100%)
Packing house	3 (33.33%)	9 (100%)	9 (100%)

Among respondents, 14% are abattoirs, 64% are meat export slaughterhouses, and 22% are packing houses. Respondents in general reflect the common characteristics of plant types. All abattoirs fall into the small and medium plant size category. They are also plants that engage more in slaughtering activities. On the contrary, all meat export slaughterhouses are either medium or large size. Their activities include both slaughtering and processing. Packing houses include all plant sizes and engage more in processing activities.

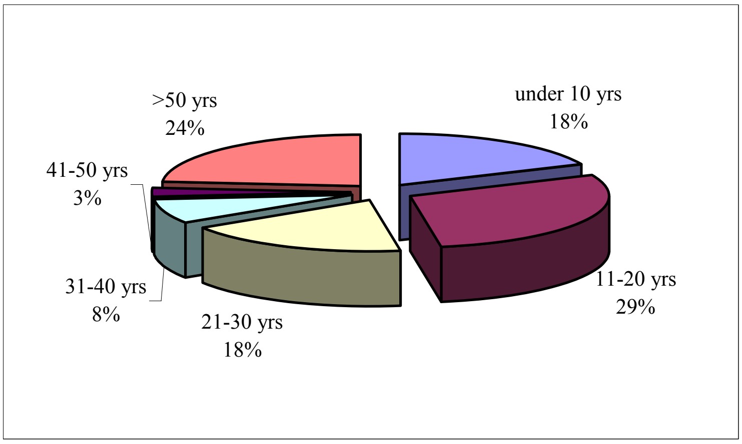
4.2.4. Plant Age

About 47% of respondents are young plants which have been operating for less than 20 years. Of these young plants, more than 60% are small and medium plants. About a quarter of all respondents have been operating for more than 50 years. Most of these are large plants. Table 10 and Figure 4 show the distribution of plant age.

Table 10. Plant Age

Age group	Response	Percent
< 10 yrs	7	18.42%
11-20 yrs	11	28.95%
21-30 yrs	7	18.42%
31-40 yrs	3	7.89%
41-50 yrs	1	2.63%
>50 yrs	9	23.68%
Total	38	100.00%

Figure 5. Plant Age



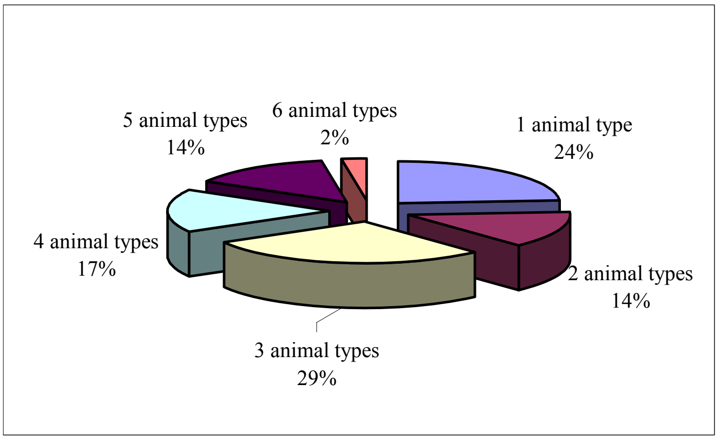
4.2.5. Plant Products

Twenty four percent (24%) of respondents handle just one animal type; 29% handle three animal types; and about 33% handle more than four animal types. Table 11 and Figure 5 show the distribution of plant products.

Table 11. Plant Products

Products	Response	Percent
1 animal type	10	23.81%
2 animal types	6	14.29%
3 animal types	12	28.57%
4 animal types	7	16.67%
5 animal types	6	14.29%
6 animal types*	1	2.38%
Total	42	100.00%

Figure 6. Plant Products



Note: * 6 animal types: Beef, Veal, Lamb, Mutton, Venison, and Other (e.g. Pigs)

4.2.6. Markets

Eighty six percent (86%) of respondents export their products. Most of them are large and medium plants. Small plants in general only serve the local market. Table 12 shows the number of respondents exporting to different markets.

Table 12. Markets

Markets	Response	Percent
Local market	5	13.89%
Export	31	86.11%
- USA	31	86.11%
- Europe	27	75.00%
- Asia	26	72.22%
Total	36	100%

4.2.7. Quality/safety Management Practices

All plants have at least some forms of quality management systems (QMSs) other than HACCP/RMP. The most common form is a combination of Sanitary Standard Operating Procedures (SSOPs), Good Manufacturing Practice (GMP), and Industry Codes of Practice (ICP) (29%). Overall, about 14% have more than 5 QMSs, 76% have SSOPs and GMP in their QMSs; and about 26% have all ISO9000, SSOPs, GMP, and ICP.

4.2.8. Non-response Statistics

The survey questionnaires were sent out to 88 meat plants nation-wide. After the follow-up survey, there were 45 responses. Among 43 non-response plants, 17 belong to the four multi-plant companies (AFFCO, Alliance, PPCS, Richmond). It was indeed pointed out in the responses from these companies that the opinions stated are representative for all plants belonging to the same company as the completed questionnaire was a result of a group exercise. Therefore, it leaves out a group of 26 non-response plants that are not represented by the survey results. The information collected from the New Zealand Meat Board website and the New Zealand Contacts in Agriculture 2002 show that among these 26 plants, eight are local abattoirs, nine are packing houses and nine are meat export slaughterhouses. Table 13 shows the percentage of non-response in each group of plants.

Table 13. Non-response Statistics

Plant type	Survey population(1)	Non-response(2)	Non-response Percent
Abattoirs	13	8	62%
Packing house	22	9	41%
Meat Export Slaughterhouse	53	9	17%

(1) survey population is also survey sample
(2) non-response group has been excluded those belonging to multi-plant companies

Abattoirs and packing houses are generally small and medium size while export slaughterhouses are often large size plants (see Table 8). The non-response statistics above show that while survey results may not represent the whole population, results for large plants (or meat export slaughterhouses) are likely to be illustrative for other large plants (or meat export slaughterhouses).

4.3. Chapter Conclusion

This chapter has discussed the method for data collection, the design of the survey questionnaire and survey procedures. The descriptive statistics of survey participants were reported. These statistics will be referred to in the next chapters where the impacts of HACCP/RMP adoption are differentiated further according to plant characteristics.

The summary of respondents' descriptive statistics differentiated by plant size is given in Table 14 below. In general, a large proportion of respondents are large plants (62%). The majority of large plants are meat export slaughterhouses. In contrast, the majority of small and medium plants are abattoirs and packing houses. Small and medium plants are often younger plants. They also generally engage in fewer activities and have a smaller number of quality/safety management systems. While 100% of large plants export their products, only 73% of medium plants and 60% of small plants export.

Table 14. Summary of Plant Descriptive Statistics

Statistics	Small Plant	Medium Plant	Large Plant	Total
Number of Plants (% of total responses)	5 (12%)	11 (26%)	26 (62%)	42 (100%)
Plant type (number of plants and % of total group responses)				
Abattoir	2 (33%)	4 (67%)	0 (0%)	6 (100%)
Packing House	3 (33%)	4 (45%)	2 (22%)	9 (100%)
Meat Expt Slaughterhouse	0 (0%)	3 (11%)	24 (89%)	27 (100%)
Plant age, product, and QMS (mean score)				
Plant average age	13.2 yrs	29.4 yrs	51.26 yrs	40.50 yrs
Average no. of products	3.8	2.27	3.00	2.90
Average no. of QMSs	2.6	2.73	3.64	3.29
Plant activity and market (% of group)				
Activities (both S & P)	0%	63.64%	91.67%	65.85%
Export plants	60%	72.73%	100%	86%

PART II

HACCP/RMP IMPLEMENTATION: EXPERIENCES FROM THE NEW ZEALAND MEAT INDUSTRY

CHAPTER 5: Plant Motivations and Implementation Problems

CHAPTER 6: Costs and Benefits Observations

CHAPTER 7: Influences of Plant Characteristics

CHAPTER 5

HACCP/RMP IMPLEMENTATION PROCESS, MOTIVATIONS AND PROBLEMS

"Our industry is driven by overseas market access issues."

Anonymous survey participant, 2003

This chapter discusses the general issues in the implementation process of HACCP/RMP, based on the information gathered from the survey (Chapter 4). The issues include plant implementation status, time spent on designing and implementation, time since HACCP/RMP in place, motivations for HACCP/RMP adoption, and the implementation problems that firms experienced. Each issue is then differentiated according to plant size (small, medium, and large) and plant type (abattoirs, packing house, and meat export slaughterhouse).

5.1. HACCP/RMP Implementation

5.1.1. Implementation Status

RMP was recently mandated by the Animal Product Act 1999. However, due to market access requirements, HACCP principles have been voluntary adopted by many members of the meat industry since the 1990s. The current situation reflects the transition period from voluntary HACCP status to mandatory RMP status. As a result, some plants have both HACCP and RMP, some have HACCP or RMP, and some have none of these programs. Table 15 shows the HACCP/RMP implementation status of the survey participants. A large proportion of participants (79%) have both HACCP and RMP. About 12% have HACCP and are developing RMP. The rest of respondents are either developing RMP or have RMP only.

Table 15. HACCP/RMP Implementation Status

Status	Response	Percent
Both HACCP & RMP	33	78.57%
No HACCP & No RMP & Developing RMP	2	4.76%
Have HACCP & Developing RMP	5	11.90%
Have RMP	2	4.76%
Total	42	100%

5.1.2. HACCP Implementation Process

As at September 2003, 90% of respondents have a HACCP system in place. Most plants that do not have HACCP are small and medium plants serving the local markets. Most of HACCP plans were developed by plants' employees (87%), 13% were developed by joint coordination with external consultants (Table 16).

Table 16. Who Developed HACCP?

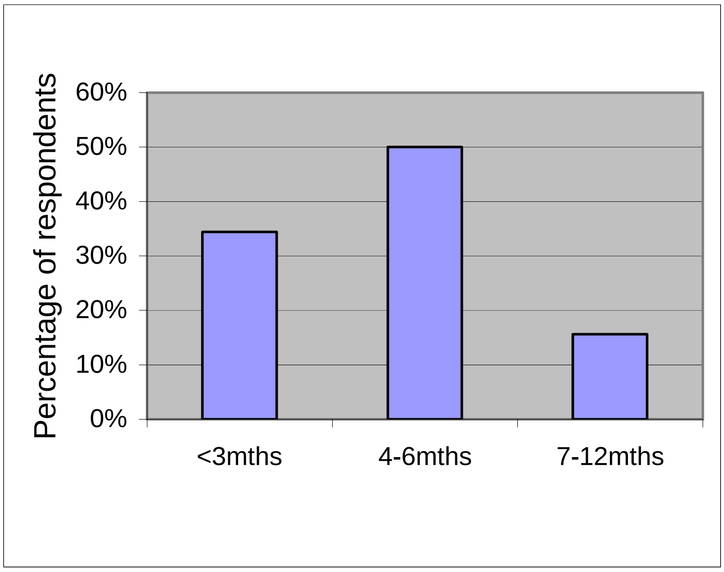
Who developed HACCP?	Response	Percent
Employees	34	87.18%
External Consultants	0	0.00%
Joint Coordination	5	12.82%
Total	39	100%

Table 17 and Figure 6 show the distribution of plants according to their HACCP implementation time. A large proportion of respondents spent less than 6 months in developing and implementing HACCP (84%). None of the respondents spent more than 12 months in developing and implementing HACCP. Average time spent on developing HACCP is five months (see also Table 19).

Table 17. HACCP Implementation Time

Time	Response	Percent
<3 mths	11	34.38%
4-6 mths	16	50.00%
7-12 mths	5	15.63%
>12 mths	0	0.00%
Total	32	100 %

Figure 7. Time Spent to Implement HACCP

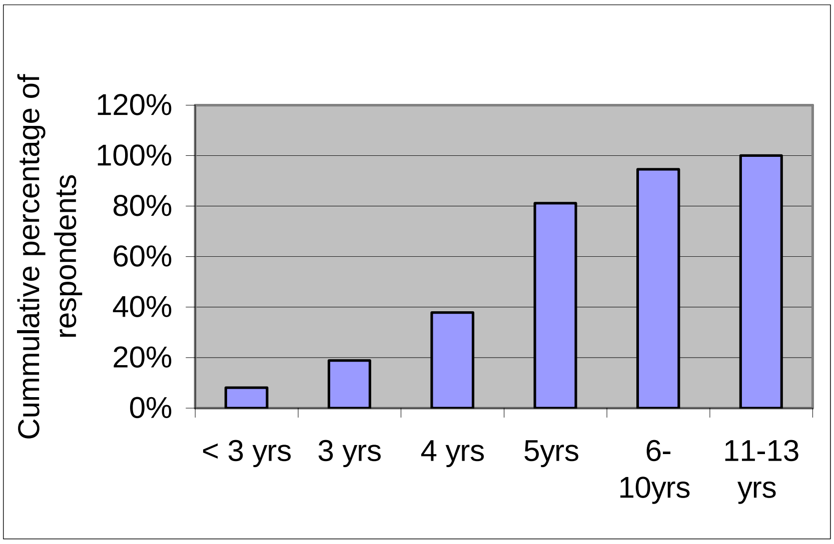


Average time HACCP in place is five years (Table 20). The majority of respondents had HACCP from three to five years (73%). Five percent (5%) are reported to have HACCP for more than 10 years. The longest time reported is 13 years. Table 18 and Figure 7 show the distribution of plants according the time HACCP in place.

Table 18. Time HACCP in Place

Time	Response	Percent
< 3 yrs	3	8.11%
3 yrs	4	10.81%
4 yrs	7	18.92%
5yrs	16	43.24%
6-10yrs	5	13.51%
11-13 yrs	2	5.41%
Total	37	100%

Figure 8. Time HACCP in Place



In general, the rate of adopting HACCP in medium and large plants is higher than that of small plants (see Table 19 below). HACCP implementation time is higher for larger plants. This could be the result of more complicated production processes in larger plants. Large plants have also adopted HACCP for a longer time than medium plants. Small plants, however, have the highest average time for HACCP in place. This figure should be interpreted with caution since there were few valid responses from small plants with various HACCP adopting characteristics. Results also show that the rate of hiring external consultants for HACCP plan design is higher for smaller plants.

Table 19. HACCP Implementation Process of Different Plant Sizes

Statistics	Small	Medium	Large	Total
Plants having HACCP	60%	91%	96%	90%
Plants having no HACCP	40%	9%	4%	10%
Average HACCP impl. time (mths)	4.00	4.44	6.05	5.15
Average time HACCP in place (yrs)	8.50	3.36	5.39	5.05
Use consultants for HACCP design	40%	9%	8%	13%

The summary statistics for different plant types (as in Table 20) show that meat export slaughterhouses have the highest HACCP adoption rate (96%). Abattoirs have the lowest adoption rate (67%). Packing houses spent the least time on HACCP developing and also have the shortest time HACCP was in place. Again, results for abattoirs must be read with caution as this category has a small number of valid responses. The rate of hiring consultants for the designing of HACCP is highest for abattoirs (67%). Only about 11% of packing houses and meat export slaughterhouses used consultants for HACCP plan design.

Table 20. HACCP Implementation Process for Different Plant Types

	Abattoir	Packing House	Meat Export	Total
Plants having HACCP	67%	89%	96%	90%
Plants having no HACCP	33%	11%	4%	10%
Average HACCP developing time (mths)	5.33	3.28	5.67	5.15
Average time HACCP in place (yrs)	6.00	3.75	5.28	5.05
Use consultants for HACCP design	67%	11%	11%	13%

5.1.3. RMP Implementation Process

The majority of RMP were developed based on existing HACCP systems (82%). Similar to HACCP, most of RMP were developed by plants' employees (80%). Table 21 shows the number of responses in each category.

Table 21. Who Developed RMP?

Who developed RMP?	Response	Percent
Employees	31	79.49%
External Consultants	1	2.56%
Joint Coordination	7	17.95%
Total	39	100%

Eighty three percent (83%) of respondents have registered RMP in place (Table 24). The average time spent on developing and implementing RMP is 8.5 months. This is longer than that spent on HACCP (5 months), despite most RMP being based on existing HACCP. This is perhaps due to the fact which some of respondents have highlighted in their answers that the process of RMP evaluation and registration is very time consuming (see examples of HACCP/RMP feedbacks, Appendix 2).

Table 22 and Figure 8 show the distribution of plants according to their RMP implementation time. Sixty two percent (62%) of respondents spent less than six months in developing and implementing RMP. Eighteen percent (18%) spent more than 12 months. The longest time recorded is 24 months.

Most of the respondents have RMP registered in the year 2003. Fifty-eight percent (58%) of respondents have RMP for less than 6 months. About 60% of these have RMP for less than three months. The longest time of RMP in place is 24 months. None of the respondents had RMP for more than two years.

Table 22. RMP Implementation Time

Time	Response	Percent
<3 months	12	30.77%
4-6 months	12	30.77%
7-12 months	8	20.51%
>12 months	7	17.95%
Total	39	100%

Figure 9. Time Spent to Implement RMP

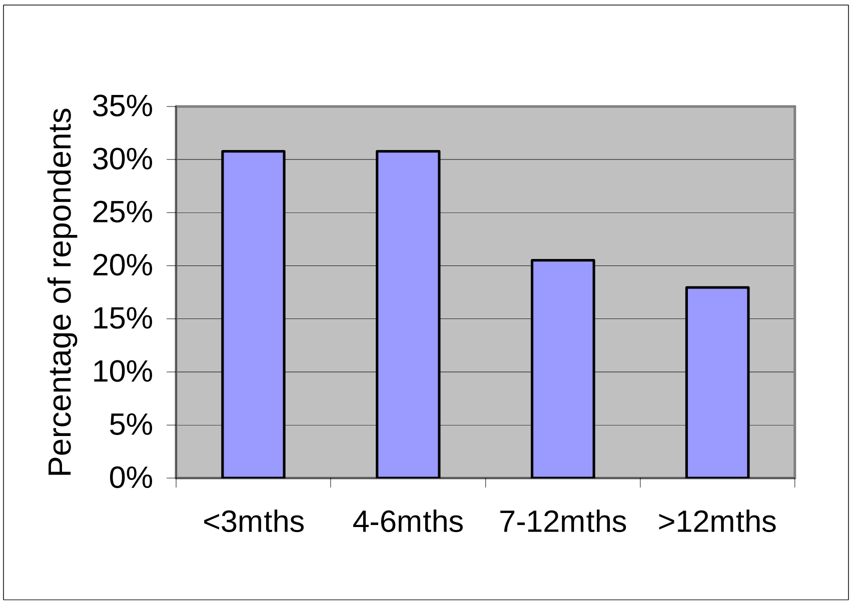
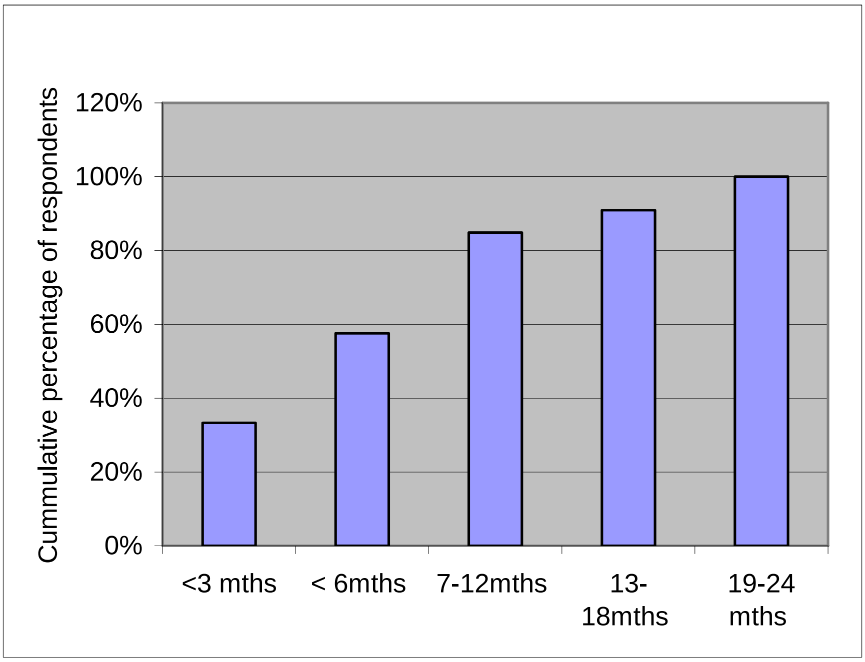


Table 23. Time RMP in Place

Time	Response	Percent
<3 months	11	33.33%
< 6 months	8	24.24%
7-12 months	9	27.27%
13-18 months	2	6.06%
19-24 months	3	9.09%
>24 months	0	0.00%
Total	33	100%

Figure 10. Time RMP in Place



Both small and medium plants lagged behind in adopting RMP. Only 60% of these plants have RMP, while the adoption rate of large plants is 96% (Table 24). On average, small and medium plants spent less time in developing and implementing RMP than large plants. Again, this could be explained by their less complicated production process. The average time RMP is in place in large plants is higher than that of small and medium plants. This again shows the lagging of small and medium plants in RMP implementation. The percentages of medium and large plants hiring consultants for RMP developing tasks are higher than those of HACCP. This is because RMP implementation is more complicated than HACCP as pointed out by respondents (Appendix 2).

Table 24. RMP Implementation Process for Different Plant Types

Statistics	Small Plant	Medium Plant	Large Plant	Total
Plants having RMP	60%	64%	96%	83%
Plants developing RMP	40%	36%	4%	17%
Average RMP impl. time (mths)	6.25	8.44	9.12	8.59
Average time RMP in place (mths)	7.00	7.00	8.07	7.80
Use consultants to design RMP	40%	36%	12.5%	20%

Table 25 shows the differentiation of RMP implementation statistics according to plant type. Meat export slaughterhouses have the highest adoption rate (96%). On the other hand, only 33% of abattoirs had finished their RMP implementation. Meat export slaughterhouses in general spent more time with RMP implementation than packing houses (nine months vs. four months). Also, their RMP time in place is longer (eight months vs. seven months). Results for abattoirs again need to be interpreted with caution as the group contained few valid responses, and the plants reported widely varying characteristics.

Table 25. RMP Implementation Process for Different Plant Types

Statistics	Abattoirs	Packing House	Meat Export	Total
Plants having RMP	33%	78%	96%	83%
Plants developing RMP	67%	22%	4%	17%
Average RMP impl. time (mths)	15	4.11	9.37	8.59
Average time RMP in place (mths)	12	7	8	7.80
Use consultants to design RMP	33%	0%	11%	20%

5.2. HACCP/RMP Adoption Motivations

In order to assess plant motivations to adopt HACCP/RMP, respondents were presented with a list of motivations and asked to rank the importance of each on a 7-point scale. Motivations as highlighted by the current HACCP literature (e.g. Henson et al, 2000; Nganje and Mazzocco, 2000) and the New Zealand context are taken into account. A zero rank is included to cover for cases when respondents do not regard the suggested item as a motivation. The median rank for each motivation item is reported in Table 26. Median is used as it is argued the most appropriate measure of central location for ordinal data (ranks) (Keller et al, 1988). In calculating the median, rank zero is included as (1) it can be considered as the lowest rank (Oppenheim, 1992), and (2) omitting zero ranks could lead to very small sample size in this case. The percentage of rank zero for each motivation is also reported. It helps to distinguish the respondents that have not confronted the suggested issue.

The median ranks in Table 26 suggest the three motivations that have the highest average ranks: (1) to meet legal requirement; (2) to access new overseas markets; and (3) to meet the needs of major customers. As analysed earlier (see chapter 1, section 1.3.3), motivation can be categorised into external and internal factors. External factors are those requirements from customers or regulations or recommendations from industry associations. Internal factors are the motivation to improve product quality and safety, to reduce wastage, or to improve the control of the production process. Survey results show that respondents in general ranked external motivations higher than internal ones. Internal motivations such as improving the control and efficiency of the production process are among the lowest ranked items and also have the highest percentage of rank zero. It suggests that in general HACCP/RMP is considered as a marketing tool rather than a business management tool.

Table 26. Plants' Motivations in Adopting HACCP/RMP

Motivation	Median	% rank 0
Meet legal requirements	7.00	0.00
Access new overseas markets	6.50	15.00
Meet the needs of major customers	6.00	2.50
Recommended by MAF/Industry Association	5.00	15.00
Generally regarded as good practice	5.00	12.50
Needed for plant to be third party accredited	5.00	20.00
Generally regarded as Board or CEO country wide policy	4.50	25.00
Improve product quality	4.00	12.50
Attract new customers for products	4.00	17.50
Improve control of production process	4.00	10.00
Improve efficiency/profitability of plants	4.00	42.50
Reduce need for quality audits by customers	4.00	37.50
Reduce customer complaints	4.00	30.00
Reduce product wastage	4.00	45.00

Note: Highlighted areas show the top three motivations.

Although the whole sample statistics (Table 26 above) show a greater than average level of importance for all motivations, statistics for different plant sizes show that their motivations are somewhat different. Small plants are not interested in gaining overseas market access as much as medium and large plants (median is zero). This could be explained by the reason that small plants mostly cater for the local market. Small plants also give lower ranking to those belonging to internal motivations and third-party accreditation. All plants are interested in gaining product quality improvement and attracting new customers (median ≥ 4). Large plants in particular are more interested in gaining third-party accreditation as this is important for their export business.

Table 27. Motivations (Median Scores) and Plant Size

Motivation	Small	Medium	Large
Meet legal requirements	7.00	7.00	7.00
Access new overseas markets	0.00	7.00	6.00
Meet the needs of major customers	6.00	5.50	7.00
Recommended by MAF/Industry Association	3.00	5.50	5.00
Improve product quality	4.00	5.00	4.00
Improve control of production process	3.00	5.00	4.00
Attract new customers for products	4.00	4.50	4.00
Generally regarded as good practice	4.00	4.50	4.00
Generally regarded as Board or CEO country wide policy	0.00	3.50	4.00
Reduce need for quality audits by customers	0.00	3.50	1.00
Improve efficiency/profitability of plants	0.00	3.00	1.00
Needed for plant to be third party accredited	1.00	2.50	5.00
Reduce customer complaints	0.00	2.50	3.00
Reduce product wastage	0.00	1.00	1.00

Note: Highlighted areas show the above average ranks.

The summary statistics for different plant types (Table 28 below) show that there is little variation in their motivation to adopt HACCP.

Table 28. Motivations (Median scores) and Plant Type

Motivation	Abattoir	Packing House	Meat Export
Meet legal requirements	7.00	7.00	7.00
Access new overseas markets	6.00	4.00	6.00
Meet the needs of major customers	4.50	5.00	7.00
Recommended by MAF/Industry Association	4.00	6.00	5.00
Improve product quality	4.50	5.00	4.00
Improve control of production process	4.50	4.00	4.00
Attract new customers for products	4.50	4.00	4.00
Generally regarded as good practice	4.50	4.00	4.00
Generally regarded as Board or CEO country wide policy	3.50	3.00	5.00
Reduce need for quality audits by customers	3.00	2.00	1.00
Improve efficiency/profitability of plants	3.50	3.00	1.00
Needed for plant to be third party accredited	4.00	1.00	5.00
Reduce customer complaints	2.50	2.00	2.00
Reduce product wastage	1.00	1.00	1.00

Note: Highlighted areas show the above average ranks.

5.3. Implementation Problems

Respondents were presented with a list of problems which they may experience in the process of HACCP/RMP implementation. They were then asked to rank the level of difficulty of each problem on a 7-point scale. Alternatively, respondents can give a zero rank if they do not think the suggested item is a problem. Median score and percentage of rank zero for each problem are reported in Table 29.

Overall, the highest ranked problem is recouping costs of implementing HACCP/RMP. This indicates that businesses are most concerned about the costs associated with the implementation. Other highly ranked problems are the lack of flexibility in introducing new products. Indeed, some respondents highlighted the problems that process cannot be changed until RMP amendments are approved (Appendix 2). Costs in terms of time spent are also a concern.

Table 29. Implementation Problems

Problem	Median	% rank 0
Recouping costs of implementing HACCP/RMP	5.00	12.50
Reduced flexibility to introduce new products	5.00	12.50
Reduced staff time available for other tasks	4.00	15.00
Reduced flexibility of production process	4.00	15.00
Need to retrain supervisory/managerial staff	3.00	5.00
Need to retrain production staff	3.00	10.00
Reduced flexibility of production staff	2.50	25.00
Attitude/motivation of supervisory/managerial staff	2.00	17.50
Attitude/motivation of production staff	2.00	15.00
Lack of expertise in HACCP/RMP implementation	1.50	37.50
Need to modify production process	1.00	30.00
Have to cut down number of products	0.00	52.50
We are too small for HACCP/RMP	0.00	70.00

Note: Highlighted areas show the above average ranks.

The differentiation of implementation problems according plant size and type (Tables 30 and 31) also shows that the implementation cost is the biggest concern for all plant sizes and types. Small plants and abattoirs however are not very concerned about the impacts of HACCP/RMP on flexibility in introducing new products compared with other types of plant. This could be explained by the fact that they have less processing activities than the others. On the other hand, small plants are more concerned about the resources required for the implementation task, especially in terms of HACCP/RMP expertise. Results for abattoirs also indicate that the level of difficulty is higher for most of the implementation issues.

Table 30. Implementation Problems (Median score) and Plant Size

Problem	Small Plant	Medium Plant	Large Plant
Recouping costs of implementing HACCP/RMP	5.00	5.50	5.00
Reduced flexibility to introduce new products	2.00	5.50	5.00
Reduced staff time available for other tasks	3.00	4.50	4.00
Reduced flexibility of production process	4.00	4.50	4.00
Need to retrain supervisory/managerial staff	3.00	2.50	3.00
Need to retrain production staff	3.00	3.50	3.00
Reduced flexibility of production staff	3.00	1.00	3.00
Attitude/motivation of supervisory/managerial staff	2.00	2.00	3.00
Attitude/motivation of production staff	2.00	2.50	3.00
Lack of expertise in HACCP/RMP implementation	3.00	1.50	1.00
Need to modify production process	0.00	2.00	1.00
Have to cut down number of products	0.00	1.00	0.00
We are too small for HACCP/RMP	0.00	0.00	0.00

Note: Highlighted areas show the above average ranks.

Table 31. Implementation Problems (Median score) and Plant Type

Problem	Abattoir	Packing House	Meat Export
Recouping costs of implementing HACCP/RMP	5.55	5.00	5.00
Reduced flexibility to introduce new products	2.00	6.00	5.00
Reduced staff time available for other tasks	4.00	3.00	5.00
Reduced flexibility of production process	3.00	4.00	4.00
Need to retrain supervisory/managerial staff	3.50	3.00	3.00
Need to retrain production staff	4.50	3.00	3.00
Reduced flexibility of production staff	2.00	1.00	3.00
Attitude/motivation of supervisory/managerial staff	3.00	2.00	2.00
Attitude/motivation of production staff	3.00	2.00	2.00
Lack of expertise in HACCP/RMP implementation	2.50	1.00	1.00
Need to modify production process	1.50	1.00	1.00
Have to cut down number of products	1.00	1.00	0.00
We are too small for HACCP/RMP	2.50	0.00	0.00

Note: Highlighted areas show the above average ranks.

5.4. Chapter Conclusion

The chapter has discussed survey respondents' experiences with HACCP/RMP implementation. In particular, adoption status, plan design, implementation time, motivation, and implementation problems have been analysed. The main conclusions that have implications for policy design are discussed below:

(1) *HACCP/RMP implementation process*:

(a) In general, small plants and those just serving the local market (abattoirs) lagged behind in both HACCP and RMP implementation. Only about 60% of those plants have implemented HACCP. Sixty percent of small plants and 33% of abattoirs have completed RMP implementation. HACCP has been adopted for quite a long time (average five years), while RMP has just been around for average eight months.

(b) Plants with more processing activities and more complicated production process (large plants and export slaughterhouses) spent more time to implement HACCP/RMP. Average implementation time for RMP is also longer than time spent for HACCP (8.5 months vs. five months), despite the fact that RMP were mostly based on existing HACCP. Many respondents have pointed out that RMP evaluation and registration are very time consuming. This time cost is an issue for NZFSA as it considers the ongoing implementation of RMP.

(c) More plants (in all categories) seek external consultants in developing RMP than with HACCP. One reason, highlighted by respondents, is that there are difficulties in understanding RMP requirements. This is another area that the NZFSA needs to take into account when reviewing RMP.

(2) *Firm motivations*: External factors such as meeting legal requirements, customer requirements, and gaining market access are ranked higher than internal factors such as increasing production efficiency or control of production process. This implies respondents in general have known of HACCP/RMP as a marketing advantage but not as a business management tool. Small plants show less motivation to adopt HACCP/RMP. This explains why they lagged behind in the implementation process.

(3) *Implementation problems*: All types of respondents were very concerned about the costs of the implementation. Costs in terms of reducing staff time available for other tasks and reducing the flexibility of the production process are also a concern. Small plants and abattoirs are more concerned about the lack of expertise in HACCP/RMP implementation, which suggests that they may need assistance with their RMP implementation.

Partial exit or cutting down number of products seems not a problem for the surveyed plants. This implementation issue is ranked very low (between zero and one) for all plant types and sizes (Tables 30 and 31).

CHAPTER 6

PLANT OBSERVATIONS ON HACCP/RMP COSTS AND BENEFITS

"The estimated cost at $10,000 to implement RMP has been a major financial burden…"

Anonymous survey participant, speaking on the cost of HACCP/RMP, 2003

"HACCP implementation involved process understanding, staff commitment, and management buy in…"

Anonymous survey participant, speaking on the management benefit of HACCP/RMP, 2003

6.1. HACCP/RMP Costs

This section outlines the plant costs that occur due to the implementation of HACCP/RMP. It also reports information collected from plants about the costs of HACCP/RMP. Survey results are further differentiated by plant size and type.

6.1.1. Types of Costs

The Animal Products Act 1999 required each animal primary processing business to have a RMP based on HACCP principles. It also stated that RMP must be individually designed and implemented to suit business production characteristics. This has shifted most of the tasks in food safety management to firms. Descriptions of the tasks involved in a RMP implementation are discussed in Table 3, Chapter 1.

Based on these tasks, costs of HACCP/RMP implementation are often grouped into implementation costs and operating costs.

Implementation costs include:

- HACCP/RMP plan design and development cost: this cost involves staff time spending in information searching, data gathering, and developing all the components of the plan (hazard analysis, determining of critical control points, critical limits, monitoring procedures, corrective actions, record-keeping and verification activities). It may also include the costs of hiring external consultants to do the task. This cost depends on the complexity of the plan and also staff knowledge and skills in plan design and development.

- Evaluation cost: this is the amount charged by the evaluator for the evaluation of the RMP. This cost may occur with the implementation of voluntary HACCP as costs of the initial full audit carried out by the Verification Agency.

- Registration costs: this is the amount charged by NZFSA for the application to register RMP.

- Training cost: businesses may have to send their employees to HACCP/RMP training courses. This cost includes, for each trained employee, the cost of the course, travel and lodging expenses, and productivity loss (i.e. time out of work). Even, if there is just internal training, there is cost in terms of working time loss. This cost varies according to the numbers of trained employees and the extent of the training.

- Cost of production process modification, for examples, equipment purchases or new building. Businesses may have to buy new equipment, modify facilities or production technologies (e.g. washing and rinsing methods) due to the implementation of HACCP/RMP.

Operating costs include:

- Verification cost: this is the cost incurred due to internal verification activities or scheduled independent verification. For internal verification, this could be cost in terms of staff time taken from work or productivity loss. For independent verification, it is the amount charged by the verification agency.

- Cost of product testing and sampling: businesses may have to do more sampling and testing with HACCP/RMP than with existing QMSs. For example, for HACCP required by the USA, there is more testing for Salmonella and E. Coli. The costs involved normally include time lost and testing fees.

- Record-keeping cost: this is normally the time taken in making observations and recording the results plus the cost of certifying and maintaining records. It depends on the complexity of the production process (e.g. the number of processing lines) and the complexity of HACCP/RMP plan (e.g. the number of critical control points).

- Recurrent training cost: this cost is incurred due to employee turnover. As the meat industry operates seasonally, changing staff may result in new training for new staff.

6.1.2. Survey Results

The pre-test survey has suggested that plants often do not have a detailed record of costs associated with the implementation of HACCP/RMP. In fact, survey results showed that 93% of respondents do not keep a separate record for HACCP/RMP implementation. Therefore, to gain information about HACCP/RMP costs, we asked respondents to rank a list of costs according to their importance in the total implementation or operating cost. For example, respondents were asked to give rank 1 for the largest cost, rank 2 for the second largest and further. They were also asked to give rank zero for the cost items that have not been incurred. There was also space for respondents to provide any estimate they may have in terms of time loss or the amount spent. Examples of cost estimates are provided in Table 32.

Table 32. Examples of HACCP/RMP Cost Estimates

Costs	Examples of Estimates
Implementation costs	
Plan design and development	Ranged from $18,000 - $70,000 or 60 – 80 working hours
Evaluation/Register	$5,000 - $10,000 for evaluation $100 for registration
Training	$0* - $20,000
Equipment purchase, new building	$0* - $3,500
Operating costs	
Verification	No examples. Respondents indicated that MAF VA takes more time as they become familiar with the program.
Sampling/Testing	$0* - $100,000 p.a.
Record-keeping	$0* - $10,000 p.a.
Recurrent training	$0* - $10,000

*No more than with existing QMSs

Median score and the percentage of ranking one and zero for each cost item are reported in Table 33.

Table 33. Ranking of Costs

Costs	Median	% rank 1	% rank 0
Implementation costs			
Design and development	1.00	57.14	0.00
Evaluation/Register	2.00	42.86	2.86
Training	2.00	20.00	14.29
Equipment purchases, new building	0.00	2.86	62.86
Operating costs			
Verification	1.00	68.57	2.86
Sampling/Testing	2.00	31.43	14.29
Record-keeping	2.00	17.14	11.43
Recurrent training	3.00	17.14	22.86

The ranking of costs indicates that: plan design and development and verification are the two significant costs. Ranking of implementation costs is similar to the international experience (see for example Henson et al, 2000), which found design and development cost has the biggest weight especially in terms of staff time in documenting systems. However, while the international experience seems to point to record keeping as a highest proportion of operating costs, it was not indicated as such in this survey. Verification cost was ranked the first in operating costs perhaps because the process is time consuming, as has been highlighted by respondents (see also HACCP/RMP feedbacks, Appendix 2). A large proportion of respondents (63%) have not experienced any new investment in equipment or new building. Also, recurrent training is not a significant cost.

Table 34 provides the ranking of HACCP/RMP costs for different plant sizes. All plants seem to agree on the point that design and verification are the two significant costs. In fact, it is obvious for medium and large plants as they have to design more complicated HACCP/RMP plan due to their production characteristics. Small plants put more weight on evaluation and training costs as these may also be large spending given their smaller production scale. They have also spent on new equipments but the amount is not as significant as the other implementation cost items. Among operating costs, large plants put more weight on sampling and testing, while medium plants indicate a large proportion of record-keeping cost. Small plants seem not to experience recurrent training costs while medium and large plants do but with insignificant amounts.

Table 34. Median Rank of Costs According to Plant Sizes

Costs	Small Plant	Medium Plant	Large Plant
Implementation costs			
Design and development	1.50	1.00	1.00
Evaluation/Register	1.00	2.00	2.00
Training	1.00	2.50	3.00
Equipment purchases, new building	3.00	0.00	0.00
Operating costs			
Verification	1.00	1.00	1.00
Sampling/Testing	2.00	2.50	1.00
Record-keeping	2.50	1.00	3.00
Recurrent training	0.50	3.50	3.00

Note: Highlighted areas show significant findings.

Table 35 shows respondents' cost rankings according to plant types. Design and verification costs are still the highest costs. Packing houses, however, seem to rank all costs equally. This could be influenced by the fact that they incurred high training, sampling/testing, and record-keeping costs due to having more processing activities at a smaller production scale compared to export slaughterhouses. Both packing houses and export slaughterhouses seem not to be experiencing large spending on new equipment while abattoirs showed a considerable amount.

Table 35. Median Rank of Costs According to Plant Types

Costs	Abattoir	Packing House	Meat Export
Implementation costs			
Design and development	1.50	1.50	1.00
Evaluation/Register	1.50	1.00	2.00
Training	3.00	1.50	3.00
Equipment purchases, new building	2.00	0.00	0.00
Operating costs			
Verification	1.50	1.00	1.00
Sampling/Testing	3.00	1.50	2.00
Record-keeping	1.50	1.50	2.00
Recurred training	3.00	1.00	4.00

Note: Highlighted areas show significant findings.

6.2. HACCP/RMP Benefits

This section discusses the benefits that may occur to businesses due to the implementation of HACCP/RMP. Plant observations of HACCP/RMP benefits are reported and further differentiated according plant sizes and types.

The current literature on HACCP/RMP implementation (see also Chapter 2) has suggested the following types of benefits:

(1) Improvement in food safety and quality;

(2) Improvement in market access (or marketing benefits); and

(3) Management benefits.

A list of benefits was constructed and introduced to respondents. They were then asked to rank each benefit on a 7-point scale according to its importance relative to the overall benefit of HACCP/RMP. There was also a rank zero to cover for cases where the benefit has not been observed. Median score and percentage of rank zero for each benefit item is reported in Table 36.

Table 36. HACCP/RMP Benefits

Benefit	Median	% rank 0
Increased ability to access new overseas markets	6.00	26.67
Increased ability to attract new customers	5.00	26.67
Increased ability to retain existing customers	5.00	20.00
Increased control over operating process	4.00	20.00
Reduced product microbial counts	2.50	33.33
Reduced product rework	2.00	40.00
Increase sales	1.50	46.67
Increased product shelf life	1.00	46.67
Increased product prices	1.00	40.00
Increased efficiency in the use of inputs	0.50	40.00
Reduced production costs	0.00	40.00

Note: Highlighted areas show the above average ranks.

Marketing benefits in general have highest ranks and also lowest percentages of rank zero. It shows that maintaining and enhancing market access have been recognised as the significant benefits of HACCP/RMP. The management benefit of improving control over the operating process is also recognised as an important benefit. The rest of benefits including quality/safety improvements, quality premiums, and production efficiency improvement are given much lower ranks.

Table 37. Median Rank of Benefits According to Plant Sizes

Benefit	Small	Medium	Large
Increased ability to access new overseas markets	0.00	6.50	6.00
Increased ability to attract new customers	0.00	5.00	5.00
Increased ability to retain existing customers	1.00	5.50	5.00
Increased control over operating process	1.00	5.00	4.00
Reduced product microbial counts	0.00	4.50	0.00
Reduced product rework	0.00	4.50	2.00
Increase sales	0.00	2.50	3.00
Increased product shelf life	0.00	2.00	1.00
Increased product prices	1.00	0.50	0.00
Increased efficiency in the use of inputs	0.00	3.00	0.00
Reduced production costs	0.00	4.00	0.00

Note: Highlighted areas show the above average ranks.

The differentiation of benefit observations according plant sizes shows that HACCP/RMP marketing benefits are mostly experienced by medium and large plants. The local market which most of small plants are operating in provides limited marketing incentives. Small plants also gave very low ranks to other benefit items while medium plants gave higher ranks for most of them. It suggests the plants that export and engage in various processing activities at a medium production scale could benefit the most from having HACCP/RMP.

The differentiation of benefit observations according to plant types (Table 38) shows that meat export slaughterhouses are the plants that experienced the most benefits. Results for abattoirs must be handled with care as there are few valid responses in this small group (average two missing values in a total of six observations). Average benefit ranks given by packing houses are very low. This could be influenced by the mix of all plant sizes in this group.

Table 38. Median Rank of Benefits According to Plant Types

Benefit	Abattoir	Packing House	Meat Export
Increased ability to access new overseas markets	7.00	5.00	6.00
Increased ability to attract new customers	5.50	2.00	5.00
Increased ability to retain existing customers	6.00	3.00	6.00
Increased control over operating process	4.50	1.00	5.00
Reduced product microbial counts	6.00	0.00	5.00
Reduced product rework	5.00	0.00	4.00
Increase sales	4.00	0.00	4.00
Increased product shelf life	3.00	0.00	4.00
Increased product prices	1.00	0.00	3.00
Increased efficiency in the use of inputs	2.50	0.00	3.00
Reduced production costs	5.50	0.00	0.00

Note: Highlighted areas show the above average ranks.

6.3. Chapter Conclusion

This chapter has presented respondents' observations about the costs and benefits of HACCP/RMP implementation. In summary, the significant points are:

(1) HACCP/RMP costs: plan design and verification are considered significant costs by all plant types and sizes. Small plants seem to put more weight on evaluation and training costs. Large plants seem to put more weight on sampling and testing, while medium plants indicated a large proportion of record-keeping cost. Among plant types, packing houses seem to rank all costs equally. It suggests that plants with more processing activities could incur higher training, sampling/testing, and record-keeping costs.

(2) HACCP/RMP benefits: marketing benefits are recognised as the most important benefits. Among different plant sizes, medium and large plants

have observed the importance of HACCP/RMP marketing benefits and other benefits while small plants seem not to experience any of these benefits. Among different plant types, meat export slaughterhouses have experienced most of the benefits while packing houses reported the least.

The specific characteristics of food safety management in New Zealand may have influence on plant observations of the benefits and costs of HACCP/RMP. As HACCP has been voluntarily adopted for years and RMP is recently mandated, it is likely that the observations on costs are influenced by plants' recent experiences with RMP implementation and benefit observations are drawn from experiences with HACCP. More details on the relationship of plant characteristics and HACCP/RMP implementation issues are discussed in the next chapter.

CHAPTER 7

ANALYSIS OF THE RELATIONSHIP BETWEEN PLANT CHARACTERISTICS AND HACCP/RMP IMPLEMENTATION ISSUES

This chapter considers the influences of plant characteristics on HACCP/RMP implementation issues. These issues have been discussed in the previous chapters, including plant motivation, implementation problems, costs and benefits of HACCP/RMP implementation. The plant characteristics considered in this analysis include: plant size, type, age, products, activities, export status, and food safety management practices.

7.1 Analysis Method

A nonparametric method is chosen for measuring the association of the observed variables. The nonparametric method is commonly used for analysing ordinal and nominal data (Argyrous, 1996). In addition, the method is simple to use and does not require any assumptions about data distribution as in the case of parametric methods.

Ordinal variables are those for which the values can be ordered on a dimension (Nowaczyk, 1988). However, the values may not be equally spaced on the dimension. Variables that have ranks as values are common ordinal variables. They indicate the levels of the dimension (for example, bad, good, excellent) but do not show how much better or stronger one case is compared with another. In the survey questionnaire, the respondents were asked to rank each implementation issue on a 7-point scale. This provides information in the form of ordinal data.

Nominal variables are those that indicate the category that a case falls into. In other words, they are not related to each other on any type of numerical dimension. They are simply used for categorising data, and thus are called categorical variables. Among plant characteristics, plant type and export status are nominal variables.

The common used measure of association for ordinal and nominal variables are Gamma and Lambda (Argyrous, 1996). They are both discussed in the next sections.

7.1.1. Gamma

The value of Gamma is specified as:

$$G = (N_c - N_d)/(N_c + N_d)$$

where

N_c is the number of concordant pairs. Concordant pairs are defined as the two cases that are ranked the same on both variables. For example, if large firm A ranks an item higher than small firm B, then A and B make a concordant pair.

N_d is the number of discordant pairs. Discordant pairs are defined as the two cases that are ranked differently on both variables. In the above example, if large firm A ranks an item less than small firm B, then A and B make a discordant pair.

The association between variables is positive if the sample contains a lot of concordant pairs and few discordant pairs. In other words, in positive association, the value of Gamma is positive and vice versa. There will be no association between variables if the number of concordant pairs equals discordant pairs (Gamma is zero). Gamma takes value between -1 and +1. A value of -1 indicates perfect negative association while +1 shows perfect positive association.

To calculate Gamma, the two variables are arranged in a bivariate table so that concordant and discordant pairs can be counted. A SPSS procedure is employed to calculate Gamma for all pairs of variables between ranked items (motivations, problems, costs, and benefits) and plant characteristics (size, age, number of products, number of QMS, and number of activities). Here, size indicates plant size which takes value one for small plants, two for medium plants, and three for large plants. Age is a variable measured by plant's operating years (ranged from two to 203 years). Number of products (PROD) are products counted in terms of the number of animal types that handled by the plants (ranged from one to six animal types). Number of QMS represents the number of quality/safety assurance systems adopted by the plant, excluding HACCP/RMP (one to six QMSs). Number of activities (SP) takes value one if there is a single activity, two if both slaughtering and processing. Note that for age, the correlation coefficient computed is Spearman's rho instead of Gamma as age has a wide range of values, which makes it more appropriate to use Spearman's rho (Argyrous, 1996), although the two measures are similar.

7.1.2. Lambda

When measuring association between two variables of which one is nominal, Lambda is commonly used. To calculate Lambda, the following procedure is used:

(1) Predict the dependent variable while ignoring the information provided by the independent variable. For example, when measuring association between a ranked implementation issue and plant type, the former is a dependent variable and the latter is an independent variable. In this case, we predict the rank without noticing the type of the plant. The simplest procedure is to assume the rank is the same for all categories.

(2) Predict the dependent variable using knowledge of the independent variable. In the above example, if we suspect that abattoirs generate a

lower rank than packing houses, then we guess lower ranks for those belonging to the abattoir group.

Then, the formula for Lambda is given by:

$$\lambda = (E_1 - E_2)/E_1$$

where

E_1 is the number of errors without information on the independent variable

E_2 is the number of errors with information on the independent variable.

The idea behind Lambda is that, if there is an association between the two variables, then the number of errors is smaller in the second case. Lambda therefore takes a value between zero and one. According to the value of Lambda, the strength of the relationship is categorised as in Table 39.

Table 39. Lambda and the Strength of the Association between Two Variables

Range	Relative strength
0.0-0.2	Very weak, negligible relationship
0.2-0.4	Weak, low association
0.4-0.7	Moderate association
0.7-0.9	Strong, high, marked association
0.9-1.0	Very high, very strong relationship

Source: Argyrous, 1996

Lambda therefore will allow us to examine the strength of the relationship but not its direction. In this case, information from the frequency table (or bivariate table or cross-tabulation) could help to indicate further the direction of the relationship. To calculate Lambda, the SPSS procedure is employed. Lambda is calculated for the two cases: (1) plant type and (2) plant export status. For plant type (TYPE), there are three categories: (1) abattoir, (2) packing house, and (3) meat export slaughterhouse. For plant export status (EXPT), there are two categories: (1) export plant, and (2) non-export plant.

7.1.3. Chi-square Test

A Chi-square significance test is conducted to see if the sample correlation is representative for the whole population. This test is similar to a test for independence, in which the null hypothesis stating that there is no relationship between the two variables. Therefore, if the chi-square test indicates a chi-square value greater than the critical value or the p-value of the test is smaller than 0.05 (or 0.1), the null hypothesis is rejected. In this case, it indicates a significant relationship between the two variables that can be representative for the whole population at a significance level of 95% (or 90%).

7.2. Results

Tables 40-43 show values of Gamma, Lambda and p-values of the chi-square test for all pairs of variables between HACCP/RMP adoption motivations, implementation problems, benefits, costs and plant characteristics. Based on these values, the relationships between plant characteristics and HACCP/RMP implementation issues are discussed in the next sections. For each issue, the discussion of sample characteristics is followed by the significant relationships that can be attributed to the general population.

Table 40. Association between Motivations and Plant Characteristics

Motivations	Size(c)	Age(a)	PROD(c)	QMS(c)	SP(c)	EXPT(b)	Type(b)
Meet legal requirements	0.244 (0.194)	-0.178 (0.299)	-0.322 (0.425)	-0.310 (0.012)**	-0.127 (0.296)	0.040 (0.021)**	0.059 (0.164)
Meet the needs of major customers	0.241 (0.424)	-0.301 (0.074)*	-0.085 (0.001)***	-0.044 (0.007)***	0.072 (0.242)	0.075 (0.027)**	0.048 (0.020)**
Attract new customers for products	-0.070 (0.830)	-0.431 (0.009)***	0.028 (0.032)**	-0.141 (0.304)	-0.043 (0.799)	0.015 (0.853)	0.033 (0.644)
Access new overseas markets	0.040 (0.240)	-0.309 (0.066)*	0.096 (0.320)	-0.242 (0.134)	0.307 (0.044)**	0.014 (0.809)	0.041 (0.446)
Reduce customer complaints	0.246 (0.920)	-0.039 (0.823)	-0.081 (0.847)	0.165 (0.119)	0.404 (0.286)	0.019 (0.431)	0.036 (0.406)
Reduce product wastage	0.125 (0.748)	-0.054 (0.756)	-0.039 (0.841)	0.152 (0.027)**	0.261 (0.055)*	0.030 (0.103)	0.040 (0.332)
Improve control of production process	0.077 (0.727)	-0.260 (0.125)	-0.196 (0.545)	-0.013 (0.100)*	0.249 (0.648)	0.017 (0.774)	0.061 (0.622)
Improve product quality	0.074 (0.298)	-0.210 (0.218)	-0.295 (0.052)*	-0.118 (0.048)**	0.106 (0.605)	0.018 (0.750)	0.067 (0.205)
Improve efficiency/profitability of plants	0.180 (0.223)	-0.040 (0.815)	-0.297 (0.603)	-0.038 (0.025)**	0.321 (0.376)	0.020 (0.460)	0.031 (0.726)
Recommended by MAF/Industry Association	-0.181 (0.173)	-0.144 (0.402)	0.000 (0.246)	-0.124 (0.009)***	0.114 (0.752)	0.038 (0.290)	0.069 (0.323)
Generally regarded as good practice	-0.041 (0.889)	-0.324 (0.054)*	-0.073 (0.109)	-0.302 (0.000)***	0.004 (0.681)	0.017 (0.774)	0.032 (0.883)
Generally regarded as Board or CEO country wide policy	0.274 (0.047)**	-0.133 (0.438)	-0.495 (0.107)	-0.074 (0.013)**	0.412 (0.332)	0.014 (0.868)	0.133 (0.104)
Needed for plant to be third party accredited	0.278 (0.514)	0.035 (0.838)	0.080 (0.167)	0.258 (0.003)***	0.386 (0.681)	0.036 (0.143)	0.125 (0.027)**
Reduce need for quality audits by customers	0.040 (0.239)	-0.021 (0.903)	0.000 (0.693)	-0.043 (0.069)*	0.061 (0.164)	0.014 (0.830)	0.055 (0.261)

Note: P-value of significance test in brackets; *, **, *** denote significance at 90%, 95%, 99%; (a) Spearman's rho; (b) Lambda; (c) Gamma

Table 41. Association between Problems and Plant Characteristics

Problems	Size(c)	Age(r)	PROD(c)	QMS(c)	SP(c)	EXPT(b)	Type(b)
We are too small for HACCP/RMP	-0.388 (0.040)**	0.051 (0.767)	0.169 (0.542)	0.171 (0.461)	-0.203 (0.215)	0.045 (0.131)	0.083 (0.046)**
Lack of expertise in HACCP/RMP implementation	-0.052 (0.695)	-0.022 (0.897)	-0.044 (0.991)	0.112 (0.119)	-0.268 (0.499)	0.043 (0.326)	0.040 (0.735)
Need to retrain supervisory/managerial staff	0.047 (0.894)	0.019 (0.910)	0.043 (0.293)	0.076 (0.295)	-0.286 (0.594)	0.014 (0.842)	0.011 (0.997)
Need to retrain production staff	0.011 (0.199)	0.060 (0.727)	-0.019 (0.860)	0.075 (0.241)	0.037 (0.159)	0.014 (0.811)	0.034 (0.463)
Attitude/motivation of supervisory/managerial staff	0.232 (0.676)	0.172 (0.315)	0.011 (0.415)	0.017 (0.410)	-0.045 (0.362)	0.034 (0.513)	0.063 (0.325)
Attitude/motivation of production staff	0.140 (0.636)	0.189 (0.270)	-0.028 (0.919)	0.064 (0.437)	0.165 (0.133)	0.020 (0.419)	0.027 (0.693)
Reduced staff time available for other tasks	0.152 (0.927)	0.276 (0.104)	0.265 (0.809)	0.055 (0.049)**	0.149 (0.533)	0.067 (0.366)	0.121 (0.380)
Reduced flexibility of production process	0.095 (0.222)	0.130 (0.450)	0.221 (0.613)	0.228 (0.365)	0.336 (0.334)	0.071 (0.087)*	0.125 (0.175)
Reduced flexibility of production staff	0.172 (0.355)	0.115 (0.504)	0.296 (0.111)	0.362 (0.068)*	0.299 (0.276)	0.074 (0.556)	0.067 (0.597)
Reduced flexibility to introduce new products	0.149 (0.555)	-0.049 (0.776)	-0.040 (0.281)	0.132 (0.236)	-0.054 (0.811)	0.034 (0.478)	0.125 (0.375)
Need to modify production process	-0.069 (0.248)	-0.176 (0.305)	0.243 (0.038)**	0.039 (0.400)	-0.032 (0.974)	0.015 (0.576)	0.036 (0.707)
Have to cut down number of products	-0.045 (0.570)	-0.016 (0.926)	0.127 (0.382)	-0.078 (0.729)	-0.237 (0.154)	0.012 (0.888)	0.053 (0.347)
Recouping costs of implementing HACCP/RMP	-0.206 (0.794)	-0.069 (0.689)	0.125 (0.807)	0.000 (0.863)	-0.237 (0.485)	0.016 (0.412)	0.069 (0.461)

Note: P-value of significance test in brackets; *, **, *** denote significance at 90%, 95%, 99%; (a) Spearman's rho; (b) Lambda; (c) Gamma

Table 42. Association between Benefits and Plant Characteristics

Benefits	Size(c)	Age(a)	PROD(c)	QMS(c)	SP(c)	EXPT(b)	Type(b)
Increased product shelf life	0.147 (0.953)	-0.004 (0.983)	0.136 (0.000)***	0.068 (0.282)	0.389 (0.775)	0.053 (0.240)	0.048 (0.235)
Reduced product microbial counts	-0.077 (0.336)	-0.068 (0.695)	0.191 (0.413)	-0.062 (0.486)	0.096 (0.231)	0.015 (0.582)	0.045 (0.032)**
Reduced product rework	0.137 (0.418)	0.125 (0.467)	0.056 (0.400)	-0.037 (0.387)	0.277 (0.783)	0.045 (0.649)	0.042 (0.264)
Increased efficiency in the use of inputs	0.006 (0.525)	-0.025 (0.883)	0.135 (0.500)	-0.063 (0.322)	0.214 (0.588)	0.020 (0.519)	0.053 (0.314)
Increased control over operating process	-0.003 (0.021)**	-0.058 (0.738)	0.143 (0.176)	-0.080 (0.134)	0.034 (0.180)	0.080 (0.381)	0.074 (0.096)*
Reduced production costs	-0.170 (0.142)	0.019 (0.910)	0.116 (0.261)	-0.134 (0.927)	-0.020 (0.180)	0.024 (0.474)	0.055 (0.097)*
Increased product prices	0.000 (0.217)	-0.148 (0.389)	0.096 (0.502)	-0.217 (0.449)	-0.032 (0.192)	0.024 (0.054)*	0.053 (0.067)*
Increase sales	0.022 (0.169)	0.049 (0.776)	0.175 (0.222)	-0.072 (0.630)	0.210 (0.489)	0.028 (0.037)**	0.078 (0.063)*
Increased ability to retain existing customers	0.178 (0.361)	0.048 (0.779)	0.004 (0.221)	-0.074 (0.320	0.292 (0.167)	0.014 (0.859)	0.069 (0.298)
Increased ability to attract new customers	0.197 (0.330)	0.064 (0.710)	0.075 (0.374)	-0.054 (0.102)	0.259 (0.453)	0.012 (0.890)	0.069 (0.260)
Increased ability to access new overseas markets	0.000 (0.734)	-0.110 (0.524)	0.256 (0.765)	-0.289 (0.260)	0.073 (0.763)	0.015 (0.869)	0.049 (0.529)

Note: P-value of significance test in brackets; *, **, *** denote significance at 90%, 95%, 99%; (a) Spearman's rho; (b) Lambda; (c) Gamma

Table 43. Association between Costs and Plant Characteristics

Costs	Size(c)	Age(a)	PROD(c)	QMS(c)	SP(c)	EXPT(b)	Type(b)
Implementation costs							
Design and development costs	0.161	0.381	-0.159	0.237	0.148	0.009	0.047
	(0.536)	(0.032)**	(0.614)	(0.214)	(0.912)	(0.678)	(0.346)
Evaluation/Register costs	0.243	-0.100	0.010	-0.249	0.664	0.021	0.050
	(0.109)	(0.593)	(0.249)	(0.735)	(0.332)	(0.033)**	(0.108)
Training costs	0.116	0.326	-0.119	0.276	0.472	0.038	0.034
	(0.708)	(0.097)*	(0.458)	(0.021)**	(0.508)	(0.421	(0.742
Equipment purchases, new building	0.042	-0.410	-0.265	-0.289	-0.429	0.056	0.101
	(0.413)	(0.164	(0.595)	(0.239)	(0.569)	(0.315	(0.446)
Operating costs							
Verification	0.008	0.278	-0.190	0.645	0.580	0.003	0.046
	(0.929)	(0.130)	(0.956)	(0.108)	(0.472)	(0.901)	(0.703)
Sampling/Testing	-0.484	-0.259	-0.086	0.226	-0.339	0.023	0.105
	(0.109)	(0.192)	(0.371)	(0.313)	(0.462)	(0.447)	(0.312)
Record-keeping	0.330	0.269	0.055	0.014	0.106	0.013	0.050
	(0.186)	(0.167)	(0.552)	(0.039)**	(0.903)	(0.654)	(0.750)
Recurred training costs	0.237	-0.035	-0.112	0.274	0.179	0.108	0.083
	(0.688)	(0.867)	(0.678)	(0.746)	(0.856)	(0.125)	(0.488)

Note: P-value of significance test in brackets; *, **, *** denote significance at 90%, 95%, 99%; (a) Spearman's rho; (b) Lambda; (c) Gamma

7.2.1. Motivation (see Table 40)

7.2.1.1. Plant Size

Results for size show that larger plants give higher ranks to most of the motivation issues (Gamma positive). They are more motivated in meeting legal requirements as well as customer requirements. Larger plants also seem more motivated with regard to the internal impacts of HACCP/RMP such as improving control of the production process or improving production efficiency. Smaller plants however are more interested in HACCP/RMP because it is recommended by the industry association or because it is regarded as a good practise or as the program provides the potential for attracting customers. There is one significant relationship, indicating that larger plants are more interested in HACCP/RMP as the program is regarded as a country wide policy.

7.2.1.2. Plant Age

Most Gamma values for age are negative, indicating that older plants are less motivated than younger plants. The significant associations between plant age and motivation issues show that:

- Younger plants are much more interested in HACCP/RMP for the reason of gaining new customers and market access.

- Younger plants are also interested in HACCP/RMP as the program is generally regarded as a good practice in food safety management.

7.2.1.3. Products

Generally plants with more product types are less motivated in adopting HACCP/RMP (most Gammas negative). This could be due to the fact that a HACCP/RMP plan is required for each type of products. The more products the plant has the more time and resources it has to spend with HACCP/RMP. Significant associations show that:

- Plants with more products are less interested in adopting HACCP/RMP to meet customer requirements but more interested in attracting new customers for products.

- Plants with more products are also less motivated in using HACCP/RMP for improving their product quality.

7.2.1.4. Quality Management System (QMS)

Again, most Gamma values are negative, showing that plants with more QMSs are less motivated in adopting HACCP/RMP. The reason could be that respondents consider the current food safety management practices are able to deal with food safety hazards and do not need further regulations. QMS is also the variable with the most significant results. It shows that, for the general population, the motivation to adopt HACCP/RMP is negatively affected by the number of the current quality/food safety management system at the plant. There are two cases that having significant and positive Gamma. These cases show that plants with more QMSs are interested in HACCP/RMP for the purpose of having a third party accreditation or reducing product wastage.

7.2.1.5. Plant Activities (SP)

Gamma values for SP show that plants with both slaughtering and processing activities are more motivated to adopt HACCP/RMP. There are just two cases, when plants with single activity show more interest in HACCP/RMP for the sake of meeting legal requirements and attracting new customers for their products. The significant associations indicate that plants, both slaughtering and processing, are more interested in HACCP/RMP for accessing new overseas markets and reducing wastage.

7.2.1.6. Export status (EXPT)

Lambda values for EXPT show a weak association between plant export status and HACCP/RMP adoption motivations. There are two cases with significant results, suggesting that in general export plants are more motivated in adopting HACCP/RMP for meeting legal as well as customer requirements.

7.2.1.7. Plant Type

Results for plant type also show a weak association between plant type and motivations. There are also two significant cases, indicating that meat export slaughterhouses are more motivated in adopting HACCP/RMP for the purposes of satisfying customer requirements and having third party accreditation.

7.2.2. Problems (see Table 41)

7.2.2.1. Size

Gamma values for plant size show that smaller plants have more problems with finding the resources (finance and expertise) for implementation task. They may also have to cut down their number of products or modify their production process due to HACCP/RMP. Larger plants, on the other hand, have more problems with training and motivating their staff. The significant results indicate that small plants in general are concerned about their small size affecting HACCP/RMP implementation.

7.2.2.2. Age

Results for plant age show that younger plants are more concerned with finding resources for HACCP/RMP implementation, modifying production process, and cutting down the number of their products. They are also more concerned about impacts of the implementation on the flexibility to introduce new products. As with large plants, older plants are more worried about training and motivating their staff (both managerial and production staff) for the implementation task.

7.2.2.3. Products

Plants with more product types seem to have fewer problems in finding human resources (expertise) for the implementation task. They also have fewer problems regarding the training and motivation for production staff. The significant results show that in general plants with more product types may have more problems with modifying their production process due to HACCP/RMP implementation.

7.2.2.4. QMS

As most Gamma values for QMS are positive, it suggests that plants with more QMSs have to deal with more difficult implementation issues. The significant results suggest that plants having more QMSs may find HACCP/RMP implementation reducing their staff time for other production tasks or reducing the flexibility of the production staff.

7.2.2.5. Activities

Plants that are doing both slaughtering and processing show more problems with finding resources, motivating managerial staff, modifying production process, and cutting product number.

7.2.2.6. Export

Lambda values for export status show a weak association between plant export status and implementation problems. One significant result shows that export plants may find HACCP/RMP reduces the flexibility of their production process.

7.2.2.7. Type

Results for plant type also show a weak relationship between plant type and implementation problems. One significant result shows that abattoirs and packing houses may be more concerned about their size and limited resource for HACCP/RMP implementation task.

7.2.3. Benefits (see Table 42)

7.2.3.1. Size

Gamma values for plant size suggest that smaller plants with HACCP/RMP, benefit more with improved product safety, control over the production process, and reduced production costs. Larger plants, on the other hand, find more benefits in terms of retaining and attracting customers and sales. Larger plants may also attain the benefits of improving product shelf life and reducing product re-work. The significant results show that in general smaller plants could have better control of their production process as a result of HACCP/RMP implementation.

7.2.3.2. Age

HACCP/RMP seems to help younger plants to improve their product quality and safety and to achieve other internal benefits. On the other hand, older plants seem to enjoy external benefits such as maintaining and attracting customers. Younger plants, however, seem to benefit more with regard to gaining overseas market access.

7.2.3.3. Products

Gamma values are all positive, showing that HACCP/RMP may bring more benefits (both internal and external) to plants with more products. One significant result shows that HACCP/RMP could help plants with more product types to improve product shelf life.

7.2.3.4. QMS

Most Gamma values for QMS are negative, suggesting that plant with more QMS observe less benefit from HACCP/RMP. It reflects the point that plants that are engaging in more food safety management activities are not highly motivated to adopt further standards.

7.2.3.5. Activities

Overall plants with more production activities benefit more from HACCP/RMP. There are only two cases when plants with a single activity observe more reduction in production costs and better product prices. However, these are weak associations.

7.2.3.6. Export

Although the associations between export status and HACCP/RMP benefits are weak, there are two cases where we observe significant relationships. These cases suggest that there are significant associations between plant export status and the gains in sales and prices as a result of HACCP/RMP. Export plants could gain a positive impact on their product prices and sales once adopting HACCP/RMP.

7.2.3.7. Type

There are several significant associations with plant type. Firstly, results also suggest that meat export slaughterhouses could be able to improve their sales and prices as a result of adopting HACCP/RMP. Secondly, they could also gain more internal benefits such as better control over the production process, reduction in production costs and microbial counts.

7.2.4. Costs (see Table 43)

As the rankings for costs are made according to the weights of the cost items, results for costs are analysed differently from the above issues. For example, if a respondent ranks 1 for an item, it means the item has the biggest weight in the total HACCP/RMP cost. To make the computation of Gamma and Lambda simple, rank 0 is excluded. Therefore, a higher rank means the cost item is less important. A positive Gamma for plant size, for example, indicates that large plants rank higher for the cost item, indicating that this cost is not significant to these plants.

7.2.4.1. Size

Results for plant size show that most cost items are more significant for smaller plants. Only sampling and testing cost is more significant for larger plants. Perhaps their larger throughput is one factor that contributes to the weight of this cost.

7.2.4.2. Age

Older plants seem to bear higher costs in evaluation and equipment purchases, compared with other implementation costs. They also put more weight on sampling/testing and recurred training costs. The significant associations suggest that, in general, younger plants could bear higher costs of plan design and staff training.

7.2.4.3. Products

Plants with more product types experienced higher costs for most items. For example, they have higher design, training, verification, and sampling/testing costs. Plants with fewer products seem to put more weight on evaluation and record-keeping costs. However, the relationships are weak and insignificant.

7.2.4.4. QMS

Plants with more QMSs seem to experience higher costs of evaluation and equipment purchases. The significant results suggest that plants having more QMSs could experience smaller staff training costs with HACCP/RMP implementation. They may also spend less on record-keeping cost. This could be the results of the experience they gained from dealing with other management systems.

7.2.4.5. Activities

Plants with more activities indicated higher spending on equipment purchases and sampling and testing costs. Plant with single activities, on the other hand, put more weight on design, evaluation, verification, and training costs.

7.2.4.6. Export and Type

Results suggest a weak association between these two variables and HACCP/RMP costs. There is one significant result for Export which suggests that export plants may bear a higher evaluation cost. However, the Lambda values again show a very weak relationship.

7.3. Chapter Conclusion

In this chapter, a nonparametric approach is employed to analyse the influences of plant characteristics on HACCP/RMP implementation process. Issues addressed include plant motivations in adopting these systems, implementation problems, and observations on benefits and costs. Based on the data gathered from our recent survey, the relationships between the rankings of these issues and plant characteristics are analysed. Analysis findings are summarised as follows:

(1) HACCP/RMP adoption motivations: plants that show more interests in HACCP/RMP are large plants, young plants, plants with fewer products, or having less QMSs. Also, plants that do both slaughtering and processing are more motivated than plants with single activity. Export plants show more interests in HACCP/RMP than non-export plants. However, the influences of plant export status and plant type on HACCP/RMP motivations are weak.

(2) Implementation problems: young and small plants show more problems with finding human and financial resources for HACCP/RMP implementation. On the other hand, old and large plants have more difficulties with the training and motivating their staff. Plants with complicated production processes (more products, more activities) are more likely to modify their production processes due to HACCP/RMP implementation. Plants that have more QMSs have to deal with more difficult implementation issues, especially in allocating staff time for both production and safety assurance tasks.

(3) HACCP/RMP benefits: small and young plants give higher ranks for the internal benefits (control of production process) while large and old plants enjoy more of the external benefits (retain and attract customers). Plants that have more complicated production processes (more products, more activities) gain more with HACCP/RMP. However, plants with more QMSs do not attach importance to HACCP/RMP benefits.

(4) HACCP/RMP costs: most cost items are more significant for small plants. Large plants and plants with more activities, on the other hand, have more significant sampling and testing costs. Young plants seem to spend more on plant design and training while old plants spend more on evaluation and equipment purchases. Plants having more QMSs indicate smaller spending on training and record-keeping costs.

PART III

MODELLING THE ECONOMIC IMPACTS OF HACCP/RMP ADOPTION

Chapter 8: HACCP/RMP Cost Estimation

Chapter 9: HACCP/RMP Implementation and Export Performance

Chapter 10: The Costs of Losing Market Access or the Potential Benefits of HACCP/RMP

Introduction

Chapter 6 has discussed meat plant observations on the costs and benefits associated with HACCP/RMP implementation. These are often considered the direct impacts that can be observed by respondents. Direct costs include the two main categories: implementation and operating costs. Direct benefits are categorised into: food safety, production management, quality premium, and market access benefits.

There are, however, secondary impacts or potential costs and benefits of the implementation. As discussed earlier in Chapter 2, potential costs of HACCP/RMP include changes in industry structure and welfare distribution impacts. Industry structure maybe affected as small firms may exit the market due to high compliance costs. There may also be distributional impacts due to losses of producer surplus and consumer surplus as a result of higher food prices. The potential benefits could be the saving of costs associated with bad quality and/or food safety outbreaks or costs of losing market access.

Table 44 summaries the direct and potential costs and benefits of HACCP/RMP on the food industry. It also provides examples of the methods used in quantifying these impacts.

Table 44. Summary of HACCP/RMP Costs and Benefits (Firm's Perspective)

	Costs	Quantifying Methods*	Benefits	Quantifying Methods*
Direct	▪ Implementation costs - Plan Design & Development - Evaluation/Register - Training - Equipment Purchases and/or New Building ▪ Operating costs: - Verification - Sampling/Testing - Record-keeping - Recurred Training	▪ By observations (e.g. FSIS (1996)) ▪ By observations (e.g. FSIS (1996)) And ▪ Estimating for non-observed costs using cost functions (e.g. Antle (2000))	▪ Reduce safety hazards (Improve product quality/safety) ▪ Management benefits (Improve production efficiency) ▪ Enhance/Maintain Overseas Market Access	▪ By observations (e.g. Henson et al (200)) ▪ Observations; Efficiency analysis (e.g. Nganje and Mazzocco (2000)) ▪ Export performance model (e.g. Zaibet (2000) and Alpay et al (2001))
Potential	▪ Reduction in number of products (partial exit) ▪ Small firms exit due to high compliance costs ▪ Loss of producer surplus as consumers switch to cheaper products	▪ Probit regression (e.g. Siebert et al (2000)) ▪ Probit regression (e.g. Muth et al (2001)) ▪ Multi-market models (e.g. Unnevehr et al (1998))	▪ Reduce costs associated with bad quality and/or food safety outbreak (costs of losing market access)	▪ Computable General Equilibrium (CGE) models (no studies to date regarding HACCP)

* For brief summaries of the methods used by the specified studies, see Chapter 2. Shaded areas are those covered in this study.

The purpose of part 3 of the thesis is to provide a quantitative analysis of the important secondary impacts of HACCP/RMP adoption on a New Zealand food industry (meat industry). The studied impacts include the change in variable cost of production due to HACCP/RMP adoption, impacts on meat industry export performance, and the potential benefits in terms of avoiding costs of losing market access. This focus reflects the three important reasons:

(1) Cost competitiveness is an essential component of firm competitiveness,

(2) Enhanced market access is an important benefit of adopting HACCP/RMP, especially for an export industry, and

(3) There is data available for quantifying these impacts.

As the research takes on an applied economic approach, we chose not to go further into discussing the modelling of other impacts. Instead, we focus on empirical methods of analysis for the three specified impacts. This is carried out in the following chapters. Chapter 8 presents a method for quantifying the change in variable cost of production due to HACCP/RMP adoption in the meat industry. Chapter 9 provides a model for analysing the impact of HACCP/RMP adoption on meat industry export performance. Chapter 10 employs a CGE model to estimate the cost of losing market access. It therefore gives an estimate of the potential benefits of adopting HACCP/RMP.

CHAPTER 8

HACCP/RMP COST ESTIMATION

The survey results provide a qualitative assessment of the costs involved with HACCP/RMP implementation. To have a closer look at the quantitative side of costs, in this chapter, secondary data is employed to estimate the effect of the implementation on changes in production costs. The current literature has suggested that food safety regulation such as HACCP/RMP has the potential to affect the operating efficiency of plants (see for example, Antle (2000)) and hence results in productivity losses and increasing operating costs. Our interviews with plants' representatives have revealed that HACCP/RMP have actually reduced the speed of the production lines. This implies that there are additional variable costs incurred such as increasing labour costs and increasing use of other material inputs. These costs are usually difficult to obtain in research using an accounting approach.

8.1. Review of Methods Used to Quantify Safety Compliance Costs

The literature has suggested three different approaches to quantify the direct costs of food safety regulation on industry: (1) accounting approach, (2) economic-engineering approach, and (3) econometric approach (see for example Antle (1999)).

8.1.1. Accounting Approach

In the accounting approach, costs are identified and calculated, without estimating a parametric representation of the cost function. According to Antle (1999), this method is unlikely to provide estimates of average costs for the whole industry due to the limited number of plants surveyed. Moreover, the accounting approach often underestimates costs, as the method is unable to measure effects of regulation on the overall operating efficiency of a plant. Examples of studies using the accounting method include: the study of the Food Safety Inspection Service (FSIS) on the costs of HACCP to the US meat and poultry industry (Crutchfield et al, 1997) and the study of Colatore and Caswell on costs of HACCP to the US breaded fish industry (Colatore and Caswell, 2000).

8.1.2. Economic-engineering Approach

The economic-engineering approach is described by Antle (1999) as a method using detailed engineering data combined with data on input costs to construct a quantitative model of the production process. This approach can provide a detailed picture of a plant's production process, but it is costly to implement for each plant studied. Therefore, it may fail to capture the heterogeneity of the industry and may not provide cost information that is representative for the industry. The study of Jensen and Unnevehr (2000) on the cost of implementing HACCP to the US pork industry provides an example of this approach.

8.1.3. Econometric Approach

With the econometric approach, cost functions are estimated and estimation results are then used to measure potential costs of regulation. Although the method cannot provide cost details as in the other two methods, its advantages are that the cost function can capture the actual production behaviour of the firm and provide a statistical basis to test for related hypotheses. Moreover, regulatory impacts on productive efficiency can be measured. Antle (2000) has provided a detailed framework for using this approach to measure the cost of HACCP to the US meat and poultry industry.

In this chapter, the econometric approach developed by Antle (2000) is employed to measure the impacts of HACCP/RMP on variable cost of production in the New Zealand red meat industry. Whereas Antle's study uses panel data, this study uses time series data, which allows for technical change to be considered.

8.2. Model and Data

8.2.1. Theoretical Framework

Antle (1999) showed that production cost can be divided into three components: (1) a variable cost component which depends on both output and product quality, (2) a separate variable cost component which depends on quality but is independent of output, and (3) a fixed cost component. Hence, if we characterised the quality-differentiated product by the triplet (y,s,**q**), where y is output quantity, s is product safety, and **q** is a vector of other non-safety quality attributes, then the cost function for a production process with quality control can be specified as:

$$C(y,s,\mathbf{q},w,k) = vc(y,s,\mathbf{q},\mathbf{w},k) + qc(s,\mathbf{q},\mathbf{w},k) + fc(k) \qquad (8.1)$$

where

w is a vector of input prices

k is the value of capital stock

vc(.) is the variable cost component that depends on both product quantity y and product quality s, q

qc(.) is the other variable cost component that is independent of y but depends on s and q

fc(k) is the conventional fixed cost component

The accounting method normally just accounts for the impacts of regulation on the cost components qc(.) and fc(.). Therefore, it is the purpose of this paper to measure the impacts on vc(.) or the productive efficiency impacts of food safety regulation.

The classical cost function usually does not account for product quality. The reason is that quality is normally treated as fixed in the short run. Additionally, many quality attributes are not readily observed and measured (Gertler and Waldman, 1992). Antle (2000), following Gertler and Waldman (1992), developed a model with an unobserved scalar safety variable whose parameter can be estimated using other observable variables.

To derive a measure for that unobserved safety variable, Antle (2000) utilized a model of a market in which price-taking firms produce a quality-differentiated product. While this assumption requires careful consideration in a highly concentrated market, it seems to be a reasonable assumption for the New Zealand meat experience, where exporting firms are price-takers in international markets.

Let product demand be described as $Y^D = D(P,S,\mathbf{Q},\mathbf{Z})$, where P is output price, S is product safety, **Q** is a vector of other quality attributes, and **Z** is a vector of other demand variables. Y^D is increasing in desirable quality attributes, for example, derivative with respect to S, $D_S > 0$. Market supply is given by $Y^M = M(P,S,\mathbf{Q},\mathbf{W},K)$ where W is a vector of input prices and K is the industry capital stock. Y^M is decreasing in quality attributes, for example, $M_S < 0$. As S is not observed, equating Y^D and Y^M to solve for S, we have:

$$S = F(\mathbf{Q},P,\mathbf{Z},\mathbf{W},K) \qquad (8.2)$$

which has the following properties:

- F(.) is increasing in price: $F_P > 0$
- Derivative with respect to elements of Q: $F_Q < 0$ for a given product price
- Derivatives with respect to elements of Z are opposite in sign from the derivatives of the demand function, and
- Derivatives with respect to W and K have the same sign as the derivatives of the supply function with respect to these variables.

8.2.2. Quality-Adjusted Translog Cost Function

Recall that the theoretical variable cost component, which depends on both product quality (s, **q**) and quantity y, is defined as vc(y,s,**q**,**w**,k). Here, q is a vector of other non-safety quality attributes. Management intensity (q_{man}), which is defined as the ratio of non-production labour to production labour, is used as a non-safety quality variable. The other quality variable (q_{mix}), which measures the proportion of processed product in total output, as used by Antle (2000), is not considered in this study due to data unavailability. This can also be explained by the fact that most meat processing businesses in New Zealand during the period studied specialized in either slaughtering or packaging. Hence, defining the input variable as consisting of labour (L) and other materials (M), the empirical variable cost function is specified as:

$$
\begin{aligned}
\ln VC = {} & \alpha_0 + \alpha_M \ln w_M + \frac{1}{2}\alpha_{MM}(\ln w_M)^2 + \alpha_L \ln w_L + \frac{1}{2}\alpha_{LL}(\ln w_L)^2 + \beta_y \ln y + \frac{1}{2}\beta_{yy}(\ln y)^2 \\
& + \delta_k \ln k + \frac{1}{2}\delta_{kk}(\ln k)^2 + \alpha_{ML} \ln w_M \ln w_L + \beta_{yM} \ln y \ln w_M + \beta_{yL} \ln y \ln w_L + \beta_{yk} \ln y \ln k + \\
& + \delta_{kM} \ln k \ln w_M + \delta_{kL} \ln k \ln w_L + \gamma_s \ln s + \gamma_{sM} \ln s \ln w_M + \gamma_{sL} \ln s \ln w_L + \gamma_{sy} \ln s \ln y + \\
& + \gamma_{sk} \ln s \ln k + \theta_{man} \ln q_{man} + \beta_{Mt} \ln w_M t + \beta_{Lt} \ln w_L t + \beta_{yt}(\ln y)t + \beta_{kt}(\ln k)t + \beta_{st}(\ln s)t + \\
& + \beta_{mant}(\ln q_{man})t + \beta_t t + \beta_{tt} t^2
\end{aligned}
\qquad (8.3)
$$

where

k is the value of capital stock at the beginning of the year,

t is a time variable which captures change in technology over time.

Following Antle (2000), the second-order term of safety $(\ln s)^2$ and the second-order terms of other quality variables are omitted in order to reduce the number of parameters and the potential collinearity caused by the large number of variable interactions in the unrestricted model.

Applying Shephard's lemma, the first-order condition for labour input is:

$$C_L = \alpha_L + \alpha_{LL} \ln w_L + \alpha_{ML} \ln w_M + \beta_{yL} \ln y + \delta_{kL} \ln k + \gamma_{sL} \ln s + \beta_{Lt} t \quad (8.4)$$

where C_L is the labour cost share.

The conditions for linear homogeneity of the cost function are $\alpha_M + \alpha_L = 1$, $\beta_{yM} + \beta_{yL} = 0$, $\gamma_{sM} + \gamma_{sL} = 0$, $\delta_{kM} + \delta_{kL} = 0$, $\beta_{Mt} + \beta_{Lt} = 0$, $\alpha_{MM} = \alpha_{LL} = -\alpha_{LM} = -\alpha_{ML}$. (8.5)

The theoretical safety function (2) is written in log-linear form as:

$$\ln s = \tau_0 + \tau_{man} \ln q_{man} + \tau_p \ln p + \tau_Z \ln z + \tau_M \ln w_M + \tau_L \ln w_L + \tau_k \ln k \quad (8.6)$$

where

q_{man} is management intensity, which is the ratio of non-production labour to production labour,

p is output price,

k is capital stock at the beginning of the year

w_M, w_L are prices of materials and labour respectively, and

z is a demand variable; here we use per capita income.

There are two restrictions with the quality equation. First, $\tau_0 = 0$ as the intercept in this case cannot be identified. Second, $\tau_p = 1$ as derivative with respect to p is positive and the units of safety cannot be defined.

8.2.3. Data

Production data for the New Zealand red meat industry are taken from census of manufacturing data for the period 1929-1984 is used for estimation. CPI deflators are taken from the New Zealand Official Yearbook 2000, and New Zealand per capita income for the period is taken from Maddison (1995). A statistical summary of the variables is presented in Table 45.

The limitation of the data set is that it is limited to the period 1929-1984. Contacts with Statistics New Zealand revealed that there was no production data published for the period between 1984 and 1993. Data from 1993 onwards however is not as detailed as in the previous publication and hence cannot be used for this estimation. Due to data limitation, estimates using data up to 1984 are adjusted to get estimates of HACCP/RMP implementation impacts on variable costs.

Table 45. Statistical Summary of Variables (Prices in 1999 Dollars)

Variable	Unit	Obs.	Mean	Standard Deviation	Minimum	Maximum
w_M	PPI* (base 1982=1000)	52	229.92	225.00	67.00	1317.00
w_L	$ (000)	52	19.45	11.01	7.67	40.01
y	Tonnes(000)	52	637.32	331.46	191.25	1234.30
k	$ (000)	52	622,260	676,760	150,190	2,604,800
q_{man}	-	52	0.14	0.018	0.07	0.18
P	$ per tonne	52	3123.70	1057.60	1846.30	6311.40
z	1990internl $	52	8804.40	2702.90	4349.00	13891.00
VC	$ (000)	52	2,051,600	1,556,100	412,380	6,436,300
C_L	-	52	0.17	0.095	0.09	0.50

* Producer Price Index

8.3. Estimation Results

To estimate the system of cost and cost share functions, equation (8.6) is substituted into (8.3) and (8.4). Then the system is estimated with the linear homogeneity restrictions imposed (group of equations (8.5)), using the nonlinear seemingly unrelated regression routine in Shazam (a command file is included in Appendix 3). Results are presented in Table 46.

To confirm that food safety regulation does affect productive efficiency in the red meat industry, a test for the hypothesis of safety exogeneity is conducted. For the cost function (8.3), safety exogeneity holds if and only if γ_S and γ_{Si} (i = y, M, L, k, t) are all equal to zero. Our test results strongly reject this hypothesis (p = 0).

The interaction term of safety and labour price γ_{sL} is negative which means that a higher labour price lowers the marginal cost of safety. On the contrary, as γ_{sM} has an opposite sign from γ_{sL}, a higher material price leads to higher marginal cost of safety. These results are similar to those presented by Antle (2000) for the US meat industry. The interaction term of safety and capital γ_{sk} is positive which means that increasing capital stock leads to increasing marginal cost of safety. Also, γ_{sy} being positive means higher rates of production are associated with higher marginal cost of safety.

The interaction term of time and material β_{Mt} is negative which shows that technical change is material saving. On the contrary, β_{Lt} is positive which implies that technical change is labour using. Moreover, β_{st} is negative, indicating that the marginal cost of safety decreases as technology progresses.

8.4. Estimation of the Effect on Variable Cost of Production

To estimate impacts of food safety regulation on variable cost, elasticity of cost with respect to safety is calculated. Elasticities are calculated for each observation and the mean is calculated (a command file is included in Appendix 3). Results show that food safety cost elasticities lie in the range of 0.94 to 1.21, with a mean of 1.04.

Table 46. Estimation Results

(Standard errors in parentheses)

Coefficient	Estimate	Coefficient	Estimate
α_0	23.58	γ_{sy}	0.17
	(13.91)		(0.15)
α_L	1.25	β_{yk}	0.22
	(0.33)		(0.14)
γ_S	-2.13	δ_{kL}	0.026
	(1.092)		(0.013)
τ_M	-0.93	τ_{man}	-0.16
	(0.052)		(0.102)
α_{LL}	0.053	θ_{man}	0.32
	(0.022)		(0.12)
γ_{SL}	-0.19	τ_z	-0.034
	(0.017)		(0.063)
τ_L	-0.12	β_t	0.17
	(0.052)		(0.16)
β_y	-4.44	β_{tt}	0.000065
	(3.88)		(0.00062)
β_{yy}	0.41	β_{Mt}	-0.0034
	(0.73)		(0.0016)
δ_k	-0.67	β_{st}	-0.02
	(1.33)		(0.0069)
τ_k	-0.21	β_{Lt}	0.0034
	(0.047)		(0.0016)
δ_{kk}	-0.041	β_{kt}	-0.00031
	(0.060)		(0.0065)
γ_{sk}	0.17	β_{yt}	-0.024
	(0.061)		(0.028)
β_{yL}	-0.21	β_{mant}	-0.0025
	(0.032)		(0.0018)

The fact that mean safety cost elasticity is positive shows that cost of production rises as the safety level increases. This result is somewhat higher than that observed for the US meat industry, which is around 0.7 for beef plants (Antle, 2000). As this is the result associated with the production technology of the period from 1929 to 1984, the estimates are subsequently adjusted to take into account technical change since 1984.

8.4.1. Adjustment for Technical Change

As technology progresses, the elasticity of cost with respect to safety will also change. Estimation results of the cost function show a negative interaction between safety and time (β_{st} = -0.02). This indicates that marginal cost of safety decreases as technology progresses. Assuming nothing else changes, from 1984 to 2002, safety cost elasticity could reduce as much as 0.36 (which is 0.02*18years). Therefore the safety cost elasticity of the present time is estimated to be 0.75 (which is elasticity of 1984 minus 0.36). Although this might seem a naïve approach, it does allow us to reach an estimation of the safety cost elasticity of the present time, given the data set used.

8.4.2. Estimation of HACCP/RMP Cost

To estimate the cost of food safety regulation, Antle (1999) has presented a theoretical framework for measuring impacts of both performance standards and process standards. HACCP as a pathogen reduction regulation for meat and poultry is viewed as a combination of design (process) standard and performance standard (Unnevehr and Jensen, 1996; Antle, 1999). The change in variable cost of production due to food safety regulation such as HACCP/RMP is then calculated as follows:

$$\Delta VC = VC.E.e.(100\text{-}S)/S \qquad (8.7)$$

where

VC is variable cost of production; here we take the mean of variable costs during the period, mean VC = 2,051,600,000 (1999 dollars) (see Table 8.1).

E is the mean of safety cost elasticities, E = 1.04 for the period before 1984, and E = 0.75 in 2002.

e is the effectiveness of the regulation in enhancing food safety (or reducing microbial pathogen as in the case of HACCP), we assume e = 20 %.

S is the level of product safety before the introduction of the new regulation, here S is defined as the percentage of negative outcomes when product is tested for microbial contamination in a unit of time ($0 < S \leq 100$).

Change in unit cost can be calculated as:

$$u = \Delta VC/y \qquad (8.8)$$

where y is output volume, y = mean output = 637,320 (tones) (see Table 8.1).

We calculate change in variable cost and the resulted unit cost for six scenarios (three different base safety levels S = 50%, 70%, and 90% in two different stages of technology). Results are presented in Table 47.

Estimation results show that for a mean variable cost of about \$2 billion, an increase in variable cost due to HACCP/RMP implementation is in the range of \$34 million to \$427 million (or 1.7% to 21% respectively). Cost per unit is in the range of five cents to 67 cents per kilogram. If using the adjusted safety elasticity, unit cost ranges from five cents to 48 cents, depending on the level of safety practices at the plant.

Table 47. Increases in variable cost and unit cost

(1999 NZ dollars)

Scenario	Safety Elasticity = 1.04	Adjusted Elasticity = 0.75
Base safety S = 50%		
Increase in cost (ΔVC)	427,383,000	306,399,000
Unit cost (u) ($/kg)	0.67	0.48
Base safety S = 70%		
Increase in cost (ΔVC)	183,164,000	131,341,000
Unit cost (u) ($/kg)	0.29	0.20
Base safety S = 90%		
Increase in cost (ΔVC)	47,487,000	34,044,000
Unit cost (u) ($/kg)	0.074	0.053

8.5. Chapter Conclusion

In this chapter, a quality-adjusted translog cost function is used to estimate the change in variable cost of production due to the implementation of HACCP/RMP. Data from New Zealand Census of Manufacturing for the period 1929-1984 are employed to derive the cost function. Then the adjustment for technical progress is used to estimate the safety cost elasticities. HACCP/RMP implementation cost was estimated for three different scenarios based on the current safety practices at the processing plant. Unit cost estimates range from 7 to 67 cents without technical progress adjustment. This is equivalent to an increase from $NZ47 million to $NZ427 million (1999 prices)[4] in total variable cost of production. With adjustment, unit cost ranges from 5 to 48 cents (or an increase in total

[4] or $NZ52 to $NZ471 million in 2002 prices, using NZ 2002 CPI = 1103 (base period 1999 = 1000)

variable cost of $NZ34 to $NZ306 million)[5]. This increase in cost represents the impact of HACCP/RMP implementation on the operating efficiency of firms. In other words, this cost is associated with the slowdown of the production line due to monitoring, sampling and testing. If using the categorisation of costs as in Chapter 6, this increase in variable cost represents HACCP/RMP operating cost. Using cost figures collected from the survey (Table 6.2), HACCP/RMP implementation (fixed) cost could be up to around $NZ100,000 for each plant. For the whole industry, the figure could be up to $NZ9 million (with a total of 90 plants nation-wide). It shows that the change in variable cost due to HACCP/RMP implementation can make up to a significant proportion of the total implementation cost.

The estimation of HACCP/RMP cost in this chapter is based on published production cost data for the period 1929-1984. Although adjustment has been made so that the estimate can be representative for the subsequent period, the differences in production cost structure of the post-1984 period may affect the estimation results. Overcoming this data limitation is a difficult task as the succeeding data series (Annual Enterprise Survey) – started in 1993 – does not provide detailed data as in the previous series (Statistics NZ, 2004). An alternative way is to gather plant-level production data. However, as the experience from the HACCP/RMP survey (Chapter 4) has shown, this is also a challenging task.

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[5] or $NZ37 to $NZ337 million in 2002 prices

CHAPTER 9

HACCP/RMP IMPLEMENTATION AND EXPORT PERFORMANCE

This chapter examines the relationship between HACCP/RMP implementation and export performance of the New Zealand meat industry. The research question is whether HACCP/RMP implementation has a positive influence on the industry's export performance. The chapter also provides an overview of the meat industry's export structure and an analysis of its competitiveness status.

9.1. Meat Industry Export Overview

The meat industry is one of the cornerstones of New Zealand's economy. In 2005, its total export earning was about NZ$5 billion, which accounts for about 17% of the country's total exports. This has made the meat industry the second biggest export earner of the country, after the dairy industry (19%). Table 48 shows export values and shares of meats and other agricultural products for selected years between 1993 and 2005. It shows that in recent years, meat and dairy exports have been increasing, while wool and other pastoral products exports have been declining.

New Zealand is an important player in the international market for beef[6] and sheep meat. More than 90% of New Zealand sheep meat production is exported, making it the world number one sheep meat exporter. New Zealand also exports 85% of its beef production, accounting for 9% of world exports and making it the fourth largest player in 2005. Figures 9.1 and 9.2 show the shares of New Zealand beef and sheep meat in the international markets.

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[6] Also includes veal

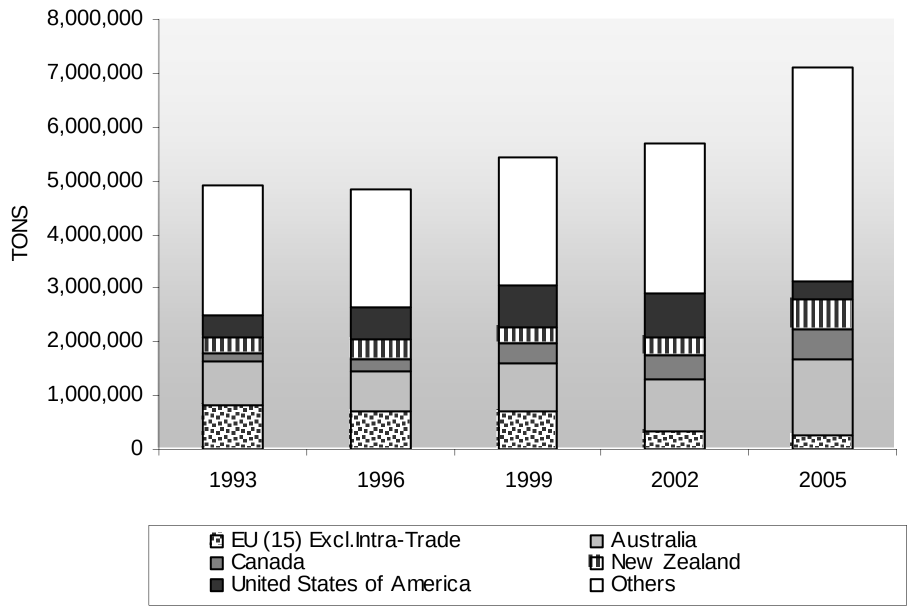
New Zealand beef and sheep meat is exported to more than a hundred different markets. Important markets for beef are the USA, Canada, and Asia. Major markets for sheep meat include the UK and other countries in the EU. The shares of major importing countries for New Zealand beef and sheep meat are shown in Table 49.

Table 48. Export values of Meat and Other Agricultural Products (1993-2004)

	1993	1996	2000	2005
		NZ$000		
Meat	**3,087,518**	**2,708,158**	**3,433,855**	**5,022,021**
	(16.93%)	(13.57%)	(13.80%)	(16.90%)
Dairy	2,656,705	2,982,101	4,700,320	5,677,987
	(14.56%)	(14.94%)	(18.90%)	(19.11%)
Wool	991,395	1,113,784	1,025,647	949,215
	(5.44%)	(5.58%)	(4.12%)	(3.19%)
Other pastoral products	1,597,518	1,848,816	1,020,584	898,068
	(8.76%)	(9.26%)	(4.10%)	(3.02%)
Horticultural products	1,213,391	1,382,857	1,709,386	2,511,509
	(6.65%)	(6.93%)	(6.87%)	(8.45%)
Other agricultural products	421,754	423,645	362,317	411,863
	(2.31%)	(2.12%)	(1.46%)	(1.39%)
Total agricultural exports	**9,968,281**	**10,459,361**	**12,428,584**	**15,470,663**
	(54.65%)	(52.40%)	(50.04%)	(52.06%)
Other exports	8,272,605	9,499,463	12,447,792	14,242,897
	(45.35%)	(47.60%)	(49.96%)	(47.93%)
Total exports	**18,240,886**	**19,958,824**	**24,876,376**	**29,713,560**
	(100%)	(100%)	(100%)	(100%)

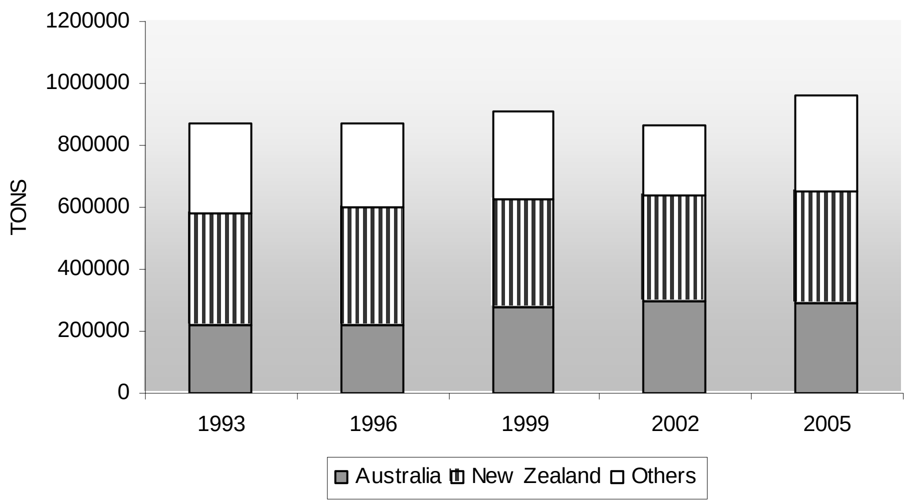
Source: Agricultural Export Statistics, New Zealand Ministry of Agriculture and Forestry (MAF, 2005)

Figure 11. Beef Meat Exporters



Source: Agriculture and Food Trade, FAOSTAT Database (2004), USDA (2007)

Figure 12. Sheep Meat Exporters



Source: Agriculture and Food Trade, FAOSTAT Database (2007)

Table 49. Top Nine Destinations for New Zealand Meat, 1991-2003

(in alphabetical order)

(% of total trade)

Destination	LAMB		BEEF		ALL MEAT	
	91-92	02-03	91-92	02-03	91-92	02-03
Australia	0.1	0.1	0.8	0.4	0.4	0.3
Canada	2.3	3.4	6.3	10.8	3.5	6.4
China	-	10.0	-	0.3	0.2	4.4
France	5.7	9.2	0.1	0.1	3.0	3.8
Germany	6.6	7.7	0.1	0.1	3.5	3.5
Japan	5.5	2.7	2.8	4.3	4.4	3.8
Korea	5.2	0.2	3.8	6.1	4.4	3.5
UK	30.5	32.9	0.1	0.1	14.8	11.0
USA	2.3	7.9	74.5	54.9	30.3	39.8
Total of 9	**58.2**	**74.1**	**88.5**	**77.1**	**64.5**	**76.5**
Other	41.8	35.9	11.5	22.9	35.5	23.5
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Meat and Wool Innovation (MWI) Annual Review (2004)

9.2. Competitiveness Analysis

To date there have not been many studies providing a thorough analysis of the competitiveness of the New Zealand meat industry. The Porter project (Crocombe et al, 1991) studied the competitiveness of New Zealand major industries but did not provide a comprehensive analysis for the meat industry. A recent study of Postiglione (2003) reviewed the competitiveness sources of the New Zealand beef industry, but for the purpose of comparison with those of the Uruguayan beef industry. The aim of this section is to provide a brief review of the determinants of the New Zealand meat competitiveness as well as an analysis of its competitiveness trends over the last decades. This helps to identify the strategies that could enhance the meat industry's competitiveness of which food safety management is one critical factor. The competitiveness trends of other players in the international meat market are also discussed which provide the characteristics of the global context.

9.2.1. Competitiveness Sources

In this section the Porter's model for analysing competitiveness is utilised as a general framework. Although the model is not sufficient for competitiveness analysis of a small net exporting country like New Zealand, its elements could serve as a baseline analysis. Other factors other than home-based ones will also be discussed.

According to Porter (1990), home-based sources of competitiveness include factor conditions, demand conditions, related and supporting industries, firm strategies, structure and rivalry, government policy, and chance.

9.2.1.1. Factor Conditions

Favourable climate. Like other New Zealand pastoral based industries, the meat industry benefits from a favourable natural production system. A mild climate, which is ideal for pastoral farming, helps to reduce cost of production. The 'clean and green' image of New Zealand has been exploited in marketing New Zealand products. Given the increasing concerns from consumers about the environmental conditions in which meat is grown, this image has a positive influence on New Zealand exports. However, relying on a natural production system also means that the industry is subject to the risk of weather changes and its production has a seasonal pattern.

Location. Being located 'down under' means being distant from many major markets. This is considered a disadvantage as it leads to a large proportion of transport costs in total costs. However being isolated can be an advantage as it helps to keep the nation far away from devastating diseases. Together with strict bio-security regulations, New Zealand is able to maintain its status as free of some animal diseases (e.g. Foot-and-Mouth Disease). Economic development in the Asia-Pacific countries recently may also offset the location disadvantage.

Infrastructure. A previous competitiveness study (Crocombe et al, 1991) has shown that New Zealand has an inefficient port and shipping system. The Trans-Tasman shipping route was analysed as the most expensive in the world. Given that about 90% of the country's exports are transported by sea, inefficiency in the shipping system adds significantly to costs, and has a negative impact on competitiveness. The deregulation of transport has reduced costs over the last decade but current problems suggest these reductions are not sustainable with existing policy settings.

Knowledge Resources. The meat industry benefits from R&D services provided by research institutions such as AgResearch. The Meat Board – now Meat & Wool New Zealand - funded via farmer levies also supports meat industry R&D activities.

9.2.1.2. Demand Conditions

Consumer demand in New Zealand is regarded as not sophisticated (Crocombe et al, 1991). This may affect the industry's rate of innovation and the introduction of new products. The small size of the domestic market also means that local demand conditions provide little comparative advantage. Arguably, New Zealand exporters, including meat exporters, do not take the local market seriously; instead they tap into pockets of sophisticated demand in overseas markets for significant market analysis. Cartwright (1993) showed that the offshore factors are as important as the home-based factors; however the impacts of the offshore factors are different for different industries. The impact was found more significant in the case of the NZ dairy industry than the meat industry.

For commodities like foods, domestic demand patterns have changed remarkably. Consumers are increasingly concerned about food quality and safety, which is reflected in stricter regulations on food sold domestically as well as exported.

Therefore, for issues such as food safety, GMO, and animal welfare, the domestic market is also a strong driver of changes.

9.2.1.3. Related and Supporting Industries

Related industries are those that share common technologies, inputs, distribution channels, customers or activities, or provide products that are complementary (Porter, 1990). Supporting industries are often mentioned as supplier industries. For the meat industry, supporting industries include inputs suppliers (farms) and processing equipment suppliers. Related industries are the other pastoral-based industries, such as dairy or wool. Related and supporting industries affect competitiveness in that they create a cluster which allows the delivering of cost-effective inputs, resource sharing, quick flow of information and exchanging of ideas and innovation. Supplier industries provide comparative advantage to the New Zealand meat industry by supplying cheaper inputs (compared to those of EU or US meat industries (Wijsman, 1999)). There are also other world-class supporting industries such as ear-tags, electric fencing, and agricultural consulting (Crocombe et al, 1991).

Meat producing sectors, such as goat and deer, have the support of other traditional and related industries. These emerging industries share common inputs (e.g. fencing and animal-husbandry skills) with more mature industries (sheep and cattle). They also share certain production and distribution technologies.

9.2.1.4. Firm Strategy, Structure and Rivalry

The nature of competition and domestic rivalry has been analysed by Porter (1990) as having a fundamental impact on the international competitiveness of a nation's firms. The argument for this impact is that competition forces firms to improve and upgrade. Recently, we have seen a consolidation trend in food businesses throughout the world and also in New Zealand. The justification for consolidation is that it brings sufficient resources for successful high-value/low-cost strategies and produces bargaining power against big buyers (retailers). The New Zealand meat industry is highly concentrated with four companies – AFFCO, Alliance, PPCS, and Richmond – dominating the processing sector.

These four companies control about 80% of the industry's output. Each has multiple plants and turnovers a little above NZ$1 billion, while the next largest public processing company has a turnover of about NZ$95 million (MAF, 2002).

Two of these four companies are farmer-owned co-operatives (PPCS and Alliance). Vertical co-ordination allows the integration of different stages in the supply chain, helps to reduce transaction costs, and also improves product quality and safety through traceability.

The New Zealand meat industry has a statutory board - Meat & Wool New Zealand[7] – funded by farmer levies, providing support with marketing and market access issues, promotion, research and development, and the administration of market quotas (Meat & Wool NZ, 2004). It also has an industry association (Meat Industry Association), which represents companies supplying 99% of New Zealand sheep meat exports and 100% of beef exports (MIA, 2004). The association provides a forum for consideration of industry-wide commercial, human resource, marketing, and sanitary and phytosanitary issues. It conveys a collective industry position to government, trade bodies and other agencies and organisations. A similar characteristic can be found with the Danish pork industry, which also has a co-operative structure and an umbrella organization – the Danske Slagterier. The Danish pork industry is considered a very competitive industry and its co-operative structure is identified as one of the strengths of the industry (Hobbs et al, 1998).

Arguably, the current structure of the industry captures the synergies of cooperation without incurring excessive costs. Changes are substantial compared to past decades and the more focused approach is likely to be beneficial as long as there is sufficient capacity to complete key tasks.

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[7] Meat & Wool New Zealand was recently founded following industry restructuring but the statutory board has a long history with the Meat Board established in 1922 and the Wool Board established in 1944.

9.2.1.5. Government policies

The New Zealand government has historically played a prominent role in the economy. The market-oriented approach taken by the government in the mid-1980s has led to a reduction in the direct role of government in the economy and to integrating New Zealand into the world economy. This is viewed by many as enhancing efficiency in the long term. However, in the short term, it may have adverse effects on the competitiveness of many industries. For the meat industry, these effects will be viewed later in the analysis of competitiveness trend.

Government's international trade policies also have a significant impact on competitiveness by gaining market access and reducing tariff barriers. Moreover, policies regarding food safety management may bring an official assurance to safeguard market access and thus may have a positive influence on competitiveness. Earlier chapters on the HACCP/RMP survey have shown that the benefit of gaining market access was ranked highest by survey participants. Also, a food safety management program with a preventative approach like HACCP/RMP can minimise the occurrences of food safety hazards and outbreaks that have adverse effects on exports.

9.2.1.6. Chance

Chance events are developments outside the control of firms. Examples of these events are inventions or breakthroughs in technologies, wars, diseases, and external political developments. New Zealand's breakthroughs in food technologies (e.g. gene technologies, processing, packaging, and distribution technologies) have a positive influence on competitiveness. However, the natural production system means that New Zealand faces a high risk with climate change. Recent developments in animal health also show that once a disease outbreak occurs (e.g. BSE), it would have a disastrous impact on export markets and consumer confidence in the safety of the product. Countries without the disease may enjoy an instantaneous increase in demand for their products. However, in the longer term, when consumer confidence has been damaged and not repaired, a reduction in total demand seems obvious.

Table 50 summarises the competitiveness sources discussed and their influences on the international competitiveness of the New Zealand meat industry.

Table 50. Sources of New Zealand Meat Competitiveness

Source	Influence	Examples
Factor condition		
- Favourable climate	- Positive	- A climate ideal for pastoral farming; 'clean and green' image helps to market products.
- Location	- Negative	- Being distant from other markets means high transportation costs;
	- Positive	- Bio security advantages;
		- Close to the booming Asia Pacific markets.
- Infrastructure	- Negative	- Inefficient port, shipping, rail, road systems lead to high transportation costs.
- Knowledge Resources	- Positive	- R&D services from the Meat Board and others (e.g. AgResearch).
Demand Conditions	- Negative	- Small and unsophisticated domestic market.
Related and Supporting Industries	- Positive	- Competitive supporting industries such as electric fence and agricultural consulting.
Strategy, Structure, Rivalry	- Positive	- Industry structure and the umbrella support from Meat New Zealand seem to provide competitive advantage.
Government Policies	- Positive	- Supports in market access negotiating and trade agreement.
- Trade policies		
- Food safety policies (HACCP/RMP)		- Maintain/Enhance market access; minimise outbreaks
Chance		
- Technology breakthrough	- Positive	- Animal breeding;
- Diseases outbreak in other countries	- Positive	- Being a free-status country in animal diseases.

9.2.2. Measuring New Zealand Meat Competitiveness

9.2.2.1. Competitiveness Measurement

Balassa's Revealed Comparative Advantage (RCA) is used to measure competitiveness (Pitts and Lagnevik, 1998). The value of RCA is calculated as follows:

$$RCA = (X_i/X_{iw}) / (X/X_w) \tag{9.1}$$

where

X_i is the value of exports of commodity i, in this case – meat,

X_{iw} is the value of exports of commodity i from all countries (world meat exports),

X is the value of exports of all manufactured goods from the country of analysis (New Zealand),

X_w is the value of exports of all manufactured goods from all countries (world exports in manufactured goods).

RCA is normally used for analysing the competitiveness of an industry in a particular country. An index higher than one means that the industry's exports share of the world exports is higher than the share of the country's total exports in world total exports. Then that particular industry is said to have comparative advantage. RCA is useful in comparing industries of a particular country or examining the trend of competitiveness over time.

RCA can not be used for comparison across countries. The reason is that the size of the index is affected by the size of the economy. For a big industry (meat) in a small country like New Zealand, the value of RCA is quite high. However, RCA of the meat industry of a big country, such as the USA, is much smaller (Table

51). Nevertheless, it is possible to compare the trends of RCA of different countries in a period of time.

Table 51. RCA of Selective Meat Industries

		EU15	Australia	Canada	New Zealand	USA
Beef	1980	NA	13.86	0.32	19.38	0.23
	1990	0.20	10.97	0.39	16.36	0.95
	2000	0.12	13.56	1.75	22.56	1.71
Sheep	1980	NA	17.28	0.01	150.90	0.01
	1990	0.03	12.19	0.00	135.18	0.06
	2000	0.02	23.44	0.01	192.02	0.02

Sources: Authors' calculations based on data from FAOSTAT database

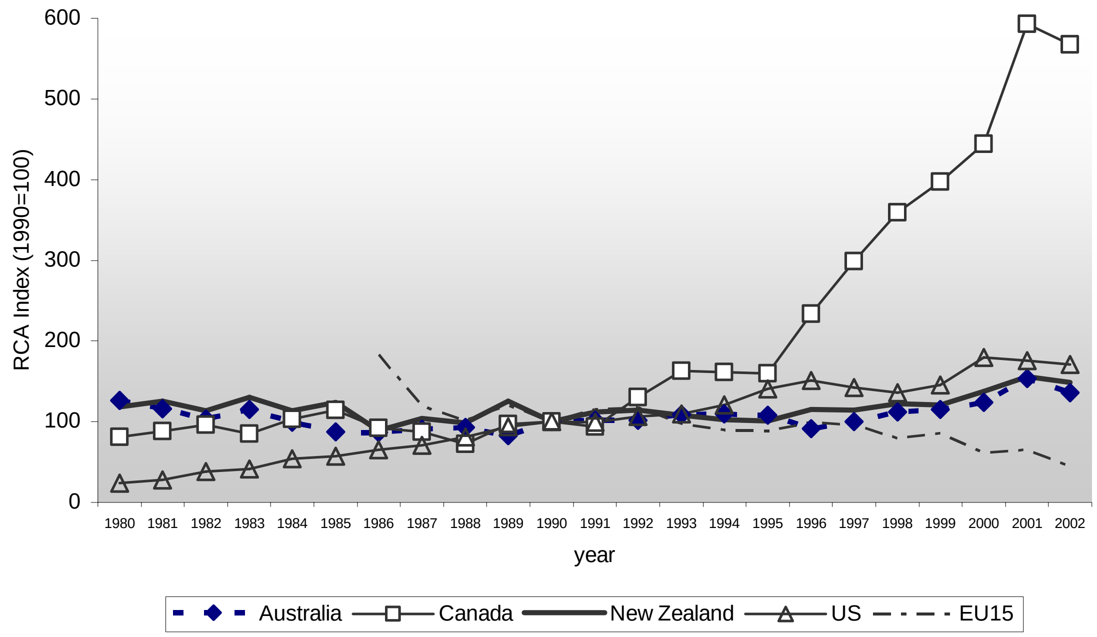
9.2.2.2. Competitiveness Trend

New Zealand meat's RCA was computed for each year of the period from 1980 to 2002. RCA of other meat exporting countries, such as Australia, the USA, Canada, and the EU are also calculated. Competitiveness indices of beef and sheep meat are treated separately. Results are given as in Figures 12 and 13.

New Zealand beef competitiveness decreased by 16% between 1980 and 1990 but increased 38% between 1990 and 2000. Australian beef competitiveness had a similar trend, decreasing 21% between 1980 and 1990 but increasing 23% between 1990 and 2000. US beef competitiveness increased more than 3 fold between 1980 and 1990 and increased a further 80% between 1990 and 2000. Canadian beef competitiveness only increased 22% between 1980 and 1990 but increased significantly (more than 3 fold) between 1990 and 2000.

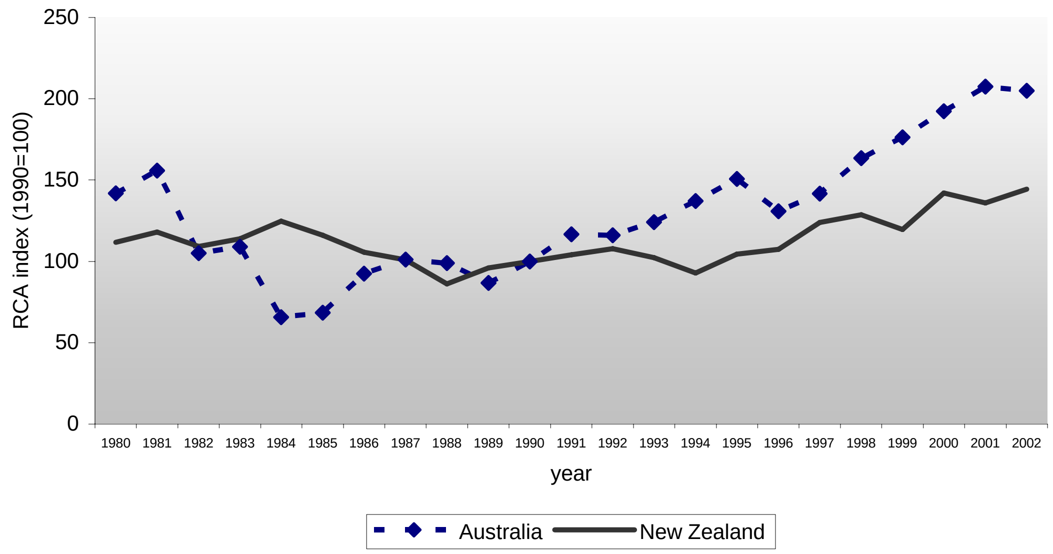
New Zealand sheep meat competitiveness had a similar trend to that of Australia between 1980 and 2000. From 1980 to 1990, both countries' sheep meat competitiveness decreased with New Zealand by 10% and Australia by 40%. However, both increased from 1990 onwards with New Zealand increasing 42% and Australia 92%.

Figure 13. Competitiveness in Beef Trade



Source: Authors' calculations based on data from FAOSTAT database

Figure 14. Competitiveness in Sheep Meat Trade



Source: Authors' calculations based on data from FAOSTAT database

9.3. HACCP/RMP Implementation and Export Performance

The previous section has argued that government policies can have significant influence on competitiveness. Food safety policies, in particular, can affect performance of any food exporting industry. In this section, the relationship between HACCP/RMP implementation and meat export performance is examined. As competitiveness is measured based on export performance of an industry, a positive effect on exports means a positive effect on competitiveness and visa versa.

9.3.1. The Model

To examine meat industry export performance, a reduced form export model is employed. This model has been widely used for analysing bilateral trade and also referred to in many studies as a gravity model (see for example Bergstrand, 1989; Hejazi and Safarian, 2001; Cyrus, 2002; and Tang, 2003). Recently this approach was also used in analysing the effects of food safety regulation on international trade (Otsuki and Wilson, 2001; Wilson et al, 2003). Trade flow between two countries is assumed to be influenced by their sizes (incomes (GDP) and population), distance apart, and other trade effected variables. To analyse trade of a single commodity, the other variables included are exchange rate, prices, production volumes, and other policy variables (see for example Koo and Karemera, 1991; Koo et al, 1994; and Dascal et al, 2002).

In this analysis, the model suggested by Koo et al (1994) is employed. This is a commodity-specific model for analysing meat trade policies. In their model, trade volume between two countries is a function of countries' GDP, distance, export price, import price, exchange rate, production volumes of the two countries, and other policy factors that either aid or restrict trade. To capture the effect of food safety management as well as the specific characteristics of NZ meat exports, the policy variables included in the analysis are QUOTA and HACCP. As a result of the GATT Uruguay Round, countries and regions such as the USA, Canada, and the EU have granted New Zealand meat (beef, veal, sheep, goat) tariff rate quotas (TRQs). TRQs allow for importing a certain amount of meat at zero or concession tariff rates. Table 52 shows examples of some of the TRQs and their utilisation. HACCP, on the other hand, represents the mandate of HACCP/RMP by the Animal Products Act 1999. The empirical model is specified as follows:

$$\begin{aligned} LnX_{it} = {} & \beta_0 + \beta_1 \ln(GDP_{NZt}) + \beta_2 \ln(GDP_{it}) + \beta_3 \ln(PROD_{NZt}) + \beta 4 \ln(PROD_{it}) \\ & + \beta_5 \ln(Distance) + \beta_6(\ln(Exchange_t)) + \beta_7 \ln(Price_{NZt}) + \\ & + \beta_8 \ln(Price_{it}) + \beta_9(HACCP) + \beta_{10}(QUOTA) + \varepsilon \end{aligned} \tag{9.2}$$

where

X is the export value of New Zealand meat (total/beef/sheep) to a country i in year t,

GDP_{NZt} is New Zealand Gross Domestic Product in year t,

GDP_{it} is the Gross Domestic Product of country i year t,

$PROD_{NZt}$ is the volume of meat production of New Zealand in year t,

$PROD_{it}$ is the volume of meat production of country i in year t,

'Distance' represents the distance between NZ and country i, it is used as a proxy for transportation cost,

$Exchange_t$ is the value of New Zealand dollar against country i's currency in year t,

$Price_{NZt}$ is aggregated FOB price of NZ Meat to country i in year t,

$Price_{it}$ is aggregated import meat price of country i (calculated as a ratio of total import value and volume),

HACCP is a dummy variable which takes value 1 in those years when HACCP/RMP is mandated (since 1999/2000), value 0 otherwise.

QUOTA is also a dummy variable which takes value 1 when it is present, zero otherwise.

Table 52. Tariff Rate Quotas Utilisation

(tonnes)

Year	TRQ	Exports	Percent
US Beef and Veal Quota Utilization			
1994	184400	176174	95.5
1995	213402	185762	87.0
1996	213402	162939	76.4
1997	213402	190079	89.1
1998	213402	191242	89.6
1999	213402	179142	83.9
2000	213402	213402	100.0
2001	213402	209681	98.3
2002	213402	199163	93.3
2003	213402	211549	99.1
2004	213402	211655	99.2
EU Sheepmeat and Goatmeat Quota Utilization			
1995	216150	210529	97.4
1996	226700	221675	97.8
1997	226700	222622	98.2
1998	226700	222722	98.3
1999	226700	220868	97.4
2000	226700	226672	99.9
2001	226700	226585	99.9
2002	226700	226638	99.9
2003	226700	226216	99.8

Source: Meat New Zealand (2004)

It is normally expected that the coefficients of income variables are positive as exporting country's income is considered production capacity and importing country's income is considered purchasing power. Distance is entered as a proxy for transportation cost, thus is expected to have negative sign. Exporting country's production coefficient is often expected to have positive sign while importing country's production coefficient is expected to have negative sign. Similarly, export price coefficient is expected to be positive while import price coefficient is expected to be negative. The coefficient of exchange rate is expected to have a negative sign as an appreciation of the exporting country's currency tends to have a negative impact on its exports. The QUOTA coefficient is expected to have a positive sign as quotas generally allow for importing a certain quantity of NZ meats (beef or sheep meat) at zero or concession tariff rates. Also, the history of quota utilisation (Table 52) shows that NZ TRQs are still under-filled in most years. Thus it excludes the restriction (negative) effect of quota on exports. Finally, the coefficient of HACCP is expected to have a positive sign as food safety management programs are hypothesised to have a positive influence on exports.

9.3.2. Data

Data of bilateral trade in meat products between NZ and nine major trading partners (as shown in Table 49) over the period 1991-2003 are used to estimate the model. These data are provided by Statistics NZ as well as Meat and Wool Economic Service (now MWI Economic Service). GDP data (real term) are taken from International Financial Statistics Yearbook (IMF, 2003). Production data is taken from FAO Statistics Database (http://apps.fao.org). Export FOB prices are provided by MWI. Import prices are calculated based on countries' import volumes and values, both taken from FAO Statistics Database. Distances between countries are calculated as distances between capital cities, data are from http://www.geobytes.com/CityDistance Tool.htm?loadpage.

In New Zealand, HACCP was mandated in 1999 so HACCP takes value 1 from the year ended 2000. Although voluntary HACCP may be present at some plants before year 2000, this fact is not modelled as the focus is on the effect of a uniform adoption of HACCP on the total industry's export performance.

TRQs are granted for NZ meats that entering the EU beef and sheep meat markets, the US beef market, and the Canadian beef market. Note that EU's TRQ for beef is just for high quality product at a very small amount (300 tonnes) (Meat and Wool NZ, 2003). There is also a temporary TRQ for sheep meat that entering the US market between 1999 and 2001, but this is not a large allocation (15000 tonnes) and rather with the purpose of protecting domestic production. Therefore, in the analysis, the quota variable takes value one for EU sheep meat market, US and Canadian beef markets, value zero for the other markets. For the regression of total meat, it takes value one for the markets that granted TRQs to NZ meats, regardless of the type of meat.

9.3.3. Results

The model specified as in equation (9.2) was estimated for total meat exports (beef and sheep) and beef and sheep separately. Estimation results are presented in Tables 53.

Diagnostic tests show that there is evidence of autocorrelation and heteroscedasticity in the data set (see also the SHAZAM outputs in the Appendix[8] for test results). Therefore to estimate the model POOL command in SHAZAM is used. The POOL command applies a generalised least squares procedure (GLS) to first estimate the model by ordinary least squares (OLS). It then transforms the observations using the estimated residuals and applies OLS to the transformed model.

Total Meat

Results for total meat show that the importing country's GDP significantly and positively affects meat exports. The importing country's production volume negatively affects meat exports. Both New Zealand's GDP and meat production volume coefficients are not significant. The distance coefficient is found to have a negative sign as expected but it is not significant. The import price coefficient is negative as expected, showing that import price increases have a negative influence on meat exports. The export price coefficient however is negative, which could be the result of a static price trend over the period. The exchange rate does not have a significant influence on total meat exports. Both the HACCP and quota coefficients have positive signs, suggesting the positive influence of the quota markets and the positive effect of having HACCP/RMP. As total meat is

[8] The outputs also contain estimation results for the cases of general gravity models.

aggregated for beef and sheep, the results maybe confounded by the different dynamics of the two markets. Results for each market are treated separately in the next sections.

Table 53. Estimation Results for Total Meat, Beef, and Sheep

Coefficient	Total Meat	Beef	Sheep
Intercept	36.32	16.03	2.06
	(11.89)***	(13.18)	(2.28)
GDP_{NZ}	-0.15	3.26	1.96
	(0.55)	(0.95)***	(0.098)***
GDPi	1.32	1.57	1.04
	(0.098)***	(0.01)***	(0.042)***
PRODNZ	-1.16	0.97	-0.85
	(0.80)	(0.99)	(0.091)***
$PROD_i$	-0.96	-1.74	-0.42
	(0.12)***	(0.16)***	(0.030)***
Distance	-0.24	-2.36	1.05
	(0.45)	(0.26)***	(0.21)***
$Price_{NZ}$	-0.80	0.61	-1.67
	(0.12)***	(0.092)***	(0.022)***
$Price_i$	-0.54	-0.15	0.77
	(0.26)**	(0.31)	(0.034)***
Exchange rate	0.030	0.0083	-0.79
	(0.074)	(0.056)	(0.033)***
HACCP	0.25	-0.37	0.22
	(0.10)**	(0.18)*	(0.012)***
QUOTA	2.51	6.33	2.15
	(0.66)***	(0.30)***	(0.18)***
Buse R^2	0.89	0.90	0.99

*, **, *** denote significance at 90%, 95%, and 99% respectively

Beef

New Zealand's GDP coefficient is found significant and positive, the same is true for the importing country's GDP. PRODNZ has the expected sign (positive) but it is not significant. Both PRODi and Distance coefficients are negative and significant. For beef products, export price coefficient has the expected sign (positive), showing that higher prices encourage beef exports. The import price coefficient is negative but not significant. Similar to the case of Total Meat, Exchange rate does not significantly affect beef exports during the period. QUOTA is positive, showing that the markets that granted NZ TRQs are the significant ones. HACCP however has a negative sign. This could be the result of the fact that strict hygiene standards for beef have long been required by the dominant markets such as the USA. Therefore, if compliance with the standards is already high, then HACCP/RMP mandate may be of little effect.

Sheep

Both GDP coefficients have the expected signs (positive), showing that exporting country's GDP increase improves its production capacity and the importing country's GDP increase improves its purchasing power. PRODNZ is significant but negative which is a result of the fact that sheep number has been falling during the period. PRODi is significant and negative as expected. Distance is significant but positive which reflects the fact that the further distant markets such as EU countries (UK, France, Germany) are the significant markets for sheep meat. Both price coefficients are significant. However the import price coefficient has a positive sign, which may be the result of an upward trend of average import prices in most of the markets. The exchange rate coefficient is significant and negative, suggesting an adverse effect on sheep meat exports once the NZ dollar appreciates. Both HACCP and quota coefficients are significant and positive.

9.4. Chapter Conclusion

This chapter discusses meat industry export performance and provides an analysis of its competitiveness sources and competitiveness trends. Furthermore, an export model is employed to examine the relationship between food safety policies (HACCP/RMP) and meat exports. Estimation results show a positive impact of HACCP/RMP on total meat exports. However results are mixed for different types of meat. HACCP/RMP does not seem to have much effect on beef exports. The reason could be that compliance with meat hygiene standards (especially those of the significant importing countries such as the USA) is already high. However the program has a positive impact on exports of sheep meat. The conclusion is that although HACCP/RMP potentially brings a positive impact on meat export performance, the magnitude of the impact is dependent on the (previous) status of compliance with hygiene standards.

CHAPTER 10

THE COSTS OF LOSING MARKET ACCESS AND THE POTENTIAL BENEFITS OF HACCP/RMP

10.1. Introduction

In chapter 9, it has been shown that the implementation of HACCP/RMP has a positive impact on the export performance of the NZ meat industry. This can be attributed to HACCP/RMP's function in providing product quality/safety assurance. HACCP/RMP can bring further gains in market access by (1) satisfying market requirements and (2) minimising the occurrence of food safety hazards or outbreak that may have adverse effects on market access.

The literature on quality costs (see for example, Zugarramurdi et al, 2000) has distinguished between three types of quality costs:

- Prevention costs: these are costs associated with any intended action to investigate, prevent, or reduce product defects and failures. HACCP/RMP implementation costs are examples of this type of cost.

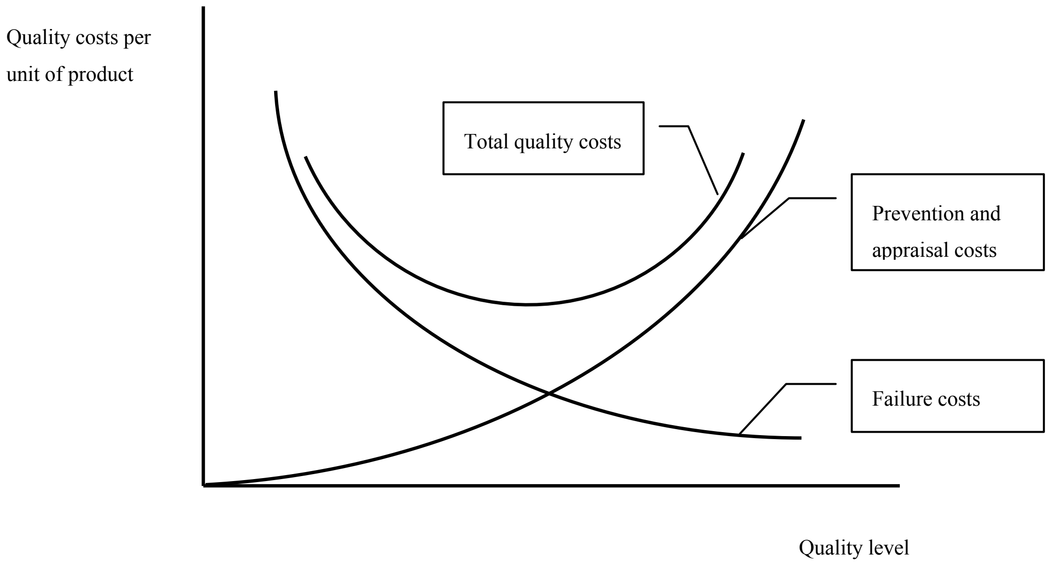
- Appraisal costs: these are costs that derive from sampling, inspection, and test actions performed to evaluate if the level of predetermined quality is maintained. HACCP/RMP operating costs fall into this type.

- Failure costs: these are costs related to the defects detected in the plant (internal failure), or after the product is delivered (external failure). Product wastages are internal failure costs. The costs of losing market due to bad quality or food safety outbreaks are external failure costs.

A graphical illustration of quality costs is provided in Figure 14. It shows that an increase in prevention and appraisal costs leads to a higher quality level, which decreases failure costs. In the case of HACCP/RMP, we could expect the saving of failure costs once firms invested in HACCP/RMP.

The purpose of this chapter is to quantify the cost of losing market access to the New Zealand meat industry and further, the whole economy. This cost estimate can be considered as a potential benefit of food safety practises that maintain and enhance market access such as HACCP/RMP. The analysis will focus on the significant export markets of the meat industry including North America, the European Union, and Asia.

Figure 15. Quality Costs



(Source: adapted from Zugarramurdi et al (2000))

10.2. A Review of Literature

The economics literature concerning the economy-wide impacts of a loss and/or gain in market access has involved the use of general equilibrium models for impact quantification. General equilibrium simulations allow a comparison between the initial equilibrium and the new equilibrium result after shocks (in this case, a decrease/increase in export volumes). Examples of the models used include: single-country Computable General Equilibrium (CGE) models (Nin-

Pratt et al, 2004; McDonald, 2002), Regional and Spatial Equilibrium models (Salin et al, 2003; Rae et al, 1998), and Regional Input-Output models (Caskie et al, 1999). Each of these models required careful model development as well as access to the necessary data. The following discussion briefly outlines the main features and findings of a selection of the current studies. More features about the models used can be found with the references provided.

10.2.1. Single-Country CGE Models

These models are constructed on data from the Social Accounting Matrix (SAM) of a particular country (or region within a country). A SAM is comprised of a set of production activities, commodity markets for goods and services, factors of production (labour and capital), households, a capital account (saving and investment), government, and the rest of the world. Each element in the SAM represents the cash flow between two sectors. With data from the SAM framework, CGE models allow for analysing impacts of a policy shock on different sectors of the chosen country/region.

Nin-Pratt et al (2004) estimated the costs of the ban on livestock exports from Ethiopia's main exporting region (Somali) by Saudi Arabia in 1998 due to an outbreak of Rift Valley fever in the region. The cost estimate was then used as benefit inputs into a benefit-cost analysis of an animal health program designed to minimise future bans and to regain market access. The model was based on data from an SAM of the Somali region. Two scenarios were developed to capture different types of adjustment to the export ban. The first scenario is a short-run scenario where it is assumed that capital and labour are not mobile between activities, so the quantity of factors employed by each activity is fixed. The second scenario represents the medium-run where labour and capital are mobile but total supply of each factor is fixed. In the first scenario, it was assumed that total exports of live animals are reduced by 15% in the first four months. In the second scenario, total exports are reduced by 42% in the last 12 months of the ban. In both scenarios, livestock export prices were shocked to cause exports of live animals to fall to the desired level. The two scenarios were run separately and effects are added up to get the total loss of a 16 month ban. The study found a significant impact on the region's GDP (a reduction of $135 million or 36%). Income losses were experienced in most sectors with the most affected being pastoralists and traders.

McDonald (2002) used a CGE model for Botswana to analyse the impacts of removing its preferential access to the EU's beef market. The model used data from a SAM for Botswana. The policy shocks were introduced as reductions in average export prices due to the loss of the high-price market (EU). The study found little impacts on the country's income (a reduction of 0.6%). This is reasonable given that meat exports accounted for just 3% of total exports. The meat sector is hit hardest with a 77% reduction in its export volume. This also leads to a significant decline in farm employee's income (16%) and other factor (land) income (18%).

The current literature using single-country CGE models has shown that accessing SAM data is necessary for the construction of the model. Also the size of the impacts of a gain/loss in market access is dependent on the contribution of the studied industry to the whole economy. The more important the industry is to the economy the bigger the impacts are likely to be.

10.2.2. Regional and Spatial Equilibrium Models

These models normally focus on one product markets but include more than one country. Often the significant trading partners of the studied market are included in the analysis. This type of CGE model is useful for an analysis of the impacts of changes in market access of one or more countries in the group to the trading volume and trading pattern between countries. Models of this type also require access to each country's data on production, consumption, and trade patterns for the studied product.

Salin, Hahn, and Somwaru (2003) analysed the impacts on the North American broiler market as a result of the lifting of the ban on poultry products from Mexico and Brazil as these regions becoming Exotic Newcastle Disease (END) free. The model includes the following countries: the USA, Canada, Mexico, and Brazil. Broiler production is differentiated into whole broilers, white meat, dark meat, and other broiler products, including backs, necks, and mechanically deboned meat. The simulation shocks were introduced in the form of increases in exports from Mexico and Brazil as a result of the lifting of the ban. The study found significant impacts on trade patterns. For example, there is a decline in product-weight consumption due to the shift from generic to value-added products (e.g. cuts with less bone and skin). Prices decline in the US and Canada but increase in Mexico and Brazil. There are welfare gains for Mexico and Brazil poultry farmers and processors and US and Canada consumers. However, for all four countries, there are gains in total welfare.

In a similar approach, Rae, Nixon, and Gardiner (1998) studied the impacts on the Pacific Rim Beef Market as results of the lifting Food and Mouth Disease trade barriers to Uruguay and Argentina. The model includes seven markets: North America, Japan, South Korea, Australia, New Zealand, Argentina, and Uruguay. Beef is categorised into grainfed beef and grassfed beef. The lifting of the trade ban was considered together with other factors that may affect the market at the same time, for example, Argentina productivity growth, economic slow down in Korea, changes in freight costs, etc. The results showed that the expansion of South American exports have negative impacts on grassfed beef exports from Australasian countries (over 40% reduction), while having little impact on exports of grainfed beef from North America.

Unlike single-country CGE models which focus on the impacts to a specific country, regional and spatial equilibrium models provide a focused approach to the analysis of a single product market. Model construction and access to countries' data on production, consumption and trade of the particular product are important for this type of model.

10.2.3. Regional Input-Output Models

These models use the same type of data as those of single-country CGE models (SAM). The difference is that data are arranged in the form of input-output tables and simulations are solved by matrices manipulation. The shock of a change in exports is introduced in the form of a change in final demand that leads to changes in the interdependence coefficients betweens sectors. Changes in output, income, and employment of each sector and the total economy are then worked out using output, income, and employment multipliers.

Caskie, Davis, and Moss (1999) used a regional input-output model for the economy of Northern Ireland to quantify the effects of a BSE-induced reduction in final demand for its beef. An exogenous stimulus to the economic system is introduced via a change in final demand which includes household consumption, export demand and capital investment. The shock introduced is a £140m fall in Northern Ireland beef exports. The macroeconomic impacts and impacts on different sectors (15 sectors in total) of the economy are estimated. Predicted net loss is 0.5% for regional GDP, 0.6% for regional employment. About 77% of the income losses and 87% of the job losses are in the beef sector.

10.3. Model, Data, and Scenarios

To estimate the economy-wide effects of a loss in the New Zealand meat export markets, the Global Trade Analysis Project (GTAP) model is employed. The use of the GTAP model offers some advantages, including: (1) the model and database are publicly available and ready to use; (2) the application fits neatly with our specific case as the beef and sheep meat sector is a separate sector in the database and New Zealand is one among the countries included in the model; (3) The simulation results will not only provide indications for the meat sector and the New Zealand economy but also reveal the associated impacts on the international meat markets. The model, however, cannot provide a more focused approach than those provided by a single-country or single market model.

10.3.1. Model Description

The GTAP was established in 1992. It provides a global database and a standard modelling framework, both publicly available. The GTAP model is a multi-region and multi-sector CGE model. It has been widely used for analysing the economy-wide effects of policy changes, especially on a global scale such as trade liberalisation or international environmental agreements (see for example, Hertel (1997)).

The GTAP model assumes a perfect competitive market. Prices and quantities of produced commodities are endogenously determined by households and firms optimising, subject to the resource limitations of the economy. On the supply side, it is assumed that producers choose inputs that minimise production costs subject to separable, constant returns to scale technologies. The assumption of separability in production means that there is no substitution between different intermediate inputs or between them and a composite primary factor. A constant elasticity of substitution (CES) function is assumed for the substitution possibilities between primary factors (natural resources, labour, capital). On the demand side, the non-homothetic preferences of private demands are captured through the use of a constant difference of elasticities (CDE) function. The GTAP model also assumes an Armington structure for imports. This means imported commodities are distinguished by origin and aggregated at the border, where the composite import is distinguished from the domestically produced commodities. The CES assumption is used for the substitution possibilities between imported products and between the composite import and domestic products. Hertel and Tsigas (1997) provide a detailed presentation of the structure of the GTAP model and the associated behavioural equations.

10.3.2. Data

The GTAP version 5 database is used. It includes 66 regions and 57 commodities. To provide a focused analysis regarding the meat industry and the international meat market, regions are aggregated to show the significant players in the international meat markets and the important export markets of New Zealand meat. Sectors are aggregated to show the significant exporting sectors of the New Zealand economy and the sectors that have strong linkages with the meat industry.

The data from Table 54 show that meat exports consist of mainly beef and sheep meat products. Other key players in the international market for beef and sheep meat include: the USA, the EU-15, Australia, Canada, and other countries in South America (Brazil, Argentina, and Uruguay) (Tables 55 and 56). Significant NZ meat importers include countries in North America (USA, Canada, Mexico), countries in the EU-15, countries in the South and East of Asia (Japan, Korea, Taiwan, and China), countries in the Middle East (Saudi Arabia, UEA), and Pacific Islands countries (Fiji, French Polynesia) (Table 57). Therefore, for our study purpose, regions in the GTAP 5 database are grouped into: (1) Australia, (2) New Zealand, (3) South & East Asia (Region no. 3-17), (4) EU-15 (Region no. 31-45), (5) The USA, (6) Other countries in North America (Canada, Mexico), (7) Latin America (Region no. 22-30), (8) Turkey and Middle East (Region no. 52-53), and (9) Rest of the World (In GTAP version 5, Pacific Islands countries cannot be separated).

The data from Table 58 show that dairy, meat, wood, fish, fruit, and wool are among the top ten export earner. Other related agricultural sectors that also have significant export revenues are live animal and animal products. Therefore, for the purpose of the study, sectors in the GTAP 5 database are grouped into: (1) processing red meats (sector no. 19), (2) live cattle (sector no. 9), (3) other meat & animal products (sector no. 10,12, & 20), (4) dairy (sector no. 11 & 22), (5) fruit & vegetable (sector no. 4), (6) forestry (sector no. 13), (7) fishing (sector no. 14), (8) other agricultural sectors, (9) manufacturing sectors, and (10) services sectors.

10.3.3. Scenarios

HACCP/RMP adoption can help to maintain and enhance overseas markets in two ways. Firstly, it satisfies market’s requirements. Secondly, it minimises the occurrences of food safety hazards which may have adverse effects on market access. In the case of NZ meat, it is also argued that the mandate of HACCP/RMP will provide an official assurance that secures overseas market access. Thus there is a risk of losing market access if HACCP/RMP is not adopted. Take the US market as an example. The US food safety legislation requires that exporters of processed meat to the country must meet the same HACCP standards as US processors. NZ meat exporters cannot access this market if they do not satisfy the requirements. The simulation scenarios are designed as follows:

1. As the US is the first country that requires exporting countries to meet with its HACCP standards, this scenario assumes a loss of 100% annual export volume of processed red meat access to this market due to the non-compliance with HACCP standards. This is the most likely scenario.

2. Assuming that other countries in North America (Canada and Mexico) adopt a similar policy as the USA. To quantify the impacts of this policy change, ceteris paribus, the second scenario assumes that there is a loss of 100% processed red meat access to the North American market (i.e. USA, Canada, and Mexico).

3. A similar assumption for the EU-15 market (100% market access loss).

4. A loss of 100% South and East Asia market.

5. A loss of 100% the Turkey and Middle East market.

6. Assuming all significant markets now adopt the same policy regarding HACCP, this scenario assumes a loss of all major markets, i.e. all markets mentioned above.

The first simulation provides the cost estimate of the most likely scenario while the last simulation provides the upper bound of the cost. The results also provide estimates on the ‘size’ of each significant market of NZ meats. It further signals the importance of maintaining access to these markets.

Table 54. Value of New Zealand Meat Exports

(NZ$million FOB)
Years ended 30 September

	2002	2003p
- Lamb	2,025.0	1,979.7
- Mutton	261.3	255.6
- Beef and Veal	1,746.7	1,590.7
- Edible Offals	112.0	120.0
- Other Meats	299.4	243.2
Total Meats	4,444.4	4,189.2

p – preliminary
Source: Meat and Wool NZ Annual Report
(http://www.meatnz.co.nz/wdbctx/corporate/docs/FILE011572.PDF2)

Table 55. Major Beef and Veal Exporters

1,000 Metric Tonnes (Carcass Weight Equivalent)

	1999	2000	2001	2002	2003 (p)	2004 (f)
Australia	1,270	1,338	1,398	1,365	1,261	1,300
Argentina	359	357	169	348	384	420
Brazil	464	492	748	881	1,175	1,350
Canada	492	523	575	610	384	565
European Union 15	994	644	575	512	400	360
New Zealand	462	505	516	505	578	560
United States	1,094	1,119	1,029	1,110	1,144	195
Uruguay	189	236	145	259	314	330
Others	556	704	659	793	789	800
World Total	5,880	5,918	5,814	6,383	6,429	5,880

p - preliminary; f – forecast
Source: USDA (http://www.fas.usda.gov/dlp/circular/2004/04-10LP/bf_sum.pdf)

Table 56. World Sheep Meat Exports

1,000 Metric Tonnes

Country	1999	2000	2001	2002
Australia	274299	310692	306523	294601
New Zealand	348604	380058	346404	341685
Others	74304	73589	62289	63416
World (excl. intraEU)	697207	764339	715216	699702

Source: FAOSTAT database

Table 57. New Zealand Meat Export Destinations

Rank	Country	**1995** US$000 (a)	%	**2002** NZ$000 (b)	%
1	United States of America	463,300	18.8%	1,293,255	28.6%
2	United Kingdom	364,800	14.8%	552,285	12.2%
3	Germany	181,300	7.3%	403,038	8.9%
4	Canada	107,800	4.4%	286,822	6.3%
5	France	111,100	4.5%	276,465	6.1%
6	Japan	183,600	7.4%	209,105	4.6%
7	Belgium	76,300	3.1%	200,431	4.4%
8	Taiwan	59,300	2.4%	129,530	2.9%
9	China, People's Republic of	98,500	4.0%	116,824	2.6%
10	Korea, Republic of	129,200	5.2%	104,316	2.3%
11	Mexico	8,700	0.4%	67,972	1.5%
12	Malaysia	36,300	1.5%	56,786	1.3%
13	Saudi Arabia		see ME	56,361	1.2%
14	Netherlands	19,700	0.8%	55,086	1.2%
15	French Polynesia		na	53,301	1.2%
16	Italy	67,200	2.7%	53,200	1.2%
17	Switzerland	30,200	0.5%	52,771	1.2%
18	Hong Kong	17,000	0.7%	52,440	1.2%
19	Greece	23,700	1.0%	40,006	0.9%
20	Spain	18,700	0.8%	30,209	0.7%
21	Singapore	34,300	1.4%	26,578	0.6%
22	Fiji		na	26,573	0.6%
23	Australia	76,300	3.1%	25,146	0.6%
24	Portugal	11,100	0.5%	24,897	0.6%
25	Indonesia	22,400	0.9%	24,453	0.5%
26	Sweden	12,900	0.5%	23,704	0.5%
27	United Arab Emirates		see ME	20,364	0.5%
28	Denmark	11,200	0.5%	20,269	0.4%
29	Jordan		see ME	17,817	0.4%
30	Papua New Guinea		na	14,298	0.3%
31	Philippines	10,100	0.4%	11,019	0.2%
32	Malta		na	10,416	0.2%
33	Egypt	13,100 (c)	0.5%	10,117	0.2%
34	Kuwait		see ME	9,632	0.2%
35	Barbados		na	9,597	0.2%
36	Tonga		na	9,210	0.2%
37	Trinidad and Tobago		na	7,975	0.2%
38	Oman		see ME	7,689	0.2%
39	Cyprus		na	7,470	0.2%
40	South Africa	6,400 (d)	0.3%	6,881	0.2%
41	Guadeloupe		na	6,872	0.2%
42	New Caledonia		na	6,738	0.1%
43	Russia	6,600 (e)	0.3%	5,267	0.1%
44	Thailand	5,200	0.2%	4,612	0.1%
45	Austria	2,400	0.1%	3,926	0.1%
	Other			91,691	2.0%
	Turkey	63,400	2.6%		
	Middle East (ME)	75,000	3.0%		
	Total	**2,321,000**		**4,523,414**	100.0%

Sources: (a) GTAP 5 database; (b) Statistics NZ; (c) incl others in North Africa (xnf); (d) incl others in SA customs union (xsc); (e) incl others in the Former Soviet Union (xsu)

Table 58. New Zealand: Exports by HS Chapter Heading

December Years (NZ$000 FOB)

Rank	HS	Description	2002	%	2003(P)	%
01	04	Dairy	5,210,168	17.47	4,751,376	17.43
02	02	Meat	4,285,979	14.37	4,160,919	15.26
03	44	Wood	2,500,580	8.39	2,078,648	7.62
04	84	Machinery	1,107,148	3.71	1,176,416	4.31
05	03	Fish	1,374,007	4.61	1,065,296	3.91
06	35	Starch	1,213,139	4.07	1,015,681	3.73
07	08	Fruit	1,104,565	3.70	997,830	3.66
08	98	New Zealand Misc. Provisions(1)	757,284	2.54	986,500	3.62
09	76	Aluminium & Articles	1,113,012	3.73	928,925	3.41
10	51	Wool	957,866	3.21	894,002	3.28
11	85	Electrical Machinery	802,083	2.69	789,126	2.89
12	41	Hides	699,277	2.34	594,305	2.18
13	21	Misc. Vegetable Preparations	417,303	1.40	439,432	1.61
14	47	Pulp	512,450	1.72	429,686	1.58
15	07	Vegetables	431,363	1.45	418,309	1.53
16	22	Beverages, Liquor	408,124	1.37	407,399	1.49
17	27	Mineral Fuels	550,251	1.85	385,522	1.41
18	39	Plastic	396,887	1.33	374,449	1.37
19	48	Paper	548,058	1.84	323,189	1.19
20	72	Iron and steel	312,473	1.05	313,461	1.15
21	89	Ships	165,200	0.55	294,993	1.08
22	71	Semi-precious Stones & Metals	303,908	1.02	287,638	1.05
23	90	Photographic	268,139	0.90	286,007	1.05
24	05	Animal Products	276,979	0.93	255,447	0.94
25	87	Vehicles	234,377	0.79	247,390	0.91
26	73	Iron & Steel Articles	226,581	0.76	237,608	0.87
27	30	Pharmaceutical	168,435	0.56	180,283	0.66
28	23	Food Wastes	200,585	0.67	178,067	0.65
29	20	Vegetable Preparations	170,346	0.57	168,212	0.62
30	19	Cereal Preparations	164,059	0.55	155,180	0.57
31	01	Animals	156,192	0.52	153,671	0.56
32	15	Fat, Oil	156,812	0.53	152,106	0.56
33	16	Meat/Fish Preparations	185,938	0.62	148,538	0.54
34	94	Furniture	154,407	0.52	138,674	0.51
35	57	Carpet	124,277	0.42	127,953	0.47
36	40	Rubber	112,251	0.38	120,511	0.44
37	38	Chemical Products n.e.s.	116,415	0.39	103,099	0.38
38	43	Furs	103,093	0.35	102,087	0.37
		Others	1,830,52	6	1,396,833	5
		Total	**29,820,534**	100.00	**27,264,768**	100.00

Source: Statistics New Zealand, Overseas Trade, 2002-2003

(1) Contains Confidential Items from April 2002.

10.4. Results

10.4.1. Macroeconomic Impacts

Table 59 reports the macroeconomic impacts on New Zealand of all six scenarios. For the most likely scenario (non-compliance with the USA's HACCP standards), there is a welfare loss of about US$90 million (1995 prices) (this is equivalent to NZ$200 million in 2002 dollars[9]). Losing market access to Turkey and Middle East results in smallest loss (US$16 million or NZ$36 million). The loss of all significant markets accounts for $US380 million or $NZ850 million reduction in welfare. These losses in welfare are the costs of losing processed meat markets to the whole economy. These figures also suggest that the EU15 is the most significant market, followed by North America, South & East Asia, and Turkey and Middle East.

Losing processed meat markets however has minor impacts on GDP. With the most likely scenario, there is a reduction of 0.6% of GDP. Losing all significant markets results in 2.5% reduction in GDP. The figures reflect the fact that agriculture sectors have a modest contribution to GDP (about 5%[10]). The biggest contribution in welfare loss is term of trade deterioration. This is a result of decreases in meat export prices. Also there are decreases in factor prices, with land experiencing the highest price drop (1.7% the first case and 7% the last case). Wages of unskilled and skilled labour drop by 0.7% and 0.6% in the first case and 3% and 2.6% in the last case. The degrees of change in factor prices are influenced by the model structure in which land is considered a sluggish factor and labour and capital are allowed to move between sectors.

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[9] This is calculated with USA's 2002 GDP deflator (112, base year 1995 = 100) and average 2002 NZ/USA exchange rate of 0.5

[10] based on 1995 data of National Account, Statistics NZ (http://www.stats.govt.nz/domino/external/web/Prod_Serv.nsf/htmldocs/National+Accounts)

Table 59. Macroeconomic Impacts

		(1) USA	(2) NA	(3) EU	(4) SEA	(5) TME	(6) ALL
Equivalent Variation EV (NZ)	(US$m) ('95 pr)	-89.93	-113.84	-162.50	-81.20	-16.46	-380.66
Changes in per capita utility u (NZ)	(%)	-0.15	-0.20	-0.28	-0.14	-0.03	-0.65
Changes in value of GDP vgdp (NZ)	(%)	-0.60	-0.76	-1.09	-0.54	-0.11	-2.55
Changes in welfare due to Term of Trade effect TOT (NZ)	(US$m) ('95 pr)	-87.35	-110.60	-157.83	-78.87	-15.97	-371.17
Changes factor prices	(%)						
Land		-1.74	-2.20	-3.15	-1.57	-0.32	-7.10
UnSkLab		-0.69	-0.88	-1.26	-0.63	-0.13	-2.96
SkLab		-0.61	-0.77	-1.11	-0.55	-0.11	-2.60
Capital		-0.55	-0.70	-1.00	-0.50	-0.10	-2.35

Table 60. Impacts on Export Volumes of Meat and Other Industries

'95 US million (% changes in brackets)

Changes in export volumes (qxw)	(1) USA	(2) NA	(3) EU	(4) SEA	(5) TME	(6) ALL
Meat (PRM)	-374.88 (-20.43)	-476.47 (-25.96)	-685.90 (-37.37)	-338.09 (-18.42)	-67.83 (-3.70)	-1666.20 (-90.79)
Live Cattle (CTL)	2.03 (3.02)	2.53 (3.77)	3.22 (4.79)	1.87 (2.78)	0.34 (0.50)	8.53 (12.70)
Other Meats & Animal Products (OMA)	21.59 (2.92)	27.41 (3.71)	39.38 (5.33)	19.45 (2.63)	3.86 (0.52)	96.80 (13.11)
Dairy (DAI)	52.73 (2.07)	67.01 (2.63)	96.73 (3.79)	47.61 (1.87)	9.56 (0.37)	233.50 (9.16)
Fruit & Vegetable (FRV)	9.73 (1.99)	12.36 (2.53)	17.70 (3.62)	8.77 (1.79)	1.76 (0.36)	42.79 (8.75)
Fish (FSH)	0.65 (0.52)	0.83 (0.66)	1.20 (0.95)	0.59 (0.47)	0.12 (0.10)	2.79 (2.22)
Forestry (FOR)	2.83 (0.58)	3.56 (0.73)	5.05 (1.03)	2.54 (0.52)	0.53 (0.11)	11.13 (2.27)
Other Agricultural Sectors (OAG)	23.58 (2.16)	29.96 (2.75)	43.00 (3.95)	21.31 (1.95)	4.25 (0.39)	104.66 (9.60)
Manufacturing (MNF)	150.25 (2.52)	191.16 (3.20)	275.88 (4.62)	135.41 (2.27)	27.18 (0.46)	672.95 (11.28)
Services (SVS)	75.57 (1.92)	96.10 (2.45)	138.94 (3.54)	68.05 (1.73)	13.70 (0.35)	336.57 (8.57)

Table 61. Impacts on Industry Output

% change

Industry Output (qo)	(1) USA	(2) NA	(3) EU	(4) SEA	(5) TME	(6) ALL
Meat	-12.38	-15.73	-22.65	-11.16	-2.24	-55.02
Cattle	-3.60	-4.58	-6.63	-3.25	-0.65	-16.07
Other Meats	-1.29	-1.64	-2.37	-1.16	-0.24	-5.72
Dairy	0.96	1.22	1.76	0.87	0.17	4.24
Fruit & Vegetable	0.80	1.01	1.44	0.72	0.14	3.48
Fish	0.18	0.23	0.32	0.16	0.03	0.76
Forestry	0.71	0.90	1.29	0.64	0.13	3.01
Other Agriculture	0.13	0.16	0.22	0.11	0.02	0.53
Manufacturing	1.00	1.26	1.82	0.90	0.18	4.40
Services	0.01	0.01	0.02	0.01	0.00	0.05

Table 62. Impacts on Prices

% change

Market prices (pm)	(1) USA	(2) NA	(3) EU	(4) SEA	(5) TME	(6) ALL
Meat	-0.57	-0.72	-1.03	-0.51	-0.10	-2.41
Cattle	-0.71	-0.90	-1.29	-0.64	-0.13	-3.03
Other Meats	-0.63	-0.80	-1.15	-0.57	-0.12	-2.7
Dairy	-0.56	-0.71	-1.02	-0.51	-0.10	-2.38
Fruit & Vegetable	-0.59	-0.75	-1.07	-0.53	-0.11	-2.5
Fish	-0.11	-0.14	-0.20	-0.09	-0.02	-0.46
Forestry	-0.13	-0.16	-0.23	-0.12	-0.02	-0.51
Other Agriculture	-0.48	-0.61	-0.88	-0.44	-0.09	-2.07
Manufacturing	-0.44	-0.56	-0.80	-0.40	-0.08	-1.89
Services	-0.53	-0.68	-0.97	-0.48	-0.10	-2.28

10.4.2. Impacts on Meat Export Revenue

Selected impacts on the processed meat industry and other industries are presented in Tables 60-62.

Table 60 shows the changes in total export volumes of all industries. There are revenue losses to the processed meat industry in all cases, with the smallest loss of \$US68 million (\$NZ 152 million) in the case of the Turkey & Middle East market, and the biggest loss in the case of losing all significant markets (\$US1.7 billion or \$NZ3.7 billion). Other industries however experience increases in their export volumes (though at smaller prices) due to the shifting of resources from the meat sector. The most likely scenario results in a loss of \$US375 million or \$NZ840 million. This is the cost to the New Zealand processed meat industry due to non-compliance with the USA HACCP standards, or in other words, the potential benefit of the implementation of HACCP/RMP. Compared with the estimated cost of HACCP/RMP implementation (Chapter 8), which ranges from \$NZ52 to \$NZ471 million, this potential benefit far outweighs the cost.

10.4.3. Impacts on Industry Output

Only three industries (meat, cattle, and other meats & animal products) experience reductions in outputs (Table 61). The processed meat industry has the highest reduction in output. In the most likely scenario, meat processing output is 12% less than the 'without market loss' scenario. In the all case scenario, i.e. when meat industry loses all its important markets, output reduces by more than a half of the 1997 output level (55%). This feeds through to output decreases in the closely related industries such as live cattle and animal products. Cattle output falls by 3.6% in the most likely scenario and 16% in the all case scenario. Other meats and animal products output is also negatively impacted although at a lesser magnitude (1.3% in the most likely scenario and 5.7% in the all case scenario). The rest of industries experience increases in outputs, with dairy and manufacturing having the highest increases (about 1% increase in the most likely scenario and 4% in the all case scenario). The output increase in the dairy industry is modest due to the fact that beef processing also sources inputs from the dairy heard; therefore the increase in output due to resource reallocation is partially offset by the flow-on effect from beef market access loss.

10.4.4. Impacts on the International Processed Meat Market

For the most likely scenario, when New Zealand loses the USA market, there is a big gain for other North American countries. Their meat exports rise by 14%. Australian meat exports increases by 3.4%, while Latin America has a modest gain (0.7%). In the last scenario, when New Zealand loses all of its significant markets, there are increases in all regions' meat exports. Other North American countries still have the largest gain with a 16% increase in their meat exports. EU15 countries meat exports rise by 10%. Australia and Latin America both gain about 8%. Details of changes in regions' meat exports in the two discussed scenarios are presented in Table 63 and 64.

As a result of the shock to the New Zealand meat export markets, some countries/regions may be better off while others may be worse off. Often, when a country/region loses its meat imports from New Zealand, it also experiences a reduction in welfare. This is shown in all scenarios (see Table 65). For example, in the case of losing the USA market, the two countries that lose are New Zealand and the USA. For the USA, there is a welfare loss of $US145 million, which is even higher than that of New Zealand ($US90 million). The same things happen for other cases, with the EU15 experiences a considerable welfare loss of $US1.3 billion. On the other hand, countries/regions which are New Zealand's competitors in the international meat market such as North America, Latin America, and Australia gain. For example, in the all case scenario, Australia has the highest welfare gain ($US56 million), followed by Latin America ($US38 million). However in the first scenario (USA), Other North American countries gain the most. The distribution of welfare gains is likely to be influenced by the trading patterns between countries/regions before the shocks. Changes in countries/regions' welfares for all scenarios are presented in Table 65.

Table 63. Impacts on the International Meat Market (Most Likely Scenario)

% change

Export Volume (qxw)	USA	ONA	LAM	EU15	SEA	TME	AUS	NZ	ROW
Meat	-0.1	14.21	0.68	-0.04	0.74	2.31	3.37	-20.43	1.8
Cattle	0.44	0.05	0.1	0.06	0.24	0.07	-0.56	3.02	0.05
Other Meats	-0.22	-0.08	0.01	0	0.02	-0.01	-0.25	2.92	0
Dairy	-0.25	-0.26	-0.25	-0.08	-0.21	-0.15	-0.37	2.07	-0.13
Fruit & Vegetable	-0.04	-0.15	0	0	-0.01	-0.01	-0.25	1.99	0
Fish	-0.02	-0.01	0	0	0	0	-0.01	0.52	0
Forestry	-0.03	-0.02	-0.03	0	-0.02	-0.01	-0.05	0.58	-0.01
Other Agriculture	-0.03	-0.06	0	0.01	0.01	0.01	-0.16	2.16	0
Manufacturing	-0.02	-0.04	0	0	0	0	-0.1	2.52	0
Services	-0.02	-0.05	-0.01	0	-0.01	0	-0.06	1.92	-0.01

Table 64. Impacts on the International Meat Market (All Case Scenario)

% change

Export Volume (qxw)	USA	ONA	LAM	EU15	SEA	TME	AUS	NZ	ROW
Meat	6.43	16.18	7.97	10.19	6.45	9.17	8.14	-90.79	5.77
Cattle	1.03	0.21	0.22	1.32	0.92	1.34	-0.9	12.7	1.36
Other Meats	-0.29	-0.27	-0.1	-0.08	-0.12	-0.06	-0.59	13.11	0
Dairy	-1.09	-0.86	-1.13	-0.36	-0.93	-0.66	-1.34	9.16	-0.53
Fruit & Vegetable	-0.13	-0.23	-0.06	-0.03	-0.1	-0.01	-0.63	8.75	0.01
Fish	-0.03	-0.01	-0.06	0.01	-0.03	0.03	0.04	2.22	-0.01
Forestry	-0.11	-0.05	-0.14	-0.05	-0.07	0.02	-0.09	2.27	-0.06
Other Agriculture	-0.04	-0.08	-0.04	-0.01	0.01	0.03	-0.4	9.6	0.03
Manufacturing	-0.03	-0.06	-0.06	-0.03	0	0	-0.23	11.28	0
Services	-0.04	-0.07	-0.07	-0.05	-0.01	-0.01	-0.1	8.57	-0.03

Table 65. Equivalent Variation (All Countries, All Scenarios)

1995 $US million

EV	(1) USA	(2) NA	(3) EU	(4) SEA	(5) TME	(6) ALL
USA	-145.53	-136.16	-9.49	29.17	1.66	-119.43
ONA	28.13	-9.40	2.45	1.84	0.26	-5.31
LAM	4.79	5.24	24.85	2.68	3.71	38.08
EU15	17.70	22.54	-1,290.24	18.66	-2.31	-1,300.44
SEA	7.92	11.91	24.12	-141.46	2.95	-108.89
TME	0.28	0.50	-5.66	0.73	-67.34	-76.93
AUS	21.15	23.37	5.70	21.12	2.32	56.36
NZ	-89.93	-113.84	-162.50	-81.20	-16.46	-380.66
ROW	8.97	10.39	-5.51	5.40	0.78	12.06

10.5. Chapter Conclusion

In this chapter, the Global Trade Analysis Project (GTAP) model is used to estimate the costs of losing the significant markets of New Zealand processed meat products. As HACCP/RMP implementation satisfies market requirements and also minimises the occurrence of food safety hazards or outbreak that can have adverse effects on market access, the estimated costs show the potential benefits of having these programs. The potential benefits were estimated to be $NZ840 million in the most likely scenario (loss of the USA market). It rises up to $NZ3.7 billion for the case of all significant markets. Compared with the estimated cost of HACCP/RMP implementation (Chapter 8), which ranges from $NZ52 to $NZ471 million, these benefits far outweigh the cost. It shows that HACCP/RMP implementation can deliver net benefit to the New Zealand meat industry.

PART IV

CONCLUSION

CHAPTER 11

CONCLUSION

11.1. Summary of research findings

This thesis has investigated food safety, one of the highest priority issues facing not just agri-businesses, but also consumers and governments. In many countries, changes in consumer demand towards a higher emphasis on food quality and safety, heightened by various food scares in recent decades, have created the driving force for the evolution in food safety legislation. Throughout the world, countries are sharpening up their institutional arrangements for food safety, not just to protect public health but also to create a comparative advantage for their food industries. Efficient food safety regulation achieved at minimal cost is a positive influence on international competitiveness. This thesis has explored the interaction between food safety and international competitiveness, based on the experience of the meat industry.

The Animal Products Act 1999 marked the reform of the New Zealand law that regulates the production and processing of animal material and animal products. At the centre of this reform was the requirement of Risk Management Programs (RMP) which are based on the principles of Hazard Analysis and Critical Control Point (HACCP). The meat industry is one of the first industries required to implement HACCP/RMP. Also, being a significant export-oriented industry, the meat industry provides an ideal case for the purpose of this study.

HACCP is considered the most revolutionary institutional innovation to ensure food safety of the 20th century (Spriggs and Isaac, 2001). With its systematic approach to the identification, evaluation, and control of food safety hazards, HACCP has been internationally recognised as an effective approach to prevent food safety hazards. Beside the food safety benefits, HACCP may also function as a business management and a marketing tool. Moreover, HACCP's function as an international trade standard has also been recognised (Caswell and Hooker, 1996). However, how businesses benefit from HACCP, especially the interaction between HACCP and industry competitiveness, will largely depend on how the program is implemented.

In New Zealand, HACCP and HACCP-like systems[11] have been voluntarily adopted by the majority of export meat plants under overseas market access requirements. The transition from voluntary HACCP to mandatory HACCP/RMP, therefore, has provided a unique feature in food safety management for New Zealand. On the one hand, HACCP/RMP brings a uniform approach to food safety management for all food (meat) processing plants and also provides an official assurance for New Zealand meat products. On the other hand, this transition may unnecessarily lead to overlaps in food safety management practices. The following sections summarise the main findings of the thesis regarding meat processing plants' experiences with the implementation of HACCP/RMP.

11.1.1. HACCP/RMP Implementation Process

Small plants in general lag behind in the adoption of both HACCP and RMP, despite their implementation process consuming less time than that of large plants. Plants that only serve the local market also lag behind those that export their products. HACCP has been adopted by the majority of plants for quite a long time (average 5 years). RMP however has been around for an average of just 8 months as at December 2003. The process of implementing RMP is shown to be more time-consuming than HACCP. Plant experiences point to the two tasks that

[11] These are the systems that adopt a preventative approach like that of HACCP but may not involve the full seven principles (see Chapter 1, section 1.3.2.2).

contribute to the extra time requirement, i.e. plan evaluation and registration. RMP also requires more external assistance than HACCP.

11.1.2. HACCP/RMP Adoption Motivations

The fact that small plants lag behind even when they have to spend less time in implementation implies that small plants are less motivated in adopting HACCP/RMP. This is also true for the local plants that do not have overseas market access incentives. Among the specified motivations, external factors such as meeting legal requirements, customer requirements, and gaining market access are ranked higher than internal factors such as increasing production efficiency or control of the production process. It shows that HACCP/RMP is regarded as a marketing advantage rather than an internal management tool.

The non-parametric analysis of survey data suggests the following points:

(a) The few reasons that motivate small plants to adopt HACCP/RMP are: (1) recommendation from industry associations, (2) the program's reputation as good practice, and (3) the potential for attracting customers.

(b) Older plants are less motivated than younger plants. The most significant motivations for younger plants to adopt HACCP/RMP are to attract new customers and to gain overseas market access.

(c) Plants with more product types are less motivated in adopting HACCP/RMP. The reason could be that the program is required for each type of product. Thus the more products the plant has the more time it has to spend to implement HACCP/RMP.

(d) Plants that have more Quality Management Systems (QMS) are less motivated to adopt HACCP/RMP. The reason could be that respondents consider the current food safety management practices are able to deal with food safety hazards and further regulations are not needed. QMS is shown to be the variable with the most significant influence on HACCP/RMP adoption motivation. The analysis also shows that if these plants are interested in HACCP/RMP, it is for the purposes of third-party accreditation or reducing product wastage.

(e) Plants with both slaughtering and processing activities are more interested in HACCP/RMP, especially for accessing new overseas markets and reducing wastage.

11.1.3. Implementation Problems

All plants regardless of sizes and types are highly concerned about the cost of HACCP/RMP implementation. They are also anxious about the cutback of staff time available for other tasks and the flexibility of the production process. Small plants and abattoirs are more concerned about the lack of expertise in HACCP/RMP implementation, which suggests that they may need assistance with their RMP implementation. Partial exit or cutting down number of products is not suggested as a serious problem for the surveyed plants.

The non-parametric analysis of survey data suggests the following points:

(a) Small plants are more likely to have problems with finding the personnel and financial resources for the implementation task. Larger plants, on the other hand, have more problems with training and motivating their staff.

(b) Similar to small plants, younger plants are more concerned with finding resources for HACCP/RMP implementation and modifying their production process. Older plants, on the other hand, are more worried about training and motivating their managerial and production staff.

(c) Plants with more product types are more likely to have problems with modifying their production process due to HACCP/RMP implementation.

(d) Plants with more QMSs have to deal with more difficult implementation issues. These plants found HACCP/RMP implementation reducing their staff time for other production tasks or reducing the flexibility of the production staff.

(e) Plants that are doing both slaughtering and processing are more likely to have problems with finding resources, motivating staff, and modifying production process than single-activity plants.

11.1.4. Implementation Costs

Plan design and verification are considered the two most significant components of HACCP/RMP costs. Among operating costs, evaluation and training are found significant for small plants while sampling/testing and record-keeping are found significant for large plants.

The non-parametric analysis of survey data suggests the following points:

(a) Older plants appear to pay more for evaluation and new investment (e.g. equipment purchase) due to HACCP/RMP implementation. They also bear higher costs of sampling/testing and recurred training. Younger plants, on the other hand, appear to pay more for plan design and staff training.

(b) Plants with more product types experience higher costs for most cost items. For example, they have higher design, training, verification, and sampling/testing costs compared with plants that have fewer products.

(c) Plants having more QMSs appear to pay more for evaluation and equipment purchases. However, they may have smaller staff training and record-keeping costs. This could be attributed to the experiences they gained from dealing with other food safety management practices.

(d) Plants both slaughtering and processing show higher spending on equipment purchases and sampling/testing costs compared with single-activity plants.

11.1.5. Implementation Benefits

Marketing benefits such as accessing overseas markets and retaining/attracting customers are recognised as the most important benefits. Management benefits such as increasing control over the production process is also recognised. Among different plant sizes, medium and large plants have observed HACCP/RMP marketing benefits while small plants have not. Among different plant types, meat export slaughterhouses have experienced the most of the benefits while packing houses have the least.

The non-parametric analysis of survey data suggests the following points:

(a) Small plants have more benefits with improved product safety and control of the production process, compared with other potential benefits of HACCP/RMP implementation. Large plants, on the other hand, have more benefits in retaining and attracting customers.

(b) Similarly, HACCP/RMP can help younger plants to improve their product quality and to achieve other internal benefits. Older plants, on the other hand, enjoy the external benefits such as maintaining and attracting customers. Younger plants can also benefit in gaining overseas market access as a result of having HACCP/RMP.

(c) Plants with more product types may have more implementation issues but they may also benefit more, both internally and externally, from HACCP/RMP implementation.

(d) Plants having more QMSs observe less benefit from HACCP/RMP. It suggests that HACCP/RMP may not be so beneficial when a plant has already engaged in other (similar) food safety management systems. It also shows that once voluntary HACCP has been in place, mandatory RMP may not provide any benefits other than a uniform approach to and an official assurance of food safety.

(e) Plants with more production activities also benefit more from HACCP/RMP compared with single-activity plants.

(f) There are significant associations between plant export status and the gains in sales and prices as a result of HACCP/RMP. Export plants could gain a positive impact on their product prices and sales once adopting HACCP/RMP.

11.1.6. HACCP/RMP Cost and Benefit Estimation

The experience of meat processing plants regarding the implementation of HACCP/RMP has highlighted that the market access issue is an important driver for the adoption of the program. Businesses would be able to maintain and enhance market access with voluntary HACCP if this satisfies customer requirements. RMP provides a uniform approach to food safety management in New Zealand and acts as an official guarantee of product safety, and could strengthen overseas market access for New Zealand meats while also safeguard against the occurrence of potential food safety outbreaks. With this approach, in part III of the thesis, several modelling techniques are employed to estimate the costs and the benefits of the implementation of HACCP-based RMP (HACCP/RMP).

In Chapter 8, a quality-adjusted cost function is employed to estimate the change in variable cost of production due to the implementation of HACCP/RMP. In the production economic literature, quality-adjusted cost functions have been developed to capture the effects of product quality on production cost (Gertler and Waldman, 1992). Recently, the framework was applied for the case of food safety (Antle, 2000). In this model, a product safety variable is introduced together with other traditional variables in a cost function such as capital, input prices, and output quantity. Production data from the New Zealand census of manufacturing data are employed to estimate the model. With adjustment for technical progress, the elasticity of cost with respect to safety is found to be 0.75 for New Zealand meat processing plants. This is similar to the safety elasticity estimated for the US beef industry (Antle, 2000), which is 0.73 for large plants and 0.74 for small plants. Based on this safety elasticity estimate, the increase in variable cost of production due to HACCP/RMP is estimated to be in the range of $NZ37-$NZ337 million. This is equivalent to an increase from 1.7% to 21% of total variable cost, or from five cents to 48 cents of unit cost, depending on the level of food safety practices of the plant before HACCP/RMP. In the HACCP/RMP implementation cost categories, it falls into the operating cost group which is associated with costs incurred due to the slowdown of the production process for the monitoring, sampling and testing tasks. The findings suggested that this type of cost can make up a significant proportion of the total implementation cost.

The market access benefits of HACCP/RMP are modelled in Chapters 9 and 10. In Chapter 9, the international competitiveness of the meat industry is reviewed. New Zealand is an important player in the international markets for beef and sheep meat. In 2002, it was the fifth largest beef exporter, after Australia, USA, Brazil, Canada, and the EU. New Zealand has always been the largest sheep meat exporter. Its sources of competitiveness are then analysed using the Porter framework (Porter, 1990). The analysis shows that the meat industry has multiple sources of comparative advantage. Many of these sources have been utilised extensively in strengthening its competitiveness. For example, the factor conditions (i.e. a favourable climate for pastoral based industries, the clean and green image, the isolation from the continental sources of diseases) have been strong influences on New Zealand meat competitiveness. On the other hand, many other sources, such as business strategies and government policies, while significantly affecting its competitiveness, would require a strong focus on the conditions of the market. Food safety policy is one example. Carefully designed legislation will create advantage. On the other hand, an inefficient and costly system will have a harmful effect on competitiveness.

An export model is employed to analyse the effects of HACCP/RMP on meat industry export performance. Models of this type have been widely used for analysing bilateral trade (see for example Bergstrand, 1989). In the model, trade flows between two countries are assumed to be influenced by their incomes (GDP) and populations, distance apart, and other trade affected variables such as exchange rate, tariff quota, and trade agreements. The model used in this analysis is a commodity-specific model. It also focuses on the export flows of meat from New Zealand to its significant markets, namely the USA, the UK, Canada, China, France, Japan, Germany, South Korea, and Australia. These markets make up more than 70% of the total of New Zealand meat exports. They are also the countries that have strict requirements on food safety. The results suggest a positive impact of HACCP/RMP on the export of total meat and sheep meat. It does not support for a positive HACCP/RMP-export relationship in the case of beef exports. This implies that when the compliance with food safety standards is already high, HACCP/RMP implementation may have little effect on competitiveness. In other words, the magnitude of the impact is dependant on the (previous) status of business food safety management practices. This again confirms the survey experience that plants having more QMSs observed less benefits from HACCP/RMP.

With its preventative approach, a uniform implementation of HACCP/RMP would also be able to safeguard the New Zealand meat industry against the occurrence of food safety outbreaks. Zugarramurdi et al (2000) identified failure cost as a part of quality cost, together with prevention cost and appraisal cost. As discussed on page 156, the saving from a reduction of failure cost is often counted as a (potential) benefit of the spending on other quality costs (Nin-Pratt et al, 2004). While Chapter 9 has shown a positive impact of HACCP/RMP on export performance, it is not able to provide an estimate on the market access benefits of the program. The approach taken in Chapter 10 provides an estimate of the cost of losing market access, or in other words, the benefit of HACCP/RMP.

The Global Trade Analysis Project (GTAP) model is employed to estimate the costs of losing markets in various scenarios. The GTAP model is a Computable

General Equilibrium (CGE) model which allows simulations of policy shocks on a global scale. This type of model not only reveals the impacts on a specific country but also on other significant players in the international markets. The model and its database were well developed and internationally recognised. It is publicly available and regularly updated (GTAP website: http://www.gtap.agecon.purdue.edu/). Moreover, the model fits neatly with our specific case as the beef and sheep meat sector is a separate sector in the database and New Zealand is one among the countries included in the model. Shocks are introduced into the model under different scenarios which assume the losses of the significant markets for New Zealand meats (the USA, North America, the EU, South and East Asia, and Turkey and Middle East market). For the most likely scenario, the simulation results show a loss of $NZ840 million to the meat industry due to market access loss. The estimate rises up to $NZ3.7 billion in the case of losing all significant markets. As HACCP/RMP implementation satisfies market requirements and at the same time minimises the occurrence of food safety hazards or outbreaks that can have adverse effects on market access, the estimated opportunity costs show the potential benefits of having the program. This benefit is clearly higher than the cost of implementation (around $NZ52 to $NZ471 million).

11.2. Policy Implications

11.2.1. HACCP/RMP Implementation Issues

The survey results and subsequent analysis of survey data have provided a rich picture of meat processing plants' experience with the adoption of HACCP/RMP. Previous studies carried out overseas (Henson et al, 2000; Colatore and Caswell, 2000) on industry's experience with HACCP adoption have suggested that implementation issues vary with different plant characteristics. This study has confirmed this hypothesis. HACCP experience varies according different plant sizes, types, age, products, and pre-HACCP/RMP food safety practices. Details of the findings have been discussed in section 11.1.1-5 above. The followings are some significant points that arise from the findings:

(a) Plants in general are not in favour of the mandate of RMP. One reason is that they do not see any more benefits in terms of market access or production management in addition to that brought by HACCP. RMP also appears to require more resources and efforts than HACCP. This implies that NZFSA needs to communicate with firms about the benefits of RMP as a uniform approach to food safety management and an official assurance of food safety. Moreover, survey results suggest some points in the adoption process such as evaluation, register, and verification that need to be improved so as to minimise the time and costs for firms.

(b) Small plants in general lag behind in the adoption of both HACCP and RMP. They are also the ones that have difficulties in finding resources (both human and financial resources) for the implementation tasks. Plants with various product types and plants with more quality management systems (apart from HACCP/RMP) find it more difficult to adopt HACCP/RMP (e.g. more implementation issues in training and motivating staff). This may require further assistance from NZFSA to these plants so as to lessen their implementation problems.

(c) Research on the impacts of HACCP/RMP is facilitated if plants keep a record of costs related to the implementation and operating of the program. It may require the involvement of the NZFSA or an industry association to bring about the necessary data for further analysis of the impacts of the program. Research on implementation issues and impacts of HACCP/RMP is important especially when the programme will be rolled out to other food processing and services industries in the near future.

11.2.2. HACCP/RMP Costs

The HACCP/RMP survey was able to gather plant qualitative observations on the costs of the programme. Costs are categorised into two major types:

implementation and operating costs. Implementation costs are made up of non-recurring costs such as plan design, evaluation, registration and other costs incurred before the deployment stage. Operating costs includes regular verification, product testing and sampling, and record keeping. Survey results show that plan design and verification are the two significant components of HACCP/RMP costs. Results also indicate the components of the implementation process that can be improved to minimise costs such as the evaluation and verification processes.

There are several methods that could be used to estimate the compliance costs associated with HACCP/RMP. One method that is straightforward and involves less modelling techniques is the accounting approach. There have been studies overseas using this method to quantify the costs of HACCP (e.g. Colatore and Caswell, 2000). This method could be used if there are plant-level data available on HACCP costs. However collecting these data is a difficult task as the survey results have shown. Another method that relies on secondary data and makes use of the production cost function is the econometric approach. This is the method employed in this study to estimate the costs of HACCP/RMP.

The increase in variable cost due to HACCP/RMP adoption is estimated in the range of 1.7% to 21% of total variable cost, or from 5 cents to 48 cents per kg of meat. A plant with a good historical food safety records is likely to incur costs at the lower end of the range. On the other hand, a plant that is doing poorly in terms of food safety management may find itself at the upper end of the estimate. This increase in variable cost is the efficiency cost which occurs due to HACCP/RMP tasks slowing down the production process. Estimation results suggest that this increase in variable cost could make up a significant part of total HACCP/RMP costs.

Staff training and motivation can play an important role in minimising HACCP/RMP costs, especially the efficiency cost. As HACCP/RMP operation involves staff time in monitoring, sampling, testing, and record-keeping, a well managed process would help to minimise staff time, and hence costs. Once

HACCP/RMP is well in place, this efficiency cost is expected to be reduced. Moreover, HACCP/RMP with its process control characteristics, once up and running, could deliver management benefits, thus helps to offset the efficiency loss. There has been overseas experience that showed the management benefits of the programme (Nganje and Mazzocco, 2000).

11.2.3. HACCP/RMP Benefits

The adoption of HACCP/RMP is expected to reduce food safety hazards and to facilitate market access. The feedback from meat plants through the survey showed that there are observations of these two types of benefit. The market access benefit, however, is observed more frequently than the safety benefit.

In this study, the analysis of an export demand model for NZ meat products shows that HACCP/RMP adoption positively influences sheep meat and total meat exports. Hence the benefit of a uniform adoption of HACCP/RMP should be considered as an additional benefit, apart from the benefit that could be delivered from voluntary adoption of HACCP or other quality management systems. Thus, if compliance with food safety standards is already high as in the case of beef, the additional benefit is less significant.

The implication of this finding is that HACCP/RMP adoption will not bring much more benefit if the voluntary system already achieved market access. However when the overseas markets require a uniform adoption of HACCP, this adoption is critical for gaining access. A failure in implementing the programme as required will lead to an exclusion of NZ products from the overseas market that requires HACCP adoption.

The Global Trade Analysis Project (GTAP) model is used to estimate the costs of losing market access if HACCP/RMP is not adopted. The use of this general equilibrium model allows for the analysis of the impacts of market access loss on the meat industry and other industries of the economy. In the most likely scenario, failing to adopt HACCP/RMP would cost the meat industry about $840 million in terms of annual export revenue loss. There would also be negative impact on the whole economy, but at a less magnitude due to resources reallocated to other unaffected industries (e.g. dairy, horticulture).

This finding shows that losing market access has a huge impact on the meat industry as well as the economy as a whole. It implies that food safety hazard prevention is important, but satisfying market requirements is even more important.

11.3. Research Implications

If plant-level data on production and HACCP/RMP implementation costs become available, further research on the impacts of the program could be performed, such as:

(a) An economic efficiency analysis of HACCP/RMP. Previous studies (e.g. Nganje and Mazzocco, 2000) provided a starting approach for this type of analysis. The literature on production economics can also be utilised so as to make an in-depth analysis on this impact. Support for the management benefits of HACCP/RMP will further provide incentives for plants to adopt the program and also may help to ease their unfavourable feelings towards HACCP/RMP.

(b) A comparison of the impacts of different HACCP regimes. This involves a comprehensive analysis of the food safety management approaches of other countries. The point is if one country's approach to provide food safety is less costly than another's, this can create a source of comparative advantage. Moreover, if one country can convince international buyers that its food safety system has more integrity than another's, this can create another source of competitive advantage – product differentiation (Spriggs and Isaac, 2001). This type of analysis could be able to shed further light on the relationship between food safety and international competitiveness.

(c) Further data availability also enables the use of a national general equilibrium model that takes into account the impacts of HACCP/RMP adoption, not only on the meat industry, but also on other sectors of the economy. This study only considers industry impacts. There are also food safety benefits to consumers from the adoption of HACCP/RMP. An economy-wide analysis of HACCP/RMP will be able to show the net welfare impact to the whole society.

11.4. Limitations

Perhaps one of the biggest challenges in measuring the economic impacts of HACCP/RMP is the lack of consistent and necessary data for quantitative analyses. The experience from the survey shows that gathering plant level data such as those of production costs and HACCP implementation costs is a difficult task. Plants may not have detailed data or do not want to disclose these types of data. It is then common that researchers have to rely on the secondary sources of data. In Chapter 8, New Zealand census of manufacturing data were utilised to estimate the change in variable cost of production due to HACCP/RMP implementation. This series provides detailed industry production costs in the form of time-series data. Unfortunately it is only up to 1984. The succeeding series has much less detail and cannot be used for the same estimation purpose. The research results will therefore be affected by this data limitation. However, in this situation, the approach taken in Chapter 8 is the best-practice way to tackle the data problem.

The lack of necessary data has also held back further analysis on the economic impacts of HACCP/RMP such as production efficiency impacts and market structure impacts. As discussed in Chapter 2, beside the market access benefit, HACCP/RMP could also bring management benefits such as improving the control of the production process, reducing wastage, and improving efficiency in the use of inputs. Quantifying these benefits involves the use of production cost and HACCP/RMP implementation cost data which the survey has failed to achieve due to plant reluctance in providing these data. Measuring market structure impacts, on the other hand, not only requires data on the production characteristics of firms but also data on the entry and exit of firms during a period of time and other market characteristics (see for example Muth et al, 2001). The experience from the HACCP/RMP survey (Chapter 4) however shows that these types of impacts are not significant compared with other marketing and market access benefits. Nevertheless, it would be sufficient to include these benefits in a quantitative assessment of HACCP/RMP impacts.

In Chapter 10, we again have a data problem. As GTAP version 5 database is the most updated database available at the time the simulation is run, we have no other choice of data. These data are not current (official year 1997) and they may influence the benefit estimates. One potential way to overcome the problem is to use this data set to project the data for the current year (2002/2003). However, this task would involve the gathering of other data on variables such as country growth rates, consumer income elasticities, or productivity growth. Due to the scope of the chapter, we decided not to proceed further with these tasks. Furthermore, as meat exports were following an upward trend from 1997 to 2002 (see Table 9.1), estimates using 2002 data are likely to be higher than those achieved based on 1997 data. The 1997 data estimates are then the lower-bound estimates. As it has been shown in Chapter 10, these lower-bound estimates already outweigh the implementation costs.

The analysis in this thesis has a static nature. It provides an insight study of the New Zealand experiences with HACCP/RMP implementation and the economic impacts of the program, but does not consider these issues in a changing international context. In other words, it does not take into account the evolution in food safety management and particularly the implementation of HACCP in other countries. Although the significant features of worldwide food safety management have been mentioned in the thesis, it is not intended to provide a comparison of countries' experiences with HACCP implementation. This could also be considered as a limitation of the thesis, as how countries implement HACCP is also an important factor in the relationship between HACCP and international competitiveness (Spriggs and Isaac, 2001).

11.5. Final Words

This thesis was commenced when HACCP/RMP started to emerge as a phenomenon in food safety management. From the time the HACCP meta-rules were launched in the US in 1996, till the time it was required by the Animal Products Act in 1999 and throughout its implementation process in the NZ seafood and meat industries which ended July 2003, it was always at the centre of the debate surrounding food safety regulations. Three years have passed. The meat industry has settled with HACCP/RMP and the programme is being rolled out to other industries including the dairy industry and domestic food services. What we are learning today from the meat industry experience can give further insight into the potential impacts of the programme. This study has fulfilled two important purposes: examining industry experience with HACCP/RMP and setting a framework for analysing its impacts.

This thesis charts a new course in food safety economic research in New Zealand. It provides a depth of insight for industry and policy analysts concerned about implementing food safety management regimes. Succeeding studies built on this thesis should be able to provide international comparisons concerning the magnitudes of the impacts of different HACCP regimes. The benefits from this work will vindicate the investment in this thesis.

APPENDIX

APPENDIX 1

SURVEY QUESTIONNAIRE

HACCP/RMP IMPLEMENTATION SURVEY 2003

Purpose

This survey is design to collect information on HACCP/RMP implementation for a study of the impacts of HACCP/RMP to the New Zealand Meat Industry. The project is supported by the Agricultural and Marketing Research and Development Trust, the University of Waikato and developed after consultation with the Meat Industry Association. The purpose of the survey is to understand your experiences with HACCP/RMP implementation.

Confidentiality of Information Supplied

The information supplied will be used for the above purpose. No information from individual respondents will be made available to other parties.

Return Date

Please return the completed questionnaire, in the reply paid envelope enclosed, **within 21 days** of receiving it.

Help and Advice

Mail	Email	Phone/Fax
HACCP survey (Attn: Kay Cao) Economics Department Waikato Management School Private Bag 3105 Hamilton	kaycao@waikato.ac.nz	Phone: 07 838 4466 ext. 6444 Fax: 07 838 4331 Mob: 021 137 0260

Notes

The questionnaire should be filled out by a Quality Manager. It takes about 15 minutes to finish. It is OK if you do not have or choose not to supply some of the information. However, we appreciate if you would strictly follow the structure of the questionnaire and complete as many questions as possible.

Part I. HACCP/RMP implementation

1. Please select the situation(s) which best describe(s) your plant's HACCP/RMP implementation. You may have to select more than one box.

   Your plant has a registered RMP in place……….……………☐

   Your plant is developing a RMP……………………..………..☐

   Your plant has a HACCP system in place……….……………☐

   Your plant neither has a RMP nor HACCP system…………… ☐▶Please go to part II (page 5)

SECTION A. RMP implementation

Please complete this section if your plant has a registered RMP in place, or is developing a RMP

2. Is your plant's RMP developed based on existing HACCP plan? Yes ☐ No ☐
3. Who developed your plant's RMP? Employees ☐ External Consultants ☐

   Joint coordination ☐ with……

If RMP has been registered and approved by MAF…

4. How long did it take to develop and implement your plant's RMP? [Months]
5. How long has your complete RMP been in place? [Since]

If RMP is underdevelopment or not yet approved by MAF…

6. How long has it been developed? [Months]
7. How long more will it take to complete and implement your RMP approximately? [Months]

SECTION B. HACCP implementation

Please complete this section if your plant has a HACCP system in place

8. Who developed your HACCP plan? Employees ☐ External Consultants ☐

   Joint coordination ☐ with……

9. How long did it take to develop and implement your HACCP system? [Months]
10. How long has your HACCP system been in place? [Since]

SECTION C. Motivation, Difficulties experienced, and Expected Benefits of HACCP/RMP.

Please complete this section if your plant either has HACCP or RMP, or is developing a RMP.

11. Below is a list of issues which may motivate the decision to implement HACCP/RMP. Please indicate the importance of each issue by ranking them on a 7-point scale. Tick zero (0) if you do not think it is a motivation. Please tick one box for each item.

	Not a Motivation	Unimportant					Important
Meet legal requirements	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Meet the needs of major customers	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Attract new customers for products	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Reduce customer complaints	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Reduce product wastage	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Improve control of production process	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Improve product quality	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Improve efficiency/profitability of plants	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Recommended by MAF/Industry Association	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Generally regarded as good practice	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Generally regarded as Board or CEO country wide policy	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Access new overseas markets	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Needed for plant to be third party accredited	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Reduce need for quality audits by customers	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Other motivations (*please specify*)	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐

12. Below is a list of issues which can be problems in the implementation of HACCP/RMP. Please indicate the level of difficult of each item by ranking them on a 7-point scale. Tick zero (0) if you do not think it is a problem. Please tick one box for each item.

	Not a Problem	Minor Problem					Major Problem
We are too small for HACCP/RMP	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Lack of expertise in HACCP/RMP implementation	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Need to retrain supervisory/managerial staff	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Need to retrain production staff	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Need to modify production process	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Attitude/motivation of supervisory/managerial staff	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Attitude/motivation of production staff	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Reduced staff time available for other tasks	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Recouping costs of implementing HACCP/RMP	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Reduced flexibility of production process	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Reduced flexibility of production staff	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Reduced flexibility to introduce new products	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐
Have to cut down number of products	**0☐**	**1☐**	**2☐**	**3☐**	**4☐**	**5☐**	**6☐**	**7☐**
Other difficulties (*please specify*)	0☐	1☐	2☐	3☐	4☐	5☐	6☐	7☐

13. Below is a list of benefits which can result from HACCP/RMP implementation. Please rank each benefit according its importance relative to the overall benefit of HACCP/RMP on a 7-point scale. Tick zero (0) if you do not think your company has got the benefit. Please tick one box for each item.

	Not a Benefit	Unimportant					Important
Reduced product rework	0☐	1☐	2☐	3☐	4☐	5☐	6☐ 7☐
Increased product shelf life	0☐	1☐	2☐	3☐	4☐	5☐	6☐ 7☐
Reduced product microbial counts	0☐	1☐	2☐	3☐	4☐	5☐	6☐ 7☐
Increased efficiency in the use of inputs	0☐	1☐	2☐	3☐	4☐	5☐	6☐ 7☐
Increased control over operating process	0☐	1☐	2☐	3☐	4☐	5☐	6☐ 7☐
Increased product prices	0☐	1☐	2☐	3☐	4☐	5☐	6☐ 7☐
Increase sales	0☐	1☐	2☐	3☐	4☐	5☐	6☐ 7☐
Reduced production costs	0☐	1☐	2☐	3☐	4☐	5☐	6☐ 7☐
Increased ability to retain existing customers	0☐	1☐	2☐	3☐	4☐	5☐	6☐ 7☐
Increased ability to attract new customers	0☐	1☐	2☐	3☐	4☐	5☐	6☐ 7☐
Increased ability to access new overseas markets	0☐	1☐	2☐	3☐	4☐	5☐	6☐ 7☐
Other benefits (*please specify*)	0☐	1☐	2☐	3☐	4☐	5☐	6☐ 7☐

SECTION D. Cost of implementing and operating HACCP/RMP

Please complete this section if your plant either has HACCP or RMP, or is developing a RMP.

14. Does your plant have a record for costs associated with HACCP/RMP implementation?

Yes ☐ No ☐

If yes, approximately how much is the change in production costs due to HACCP/RMP (%)…………..
The next two questions ask about HACCP/RMP implementation costs (one-time costs) and operating costs (recurring costs). Please rank each item according to its proportion in the overall cost of implementation or operating HACCP/RMP. For example, rank 1 for the biggest cost, rank 2 for the second biggest cost, rank 3 for the third biggest cost. Rank 0 (zero) if a cost had not been incurred. Please use the last column for notes if you have any estimates on the amount of time or actual costs spent. You can separate HACCP and RMP costs if you think it is necessary to do so.

15. Implementation costs

	Rank	Notes
Design and development costs		
Evaluation/Register costs		
Training costs		
Equipment purchases, new building		
Other costs (*please specify*)		

16. Operating costs

	Rank	Notes
Verification		
Sampling/Testing		
Record-keeping		
Recurred training costs		
Other costs (*please specify*)		

Part II. Other information

17. How long has your plant been involved in meat processing? | Since |

18. What is (are) your plant's activiti(es)? Slaughtering ☐ Processing ☐
Others (*please specify*)……………

19. What is (are) your plant's product(s)? Beef ☐ Veal ☐ Mutton ☐ Lamb ☐
Venison ☐ Others (*please specify*)……………

20. Other than HACCP/RMP, which quality/safety management system(s) is (are) used by this plant?
ISO9000 ☐ Sanitary Standard Operating Procedures (SSOPs) ☐
Good Manufacturing Practice (GMP) ☐ Industry codes of practice ☐
Total Quality Management System (TQM) ☐ Others *(please specify)*……………………………….…

21. Please give an estimate of your plant's annual volume of production (Tonnes/Animals)……………...
……………………………………………………………………………………………………..

22. Please give an estimate of your plant's annual sales ($/thousand $/million $)…………………………
……………………………………………………………………………………………………..

23. Please give an estimate of your plant's total annual operating cost ($)…..…………………………….
Of which, approximately how much is salary/wages payments?……………………………………….

24. Please give an estimate of your plant's export (% of production/sales) to:
US market…………………………….. Asia market…………………………………..
EU market…………………………….. Other markets…….……………………………..

25. Please give an estimate of your plant's total number of employees when operating at peak performance:
Full-time………………………………. Part-time……………………………………..
Management staff………………………

26. Details of the person completing this questionnaire:

Name	Position	Signature
Plant/Company	**Phone/Fax**	**Email**

Thank you for completing this questionnaire!

Please use this part for further comments on HACCP/RMP implementation.

🖂 Would you like to receive a copy of our survey results? Yes ☐ No ☐

APPENDIX 2

EXAMPLES OF HACCP/RMP FEEDBACKS

“The estimated cost at $10,000 to implement RMP has been a major financial burden because: (1) it happened at the same time SARS effected the Asia market by 70%; (2) as most other processors involved in our industry do not have to implement their RMP until 2006, this has been a financial disadvantage over our competitors. The implementation of RMP has not improved any systems or outputs than those already in place under the Meat Act”.

“We have had a HACCP plan in place for years. So far we have found the implementation of RMP to be a lot of work, paper work, hours for no gain”.

“For export meat plants, the majority of work was in HACCP implementation with bringing plant quality systems up to auditable standards. HACCP implementation involved process understanding, staff commitment, and management buy in. RMP is an 'add on' (good in theory but changed in practice by verification)”.

“…a huge waste of resources for little financial gain to the plant. Benefits initially claimed nullified by OMAR requirements”.

“RMP are a complete waste of time and space. We are not selling anymore meat and the meat is no safer than it always has been. Our industry is driven by overseas market access issues. The science base approach to food safety has been thrown out the window and we merely comply with what the USA and EU reviewers request”.

“The benefits expected from having a registered RMP have not been realised due to NZFSA making all industry standards incorporated as current requirement until such time as the OMARs can be 'unravelled' from within them. Since registration of our RMP there has been NO CHANGE in production, auditing by MAF VA. In fact the RMP has never been mentioned. At this stage there is no difference between operating under the Meat Act to operating under the APA”.

“We took advantage of the streamlined approach, and will need to apply to register a full RMP by Apr 06”.

“RMP has incurred additional and unnecessary cost. There were no food safety issues prior to RMPs under Industry standards and HACCP. Now have additional cost of independent evaluation initially and for subsequent amendments to an RMP. No reduction in MAF VA compliance costs”.

“I think the most difficult hurdle was interpretation of what is required. Different MAF VA and evaluators interpret requirements of regulations and standards differently (in some instance) which can cause confusion and hence increase the time required to complete a task”.

“…both are a mandatory requirement for operation of meat export permit. Compliance cost and time commitment are significant”.

“I believed a number of the potential benefits from RMP have been lost due to the changes made since the initial introduction ie it is not solely outcome based as I understood it to be”.

“HACCP is required for market access, RMP adds nothing to process that is not already covered in operating systems”.

“RMP are a bureaucratic nightmare. NZFSA has difficulty in handling independent evaluation and hence registration is in effect a 2nd evaluation. The length of time for registration/reregistration is totally absurd given that this should be nothing more than a rubber stamping exercise. For export companies RMP provide no benefit what so ever”.

APPENDIX 3

SHAZAM OUTPUTS FOR CHAPTER 8

Cost function estimation

```
|_*model for export meat works
|_*NON-NEUTRAL TECHNOLOGY CHANGE
|_*
|_sample 1 52
|_read(F:\meatdata.dif) wm wl y k qman p z vc sl / dif
UNIT 88 IS NOW ASSIGNED TO: F:\meatdata.dif
..NOTE..DIF FILE HAS    9 COLUMNS AND     52 ROWS
9 VARIABLES AND       52 OBSERVATIONS STARTING AT OBS       1

|_stat wm wl y k qman p z vc sl
NAME        N    MEAN        ST. DEV      VARIANCE     MINIMUM
MAXIMUM
WM           52   229.92      225.03      50637.       67.000
1317.0
WL           52   19.450      11.009      121.21       7.6700
40.010
Y            52   637.32      331.46     0.10986E+06   191.25
1234.3
K            52  0.62226E+06 0.67676E+06 0.45800E+12  0.15019E+06
0.26048E+07
QMAN         52  0.13750     0.17919E-01 0.32108E-03  0.70000E-01
0.18000
P            52   3123.7      1057.6     0.11184E+07   1846.3
6311.4
Z            52   8804.4      2702.9     0.73055E+07   4349.0
13891.
VC           52  0.20516E+07 0.15561E+07 0.24215E+13  0.41238E+06
0.64363E+07
SL           52  0.17019     0.95002E-01 0.90255E-02  0.90000E-01
0.50000
|_*
|_genr lwm=log(wm)
|_genr lwl=log(wl)
|_genr ly=log(y)
|_genr lk=log(k)
|_genr lqman=log(qman)
|_genr lz=log(z)
|_genr lpr=log(p)
|_genr lvc=log(vc)
|_*
|_genr lwmm=lwm**2
|_genr lwll=lwl**2
|_genr lyy=ly**2
|_genr lkk=lk**2
|_*
|_genr lwml=lwm*lwl
|_genr lym=ly*lwm
|_genr lyl=ly*lwl
|_genr lyk=ly*lk
|_genr lkm=lk*lwm
|_genr lkl=lk*lwl
|_genr lpm=lpr*lwm
```

```
|_genr lpl=lpr*lwl
|_genr lpk=lpr*lk
|_genr lpy=lpr*ly
|_genr lqman_m=lqman*lwm
|_genr lqman_l=lqman*lwl
|_genr lqman_k=lqman*lk
|_genr lqman_y=lqman*ly
|_genr lzm=lz*lwm
|_genr lzl=lz*lwl
|_genr lzk=lz*lk
|_genr lzy=lz*ly
|_*
|_genr t=time(0)
|_genr tt=t**2
|_*

|_nl 2 / ncoef=27 iter=400
...NOTE..SAMPLE RANGE SET TO:      1,    52
|_eq lvc=a0 + (1-al+gs*tm)*lwm + (0.5*all-gsl*tm)*lwmm +
(al+gs*tl)*lwl + &
| (0.5*all+gsl*tl)*lwll + by*ly + 0.5*byy*lyy + (dk+gs*tk)*lk +
(0.5*dkk+gsk*tk)*lkk &
| + (-all-gsl*tl+gsl*tm)*lwml + (-byl+gsy*tm)*lym
+(byl+gsy*tl)*lyl &
| +(byk+gsy*tk)*lyk +(-dkl-gsl*tk+gsk*tm)*lkm
+(dkl+gsl*tk+gsk*tl)*lkl &
| +gs*lpr -gsl*lpm +gsl*lpl +gsk*lpk +gsy*lpy &
| +(gs*tman+theta_man)*lqman -gsl*tman*lqman_m +gsl*tman*lqman_l &
| +gsk*tman*lqman_k +gsy*tman*lqman_y +gs*tz*lz -gsl*tz*lzm &
| +gsl*tz*lzl +gsk*tz*lzk +gsy*tz*lzy +bt*t +btt*tt &
| +(-blt+bst*tm)*lwm*t +(blt+bst*tl)*lwl*t +(bkt+bst*tk)*lk*t
+byt*ly*t &
| +bst*lpr*t +bst*tman*lqman*t +bst*tz*lz*t +bmant*lqman*t
|_eq sl=al +(all+gsl*tl)*lwl +(-all+gsl*tm)*lwm +(dkl+gsl*tk)*lk
+byl*ly +gsl*lpr &
| +gsl*tman*lqman +gsl*tz*lz +blt*t
|_coef al -0.98 all -0.082 by -13.77 byy 0.66 dk 2.5 dkk -0.17 byl
-0.03 &
| byk 0.42 dkl 0.089 bt 0.13 btt -0.0023
33 VARIABLES IN  2 EQUATIONS WITH  27 COEFFICIENTS
52 OBSERVATIONS

REQUIRED MEMORY IS PAR=      89 CURRENT PAR=    2000
|_end

COEFFICIENT STARTING VALUES
A0         1.0000      AL       -0.98000      GS          1.0000
TM         1.0000      ALL      -0.82000E-01  GSL         1.0000
TL         1.0000      BY        -13.770      BYY        0.66000
DK         2.5000      TK         1.0000      DKK       -0.17000
GSK        1.0000      BYL      -0.30000E-01  GSY         1.0000
BYK      0.42000       DKL       0.89000E-01  TMAN        1.0000
THETA_MA   1.0000      TZ         1.0000      BT         0.13000
BTT      -0.23000E-02  BLT        1.0000      BST         1.0000
BKT        1.0000      BYT        1.0000      BMANT       1.0000
400 MAXIMUM ITERATIONS, CONVERGENCE =   0.100000E-04

INITIAL STATISTICS :

TIME =     0.0600 SEC.   ITER. NO.     0   FUNCT. EVALUATIONS
1
```

```
LOG-LIKELIHOOD FUNCTION=   -674.6639
COEFFICIENTS
1.000000     -0.9800000       1.000000       1.000000     -
0.8200000E-01
1.000000      1.000000      -13.77000      0.6600000
2.500000
1.000000     -0.1700000       1.000000     -0.3000000E-01
1.000000
0.4200000      0.8900000E-01   1.000000       1.000000
1.000000
0.1300000     -0.2300000E-02   1.000000       1.000000
1.000000
1.000000      1.000000
GRADIENT
0.3537827E-01  -2.044661      0.9452571      -13.66074
4.391466
-62.14013      -7.764816      0.1529020      0.2671695
0.3353822
-33.48308       1.368785       7.792056      -10.47612
3.453407
1.205611      -22.12989       5.027385     -0.6245353E-01  -
22.63004
-0.9449548      -71.42254       10.73084      -42.59092      -
15.63176
-7.584035       2.106981

INTERMEDIATE STATISTICS :

TIME =     0.2000 SEC.   ITER. NO.    15   FUNCT. EVALUATIONS
45
LOG-LIKELIHOOD FUNCTION=   -321.3660
COEFFICIENTS
1.012163     -0.8849437       1.021437       1.087287
0.2576649
-0.7332202      0.9004450      -13.71539      0.7721792
2.650512
-0.9685134E-01  0.7814424       2.662199      0.7399995
0.7082610
1.112483     -0.1180901       1.181866      0.9680507      -
1.801187
0.4528949E-02  0.9994737E-02 -0.1470841     -0.3221470
0.2916207E-01
0.1657604      0.8420645
GRADIENT
-0.4088350      -12.54032      0.1970478      -37.16613
6.230062
31.21444      -31.90276      -2.339249      -7.018501      -
5.972098
-111.2908      -43.12825       3.928643      -62.45683      -
0.6112605
-35.36330      -159.2867       8.386774      0.3890448      -
64.20685
-5.129150      -443.1508       99.62866      -40.28084      -
101.4925
-45.23437      -2.500497

TIME =     0.2700 SEC.   ITER. NO.    30   FUNCT. EVALUATIONS
68
LOG-LIKELIHOOD FUNCTION=   -160.7022
COEFFICIENTS
```

```
0.9961573     -0.8079129      0.8203903      0.5413569     -
0.4266406
-0.7520366      -1.817108      -13.75861      0.8227131
2.430624
0.2220408     -0.6529128       2.757935     -0.3232852
0.2667271
0.5122442      0.2182868     -0.9784594E-01  0.9366951     -
0.9580132
-0.1139006      0.1457701E-01 -0.2731508E-01 -0.1568630     -
0.5613544
1.142248     -0.7163569
GRADIENT
1.628368       129.8290       1.385113      -220.4476      -
311.5712
146.9464      -91.86445       8.922208       24.10719
18.93739
-495.9296       109.1096       17.10518       761.2567
8.103415
102.5121       1507.136       103.6976      -3.115030      -
393.9605
7.260646      -605.5440       1982.598       22.73077
46.03830
18.85656      -8.482882

TIME =     0.3400 SEC.   ITER. NO.    45   FUNCT. EVALUATIONS
89
LOG-LIKELIHOOD FUNCTION=   -16.21366
COEFFICIENTS
0.9682752       1.958578      0.5538928     -0.1984030E-01 -
0.7219758E-01
-0.7393817      -1.429003      -13.66036       1.755321
2.134805
0.2826800      -2.248989       2.122569     -0.4181143
2.098686
2.218938      0.1058970      0.6317666      0.7503538     -
0.6440212
-0.5284471      0.3271235E-02 -0.1430969E-01 -0.2510808
0.2619855
-0.2758519      0.1557892
GRADIENT
0.5996914       122.7868       7.764791      -120.3366      -
61.32504
597.7722      -63.56079      -5.022851      -41.93590
0.8267797
-576.5663      -40.21392       91.50144       239.5930
40.57161
-105.1850       1182.691       74.86859      -1.156835      -
390.3309
-201.7499      -9509.235      -10015.56       3.512026      -
2743.736
-1429.393       404.8281
TIME =     0.3900 SEC.   ITER. NO.    60   FUNCT. EVALUATIONS
106
LOG-LIKELIHOOD FUNCTION=    15.81037
COEFFICIENTS
0.2234194       2.895850       1.414517      0.4596574E-01 -
0.7196950E-01
-0.6472324      -1.062395      -17.02696      -5.738439      -
1.806016
-0.2984605E-01  -2.438091      0.3976902     -0.3708465
5.394297
```

```
5.094428     -0.2342421E-01  0.6570242E-02  -8.707955     -
0.5084597
-0.6259665     -0.4113347E-02 -0.3283549E-02 -0.3608495
0.9430201E-01
0.9955937E-01  0.2801096
GRADIENT
5.858103       349.8914      0.4386392      -231.7349      -
877.8304
129.8048      -126.7537       37.04205       117.4090
72.63609
-567.2915       453.0072     -0.8954511E-01   2201.327
1.038487
460.7279       4351.050       95.12185      -11.23442      -
399.7742
153.7437       4478.769       9101.645      -35.68055
1938.515
986.3508      -323.1035

TIME =     0.4500 SEC.   ITER. NO.    75   FUNCT. EVALUATIONS
121
LOG-LIKELIHOOD FUNCTION=    57.92240
COEFFICIENTS
-1.727006       2.687940       5.679873     -0.1744864     -
0.2973915E-01
-0.2821316     -0.7237384      -24.38646      -17.67581      -
15.87580
-0.3190547      -3.208310      -6.791098     -0.3400689
18.00386
12.39064     -0.4699919E-01 -0.1584939      -2.356612     -
0.1168011
6.644491      0.2288233E-01  0.8441471E-02 -0.6347107     -
0.5783694
-0.1049528      0.1147867
GRADIENT
-6.012490      -635.1293      -2.675410       579.1109
1414.809
-177.4699       350.5325      -40.79442      -137.8655      -
81.78301
1469.527      -557.3266      -34.69687      -4126.919      -
17.63513
-554.4312      -8398.023      -222.7942       12.59566
1006.877
-228.5000      -8564.555      -20523.55      -82.90411      -
3114.619
-1533.581       472.2732

TIME =     0.5000 SEC.   ITER. NO.    90   FUNCT. EVALUATIONS
136
LOG-LIKELIHOOD FUNCTION=    86.65705
COEFFICIENTS
1.486939       1.140493       6.475424     -0.4663686     -
0.3387379E-01
-0.2022604     -0.6632385      -15.76803      -15.91328
3.831159
-0.2837563      -2.572558      -9.789097     -0.1794294
21.92839
6.925376      0.6802103E-02 -0.7817852E-01  -4.082698     -
0.3049651E-02
-0.4563420     -0.2356080E-01  0.1304501E-02 -0.4757691     -
0.4385097
1.220739      0.2081035
```

```
GRADIENT
3.328844       362.9345      0.8801386      -196.4484      -
801.0012
164.7475      -98.30381       17.77574       46.31859
38.98976
-536.6635       224.8204       13.07293       2057.509
4.118639
203.4096       4453.765       92.96356      -6.709159      -
384.8206
-0.8583736      -1539.120       4256.568      -22.36182      -
111.0071
-64.05586      -20.08388

TIME =     0.5510 SEC.   ITER. NO.   105   FUNCT. EVALUATIONS
151
LOG-LIKELIHOOD FUNCTION=    139.0535
COEFFICIENTS
0.8859756      0.1674057      -4.328489     -0.2950641     -
0.1061345
-0.1583525      -1.057098      -14.10620       1.487711
6.705785
0.1897909E-01 -0.9357993E-01  -3.043421     -0.1884955
7.383012
-0.2117239      0.7821147E-01 -0.4759246E-01  -2.085801     -
0.3988708
0.3592935E-01 -0.1455790E-02 -0.9083094E-03 -0.5085195E-01 -
0.1096948
0.2566979      0.6705448E-01
GRADIENT
-39.23145      -296.4409      -3.274281      -189.4847
702.3074
-661.8535      -145.2442      -260.7710      -867.9657      -
529.5912
-449.4228      -3594.360      -32.59873      -1396.811      -
25.96558
-3536.566      -3267.957       51.61694       81.60390      -
276.0664
-1390.704      -51394.71       3579.295      -225.5248      -
19133.24
-9320.148       2794.743

TIME =     0.6110 SEC.   ITER. NO.   120   FUNCT. EVALUATIONS
168
LOG-LIKELIHOOD FUNCTION=    196.2510
COEFFICIENTS
0.5753507     -0.1272905      -8.756751     -0.4314399     -
0.1112448
-0.9914386E-01 -0.6917457      -14.63256       4.012104
8.886043
-0.4876558E-01 -0.3505008      0.9769042E-01 -0.1660832
1.574548
-0.8125172      0.8477452E-01 -0.2780024      0.7278777     -
0.3873278
-0.3801079     -0.3816911E-02  0.9592172E-03 -0.5848797E-01
0.5491366E-01
-0.1775900E-01 -0.4193657E-02
GRADIENT
-10.46067      -660.0749      -73.42875       278.8714
1634.597
-275.1794       145.6429      -18.67834       93.12678      -
113.8472
```

446.5363   -585.0512   -983.5766   -4128.205   -
470.8978
-94.21325   -8301.026   -59.94582   29.69108
339.0145
1404.022   94771.95   -18900.18   -2277.680
18990.92
10401.79   -2739.549

TIME =   0.6610 SEC.   ITER. NO.   135   FUNCT. EVALUATIONS
186
LOG-LIKELIHOOD FUNCTION=   243.4010
COEFFICIENTS
1.631135   0.2904698   2.069399   -0.6634031   -
0.5363801E-01
-0.1049351   -0.3705786   -10.95516   2.868409
5.464930
-0.1874696   -0.2845341   -0.3018858E-01 -0.1500722   -
0.1835526
-0.3121202   0.5174589E-01 -0.2929012   0.5366697   -
0.1655643
0.2852460   0.1591786E-02 0.2103304E-02 0.1329430E-01
0.2198549E-01
-0.1017061   -0.2196143E-02
GRADIENT
67.54830   -26.39774   1.883093   246.0740   -
396.6255
-717.4604   195.0550   452.3110   1503.651
908.5033
819.7142   6166.488   26.53826   64.79073
36.34519
6093.386   233.4511   -116.0604   -125.1861
614.6559
2512.949   85360.09   6748.196   620.1268
34219.78
16453.57   -4823.846

TIME =   0.7210 SEC.   ITER. NO.   150   FUNCT. EVALUATIONS
203
LOG-LIKELIHOOD FUNCTION=   271.9693
COEFFICIENTS
3.018479   0.5359606   -1.105051   -0.9831892   -
0.1109453E-01
-0.1380724   -0.7044207E-01   1.182977   -0.3739187
0.1082894
-0.2383637   -0.4361201E-01 0.1161180   -0.1631051
0.9923638E-01
0.1054962   0.4833974E-01 -0.3063822   0.4458295   -
0.4765881E-02
-0.2768695E-01 -0.4016687E-03 0.1794777E-02 -0.1375787E-01
0.1521741E-02
0.7221970E-02 -0.2378493E-02
GRADIENT
66.23343   -212.3748   -3.723984   400.2076
403.7572
-63.31366   217.0819   437.5321   1452.167
882.6520
917.4426   5917.100   -91.78628   -1381.076   -
41.35687
5867.162   -2721.527   -143.0302   -135.6254
637.4850

2343.299   88443.10   -6800.619   -604.5028
31934.47
15711.24   -4771.233

TIME =   0.7710 SEC.   ITER. NO.   165   FUNCT. EVALUATIONS
218
LOG-LIKELIHOOD FUNCTION=   277.4213
COEFFICIENTS
15.02720   1.208626   -1.693661   -0.9058444
0.5066276E-01
-0.1904973   -0.1123031   -2.407411   0.1442156   -
0.1698472
-0.2036633   -0.5868483E-01 0.1505931   -0.2115178
0.1278713
0.1699156   0.2819924E-01 -0.1558045   0.3072440   -
0.5530901E-01
0.8876084E-01 -0.1574549E-03 0.3356041E-02 -0.1798001E-01
0.1733921E-02
-0.1347271E-01 -0.2120918E-02
GRADIENT
-54.37151   221.6251   -57.57778   -368.1024   -
355.5824
164.2863   -196.0489   -301.2039   -831.9921   -
656.0160
-962.1625   -3952.574   -702.6657   1299.698   -
328.1471
-3630.028   2742.460   150.8552   104.8321   -
687.4667
-483.7765   -4283.730   3571.877   -676.0031   -
5775.168
-2629.708   862.8052

TIME =   0.8210 SEC.   ITER. NO.   180   FUNCT. EVALUATIONS
233
LOG-LIKELIHOOD FUNCTION=   277.7364
COEFFICIENTS
20.29843   1.256157   -2.021508   -0.9211488
0.5416528E-01
-0.1903931   -0.1177398   -3.491139   0.2651921   -
0.5449474
-0.2090394   -0.4402683E-01 0.1658894   -0.2137811
0.1529328
0.2053323   0.2616727E-01 -0.1614733   0.3182692   -
0.3834363E-01
0.1368361   -0.3060068E-04 0.3438790E-02 -0.1941682E-01
0.1843304E-03
-0.1902392E-01 -0.2526357E-02
GRADIENT
-5.627435   -27.09240   -12.99751   17.98913
67.08298
43.25782   12.65633   -28.41127   -67.82987   -
63.03873
24.92896   -343.3920   -173.2595   -210.0465   -
83.43285
-305.5279   -418.8115   -0.5998356   12.31833
11.14123
65.72338   7047.094   -1830.007   -421.8997
1111.806
569.7222   -60.15503

```
TIME =     0.8710 SEC.   ITER. NO.   195   FUNCT. EVALUATIONS
248
LOG-LIKELIHOOD FUNCTION=    277.7891
COEFFICIENTS
23.58185       1.245845      -2.125455     -0.9275427
0.5271661E-01
-0.1890925     -0.1172391      -4.440979      0.4095792     -
0.6654712
-0.2102166     -0.4076454E-01  0.1676759     -0.2127610
0.1687669
0.2199284      0.2627382E-01 -0.1635413      0.3186993     -
0.3374433E-01
0.1716457      0.6457047E-04  0.3381623E-02 -0.2008883E-01 -
0.3069498E-03
-0.2437301E-01 -0.2507580E-02
GRADIENT
-0.7652252E-02  0.2022755E-01  0.1143086E-02 -0.4537193E-01 -
0.2610995E-01
-0.7785447E-02 -0.2301308E-01 -0.4552633E-01 -0.1384463     -
0.1004743
-0.1217247     -0.6643210      0.2785906E-01  0.1245328
0.1819582E-01
-0.6065240      0.2763160      0.1868857E-01  0.1579620E-01 -
0.8129857E-01
-0.1394825      -7.612128      0.5009516      0.3442241      -
2.096363
-1.005663      0.3205311

FINAL STATISTICS :

TIME =     0.8910 SEC.   ITER. NO.   199   FUNCT. EVALUATIONS
252
LOG-LIKELIHOOD FUNCTION=    277.7891
COEFFICIENTS
23.58187       1.245837      -2.125452     -0.9275413
0.5271574E-01
-0.1890923     -0.1172388      -4.440978      0.4095788     -
0.6654769
-0.2102182     -0.4076344E-01  0.1676742     -0.2127606
0.1687702
0.2199280      0.2627414E-01 -0.1635465      0.3187044     -
0.3374402E-01
0.1716456      0.6456452E-04  0.3381596E-02 -0.2008886E-01 -
0.3070592E-03
-0.2437275E-01 -0.2507583E-02
GRADIENT
0.5477123E-04 -0.2214664E-03 -0.8541782E-04  0.4191004E-03
0.3135024E-03
0.1960120E-03  0.2104674E-03  0.3679899E-03  0.1252153E-02
0.7582990E-03
0.9472689E-03  0.5281406E-02 -0.1238614E-02 -0.1500990E-02 -
0.6241796E-03
0.5130996E-02 -0.3077095E-02 -0.1389768E-03 -0.1130943E-03
0.6374849E-03
0.2287561E-02  0.1207616     -0.9114090E-02 -0.4847219E-02
0.3285046E-01
0.1626176E-01 -0.4979354E-02

SIGMA MATRIX
0.43090E-03
-0.20078E-03  0.27577E-03
```

```
GTRANSPOSE*INVERSE(H)*G  STATISTIC  -  =  0.21584E-13

COEFFICIENT    ST. ERROR   T-RATIO

A0        23.582      13.908      1.6956
AL        1.2458     0.32901      3.7866
GS       -2.1255      1.0919     -1.9465
TM       -0.92754     0.52121E-01 -17.796
ALL       0.52716E-01 0.22004E-01  2.3957
GSL      -0.18909     0.17300E-01 -10.930
TL       -0.11724     0.51684E-01 -2.2684
BY       -4.4410      3.8835     -1.1436
BYY       0.40958     0.73324     0.55859
DK       -0.66548      1.3287    -0.50084
TK       -0.21022     0.46962E-01 -4.4763
DKK      -0.40763E-01 0.59625E-01-0.68366
GSK       0.16767     0.61005E-01  2.7485
BYL      -0.21276     0.32281E-01 -6.5909
GSY       0.16877     0.15412      1.0951
BYK       0.21993     0.13995      1.5714
DKL       0.26274E-01 0.13377E-01  1.9641
TMAN     -0.16355     0.10236     -1.5977

THETA_MA 0.31870     0.12088      2.6364
TZ       -0.33744E-01 0.63331E-01-0.53282
BT        0.17165     0.15550      1.1038
BTT       0.64565E-04 0.61745E-03 0.10457
BLT       0.33816E-02 0.16178E-02  2.0902
BST      -0.20089E-01 0.68551E-02 -2.9305
BKT      -0.30706E-03 0.65289E-02-0.47030E-01
BYT      -0.24373E-01 0.27672E-01-0.88077
BMANT    -0.25076E-02 0.17998E-02 -1.3933
|_end
|
|_*
|_test
|_test gs=0
|_test gsy=0
|_test gsl=0
|_test gsk=0
|_test bst=0
|_end
WALD CHI-SQUARE STATISTIC =   1597.2370     WITH    5 D.F.  P-
VALUE= 0.00000
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.00313
|_*test for neutral tech change
|_test
|_test blt=0
|_test byt=0
|_test bkt=0
|_test bst=0
|_test bmant=0
|_end
WALD CHI-SQUARE STATISTIC =   18.077897     WITH    5 D.F.  P-
VALUE= 0.00285
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.27658
|_*
|_test
|_test al=0
|_end
TEST VALUE =   1.2458     STD. ERROR OF TEST VALUE  0.32901
```

```
ASYMPTOTIC NORMAL STATISTIC =   3.7866244      P-VALUE= 0.00015
WALD CHI-SQUARE STATISTIC =   14.338524     WITH    1 D.F.  P-
VALUE= 0.00015
UPPER BOUND ON P-VALUE BY CHEBYCHEV INEQUALITY = 0.06974

..INPUT FILE COMPLETED..TYPE A NEW COMMAND OR TYPE: STOP
```

Food safety cost estimation

```
Welcome to SHAZAM - Version 9.0  -  JAN 2003 SYSTEM=WIN2000  PAR=
2000
CURRENT WORKING DIRECTORY IS: C:\TEMP
|_*checking values of lns, cost share, and calculate safety cost
elasticity
|_*for export meat works
|_*NON-NEUTRAL TECHNOLOGY CHANGE
|_*
|_sample 1 52
|_read(F:\meatdata.dif) wm wl y k qman p z vc sl / dif
UNIT 88 IS NOW ASSIGNED TO: F:\meatdata.dif
..NOTE..DIF FILE HAS    9 COLUMNS AND     52 ROWS
9 VARIABLES AND       52 OBSERVATIONS STARTING AT OBS       1

|_*
|_genr lwm=log(wm)
|_genr lwl=log(wl)
|_genr ly=log(y)
|_genr lk=log(k)
|_genr lqman=log(qman)
|_genr lz=log(z)
|_genr lpr=log(p)
|_genr lvc=log(vc)
|_*
|_genr lwmm=lwm**2
|_genr lwll=lwl**2
|_genr lyy=ly**2
|_genr lkk=lk**2
|_*
|_genr lwml=lwm*lwl
|_genr lym=ly*lwm
|_genr lyl=ly*lwl
|_genr lyk=ly*lk
|_genr lkm=lk*lwm
|_genr lkl=lk*lwl
|_genr lpm=lpr*lwm
|_genr lpl=lpr*lwl
|_genr lpk=lpr*lk
|_genr lpy=lpr*ly
|_genr lqman_m=lqman*lwm
|_genr lqman_l=lqman*lwl
|_genr lqman_k=lqman*lk
|_genr lqman_y=lqman*ly
|_genr lzm=lz*lwm
|_genr lzl=lz*lwl
|_genr lzk=lz*lk
|_genr lzy=lz*ly
|_*
|_genr t=time(0)
|_genr tt=t**2
|_*
|_*calculate lns
|_gen1 tman=-0.16
|_gen1 tz=-0.034
|_gen1 tm=-0.93
|_gen1 tl=-0.12
|_gen1 tk=-0.21
|_genr lns=lpr +tman*lqman +tz*lz +tm*lwm +tl*lwl +tk*lk
```

```
|_*
|_*
|_*calculate safety cost elasticity
|_gen1 gs=-2.13
|_gen1 gsy=0.17
|_gen1 gsk=0.17
|_gen1 bst=-0.02
|_gen1 gsl=-0.19
|_genr safe_el=gs -gsl*lwm +gsl*lwl +gsy*ly +gsk*lk +bst*t
|_print safe_el
SAFE_EL
1.208412       1.168112       1.127633       1.128985
1.142843
1.148068       1.158823       1.136134       1.113095
1.080673
1.064806       1.089118       1.090809       1.092914
1.079712
1.066385       1.046107       1.009887       1.001023
1.002049
0.9795190      0.9749270      0.9425551       1.013464
0.9959306
0.9752878       1.012115       1.025787       1.012362
1.002978
0.9981662       1.005069       1.005642       1.012941
0.9948373
0.9885622      0.9680622      0.9549251      0.9450174
0.9606902
0.9554325      0.9751856      0.9484258      0.9612507
1.002683
1.081262       1.056838       1.100023       1.083386
1.085300
1.082717       1.106750
|_stat safe_el /mean=mean_el
NAME         N    MEAN        ST. DEV      VARIANCE     MINIMUM
MAXIMUM
SAFE_EL      52   1.0416     0.67910E-01 0.46118E-02  0.94256
1.2084
|_print mean_el
MEAN_EL
1.041609
|_*
|_*calculate effects of technological change on cost (dvc/dt)
|_gen1 bmt=-0.0034
|_gen1 blt=0.0034
|_gen1 byt=-0.024
|_gen1 bkt=-0.00031
|_gen1 bt=0.17
|_gen1 btt=0.000064
|_gen1 bmant=-0.0025
|_genr tech=bmt*lwm +blt*lwl +byt*ly +bkt*lk +bst*lns +bt
+2*btt+bmant*lqman
|_print tech
TECH
0.1351005E-01  0.1510512E-01  0.1680850E-01  0.1795329E-01
0.1554251E-01
0.1146560E-01  0.8125136E-02  0.8277959E-02  0.7746312E-02
0.8688525E-02
0.1079067E-01  0.9636363E-02  0.8693420E-02  0.1038347E-01
0.1087392E-01
0.1186076E-01  0.9788500E-02  0.8619285E-02  0.7234728E-02
0.8202849E-02
```

```
0.8272653E-02  0.7289549E-02  0.7586420E-02  0.8288984E-02
0.6312897E-02
0.6148281E-02  0.5925540E-02  0.6598107E-02  0.6780697E-02
0.7002010E-02
0.7950517E-02  0.7530955E-02  0.9263135E-02  0.8201776E-02
0.9418459E-03
-0.7930800E-03 -0.1807474E-03 -0.6473686E-03  0.1791136E-03 -
0.3072107E-02
-0.3654108E-02 -0.3138571E-02 -0.3557611E-03  0.2951434E-03 -
0.8074627E-03
0.5858541E-02  0.9569341E-02  0.1569955E-01  0.1396896E-01
0.2446784E-01
0.2764370E-01  0.3011092E-01
|_stat tech
NAME         N    MEAN         ST. DEV      VARIANCE     MINIMUM
MAXIMUM
TECH          52  0.84335E-02 0.70657E-02 0.49924E-04 -0.36541E-02
0.30111E-01
|_*
|_*calculate change in variable cost due to safety regulation
(dvc) and
|_*unit cost (unit)
|_*
|_stat vc / mean=meanvc
NAME         N    MEAN         ST. DEV      VARIANCE     MINIMUM
MAXIMUM
VC            52  0.20516E+07 0.15561E+07 0.24215E+13  0.41238E+06
0.64363E+07
|_print meanvc
MEANVC
2051554.
|_stat y / mean=meany
NAME         N    MEAN         ST. DEV      VARIANCE     MINIMUM
MAXIMUM
Y             52   637.32       331.46     0.10986E+06   191.25
1234.3
|_print meany
MEANY
637.3227
|_print mean_el
MEAN_EL
1.041609
|_sample 52 52
|_gen1 e=20
|_gen1 s1=50
|_gen1 s2=70
|_gen1 s3=90
|_genr dvc1=meanvc*mean_el*e*(100-s1)/(100*s1)
|_genr unit1=dvc1/meany
|_genr dvc2=meanvc*mean_el*e*(100-s2)/(100*s2)
|_genr unit2=dvc2/meany
|_genr dvc3=meanvc*mean_el*e*(100-s3)/(100*s3)
|_genr unit3=dvc3/meany
|_print dvc1 unit1
DVC1           UNIT1
427383.5       670.5920
|_print dvc2 unit2
DVC2           UNIT2
183164.4       287.3966
|_print dvc3 unit3
DVC3           UNIT3
```

```
47487.06       74.51022
|_*
|_*safety cost elasticity (safe_ad), change in variable cost
(dvc_ad), and
|_*safety unit cost per tonne (unit_ad) adjusted by technology
change. Note that
|_*bst=-0.026 means that with tech change safety elasticity
reduces by
|_*0.026 percent annually. Present time is 2002 means time gap is
18 yrs
|_*
|_gen1 change=18*0.02
|_print change
CHANGE
0.3600000
|_genr safe_ad=1.10675-change
|_genr dvc1_ad=meanvc*safe_ad*e*(100-s1)/(100*s1)
|_genr unit1_ad=dvc1_ad/meany
|_genr dvc2_ad=meanvc*safe_ad*e*(100-s2)/(100*s2)
|_genr unit2_ad=dvc2_ad/meany
|_genr dvc3_ad=meanvc*safe_ad*e*(100-s3)/(100*s3)
|_genr unit3_ad=dvc3_ad/meany
|_print safe_ad
SAFE_AD
0.7467500
|_print dvc1_ad unit1_ad
DVC1_AD        UNIT1_AD
306399.6       480.7605
|_print dvc2_ad unit2_ad
DVC2_AD        UNIT2_AD
131314.1       206.0402
|_print dvc3_ad unit3_ad
DVC3_AD        UNIT3_AD
34044.40       53.41784

..INPUT FILE COMPLETED..TYPE A NEW COMMAND OR TYPE: STOP
```

APPENDIX 4

SHAZAM OUTPUTS FOR CHAPTER 9

Estimation of Gravity model for Total Meat

```
CURRENT WORKING DIRECTORY IS: C:\TEMP
|_*total meat 91 02 final
|_sample 1 108
|_read (H:\TM9102final.dif) exp_vol exp_val gdppcNZ gdppcIMP ER
prodIMP &
| HACCP gdp_prod gdppc_prod popNZ popIMP gdpNZ gdpIMP dis pr quota
prodNZ pr_impt / dif
..WARNING..gdppc_prod               IS TRUNCATED TO gdppc_pr
UNIT 88 IS NOW ASSIGNED TO: H:\TM9102final.dif
..NOTE..DIF FILE HAS   18 COLUMNS AND    108 ROWS
18 VARIABLES AND      108 OBSERVATIONS STARTING AT OBS       1

|_*
|_*generate variables
|_*
|_genr lexp_vol=log(exp_vol)
|_genr lexp_val=log(exp_val)
|_genr lgdppcIMP=log(gdppcIMP)
.WARNING.VAR LONGER THAN 8 CHARACTERS TRUNCATED TO:lgdppcIM
|_genr lER=log(ER)
|_genr lprodIMP=log(prodIMP)
|_genr lgdppcNZ= log(gdppcNZ)
|_genr ldis=log(dis)
|_genr lpr=log(pr)
|_genr lgdp_prod=log(gdp_prod)
.WARNING.VAR LONGER THAN 8 CHARACTERS TRUNCATED TO:lgdp_pro
|_genr lgdppc_prod=log(gdppc_prod)
.WARNING.VAR LONGER THAN 8 CHARACTERS TRUNCATED TO:lgdppc_p
|_genr lpopNZ=log(popNZ)
|_genr lpopIMP=log(popIMP)
|_genr lgdpNZ=log(gdpNZ)
|_genr lgdpIMP=log(gdpIMP)
|_genr lprodNZ=log(prodNZ)
|_genr lpr_impt=log(pr_impt)
|_*
|_* (1) GENERAL/FULL model
|_*
|_*Volume model
|_*test

|_ols lexp_vol lgdpNZ lgdpIMP lpopNZ lpopIMP lprodNZ lprodIMP ldis
lpr lpr_impt lER  HACCP quota/ dwpvalue

REQUIRED MEMORY IS PAR=     136 CURRENT PAR=    2000
OLS ESTIMATION
108 OBSERVATIONS     DEPENDENT VARIABLE= LEXP_VOL
...NOTE..SAMPLE RANGE SET TO:      1,    108

DURBIN-WATSON STATISTIC  =   0.93472
DURBIN-WATSON POSITIVE AUTOCORRELATION TEST P-VALUE =    0.000000
NEGATIVE AUTOCORRELATION TEST P-VALUE =    1.000000
```

```
R-SQUARE =   0.8942     R-SQUARE ADJUSTED =   0.8808
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.43614
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.66041
SUM OF SQUARED ERRORS-SSE=   41.433
MEAN OF DEPENDENT VARIABLE =   10.005
LOG OF THE LIKELIHOOD FUNCTION = -101.511


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR      95 DF   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ    -2.7593      6.476     -0.4261     0.671-0.044    -
0.1644    -1.1408
LGDPIMP    1.9658     0.2213       8.881     0.000 0.674
1.0381     1.4212
LPOPNZ    0.22138      19.60      0.1129E-01 0.991 0.001
0.0045     0.0286
LPOPIMP   -1.4086     0.7190      -1.959     0.053-0.197    -
0.8825    -0.6294
LPRODNZ   -3.3893      2.602      -1.302     0.196-0.132    -
0.0748    -4.7641
LPRODIMP -0.36275     0.4840     -0.7495     0.455-0.077    -
0.2104    -0.5670
LDIS       1.2435      1.100       1.130     0.261 0.115
0.4030     1.1603
LPR       -2.9147     0.2573      -11.33     0.000-0.758    -
0.6453    -0.4263
LPR_IMPT  -1.5795     0.6767      -2.334     0.022-0.233    -
0.2777    -0.1304
LER      -0.15912     0.1209      -1.316     0.191-0.134    -
0.1944    -0.0192
HACCP     0.73290     0.2499       2.933     0.004 0.288
0.1667     0.0183
QUOTA    -0.58196E-01  1.769     -0.3289E-01 0.974-0.003    -
0.0152    -0.0032
CONSTANT   60.552      39.01       1.552     0.124 0.157
0.0000     6.0519
|_diagnos / het

REQUIRED MEMORY IS PAR=     198 CURRENT PAR=    2000
DEPENDENT VARIABLE = LEXP_VOL       108 OBSERVATIONS
REGRESSION COEFFICIENTS
-2.75928664052       1.96575100443      0.221375382118      -
1.40857266061
-3.38931465426     -0.362749853647       1.24345219913      -
2.91470408857
-1.57947504959     -0.159124482755      0.732900836702     -
0.581963163021E-01
60.5516801178

HETEROSKEDASTICITY TESTS
CHI-SQUARE     D.F.   P-VALUE
TEST STATISTIC
E**2 ON YHAT:                     18.290     1    0.00002
E**2 ON YHAT**2:                  15.832     1    0.00007
E**2 ON LOG(YHAT**2):             19.474     1    0.00001
E**2 ON LAG(E**2) ARCH TEST:      14.923     1    0.00011
LOG(E**2) ON X (HARVEY) TEST:     16.108    12    0.18634
ABS(E) ON X (GLEJSER) TEST:       31.997    12    0.00139
E**2 ON X                 TEST:
```

```
KOENKER(R2):             34.816    12    0.00050
B-P-G (SSR) :            42.875    12    0.00002

...MATRIX INVERSION FAILED IN ROW   24
...RESULTS MAY BE UNRELIABLE
E**2 ON X X**2    (WHITE) TEST:
KOENKER(R2):         **********    24  *********
B-P-G (SSR) :        **********    24  *********

...MATRIX INVERSION FAILED IN ROW   24
...RESULTS MAY BE UNRELIABLE
E**2 ON X X**2 XX (WHITE) TEST:
KOENKER(R2):         **********    90  *********
B-P-G (SSR) :        **********    90  *********

|_*
|_*pooling across countries and years
|_pool lexp_vol lgdpNZ lgdpIMP lpopNZ lpopIMP lprodNZ lprodIMP
ldis lpr lpr_impt lER  HACCP quota/ ncross=9 full same

REQUIRED MEMORY IS PAR=      45 CURRENT PAR=    2000
POOLED CROSS-SECTION TIME-SERIES ESTIMATION
108 TOTAL OBSERVATIONS
9 CROSS-SECTIONS
12 TIME-PERIODS

DEPENDENT VARIABLE = LEXP_VOL
...WARNING..TOO FEW DEGREES OF FREEDOM, DN OPTION USED

MODEL ASSUMPTIONS:
SAME ESTIMATED RHO FOR EACH CROSS-SECTION
FULL PHI MATRIX - CROSS-SECTION CORRELATION

OLS COEFFICIENTS
-2.7593       1.9658      0.22138      -1.4086      -3.3893
-0.36275       1.2435      -2.9147      -1.5795     -0.15912
0.73290     -0.58196E-01   60.552

RHO VECTOR
0.93607      0.37745      0.79482      0.74344      0.70017
0.30964      0.47169      0.70023      0.25207

SAME ESTIMATED RHO FOR ALL CROSS-SECTIONS =  0.58116

VARIANCES (DIAGONAL OF PHI MATRIX)
0.30669      0.82235E-01  0.95192E-01  0.15087      0.89115E-01
0.13935      0.10735      0.15077      0.90103

BUSE [1973] R-SQUARE = 0.8591      BUSE RAW-MOMENT R-SQUARE =
0.9974
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.79800
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.89331
SUM OF SQUARED ERRORS-SSE=   86.184
MEAN OF DEPENDENT VARIABLE =   10.005
LOG OF THE LIKELIHOOD FUNCTION = -13.1477


ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
```

```
NAME    COEFFICIENT   ERROR   --------   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ    -3.1127      1.855      -1.678     0.093-0.170    -
0.1855    -1.2869
LGDPIMP    1.3120     0.1517       8.651     0.000 0.664
0.6928     0.9485
LPOPNZ     8.3029      5.722       1.451     0.147 0.147
0.1692     1.0730
LPOPIMP  -0.31734     0.4734     -0.6703     0.503-0.069    -
0.1988    -0.1418
LPRODNZ   -1.5421     0.8395      -1.837     0.066-0.185    -
0.0340    -2.1676
LPRODIMP -0.65874     0.3036      -2.170     0.030-0.217    -
0.3822    -1.0296
LDIS      0.31152     0.7867      0.3960     0.692 0.041
0.1010     0.2907
LPR       -1.7610     0.1321      -13.33     0.000-0.807    -
0.3898    -0.2576
LPR_IMPT -0.34138     0.2840      -1.202     0.229-0.122    -
0.0600    -0.0282
LER      -0.18609E-01 0.9597E-01 -0.1939     0.846-0.020    -
0.0227    -0.0022
HACCP     0.26857     0.9608E-01   2.795     0.005 0.276
0.0611     0.0067
QUOTA      1.6546      1.265       1.308     0.191 0.133
0.4318     0.0919
CONSTANT   35.045      16.01       2.189     0.029 0.219
0.0000     3.5026
|_*
|_*Value model
|_*test

|_ols lexp_val lgdpNZ lgdpIMP lpopNZ lpopIMP lprodNZ lprodIMP ldis
lpr lpr_impt lER  HACCP quota/ dwpvalue

REQUIRED MEMORY IS PAR=     136 CURRENT PAR=    2000
OLS ESTIMATION
108 OBSERVATIONS     DEPENDENT VARIABLE= LEXP_VAL
...NOTE..SAMPLE RANGE SET TO:      1,    108

DURBIN-WATSON STATISTIC  =   0.93472
DURBIN-WATSON POSITIVE AUTOCORRELATION TEST P-VALUE =    0.000000
NEGATIVE AUTOCORRELATION TEST P-VALUE =    1.000000

R-SQUARE =   0.8951     R-SQUARE ADJUSTED =   0.8818
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.43614
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.66041
SUM OF SQUARED ERRORS-SSE=   41.433
MEAN OF DEPENDENT VARIABLE =   11.469
LOG OF THE LIKELIHOOD FUNCTION = -101.511


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR      95 DF   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ    -2.7593      6.476     -0.4261     0.671-0.044    -
0.1637    -0.9952
LGDPIMP    1.9658     0.2213       8.881     0.000 0.674
1.0336     1.2399
```

```
LPOPNZ    0.22138      19.60      0.1129E-01 0.991 0.001
0.0045     0.0250
LPOPIMP   -1.4086     0.7190      -1.959     0.053-0.197    -
0.8787    -0.5491
LPRODNZ   -3.3893      2.602      -1.302     0.196-0.132    -
0.0745    -4.1562
LPRODIMP -0.36275     0.4840     -0.7495     0.455-0.077    -
0.2095    -0.4946
LDIS       1.2435      1.100       1.130     0.261 0.115
0.4013     1.0122
LPR       -1.9147     0.2573      -7.440     0.000-0.607    -
0.4220    -0.2443
LPR_IMPT  -1.5795     0.6767      -2.334     0.022-0.233    -
0.2765    -0.1137
LER      -0.15912     0.1209      -1.316     0.191-0.134    -
0.1936    -0.0167
HACCP     0.73290     0.2499       2.933     0.004 0.288
0.1660     0.0160
QUOTA    -0.58196E-01  1.769     -0.3289E-01 0.974-0.003    -
0.0151    -0.0028
CONSTANT   60.552      39.01       1.552     0.124 0.157
0.0000     5.2797
|_diagnos / het

REQUIRED MEMORY IS PAR=     198 CURRENT PAR=    2000
DEPENDENT VARIABLE = LEXP_VAL       108 OBSERVATIONS
REGRESSION COEFFICIENTS
-2.75928664370       1.96575100431      0.221375393493      -
1.40857266058
-3.38931465585     -0.362749853519       1.24345219919      -
1.91470408864
-1.57947504903     -0.159124482746      0.732900836785     -
0.581963163255E-01
60.5516801366

HETEROSKEDASTICITY TESTS
CHI-SQUARE     D.F.   P-VALUE
TEST STATISTIC
E**2 ON YHAT:                     20.190     1    0.00001
E**2 ON YHAT**2:                  18.308     1    0.00002
E**2 ON LOG(YHAT**2):             21.440     1    0.00000
E**2 ON LAG(E**2) ARCH TEST:      14.923     1    0.00011
LOG(E**2) ON X (HARVEY) TEST:     16.108    12    0.18634
ABS(E) ON X (GLEJSER) TEST:       31.997    12    0.00139
E**2 ON X                  TEST:
KOENKER(R2):            34.816    12    0.00050
B-P-G (SSR) :           42.875    12    0.00002

...MATRIX INVERSION FAILED IN ROW   24
...RESULTS MAY BE UNRELIABLE

E**2 ON X X**2    (WHITE) TEST:
KOENKER(R2):        **********    24  *********
B-P-G (SSR) :       **********    24  *********

...MATRIX INVERSION FAILED IN ROW   24
...RESULTS MAY BE UNRELIABLE
E**2 ON X X**2 XX (WHITE) TEST:
KOENKER(R2):        **********    90  *********
B-P-G (SSR) :       **********    90  *********
```

```
|_*
|_*pooling across countries and years

|_pool lexp_val lgdpNZ lgdpIMP lpopNZ lpopIMP lprodNZ lprodIMP
ldis lpr lpr_impt lER  HACCP quota/ ncross=9 full same

REQUIRED MEMORY IS PAR=      45 CURRENT PAR=    2000
POOLED CROSS-SECTION TIME-SERIES ESTIMATION
108 TOTAL OBSERVATIONS
9 CROSS-SECTIONS
12 TIME-PERIODS

DEPENDENT VARIABLE = LEXP_VAL
...WARNING..TOO FEW DEGREES OF FREEDOM, DN OPTION USED

MODEL ASSUMPTIONS:
SAME ESTIMATED RHO FOR EACH CROSS-SECTION
FULL PHI MATRIX - CROSS-SECTION CORRELATION

OLS COEFFICIENTS
-2.7593       1.9658      0.22138      -1.4086      -3.3893
-0.36275       1.2435      -1.9147      -1.5795     -0.15912
0.73290     -0.58196E-01   60.552

RHO VECTOR
0.93607      0.37745      0.79482      0.74344      0.70017
0.30964      0.47169      0.70023      0.25207

SAME ESTIMATED RHO FOR ALL CROSS-SECTIONS =  0.58116

VARIANCES (DIAGONAL OF PHI MATRIX)
0.30669      0.82235E-01  0.95192E-01  0.15087      0.89115E-01
0.13935      0.10735      0.15077      0.90103

BUSE [1973] R-SQUARE = 0.8430      BUSE RAW-MOMENT R-SQUARE =
0.9981
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.79800
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.89331
SUM OF SQUARED ERRORS-SSE=   86.184
MEAN OF DEPENDENT VARIABLE =   11.469
LOG OF THE LIKELIHOOD FUNCTION = -13.1477


ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR   --------   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ    -3.1127      1.855      -1.678     0.093-0.170    -
0.1847    -1.1227
LGDPIMP    1.3120     0.1517       8.651     0.000 0.664
0.6898     0.8275
LPOPNZ     8.3029      5.722       1.451     0.147 0.147
0.1684     0.9361
LPOPIMP  -0.31734     0.4734     -0.6703     0.503-0.069    -
0.1980    -0.1237
LPRODNZ   -1.5421     0.8395      -1.837     0.066-0.185    -
0.0339    -1.8910
LPRODIMP -0.65874     0.3036      -2.170     0.030-0.217    -
0.3805    -0.8982
```

```
LDIS       0.31152     0.7867      0.3960     0.692 0.041
0.1005     0.2536
LPR       -0.76099     0.1321      -5.760     0.000-0.509    -
0.1677    -0.0971
LPR_IMPT -0.34138     0.2840      -1.202     0.229-0.122    -
0.0598    -0.0246
LER       -0.18609E-01 0.9597E-01 -0.1939    0.846-0.020    -
0.0226    -0.0020
HACCP      0.26857     0.9608E-01   2.795     0.005 0.276
0.0608     0.0059
QUOTA      1.6546      1.265       1.308     0.191 0.133
0.4300     0.0801
CONSTANT   35.045      16.01       2.189     0.029 0.219
0.0000     3.0556
|_*
|_* (2) CAO & JOHNSON model (a simple version of general model)
|_*
|_*using gdp product
|_*
|_*Value model

|_pool lexp_val lgdp_prod lgdppc_prod ldis lER lprodIMP lpr HACCP
quota / ncross=9 full same
..WARNING..lgdp_prod                IS TRUNCATED TO lgdp_pro
..WARNING..lgdppc_prod              IS TRUNCATED TO lgdppc_p

REQUIRED MEMORY IS PAR=      41 CURRENT PAR=    2000
POOLED CROSS-SECTION TIME-SERIES ESTIMATION
108 TOTAL OBSERVATIONS
9 CROSS-SECTIONS
12 TIME-PERIODS

DEPENDENT VARIABLE = LEXP_VAL

MODEL ASSUMPTIONS:
SAME ESTIMATED RHO FOR EACH CROSS-SECTION
FULL PHI MATRIX - CROSS-SECTION CORRELATION

OLS COEFFICIENTS
1.0102      0.39388      0.16098E-01 -0.19165E-01 -0.68301
-1.8269      0.27433       1.9885       9.8285

RHO VECTOR
0.90825      0.74845      0.78756      0.75182      0.78615
0.76635      0.65066      0.78908      0.47999

SAME ESTIMATED RHO FOR ALL CROSS-SECTIONS =  0.72174

VARIANCES (DIAGONAL OF PHI MATRIX)
1.0148      0.21923      0.21864      0.57387      0.36422
0.49304      0.27649      0.52837       3.5529

BUSE [1973] R-SQUARE = 0.7037      BUSE RAW-MOMENT R-SQUARE =
0.9967
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.23806
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.48791
SUM OF SQUARED ERRORS-SSE=   23.568
MEAN OF DEPENDENT VARIABLE =   11.469
LOG OF THE LIKELIHOOD FUNCTION = -3.70915
```

```
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR      99 DF   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDP_PRO  0.62644     0.3492       1.794     0.076 0.177
0.3360     0.6211
LGDPPC_P  0.50538     0.4401       1.148     0.254 0.115
0.3211     0.2471
LDIS       1.2063     0.7064       1.708     0.091 0.169
0.3893     0.9820
LER      -0.11162     0.8960E-01  -1.246     0.216-0.124    -
0.1358    -0.0117
LPRODIMP -0.29284     0.3028     -0.9670     0.336-0.097    -
0.1691    -0.3993
LPR      -0.48927     0.1082      -4.522     0.000-0.414    -
0.1078    -0.0624
HACCP     0.13887     0.8583E-01   1.618     0.109 0.160
0.0314     0.0030
QUOTA     0.25126      1.132      0.2220     0.825 0.022
0.0653     0.0122
CONSTANT  -4.5509      8.673     -0.5247     0.601-0.053
0.0000    -0.3968
|_*
|_*using gdp and pop
|_*
|_*value model

|_pool lexp_val lgdpNZ lgdpIMP lpopNZ lpopIMP ldis lER lprodIMP
lpr HACCP quota/ ncross=9 full same

REQUIRED MEMORY IS PAR=      43 CURRENT PAR=    2000
POOLED CROSS-SECTION TIME-SERIES ESTIMATION
108 TOTAL OBSERVATIONS
9 CROSS-SECTIONS
12 TIME-PERIODS

DEPENDENT VARIABLE = LEXP_VAL

MODEL ASSUMPTIONS:
SAME ESTIMATED RHO FOR EACH CROSS-SECTION
FULL PHI MATRIX - CROSS-SECTION CORRELATION

OLS COEFFICIENTS
-1.4367       1.5872      -3.2242     -0.84591      0.61013
-0.85012E-01 -0.40636      -2.1531      0.97637      0.99739
16.995

RHO VECTOR
0.95844      0.24199      0.64239      0.70542      0.62199
0.51168      0.51607      0.80791      0.32290

SAME ESTIMATED RHO FOR ALL CROSS-SECTIONS =  0.59377

VARIANCES (DIAGONAL OF PHI MATRIX)
3.9281      0.78428      0.95395       2.0888       1.0623
1.9387       1.1557       1.7364       11.728

BUSE [1973] R-SQUARE = 0.8185      BUSE RAW-MOMENT R-SQUARE =
0.9977
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.78620E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.28039
```

```
SUM OF SQUARED ERRORS-SSE=   7.6262
MEAN OF DEPENDENT VARIABLE =   11.469
LOG OF THE LIKELIHOOD FUNCTION = -11.9544


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR      97 DF   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ    -1.4893      1.891     -0.7877     0.433-0.080    -
0.0884    -0.5372
LGDPIMP    1.2627     0.1408       8.970     0.000 0.673
0.6639     0.7964
LPOPNZ     2.6629      5.545      0.4802     0.632 0.049
0.0540     0.3002
LPOPIMP  -0.56296     0.4763      -1.182     0.240-0.119    -
0.3512    -0.2194
LDIS       1.0380     0.7568       1.372     0.173 0.138
0.3350     0.8450
LER      -0.97329E-01 0.9059E-01  -1.074     0.285-0.108    -
0.1184    -0.0102
LPRODIMP -0.34739     0.3287      -1.057     0.293-0.107    -
0.2007    -0.4737
LPR      -0.76218     0.1354      -5.629     0.000-0.496    -
0.1680    -0.0973
HACCP     0.24275     0.1053       2.305     0.023 0.228
0.0550     0.0053
QUOTA     0.50900      1.229      0.4142     0.680 0.042
0.1323     0.0247
CONSTANT   4.1800      9.766      0.4280     0.670 0.043
0.0000     0.3645
|_*
|_* (3) Commodity-specific model (KOO model)
|_*value model

|_pool lexp_val lgdpNZ lgdpIMP lprodNZ lprodIMP ldis lpr lpr_impt
lER  HACCP quota/ ncross=9 full same

REQUIRED MEMORY IS PAR=      43 CURRENT PAR=    2000
POOLED CROSS-SECTION TIME-SERIES ESTIMATION
108 TOTAL OBSERVATIONS
9 CROSS-SECTIONS
12 TIME-PERIODS

DEPENDENT VARIABLE = LEXP_VAL

MODEL ASSUMPTIONS:
SAME ESTIMATED RHO FOR EACH CROSS-SECTION
FULL PHI MATRIX - CROSS-SECTION CORRELATION

OLS COEFFICIENTS
-1.6679       1.6283      -4.0959      -1.2693     -0.85998
-1.9884      -1.1148      0.34886E-01  0.78905       3.3095
93.824

RHO VECTOR
0.93276      0.36235      0.74454      0.66199      0.65812
0.84501E-01  0.47610      0.57585      0.41077

SAME ESTIMATED RHO FOR ALL CROSS-SECTIONS =  0.59067
```

```
VARIANCES (DIAGONAL OF PHI MATRIX)
3.8262      0.97697      0.96530       1.5311       1.0712
1.2058       1.2809       1.4167       12.465

BUSE [1973] R-SQUARE = 0.8930      BUSE RAW-MOMENT R-SQUARE =
0.9978
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.81504E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.28549
SUM OF SQUARED ERRORS-SSE=   7.9059
MEAN OF DEPENDENT VARIABLE =   11.469
LOG OF THE LIKELIHOOD FUNCTION = -12.8537


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR      97 DF   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ   -0.15429     0.5457     -0.2828     0.778-0.029    -
0.0092    -0.0557
LGDPIMP    1.3200     0.9863E-01   13.38     0.000 0.805
0.6940     0.8326
LPRODNZ   -1.1607     0.7975      -1.456     0.149-0.146    -
0.0255    -1.4234
LPRODIMP -0.96332     0.1179      -8.172     0.000-0.639    -
0.5564    -1.3135
LDIS     -0.24186     0.4532     -0.5336     0.595-0.054    -
0.0780    -0.1969
LPR      -0.79962     0.1163      -6.875     0.000-0.572    -
0.1762    -0.1020
LPR_IMPT -0.53946     0.2616      -2.063     0.042-0.205    -
0.0944    -0.0388
LER       0.29821E-01 0.7442E-01  0.4007     0.690 0.041
0.0363     0.0031
HACCP     0.24686     0.1042       2.370     0.020 0.234
0.0559     0.0054
QUOTA      2.5080     0.6618       3.790     0.000 0.359
0.6517     0.1215
CONSTANT   36.317      11.89       3.053     0.003 0.296
0.0000     3.1666

..INPUT FILE COMPLETED..TYPE A NEW COMMAND OR TYPE: STOP
```

Estimation of Gravity model for Beef

```
Welcome to SHAZAM - Version 9.0  -  JAN 2003 SYSTEM=WIN2000  PAR=
2000
CURRENT WORKING DIRECTORY IS: C:\TEMP
|_*beef final
|_sample 1 90
|_read (H:\beeffinal.dif) exp_vol exp_val gdppcNZ gdppcIMP ER
prodIMP &
| HACCP gdp_prod gdppc_prod popNZ popIMP gdpNZ gdpIMP dis pr quota
prodNZ pr_impt / dif
..WARNING..gdppc_prod               IS TRUNCATED TO gdppc_pr
UNIT 88 IS NOW ASSIGNED TO: H:\beeffinal.dif
..NOTE..DIF FILE HAS   18 COLUMNS AND     90 ROWS
18 VARIABLES AND       90 OBSERVATIONS STARTING AT OBS       1

|_*
|_*generate variables
|_*
|_genr lexp_vol=log(exp_vol)
|_genr lexp_val=log(exp_val)
|_genr lgdppcIMP=log(gdppcIMP)
.WARNING.VAR LONGER THAN 8 CHARACTERS TRUNCATED TO:lgdppcIM
|_genr lER=log(ER)
|_genr lprodIMP=log(prodIMP)
|_genr lgdppcNZ= log(gdppcNZ)
|_genr ldis=log(dis)
|_genr lpr=log(pr)
|_genr lgdp_prod=log(gdp_prod)
.WARNING.VAR LONGER THAN 8 CHARACTERS TRUNCATED TO:lgdp_pro
|_genr lgdppc_prod=log(gdppc_prod)
.WARNING.VAR LONGER THAN 8 CHARACTERS TRUNCATED TO:lgdppc_p
|_genr lpopNZ=log(popNZ)
|_genr lpopIMP=log(popIMP)
|_genr lgdpNZ=log(gdpNZ)
|_genr lgdpIMP=log(gdpIMP)
|_genr lprodNZ=log(prodNZ)
|_genr lpr_impt=log(pr_impt)
|_*
|_* (1) GENERAL/FULL model
|_*
|_*Volume model
|_*test

|_ols lexp_vol lgdpNZ lgdpIMP lpopNZ lpopIMP lprodNZ lprodIMP ldis
lpr lpr_impt lER  HACCP quota/ dwpvalue

REQUIRED MEMORY IS PAR=     101 CURRENT PAR=    2000
OLS ESTIMATION
90 OBSERVATIONS     DEPENDENT VARIABLE= LEXP_VOL
...NOTE..SAMPLE RANGE SET TO:      1,     90

DURBIN-WATSON STATISTIC  =   0.93896
DURBIN-WATSON POSITIVE AUTOCORRELATION TEST P-VALUE =    0.000000
NEGATIVE AUTOCORRELATION TEST P-VALUE =    1.000000

R-SQUARE =   0.8040     R-SQUARE ADJUSTED =   0.7734
VARIANCE OF THE ESTIMATE-SIGMA**2 =   2.0021
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.4150
SUM OF SQUARED ERRORS-SSE=   154.17
```

```
MEAN OF DEPENDENT VARIABLE =   7.8065
LOG OF THE LIKELIHOOD FUNCTION = -151.924


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR      77 DF   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ    -5.7862      17.56     -0.3295     0.743-0.038    -
0.1971    -3.0877
LGDPIMP    1.6728     0.2197       7.613     0.000 0.655
0.5620     1.5567
LPOPNZ     20.995      48.54      0.4325     0.667 0.049
0.2515     3.5032
LPOPIMP   0.29011     0.2183       1.329     0.188 0.150
0.1171     0.1663
LPRODNZ   0.71772      3.066      0.2341     0.816 0.027
0.0158     1.2217
LPRODIMP  -2.0300     0.3362      -6.039     0.000-0.567    -
0.7304    -3.6831
LDIS      -2.4161     0.3753      -6.438     0.000-0.592    -
0.5044    -2.8894
LPR      -0.73370     0.4823      -1.521     0.132-0.171    -
0.1100    -0.1472
LPR_IMPT  -1.8743      1.429      -1.312     0.194-0.148    -
0.1410    -0.2251
LER      -0.76872E-01 0.1198     -0.6416     0.523-0.073    -
0.0606    -0.0121
HACCP    -0.44622     0.5909     -0.7551     0.452-0.086    -
0.0692    -0.0171
QUOTA      5.5730     0.7162       7.781     0.000 0.663
0.7838     0.1586
CONSTANT   34.780      41.58      0.8366     0.405 0.095
0.0000     4.4552
|_diagnos / het

REQUIRED MEMORY IS PAR=     179 CURRENT PAR=    2000
DEPENDENT VARIABLE = LEXP_VOL        90 OBSERVATIONS
REGRESSION COEFFICIENTS
-5.78618827326       1.67284156353       20.9954090623
0.290111662461
0.717717221137      -2.03001082074      -2.41610056627     -
0.733697739319
-1.87431281457     -0.768719623969E-01 -0.446220114292
5.57301185327
34.7797360493

HETEROSKEDASTICITY TESTS
CHI-SQUARE     D.F.   P-VALUE
TEST STATISTIC
E**2 ON YHAT:                     5.197     1    0.02263
E**2 ON YHAT**2:                  3.648     1    0.05614
E**2 ON LOG(YHAT**2):             7.977     1    0.00474
E**2 ON LAG(E**2) ARCH TEST:      0.024     1    0.87662
LOG(E**2) ON X (HARVEY) TEST:     7.305    12    0.83684
ABS(E) ON X (GLEJSER) TEST:      17.763    12    0.12307
E**2 ON X                TEST:
KOENKER(R2):            17.510    12    0.13138
B-P-G (SSR) :           58.685    12    0.00000

...MATRIX INVERSION FAILED IN ROW   24
```

```
...RESULTS MAY BE UNRELIABLE
E**2 ON X X**2    (WHITE) TEST:
KOENKER(R2):        **********    24  *********
B-P-G (SSR) :       **********    24  *********

...MATRIX INVERSION FAILED IN ROW   24
...RESULTS MAY BE UNRELIABLE
E**2 ON X X**2 XX (WHITE) TEST:
KOENKER(R2):        **********    90  *********
B-P-G (SSR) :       **********    90  *********

|_*
|_*pooling across countries and years

|_pool lexp_vol lgdpNZ lgdpIMP lpopNZ lpopIMP lprodNZ lprodIMP
ldis lpr lpr_impt lER  HACCP quota/ ncross=9 full same

REQUIRED MEMORY IS PAR=      38 CURRENT PAR=    2000
POOLED CROSS-SECTION TIME-SERIES ESTIMATION
90 TOTAL OBSERVATIONS
9 CROSS-SECTIONS
10 TIME-PERIODS

DEPENDENT VARIABLE = LEXP_VOL
...WARNING..TOO FEW DEGREES OF FREEDOM, DN OPTION USED

MODEL ASSUMPTIONS:
SAME ESTIMATED RHO FOR EACH CROSS-SECTION
FULL PHI MATRIX - CROSS-SECTION CORRELATION

OLS COEFFICIENTS
-5.7862       1.6728       20.995      0.29011      0.71772
-2.0300      -2.4161     -0.73370      -1.8743     -0.76872E-01
-0.44622       5.5730       34.780

RHO VECTOR
0.82637       1.0572      0.76998      0.74018      0.89348
0.26991      0.76258      0.84486      0.35115

SAME ESTIMATED RHO FOR ALL CROSS-SECTIONS =  0.55104

VARIANCES (DIAGONAL OF PHI MATRIX)
0.42521      0.36502      0.92083      0.40568      0.39325
4.1589      0.43405      0.65596      1.0927

BUSE [1973] R-SQUARE = 0.9973      BUSE RAW-MOMENT R-SQUARE =
1.0000
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.91284
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.95543
SUM OF SQUARED ERRORS-SSE=   82.156
MEAN OF DEPENDENT VARIABLE =   7.8065
LOG OF THE LIKELIHOOD FUNCTION = -33.1488


ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR   --------   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ    -13.979     0.4899      -28.53     0.000-0.956    -
0.4762    -7.4595
```

```
LGDPIMP    1.4243     0.1222       11.66     0.000 0.799
0.4785     1.3254
LPOPNZ     53.791      1.629       33.03     0.000 0.966
0.6443     8.9753
LPOPIMP   0.36621     0.1208       3.032     0.002 0.327
0.1478     0.2100
LPRODNZ   0.18820     0.8617E-01   2.184     0.029 0.242
0.0041     0.3203
LPRODIMP  -1.9481     0.3217E-01  -60.56     0.000-0.990    -
0.7009    -3.5344
LDIS      -2.4677     0.2109      -11.70     0.000-0.800    -
0.5151    -2.9511
LPR      -0.39449     0.1316E-01  -29.98     0.000-0.960    -
0.0591    -0.0791
LPR_IMPT  0.46642     0.4973E-01   9.380     0.000 0.730
0.0351     0.0560
LER      -0.70962E-01 0.3040E-01  -2.334     0.020-0.257    -
0.0560    -0.0111
HACCP    -0.36090     0.1302E-01  -27.73     0.000-0.953    -
0.0559    -0.0139
QUOTA      6.6242     0.2440       27.14     0.000 0.952
0.9317     0.1886
CONSTANT   31.000      2.215       13.99     0.000 0.847
0.0000     3.9711
|_*
|_*Value model
|_*test

|_ols lexp_val lgdpNZ lgdpIMP lpopNZ lpopIMP lprodNZ lprodIMP ldis
lpr lpr_impt lER  HACCP quota/ dwpvalue

REQUIRED MEMORY IS PAR=     101 CURRENT PAR=    2000
OLS ESTIMATION
90 OBSERVATIONS     DEPENDENT VARIABLE= LEXP_VAL
...NOTE..SAMPLE RANGE SET TO:      1,     90

DURBIN-WATSON STATISTIC  =   0.93896
DURBIN-WATSON POSITIVE AUTOCORRELATION TEST P-VALUE =    0.000000
NEGATIVE AUTOCORRELATION TEST P-VALUE =    1.000000

R-SQUARE =   0.7887     R-SQUARE ADJUSTED =   0.7558
VARIANCE OF THE ESTIMATE-SIGMA**2 =   2.0021
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.4150
SUM OF SQUARED ERRORS-SSE=   154.17
MEAN OF DEPENDENT VARIABLE =   9.3727
LOG OF THE LIKELIHOOD FUNCTION = -151.924


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR      77 DF   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ    -5.7862      17.56     -0.3295     0.743-0.038    -
0.2046    -2.5718
LGDPIMP    1.6728     0.2197       7.613     0.000 0.655
0.5834     1.2966
LPOPNZ     20.995      48.54      0.4325     0.667 0.049
0.2610     2.9178
LPOPIMP   0.29011     0.2183       1.329     0.188 0.150
0.1215     0.1386
```

```
LPRODNZ   0.71772      3.066      0.2341     0.816 0.027
0.0164     1.0175
LPRODIMP  -2.0300     0.3362      -6.039     0.000-0.567    -
0.7582    -3.0676
LDIS      -2.4161     0.3753      -6.438     0.000-0.592    -
0.5236    -2.4066
LPR       0.26630     0.4823      0.5521     0.582 0.063
0.0414     0.0445
LPR_IMPT  -1.8743      1.429      -1.312     0.194-0.148    -
0.1463    -0.1875
LER      -0.76872E-01 0.1198     -0.6416     0.523-0.073    -
0.0630    -0.0101
HACCP    -0.44622     0.5909     -0.7551     0.452-0.086    -
0.0718    -0.0143
QUOTA      5.5730     0.7162       7.781     0.000 0.663
0.8137     0.1321
CONSTANT   34.780      41.58      0.8366     0.405 0.095
0.0000     3.7107
|_diagnos / het

REQUIRED MEMORY IS PAR=     179 CURRENT PAR=    2000
DEPENDENT VARIABLE = LEXP_VAL        90 OBSERVATIONS
REGRESSION COEFFICIENTS
-5.78618827319       1.67284156355       20.9954090626
0.290111662465
0.717717220922      -2.03001082075      -2.41610056638
0.266302260647
-1.87431281435     -0.768719624164E-01 -0.446220114288
5.57301185331
34.7797360522

HETEROSKEDASTICITY TESTS
CHI-SQUARE     D.F.   P-VALUE
TEST STATISTIC
E**2 ON YHAT:                      5.280     1    0.02157
E**2 ON YHAT**2:                   4.114     1    0.04253
E**2 ON LOG(YHAT**2):              6.806     1    0.00908
E**2 ON LAG(E**2) ARCH TEST:       0.024     1    0.87662
LOG(E**2) ON X (HARVEY) TEST:      7.305    12    0.83684
ABS(E) ON X (GLEJSER) TEST:       17.763    12    0.12307
E**2 ON X                  TEST:
KOENKER(R2):             17.510    12    0.13138
B-P-G (SSR) :            58.685    12    0.00000

...MATRIX INVERSION FAILED IN ROW   24
...RESULTS MAY BE UNRELIABLE
E**2 ON X X**2    (WHITE) TEST:
KOENKER(R2):        **********    24  *********
B-P-G (SSR) :       **********    24  *********

...MATRIX INVERSION FAILED IN ROW   24
...RESULTS MAY BE UNRELIABLE
E**2 ON X X**2 XX (WHITE) TEST:
KOENKER(R2):        **********    90  *********
B-P-G (SSR) :       **********    90  *********

|_*
|_*pooling across countries and years

|_pool lexp_val lgdpNZ lgdpIMP lpopNZ lpopIMP lprodNZ lprodIMP
ldis lpr lpr_impt lER  HACCP quota/ ncross=9 full same
```

```
REQUIRED MEMORY IS PAR=      38 CURRENT PAR=    2000
POOLED CROSS-SECTION TIME-SERIES ESTIMATION
90 TOTAL OBSERVATIONS
9 CROSS-SECTIONS
10 TIME-PERIODS

DEPENDENT VARIABLE = LEXP_VAL
...WARNING..TOO FEW DEGREES OF FREEDOM, DN OPTION USED

MODEL ASSUMPTIONS:
SAME ESTIMATED RHO FOR EACH CROSS-SECTION
FULL PHI MATRIX - CROSS-SECTION CORRELATION

OLS COEFFICIENTS
-5.7862       1.6728       20.995      0.29011      0.71772
-2.0300      -2.4161      0.26630      -1.8743     -0.76872E-01
-0.44622       5.5730       34.780

RHO VECTOR
0.82637       1.0572      0.76998      0.74018      0.89348
0.26991      0.76258      0.84486      0.35115

SAME ESTIMATED RHO FOR ALL CROSS-SECTIONS =  0.55104

VARIANCES (DIAGONAL OF PHI MATRIX)
0.42521      0.36502      0.92083      0.40568      0.39325
4.1589      0.43405      0.65596      1.0927

BUSE [1973] R-SQUARE = 0.9968      BUSE RAW-MOMENT R-SQUARE =
1.0000
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.91284
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.95543
SUM OF SQUARED ERRORS-SSE=   82.156
MEAN OF DEPENDENT VARIABLE =   9.3727
LOG OF THE LIKELIHOOD FUNCTION = -33.1488


ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR   --------   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ    -13.979     0.4899      -28.53     0.000-0.956    -
0.4944    -6.2130
LGDPIMP    1.4243     0.1222       11.66     0.000 0.799
0.4967     1.1039
LPOPNZ     53.791      1.629       33.03     0.000 0.966
0.6688     7.4755
LPOPIMP   0.36621     0.1208       3.032     0.002 0.327
0.1534     0.1749
LPRODNZ   0.18820     0.8617E-01   2.184     0.029 0.242
0.0043     0.2668
LPRODIMP  -1.9481     0.3217E-01  -60.56     0.000-0.990    -
0.7276    -2.9438
LDIS      -2.4677     0.2109      -11.70     0.000-0.800    -
0.5348    -2.4580
LPR       0.60551     0.1316E-01   46.01     0.000 0.982
0.0942     0.1012
LPR_IMPT  0.46642     0.4973E-01   9.380     0.000 0.730
0.0364     0.0467
```

```
LER       -0.70962E-01 0.3040E-01  -2.334     0.020-0.257    -
0.0581    -0.0093
HACCP     -0.36090     0.1302E-01  -27.73     0.000-0.953    -
0.0581    -0.0116
QUOTA      6.6242     0.2440       27.14     0.000 0.952
0.9671     0.1571
CONSTANT   31.000      2.215       13.99     0.000 0.847
0.0000     3.3075
|_*
|_* (2) CAO & JOHNSON model (a simple version of general model)
|_*
|_*using gdp product
|_*
|_*Value model

|_pool lexp_val lgdp_prod lgdppc_prod ldis lER lprodIMP lpr HACCP
quota / ncross=9 full same
..WARNING..lgdp_prod                IS TRUNCATED TO lgdp_pro
..WARNING..lgdppc_prod              IS TRUNCATED TO lgdppc_p

REQUIRED MEMORY IS PAR=      35 CURRENT PAR=    2000
POOLED CROSS-SECTION TIME-SERIES ESTIMATION
90 TOTAL OBSERVATIONS
9 CROSS-SECTIONS
10 TIME-PERIODS

DEPENDENT VARIABLE = LEXP_VAL

MODEL ASSUMPTIONS:
SAME ESTIMATED RHO FOR EACH CROSS-SECTION
FULL PHI MATRIX - CROSS-SECTION CORRELATION

OLS COEFFICIENTS
1.9855     -0.34673      -2.6550     -0.11109      -2.0739
-0.75432E-01 -0.20807       6.1595       41.746

RHO VECTOR
0.81779       1.0651      0.78408      0.78965      0.89429
0.28845      0.78610      0.91665      0.11229

SAME ESTIMATED RHO FOR ALL CROSS-SECTIONS =  0.54318

VARIANCES (DIAGONAL OF PHI MATRIX)
2.5683       4.1270       10.748       1.9237       2.5003
51.124       4.2956       5.9777       12.838

BUSE [1973] R-SQUARE = 0.9228      BUSE RAW-MOMENT R-SQUARE =
0.9993
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.10820
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.32894
SUM OF SQUARED ERRORS-SSE=   8.7642
MEAN OF DEPENDENT VARIABLE =   9.3727
LOG OF THE LIKELIHOOD FUNCTION = -55.8830


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR      81 DF   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDP_PRO   2.0469     0.1283       15.95     0.000 0.871
0.7257     2.4963
```

```
LGDPPC_P -0.42107     0.1416      -2.973     0.004-0.314    -
0.1768    -0.2539
LDIS      -2.7822     0.2941      -9.460     0.000-0.725    -
0.6029    -2.7713
LER      -0.86682E-01 0.5461E-01  -1.587     0.116-0.174    -
0.0710    -0.0113
LPRODIMP  -2.1279     0.1695      -12.55     0.000-0.813    -
0.7947    -3.2155
LPR       0.54023     0.5994E-01   9.012     0.000 0.708
0.0841     0.0903
HACCP    -0.17509     0.6768E-01  -2.587     0.011-0.276    -
0.0282    -0.0056
QUOTA      6.7097     0.3474       19.32     0.000 0.906
0.9796     0.1591
CONSTANT   42.250      3.693       11.44     0.000 0.786
0.0000     4.5078
|_*
|_*using gdp and pop
|_*
|_*value model

|_pool lexp_val lgdpNZ lgdpIMP lpopNZ lpopIMP ldis lER lprodIMP
lpr HACCP quota/ ncross=9 full same

REQUIRED MEMORY IS PAR=      37 CURRENT PAR=    2000
POOLED CROSS-SECTION TIME-SERIES ESTIMATION
90 TOTAL OBSERVATIONS
9 CROSS-SECTIONS
10 TIME-PERIODS

DEPENDENT VARIABLE = LEXP_VAL
...WARNING..TOO FEW DEGREES OF FREEDOM, DN OPTION USED

MODEL ASSUMPTIONS:
SAME ESTIMATED RHO FOR EACH CROSS-SECTION
FULL PHI MATRIX - CROSS-SECTION CORRELATION

OLS COEFFICIENTS
-6.8066       1.5924       28.070      0.35382      -2.6387
-0.99699E-01  -2.0602      0.62163E-01 -0.34030       6.2368
40.570

RHO VECTOR
0.75000       1.0657      0.81602      0.73843      0.90856
0.32222      0.72489      0.88764      0.21340

SAME ESTIMATED RHO FOR ALL CROSS-SECTIONS =  0.57661

VARIANCES (DIAGONAL OF PHI MATRIX)
0.42667      0.35408      0.90923      0.36747      0.35936
4.1378      0.44989      0.61680       1.0451

BUSE [1973] R-SQUARE = 0.9958      BUSE RAW-MOMENT R-SQUARE =
1.0000
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.94425
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.97173
SUM OF SQUARED ERRORS-SSE=   84.983
MEAN OF DEPENDENT VARIABLE =   9.3727
LOG OF THE LIKELIHOOD FUNCTION = -36.7951
```

```
ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR   --------   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ    -14.114     0.4822      -29.27     0.000-0.957    -
0.4991    -6.2729
LGDPIMP    1.4521     0.1181       12.30     0.000 0.811
0.5065     1.1255
LPOPNZ     53.648      1.486       36.11     0.000 0.971
0.6670     7.4556
LPOPIMP   0.39718     0.1130       3.516     0.000 0.368
0.1664     0.1897
LDIS      -2.6878     0.2035      -13.21     0.000-0.830    -
0.5824    -2.6772
LER      -0.86401E-03 0.2719E-01 -0.3178E-01 0.975-0.004    -
0.0007    -0.0001
LPRODIMP  -1.9277     0.3384E-01  -56.96     0.000-0.988    -
0.7200    -2.9130
LPR       0.60358     0.1039E-01   58.09     0.000 0.988
0.0939     0.1009
HACCP    -0.33424     0.1533E-01  -21.81     0.000-0.926    -
0.0538    -0.0107
QUOTA      6.8012     0.2274       29.91     0.000 0.959
0.9930     0.1613
CONSTANT   36.013      1.861       19.35     0.000 0.909
0.0000     3.8423
|_*
|_* (3) Commodity-specific model (KOO model)
|_*value model

|_pool lexp_val lgdpNZ lgdpIMP lprodNZ lprodIMP ldis lpr lpr_impt
lER  HACCP quota/ ncross=9 full same

REQUIRED MEMORY IS PAR=      37 CURRENT PAR=    2000
POOLED CROSS-SECTION TIME-SERIES ESTIMATION
90 TOTAL OBSERVATIONS
9 CROSS-SECTIONS
10 TIME-PERIODS

DEPENDENT VARIABLE = LEXP_VAL
...WARNING..TOO FEW DEGREES OF FREEDOM, DN OPTION USED

MODEL ASSUMPTIONS:
SAME ESTIMATED RHO FOR EACH CROSS-SECTION
FULL PHI MATRIX - CROSS-SECTION CORRELATION

OLS COEFFICIENTS
1.2105       1.6898       1.1416      -1.7062      -2.1404
0.30018      -2.3548      0.13273E-01 -0.51144       5.1483
21.765

RHO VECTOR
0.90299       1.0669      0.76603      0.72744      0.89066
0.31379      0.75272      0.80700      0.34723

SAME ESTIMATED RHO FOR ALL CROSS-SECTIONS =  0.53707

VARIANCES (DIAGONAL OF PHI MATRIX)
0.40928      0.27116       1.0030      0.33047      0.31308
5.1990      0.45852      0.52383       1.0183
```

```
BUSE [1973] R-SQUARE = 0.8998      BUSE RAW-MOMENT R-SQUARE =
0.9935
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.95821
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.97888
SUM OF SQUARED ERRORS-SSE=   86.238
MEAN OF DEPENDENT VARIABLE =   9.3727
LOG OF THE LIKELIHOOD FUNCTION = -63.8763


ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR   --------   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ     3.2638     0.9469       3.447     0.001 0.362
0.1154     1.4506
LGDPIMP    1.5712     0.9551E-01   16.45     0.000 0.880
0.5480     1.2178
LPRODNZ   0.96560     0.9861      0.9792     0.327 0.110
0.0220     1.3690
LPRODIMP  -1.7361     0.1641      -10.58     0.000-0.766    -
0.6484    -2.6235
LDIS      -2.3642     0.2578      -9.171     0.000-0.718    -
0.5123    -2.3549
LPR       0.60887     0.9192E-01   6.624     0.000 0.598
0.0948     0.1017
LPR_IMPT -0.15288     0.3075     -0.4972     0.619-0.056    -
0.0119    -0.0153
LER       0.82557E-02 0.5606E-01  0.1473     0.883 0.017
0.0068     0.0011
HACCP    -0.36519     0.1843      -1.981     0.048-0.218    -
0.0588    -0.0117
QUOTA      6.3273     0.2971       21.30     0.000 0.923
0.9238     0.1500
CONSTANT   16.028      13.18       1.216     0.224 0.136
0.0000     1.7101

..INPUT FILE COMPLETED..TYPE A NEW COMMAND OR TYPE: STOP
```

Estimation of Gravity model for Lamb

```
Welcome to SHAZAM - Version 9.0  -  JAN 2003 SYSTEM=WIN2000  PAR=
2000
CURRENT WORKING DIRECTORY IS: C:\TEMP
|_*lamb final
|_sample 1 90
|_read (H:\lambfinal.dif) exp_vol exp_val gdppcNZ gdppcIMP ER
prodIMP &
| HACCP gdp_prod gdppc_prod popNZ popIMP gdpNZ gdpIMP dis pr quota
prodNZ pr_impt / dif
..WARNING..gdppc_prod              IS TRUNCATED TO gdppc_pr
UNIT 88 IS NOW ASSIGNED TO: H:\lambfinal.dif
..NOTE..DIF FILE HAS   18 COLUMNS AND     90 ROWS
18 VARIABLES AND       90 OBSERVATIONS STARTING AT OBS       1

|_*
|_*generate variables
|_*
|_genr lexp_vol=log(exp_vol)
|_genr lexp_val=log(exp_val)
|_genr lgdppcIMP=log(gdppcIMP)
.WARNING.VAR LONGER THAN 8 CHARACTERS TRUNCATED TO:lgdppcIM
|_genr lER=log(ER)
|_genr lprodIMP=log(prodIMP)
|_genr lgdppcNZ= log(gdppcNZ)
|_genr ldis=log(dis)
|_genr lpr=log(pr)
|_genr lgdp_prod=log(gdp_prod)
.WARNING.VAR LONGER THAN 8 CHARACTERS TRUNCATED TO:lgdp_pro
|_genr lgdppc_prod=log(gdppc_prod)
.WARNING.VAR LONGER THAN 8 CHARACTERS TRUNCATED TO:lgdppc_p
|_genr lpopNZ=log(popNZ)
|_genr lpopIMP=log(popIMP)
|_genr lgdpNZ=log(gdpNZ)
|_genr lgdpIMP=log(gdpIMP)
|_genr lprodNZ=log(prodNZ)
|_genr lpr_impt=log(pr_impt)
|_*
|_* (1) GENERAL/FULL model
|_*
|_*Volume model
|_*test

|_ols lexp_vol lgdpNZ lgdpIMP lpopNZ lpopIMP lprodNZ lprodIMP ldis
lpr lpr_impt lER  HACCP quota/ dwpvalue

REQUIRED MEMORY IS PAR=     101 CURRENT PAR=    2000
OLS ESTIMATION
90 OBSERVATIONS     DEPENDENT VARIABLE= LEXP_VOL
...NOTE..SAMPLE RANGE SET TO:      1,     90

DURBIN-WATSON STATISTIC  =   0.80600
DURBIN-WATSON POSITIVE AUTOCORRELATION TEST P-VALUE =    0.000000
NEGATIVE AUTOCORRELATION TEST P-VALUE =    1.000000

R-SQUARE =   0.8664     R-SQUARE ADJUSTED =   0.8455
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.68722
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.82899
SUM OF SQUARED ERRORS-SSE=   52.916
```

```
MEAN OF DEPENDENT VARIABLE =   8.8935
LOG OF THE LIKELIHOOD FUNCTION = -103.805


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR      77 DF   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ    -1.0885      10.67     -0.1020     0.919-0.012    -
0.0451    -0.5107
LGDPIMP    2.1464     0.2204       9.738     0.000 0.743
1.0109     1.7548
LPOPNZ     9.6732      30.54      0.3167     0.752 0.036
0.1362     1.4199
LPOPIMP   -1.4126     0.2313      -6.106     0.000-0.571    -
0.8032    -0.7113
LPRODNZ   -3.6594      3.115      -1.175     0.244-0.133    -
0.0667    -5.4210
LPRODIMP  0.90724E-01 0.1057      0.8579     0.394 0.097
0.1685     0.1023
LDIS       3.0929     0.3660       8.451     0.000 0.694
0.9099     3.2467
LPR       -3.4480     0.3709      -9.297     0.000-0.727    -
0.9940    -0.5499
LPR_IMPT -0.70502     0.5765      -1.223     0.225-0.138    -
0.1481    -0.0714
LER      -0.33705     0.1554      -2.168     0.033-0.240    -
0.3741    -0.0464
HACCP     0.64652     0.3479       1.858     0.067 0.207
0.1412     0.0218
QUOTA     0.42452     0.4212       1.008     0.317 0.114
0.0954     0.0159
CONSTANT   15.556      40.55      0.3836     0.702 0.044
0.0000     1.7492
|_diagnos / het

REQUIRED MEMORY IS PAR=     179 CURRENT PAR=    2000
DEPENDENT VARIABLE = LEXP_VOL        90 OBSERVATIONS
REGRESSION COEFFICIENTS
-1.08849223406       2.14639010410       9.67318226686      -
1.41263980005
-3.65938277926      0.907241529066E-01   3.09285412527      -
3.44799372627
-0.705017826114     -0.337049209947      0.646515467827
0.424522232794
15.5562751880

HETEROSKEDASTICITY TESTS
CHI-SQUARE     D.F.   P-VALUE
TEST STATISTIC
E**2 ON YHAT:                       22.123     1    0.00000
E**2 ON YHAT**2:                    15.690     1    0.00007
E**2 ON LOG(YHAT**2):               30.449     1    0.00000
E**2 ON LAG(E**2) ARCH TEST:         4.817     1    0.02818
LOG(E**2) ON X (HARVEY) TEST:       32.277    12    0.00125
ABS(E) ON X (GLEJSER) TEST:         60.106    12    0.00000
E**2 ON X                  TEST:
KOENKER(R2):              45.562    12    0.00001
B-P-G (SSR) :            120.579    12    0.00000

...MATRIX INVERSION FAILED IN ROW   24
```

```
...RESULTS MAY BE UNRELIABLE
E**2 ON X X**2    (WHITE) TEST:
KOENKER(R2):        **********    24  *********
B-P-G (SSR) :       **********    24  *********

...MATRIX INVERSION FAILED IN ROW   24
...RESULTS MAY BE UNRELIABLE
E**2 ON X X**2 XX (WHITE) TEST:
KOENKER(R2):        **********    90  *********
B-P-G (SSR) :       **********    90  *********

|_*
|_*pooling across countries and years

|_pool lexp_vol lgdpNZ lgdpIMP lpopNZ lpopIMP lprodNZ lprodIMP
ldis lpr lpr_impt lER  HACCP quota/ ncross=9 full same

REQUIRED MEMORY IS PAR=      38 CURRENT PAR=    2000
POOLED CROSS-SECTION TIME-SERIES ESTIMATION
90 TOTAL OBSERVATIONS
9 CROSS-SECTIONS
10 TIME-PERIODS

DEPENDENT VARIABLE = LEXP_VOL
...WARNING..TOO FEW DEGREES OF FREEDOM, DN OPTION USED

MODEL ASSUMPTIONS:
SAME ESTIMATED RHO FOR EACH CROSS-SECTION
FULL PHI MATRIX - CROSS-SECTION CORRELATION

OLS COEFFICIENTS
-1.0885       2.1464       9.6732      -1.4126      -3.6594
0.90724E-01   3.0929      -3.4480     -0.70502     -0.33705
0.64652      0.42452       15.556

RHO VECTOR
0.59076E-01  0.75899      0.18045      0.73375      0.26392
0.69274      0.89833E-01  0.66171      0.63504

SAME ESTIMATED RHO FOR ALL CROSS-SECTIONS =  0.51259

VARIANCES (DIAGONAL OF PHI MATRIX)
0.70594      0.68694E-01  0.14726      0.18109      0.61444E-01
0.17180      0.47305E-01  0.38424       1.4106

BUSE [1973] R-SQUARE = 0.9759      BUSE RAW-MOMENT R-SQUARE =
0.9966
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.95367
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.97656
SUM OF SQUARED ERRORS-SSE=   85.830
MEAN OF DEPENDENT VARIABLE =   8.8935
LOG OF THE LIKELIHOOD FUNCTION = -7.22590


ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR   --------   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ   -0.88778      2.723     -0.3260     0.744-0.037    -
0.0368    -0.4166
```

```
LGDPIMP    1.8652     0.8741E-01   21.34     0.000 0.925
0.8785     1.5249
LPOPNZ     9.7788      8.340       1.172     0.241 0.132
0.1377     1.4354
LPOPIMP   -1.4349     0.1679      -8.547     0.000-0.698    -
0.8159    -0.7225
LPRODNZ   -1.2853     0.8562      -1.501     0.133-0.169    -
0.0234    -1.9040
LPRODIMP  0.16233     0.4723E-01   3.437     0.001 0.365
0.3015     0.1830
LDIS       2.7813     0.2286       12.16     0.000 0.811
0.8182     2.9196
LPR       -2.8560     0.8258E-01  -34.58     0.000-0.969    -
0.8233    -0.4555
LPR_IMPT  0.12038     0.1566      0.7689     0.442 0.087
0.0253     0.0122
LER      -0.11615     0.7693E-01  -1.510     0.131-0.170    -
0.1289    -0.0160
HACCP     0.39660     0.1126       3.521     0.000 0.372
0.0866     0.0134
QUOTA     0.17136     0.1573       1.089     0.276 0.123
0.0385     0.0064
CONSTANT  -13.969      11.54      -1.211     0.226-0.137
0.0000    -1.5707
|_*
|_*Value model
|_*test

|_ols lexp_val lgdpNZ lgdpIMP lpopNZ lpopIMP lprodNZ lprodIMP ldis
lpr lpr_impt lER  HACCP quota/ dwpvalue

REQUIRED MEMORY IS PAR=     101 CURRENT PAR=    2000
OLS ESTIMATION
90 OBSERVATIONS     DEPENDENT VARIABLE= LEXP_VAL
...NOTE..SAMPLE RANGE SET TO:      1,     90

DURBIN-WATSON STATISTIC  =   0.80600
DURBIN-WATSON POSITIVE AUTOCORRELATION TEST P-VALUE =    0.000000
NEGATIVE AUTOCORRELATION TEST P-VALUE =    1.000000

R-SQUARE =   0.8916     R-SQUARE ADJUSTED =   0.8747
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.68722
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.82899
SUM OF SQUARED ERRORS-SSE=   52.916
MEAN OF DEPENDENT VARIABLE =   10.312
LOG OF THE LIKELIHOOD FUNCTION = -103.805


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR      77 DF   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ    -1.0885      10.67     -0.1020     0.919-0.012    -
0.0406    -0.4405
LGDPIMP    2.1464     0.2204       9.738     0.000 0.743
0.9105     1.5135
LPOPNZ     9.6732      30.54      0.3167     0.752 0.036
0.1227     1.2246
LPOPIMP   -1.4126     0.2313      -6.106     0.000-0.571    -
0.7234    -0.6134
```

```
LPRODNZ   -3.6594      3.115      -1.175     0.244-0.133    -
0.0601    -4.6753
LPRODIMP  0.90724E-01 0.1057      0.8579     0.394 0.097
0.1517     0.0882
LDIS       3.0929     0.3660       8.451     0.000 0.694
0.8195     2.8001
LPR       -2.4480     0.3709      -6.601     0.000-0.601    -
0.6356    -0.3367
LPR_IMPT -0.70502     0.5765      -1.223     0.225-0.138    -
0.1334    -0.0615
LER      -0.33705     0.1554      -2.168     0.033-0.240    -
0.3369    -0.0400
HACCP     0.64652     0.3479       1.858     0.067 0.207
0.1272     0.0188
QUOTA     0.42452     0.4212       1.008     0.317 0.114
0.0859     0.0137
CONSTANT   15.556      40.55      0.3836     0.702 0.044
0.0000     1.5086
|_diagnos / het

REQUIRED MEMORY IS PAR=     179 CURRENT PAR=    2000
DEPENDENT VARIABLE = LEXP_VAL        90 OBSERVATIONS
REGRESSION COEFFICIENTS
-1.08849223056       2.14639010409       9.67318225766      -
1.41263979999
-3.65938277818      0.907241528819E-01   3.09285412521      -
2.44799372619
-0.705017826258     -0.337049209996      0.646515467724
0.424522232892
15.5562751719

HETEROSKEDASTICITY TESTS
CHI-SQUARE     D.F.   P-VALUE
TEST STATISTIC
E**2 ON YHAT:                     20.575     1    0.00001
E**2 ON YHAT**2:                  15.907     1    0.00007
E**2 ON LOG(YHAT**2):             27.028     1    0.00000
E**2 ON LAG(E**2) ARCH TEST:       4.817     1    0.02818
LOG(E**2) ON X (HARVEY) TEST:     32.277    12    0.00125
ABS(E) ON X (GLEJSER) TEST:       60.106    12    0.00000
E**2 ON X                 TEST:
KOENKER(R2):            45.562    12    0.00001
B-P-G (SSR) :          120.579    12    0.00000

...MATRIX INVERSION FAILED IN ROW   24
...RESULTS MAY BE UNRELIABLE
E**2 ON X X**2    (WHITE) TEST:
KOENKER(R2):        **********    24  *********
B-P-G (SSR) :       **********    24  *********

...MATRIX INVERSION FAILED IN ROW   24
...RESULTS MAY BE UNRELIABLE
E**2 ON X X**2 XX (WHITE) TEST:
KOENKER(R2):        **********    90  *********
B-P-G (SSR) :       **********    90  *********

|_*
|_*pooling across countries and years

|_pool lexp_val lgdpNZ lgdpIMP lpopNZ lpopIMP lprodNZ lprodIMP
ldis lpr lpr_impt lER  HACCP quota/ ncross=9 full same
```

```
REQUIRED MEMORY IS PAR=      38 CURRENT PAR=    2000
POOLED CROSS-SECTION TIME-SERIES ESTIMATION
90 TOTAL OBSERVATIONS
9 CROSS-SECTIONS
10 TIME-PERIODS

DEPENDENT VARIABLE = LEXP_VAL
...WARNING..TOO FEW DEGREES OF FREEDOM, DN OPTION USED

MODEL ASSUMPTIONS:
SAME ESTIMATED RHO FOR EACH CROSS-SECTION
FULL PHI MATRIX - CROSS-SECTION CORRELATION

OLS COEFFICIENTS
-1.0885       2.1464       9.6732      -1.4126      -3.6594
0.90724E-01   3.0929      -2.4480     -0.70502     -0.33705
0.64652      0.42452       15.556

RHO VECTOR
0.59076E-01  0.75899      0.18045      0.73375      0.26392
0.69274      0.89833E-01  0.66171      0.63504

SAME ESTIMATED RHO FOR ALL CROSS-SECTIONS =  0.51259

VARIANCES (DIAGONAL OF PHI MATRIX)
0.70594      0.68694E-01  0.14726      0.18109      0.61444E-01
0.17180      0.47305E-01  0.38424       1.4106

BUSE [1973] R-SQUARE = 0.9758      BUSE RAW-MOMENT R-SQUARE =
0.9972
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.95367
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.97656
SUM OF SQUARED ERRORS-SSE=   85.830
MEAN OF DEPENDENT VARIABLE =   10.312
LOG OF THE LIKELIHOOD FUNCTION = -7.22590


ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR   --------   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ   -0.88778      2.723     -0.3260     0.744-0.037    -
0.0332    -0.3593
LGDPIMP    1.8652     0.8741E-01   21.34     0.000 0.925
0.7912     1.3152
LPOPNZ     9.7788      8.340       1.172     0.241 0.132
0.1240     1.2380
LPOPIMP   -1.4349     0.1679      -8.547     0.000-0.698    -
0.7348    -0.6231
LPRODNZ   -1.2853     0.8562      -1.501     0.133-0.169    -
0.0211    -1.6421
LPRODIMP  0.16233     0.4723E-01   3.437     0.001 0.365
0.2715     0.1579
LDIS       2.7813     0.2286       12.16     0.000 0.811
0.7369     2.5180
LPR       -1.8560     0.8258E-01  -22.47     0.000-0.932    -
0.4819    -0.2553
LPR_IMPT  0.12038     0.1566      0.7689     0.442 0.087
0.0228     0.0105
```

```
LER      -0.11615     0.7693E-01  -1.510     0.131-0.170    -
0.1161    -0.0138
HACCP     0.39660     0.1126       3.521     0.000 0.372
0.0780     0.0115
QUOTA     0.17136     0.1573       1.089     0.276 0.123
0.0347     0.0055
CONSTANT  -13.969      11.54      -1.211     0.226-0.137
0.0000    -1.3547
|_*
|_* (2) CAO & JOHNSON model (a simple version of general model)
|_*
|_*using gdp product
|_*
|_*Value model

|_pool lexp_val lgdp_prod lgdppc_prod ldis lER lprodIMP lpr HACCP
quota / ncross=9 full same
..WARNING..lgdp_prod                IS TRUNCATED TO lgdp_pro
..WARNING..lgdppc_prod              IS TRUNCATED TO lgdppc_p

REQUIRED MEMORY IS PAR=      35 CURRENT PAR=    2000
POOLED CROSS-SECTION TIME-SERIES ESTIMATION
90 TOTAL OBSERVATIONS
9 CROSS-SECTIONS
10 TIME-PERIODS

DEPENDENT VARIABLE = LEXP_VAL

MODEL ASSUMPTIONS:
SAME ESTIMATED RHO FOR EACH CROSS-SECTION
FULL PHI MATRIX - CROSS-SECTION CORRELATION

OLS COEFFICIENTS
0.63255       1.3223       2.8943     -0.29362      0.87863E-01
-2.4465      0.60233      0.37372      -28.790

RHO VECTOR
0.10926      0.65406      0.38742      0.77491      0.25193
0.69888      0.47146E-01  0.66442      0.70503

SAME ESTIMATED RHO FOR ALL CROSS-SECTIONS =  0.55421

VARIANCES (DIAGONAL OF PHI MATRIX)
6.9927      0.68734      1.3461       1.7367      0.53905
1.7162      0.56375      3.4518       13.791

BUSE [1973] R-SQUARE = 0.9725      BUSE RAW-MOMENT R-SQUARE =
0.9971
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.10728
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.32754
SUM OF SQUARED ERRORS-SSE=   8.6899
MEAN OF DEPENDENT VARIABLE =   10.312
LOG OF THE LIKELIHOOD FUNCTION = -5.76509


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR      81 DF   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDP_PRO  0.40869     0.1091       3.745     0.000 0.384
0.1756     0.4536
```

```
LGDPPC_P   1.4965     0.1745       8.575     0.000 0.690
0.7620     0.8215
LDIS       2.7916     0.2609       10.70     0.000 0.765
0.7397     2.5274
LER      -0.90499E-01 0.7655E-01  -1.182     0.241-0.130    -
0.0905    -0.0107
LPRODIMP  0.17735     0.4726E-01   3.753     0.000 0.385
0.2966     0.1725
LPR       -1.7593     0.7020E-01  -25.06     0.000-0.941    -
0.4568    -0.2420
HACCP     0.40739     0.8344E-01   4.882     0.000 0.477
0.0802     0.0119
QUOTA     0.15889     0.1661      0.9567     0.342 0.106
0.0322     0.0051
CONSTANT  -28.141      2.790      -10.09     0.000-0.746
0.0000    -2.7289
|_*
|_*using gdp and pop
|_*
|_*value model

|_pool lexp_val lgdpNZ lgdpIMP lpopNZ lpopIMP ldis lER lprodIMP
lpr HACCP quota/ ncross=9 full same

REQUIRED MEMORY IS PAR=      37 CURRENT PAR=    2000
POOLED CROSS-SECTION TIME-SERIES ESTIMATION
90 TOTAL OBSERVATIONS
9 CROSS-SECTIONS
10 TIME-PERIODS

DEPENDENT VARIABLE = LEXP_VAL
...WARNING..TOO FEW DEGREES OF FREEDOM, DN OPTION USED

MODEL ASSUMPTIONS:
SAME ESTIMATED RHO FOR EACH CROSS-SECTION
FULL PHI MATRIX - CROSS-SECTION CORRELATION

OLS COEFFICIENTS
0.32925      1.9613       2.5314      -1.3276       2.8984
-0.29204     0.89628E-01  -2.4545      0.65845      0.36945
-27.123

RHO VECTOR
0.11305      0.65307      0.36672      0.76560      0.24603
0.70658      0.47909E-01  0.65422      0.70128

SAME ESTIMATED RHO FOR ALL CROSS-SECTIONS =  0.55294

VARIANCES (DIAGONAL OF PHI MATRIX)
0.69001      0.71102E-01  0.13988      0.17114      0.54873E-01
0.17733      0.52876E-01  0.35435       1.3714

BUSE [1973] R-SQUARE = 0.9736      BUSE RAW-MOMENT R-SQUARE =
0.9973
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.95141
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.97540
SUM OF SQUARED ERRORS-SSE=   85.627
MEAN OF DEPENDENT VARIABLE =   10.312
LOG OF THE LIKELIHOOD FUNCTION = -4.99322
```

```
ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR   --------   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ    0.63825      2.206      0.2894     0.772 0.033
0.0238     0.2583
LGDPIMP    1.8676     0.8203E-01   22.77     0.000 0.932
0.7923     1.3169
LPOPNZ     4.6908      6.690      0.7012     0.483 0.079
0.0595     0.5938
LPOPIMP   -1.4458     0.1693      -8.541     0.000-0.693    -
0.7404    -0.6278
LDIS       2.8055     0.2450       11.45     0.000 0.790
0.7433     2.5400
LER      -0.97752E-01 0.7210E-01  -1.356     0.175-0.151    -
0.0977    -0.0116
LPRODIMP  0.16912     0.4484E-01   3.772     0.000 0.391
0.2829     0.1645
LPR       -1.7307     0.6632E-01  -26.10     0.000-0.947    -
0.4494    -0.2381
HACCP     0.34232     0.9211E-01   3.716     0.000 0.386
0.0674     0.0100
QUOTA     0.15942     0.1557       1.024     0.306 0.114
0.0323     0.0052
CONSTANT  -30.942      3.569      -8.669     0.000-0.698
0.0000    -3.0006
|_*
|_* (3) Commodity-specific model (KOO model)
|_*value model

|_pool lexp_val lgdpNZ lgdpIMP lprodNZ lprodIMP ldis lpr lpr_impt
lER  HACCP quota/ ncross=9 full same

REQUIRED MEMORY IS PAR=      37 CURRENT PAR=    2000
POOLED CROSS-SECTION TIME-SERIES ESTIMATION
90 TOTAL OBSERVATIONS
9 CROSS-SECTIONS
10 TIME-PERIODS

DEPENDENT VARIABLE = LEXP_VAL
...WARNING..TOO FEW DEGREES OF FREEDOM, DN OPTION USED

MODEL ASSUMPTIONS:
SAME ESTIMATED RHO FOR EACH CROSS-SECTION
FULL PHI MATRIX - CROSS-SECTION CORRELATION

OLS COEFFICIENTS
2.4779       1.1881     -0.86622     -0.44021       1.3282
-1.5241     -0.29151     -0.90524      0.20317       2.2362
-2.5140

RHO VECTOR
-0.39388E-01  0.73013      0.53614      0.74782      0.81343
0.72705      0.95680      0.90135      0.56204

SAME ESTIMATED RHO FOR ALL CROSS-SECTIONS =  0.61306

VARIANCES (DIAGONAL OF PHI MATRIX)
0.56709      0.10528      0.79945E-01  0.84667E-01  0.10300
0.11670      0.18372      0.42816       1.9484
```

```
BUSE [1973] R-SQUARE = 0.9944      BUSE RAW-MOMENT R-SQUARE =
1.0000
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.92591
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.96224
SUM OF SQUARED ERRORS-SSE=   83.331
MEAN OF DEPENDENT VARIABLE =   10.312
LOG OF THE LIKELIHOOD FUNCTION =  3.73414


ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL
STANDARDIZED ELASTICITY
NAME    COEFFICIENT   ERROR   --------   P-VALUE CORR. COEFFICIENT
AT MEANS
LGDPNZ     1.9613     0.9786E-01   20.04     0.000 0.914
0.0732     0.7937
LGDPIMP    1.0414     0.4187E-01   24.87     0.000 0.942
0.4418     0.7343
LPRODNZ  -0.84893     0.9138E-01  -9.290     0.000-0.723    -
0.0139    -1.0846
LPRODIMP -0.41661     0.3023E-01  -13.78     0.000-0.840    -
0.6968    -0.4051
LDIS       1.0463     0.2093       5.000     0.000 0.490
0.2772     0.9473
LPR       -1.6659     0.2162E-01  -77.05     0.000-0.993    -
0.4325    -0.2292
LPR_IMPT  0.77479     0.3456E-01   22.42     0.000 0.930
0.1466     0.0676
LER      -0.78876     0.3329E-01  -23.69     0.000-0.936    -
0.7884    -0.0936
HACCP     0.21903     0.1232E-01   17.78     0.000 0.895
0.0431     0.0064
QUOTA      2.1459     0.1797       11.94     0.000 0.802
0.4344     0.0694
CONSTANT   2.0572      2.284      0.9009     0.368 0.101
0.0000     0.1995

..INPUT FILE COMPLETED..TYPE A NEW COMMAND OR TYPE: STOP
```

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