

Option Contracts for Supermarket Fruit Supply Chains: Theory and Practice

A thesis submitted in fulfilment of the requirements for the
award of the degree of

Doctor of Philosophy

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2015

Abstract

Perishability increases uncertainty in food supply chains and supply chain players must respond quickly to produce changes in order to minimize loss through waste. In high income countries such as Australia, as elsewhere, waste is a function of uncertainty in decision making and lack of coordination between different players in the supply chain. Contract-of-Sale agreements between farmers and retailers may be directly responsible for crop waste at the farm gate and/or in supply chains into retail stores. Lack of coordination results in poor performance of the supply chain and inaccurate forecasts will result in excessive inventory costs, food wastage, quality-related costs and customer dissatisfaction.

Option contracts have been recognized as a contractual mechanism to minimise the costs in the supply chain caused by demand uncertainty and to improve the performance of the whole supply chain as well as that of individual chain players. Option contracts respond to demand uncertainty by offering flexibility in ordering. The literature argues, however, that they can only be applied in supply chains characterized by three critical requirements - high demand uncertainty, short sale season, and long production lead times. Prima facie, perishable food supply chains seem to satisfy these requirements. Numerous studies have suggested, therefore, that the use of option contracts in food supply chains may reduce the impacts of demand uncertainty and in so doing reduce the waste associated within the supply chain. These studies are, however, essentially theoretical and appear to be exceptionally constrained by the limiting assumptions on which they are based. The question arises, therefore, as to whether the application of option contracts in real world perishable food supply chains is well described by these theoretical studies; and if not, why not and what supply chain relationships need to be more carefully understood before option contracts can be usefully applied.

This thesis argues that the applicability of option contracts must be investigated through the actual operations, processes and relationships between the players in the supply chain. Further, the structure of the supply chain in terms of the number of players, hierarchy of players, various roles and responsibilities in the chain are likely to impact on the

application of option contracts in the supply chain. The relationships between players especially in terms of ordering, pricing and power balances in the chain are decisive parameters in the application of option contracts. If option contracts are to be applied in actual supply chains this research suggests that their design and development must be compatible with the existing real world chain structure and relationships.

There are two major Australian supermarket firms which dominate the retail food markets and have a substantial role in pricing, cost leadership, contractual agreements and in influencing consumers' demand. The researcher partnered with one of these supermarkets to investigate the applicability of option contracts in supermarket fruit chains. Multi criteria decision making techniques were applied to select the most appropriate fruits as the basis of detailed case studies. The criteria represented the option contract requirements and alternatives were determined from a range of seasonal fruits and vegetables which are sold from the supermarket shelves. The matrix of criteria-alternatives was scored by supermarket head managers, store managers and fresh fruit industry experts and resulted in the identification of four perishable fruit supply chains most suitable for intensive case study analysis. The chains were for peaches, grapes, strawberries and mangoes.

A qualitative research method was adopted to provide in-depth, detailed insights into these supermarket-oriented fruit supply chains focused into supermarket stores in southern and eastern Australia. Semi-structured interviews were designed to address the issues associated with option contracts in the supply chain and interviewees were representatives of the major supply chain players including farmers, suppliers, associations, and supermarkets in southern and eastern Australia.

The results show that although the supermarket fruit supply chains theoretically satisfy the option contracts requirements there are other factors that must be considered if the framework is to reflect the operations of real world, perishable food chains. The often complex relationships between farmers and the supermarket, the emphasis on quality standards, and uncontrolled weather events and supply uncertainty - as distinct from the more usual and well understood demand uncertainty - are fundamental challenges in applying option contracts in the fruit supply chain. Adding these extra factors to the

contract reflects the real dynamics of perishable supply chains and enables the application of a meaningful option contracts framework.

This study of selected though important supermarket-oriented fruit supply chains in southern and eastern Australia has indicated that the current assumptions in the literature regarding application of option contracts in perishable food supply chains are not sufficient. It suggests that there is a gap between what is proposed in the literature and the reality of complex relationships that structure perishable fruit supply chains; and that the supply chain factors highlighted in this study would require practitioners to rethink option contracts in order to benefit from their ability to minimise the impact of demand uncertainty and reducing waste.

Declaration

I, Aida Ghalebeigi, declare that the PhD thesis entitled “Option contracts for supermarket fruit supply chains: theory and practice” is no more than 100,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work.

Signature

Date

To my Dad
Hassan Ghalebeigi

Acknowledgments

I would like to thank my principal supervisor, Professor Ross Robinson, for his ongoing support throughout my candidature. His encouragement and guidance were invaluable.

I would like to thank my second supervisor, Dr Himanshu Shee, who provided guidance especially in early stages of my journey. My deep appreciations go to Professor Sophia Everett for her valuable comments at the final stages of my thesis.

My thanks are also extended to, Dr Hermione Parsons, director of Institute for Supply Chain and Logistics. Her support and confidence in me was always encouraging.

My sincere thanks go to my dear mentor, Associate Professor Jim Sillitoe. He was always supportive and encouraging throughout my candidature journey especially during the tough times.

I would like to acknowledge the cooperation of research participants, fantastic growers, marketers, and industry experts who honestly share their experiences during the interviews.

I would like to thank my peers at university, Ms. Serli Wijiya, Ms. Joanne Tan, Ms. Hayyah Rahman, Ms. Li Ha, and Mr. Jonathan Robertson. Our discussions and knowledge sharing during lunch times were so productive and encouraging.

I would like to thank my dad, although he is not with us anymore, for his ongoing supports even when he disagreed with my decisions, my mum for her unconditional and infinite love even from thousand kilometres far, my brother who I owe this achievement to him for his sacrifices to support his little sister.

At last, but definitely not the least, I would like to thank Ehsan, my husband, for his ongoing love, encouragement and patience throughout my journey, for his fantastic mentorship, acknowledgement of my small achievements, and in short, without him this could not be possible.

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List of Abbreviations

ACT	Australian Capital Territory
DC	Distribution Centre
FFV	Fresh Fruit and Vegetables
MADM	Multi Attribute Decision Making
MCDM	Multi Criteria Decision Making
MODM	Multi Objective Decision Making
NSW	New South Wales
NT	Northern Territory
Qld	Queensland
SA	South Australia
Vic	Victoria
WA	Western Australia

Chapter One

Introduction

1.1 Background to the research

One third of all food, equal to 1.3 billion tonnes, is wasted annually in the world. All countries, including developed and developing countries, are responsible for the huge amount of waste. Lundqvist, de Fraiture and Molden (2008) show that as much as half of the food harvested for human consumption is wasted in the supply chain even before it reaches the consumers. Widodo et al. (2006) report that between 20% to 60% of harvested food is wasted in any country. Kader (2005) claims that one third of fruit and vegetables are wasted worldwide annually. Food waste in Australia is estimated to be 3.3 million tonnes annually, worth about AUD \$5.3 billion. Significant food wastage occurs during production and processing, i.e before food reaches consumers (Heffernan 2010).

Food products decay over time due to perishability. Perishability increases the uncertainty in the supply chain and players must respond to the produce changes quickly. Failure to market the produce results in waste.

Food is wasted in low income countries due to financial, managerial and technical limitations in harvesting, storage and cooling facilities. In contrast, waste in high income countries such as Australia, is due to uncertainty involved in the decision making and lack of coordination

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between different players in the supply chain. Sale agreements between farmers and retailers could end up with crop waste specially at the farm gates or retail stores (Gustavsson et al. 2011). “Walk-bys” is an example of waste due to lack of coordination in the supply chain. Walk-bys happens when the grower does not harvest the crop because the cost of harvesting and transportation is higher than the revenue of selling the produce. This is often an issue in Australia’s Northern Territory (Morgan 2009). Figure 1-1 illustrates an example of walk-bys experienced by pear growers in Mildura, Victoria in 2013. The pears were left on trees and wasted. The photo is taken by the researcher during a field observation. The pears on trees are over-ripe and never reach the market.



Figure 1-1 An example of walk-bys experienced by pear growers in Mildura, Victoria in 2013

Lack of coordination results in poor performance of the supply chain; and inaccurate forecasts, excessive inventory costs, food wastage, quality costs and dissatisfaction among customers are counted as the result of poor performance (Arshinder, Kanda & Deshmukh 2011; Ramdas & Spekman 2000).

Uncertainty in the supply chain is an unavoidable issue that impacts on the coordination in decentralised supply chain. Strategies such as coordination mechanisms, information sharing and risk sharing have been introduced to improve supply chain performance (Lee, So & Tang 2000; Li, X & Wang 2007; Moinszadeh 2002). These strategies aim at reducing

the impact of uncertainty in the supply chain.

A coordination mechanism is defined as “an operational plan to coordinate the operations of individual supply chain members and improve system profit”(Li, X & Wang 2007). The action plan could be an incentive scheme to consider how each member benefits from coordination. This incentive scheme may be a kind of contract, which is mostly offered by suppliers.

Flexible contracts enable the supply chain, and specifically the retailer, to deal with demand fluctuations by increasing or decreasing order quantity during the sale season. Flexible contracts are like incentive schemes, offered by one member of the supply chain, with consideration of profit for each member of the chain (Li, X & Wang 2007).

Coordination mechanisms, and particularly flexible contracts, have been used in industries such as computer and hardware, video rental (Cachon & Lariviere 2005), automobile (Taylor 2002), fashion (Donohue 2000), publishing (Katok & Wu 2009) and perishable supply chains (Wang, Y & Zhang 2011).

Among flexible contracts, option contracts have been used as a mechanism to minimise the cost related to the supply chain caused by demand uncertainty and to improve the performance of the whole supply chain as well as that of individual members. Option contracts are usually offered by the retailer who is the powerful member of the supply chain. These contracts allow the retailer to purchase up to a given quantity of a product during a specific time at a specific price (Xu 2006).

Consequently, they enable the retailer to reduce the potential cost of overstocking or understocking. However, buying option contracts involves an extra cost to the retailer, which gives the supplier the incentive to accept the contract while undertaking risk (Cheng et al. 2011).

The idea of option contracts comes from financial markets, pioneered by Black and Scholes (1973). Option contracts are used in financial markets as an instrument to hedge the risk of trading in those markets. Following the successful use of options in the financial markets,

the idea of using options in the manufacturing supply chains as a means of risk management emerged.

Cucchiella and Gastaldi (2006) argue that option contracts can manage and cover the risk to the supply chain caused by uncertainty. Apparel, toy and electronic industries are examples of industries in which the use of option contracts have been investigated (Barnes-Schuster et al. 2002; Böckem & Schiller 2008; Wang, Q et al. 2011).

Option contracts can be applied in any supply chain as long as the supply chain satisfies the requirements of demand uncertainty, a short selling season, long lead times and retailer-led supply chains (Wang, Y & Zhang 2011). Perishable food products meet all of these requirements (Ahumada & Villalobos 2009) and food supply chains are often retailer-led chains (Harvey, Mark 2007). In addition, perishable produce account for as much as half of the food waste in the food supply chains.

Option contracts have been proposed to reduce the uncertainty impacts and achieve coordination in the supply chain. It was argued that food waste in the high income countries is due to lack of coordination in the supply chain. As a consequence, applications of option contracts in perishable food supply chains are likely to reduce waste.

However, studies in the use of option contracts in food supply chains are limited to Zhao, L, Li and Liu (2009), Wang, Y and Zhang (2011) and Wang, C and Chen (2013). These studies focus on the model development of the contract based on certain assumptions. The main purpose was to develop a model contract to maximise the profit and minimise the supply chain costs. These assumptions have been customised for the food chains. But there is no empirical evidence of application of option contracts in real food supply chains.

Whilst the issue of food waste is an important issue even in developed countries such as Australia, there has been no attention paid to the applications of option contracts. Investigation of the perishable food chain in real supply chains is essential in order to understand the real characteristics of the chain. Although the option contract has been developed theoretically, when it gets to real world applications it becomes an agreement

between the supply chain players which underlines the need for exploration of real world examples of perishable food supply chains.

The applicability of option contracts must be investigated through the actual operations, processes and relationships between the players in the supply chain. The structure of the supply chain in terms of the number of players, hierarchy of players, various roles and responsibilities in the chain might impact on the application of option contract in the supply chain. The relationships between players especially in terms of ordering, pricing and power balances in the chain are decisive parameters in the application of option contract.

If option contracts are to be applied in actual supply chains, their design and developments must be compatible with the existing chain structure and relationships. In-depth exploration of perishable food supply chains with the aim of applying option contracts is required.

The aim of this research, therefore, is to investigate the applicability of option contracts in perishable food supply chains. The aim and objectives of this research will be articulated in more details in the following section.

1.2 Research aim and objectives

The *research aim* is to investigate the applicability of option contracts in the perishable food supply chain. To achieve this aim, there are three research objectives. These objectives are designed to address the research aim in all stages of the research.

The *research objectives* are:

- To explore the current contractual arrangements and influencing parameters on the relationships between the players in the supply chain;
- To investigate the validity of option contract assumptions in the actual supply chain;
- To recommend modifications and new requirements in applying option contracts in the perishable food supply chains.

The research enhances the literature of option contracts by adding the investigation of the option contract in actual supply chains and particularly in perishable food chains. Further,

required modifications to the existing models can be identified. As the research applies an exploratory and inductive approach to the problem, the actual processes, operations and relationships between the supply chain players will be examined in detail.

1.3 Research scope

This research investigates application of option contracts in perishable food supply chains, and is therefore confined to perishable food products. In addition, since the investigation is in regard to the option contract, the research scope must fit into the option contract requirements.

Option contracts can be applied in a retailer-led supply chain. Supermarket chains have become retailer-led with the supermarket as the powerful member of the chain. Supermarket chains have become the consumers' grocery needs destinations, evident by their grocery market shares. Wal-mart, Tesco, Carrefour, Woolworths and Coles are examples of dominant supermarkets in the USA, England, France and Australia respectively (Burch & Lawrence 2007; Lang & Heasman 2004). In addition, the number of supermarkets, and consequently their market share, is also growing in developing countries in the 21st century. China, Indonesia, India, Malaysia, and the Philippines are examples of these countries. The supermarkets in these countries are managed by either local companies or international supermarkets such as Wal-mart and Carrefour (Ridley 2009).

This study focuses on supermarket chains, particularly on those chains in Australia which sell perishable food products such as fresh fruit and vegetables, meat, and poultry. The next section introduces the research design framework applied in conducting the research.

1.4 Research methodology

This research adopts a framework suggested by Creswell (2014). The framework consists of three elements- the philosophical worldview, research design and method. This research applies a constructivist worldview, since it explores the actual perishable food supply chains in terms of applicability of option contracts which have not been explored so far.

Qualitative research is used to understand and explore the meaning of individuals or groups associated with a social or human problem (Creswell 2013, 2014). As discussed in Chapter 4, a qualitative research approach is appropriate to achieve the aim of this research. This study requires in-depth insight and understanding of the perishable food supply chains in order to apply option contracts within the supply chain.

There are five research designs suggested by Creswell (2013) which can be applied in qualitative research. A case study research design has been selected as the main approach in the research. Case study design enables a deep understanding of supply chain dynamics and the applicability of option contracts within the supply chain. This research answers the question in terms of how and why and fits well into a case study design (Yin 2009).

Furthermore, this research seeks to test the applicability of option contracts, or generate new theories with regard to the application of option contracts in the perishable food supply chains and a multiple-case study approach is considered appropriate.

Perishable food products are classified into groups including fresh fruit and vegetables, meat, poultry, dairy, bread, and frozen and processed food. In this research fresh fruit and vegetables are selected as the perishable food products that fulfil the option contract requirements - this includes long production lead time and seasonality.

To select the multiple cases among fresh fruit and vegetables, the research deals with a decision relative to multi alternatives and multi criteria. A Multi Criteria Decision Making (MCDM) technique has been applied to address all criteria within the assurance of selecting the best possible cases. The MCDM approach and the process of decision making are provided in Chapter 5. Four fruit supply chains - mangoes, peaches, strawberries, and grapes- have been chosen for the MCDM approach as the four case studies in the research.

Face-to-face individual interviews, explained in Chapter 4, is the research method used for data collection. It leads to an exploration of the supply chains inductively, and enables the achievement of the first objective of the research. Grounded theory and elaborative coding in analysis direct the research to achieve the second and third objectives of the research. The details of the approach are provided in Chapter 4.

1.5 Thesis outline

This section presents the structure of the thesis. The thesis includes eight chapters, and each chapter is briefly described below. Figure 1-2 demonstrates the thesis structure.

Chapter One *Introduction-* This chapter introduces the background of the research and notes the research problem. The thesis aim and objectives are presented and a brief description of research design is set out.

Chapter Two *Option contracts in the literature-* The chapter reviews the relevant literature on option contracts. It includes a brief explanation of flexible contracts, a detailed review of literature that has specifically focused on the option contract and examined the background of option contracts, mathematical developments, and option contracts in practice.

Chapter Three *Fresh food supply chains: the Australian context-* This chapter explains the concept of food supply chains; it maps the Australian fresh food supply chain and describes the various channels involved in the distribution of food products to consumers. Supermarket chains in Australia, as the main focus of the thesis, are described at the end of the chapter.

Chapter Four *Research approach-* The research approach adopted by the thesis is outlined in this chapter. It explains the philosophical stances that the research is based on and looks, in detail, at justification and description of research methods, data collection and data analysis.

Chapter Five *Selection of case studies-* The MCDM technique used in the selection of case studies is described in this chapter. The alternatives and criteria involved in decision making are defined and justified. The chapter presents, in detail, four selected case studies in Australia.

Chapter Six *Structure and key relationships in supermarket fruit chains-* The chapter outlines the exploratory findings with regard to supply chain

structure and relationships. The chapter addresses the first research objective, which is the exploration of the current contractual arrangements and influencing parameters of the relationships between the players in the supply chain. Supply chain players, supply chain structure, planning and ordering, negotiations and pricing, cost factors in the supply chain, demand patterns and quality standards are the main topics in this chapter.

Chapter Seven *Option contracts for supermarket fruit supply chains: rethinking theory for real-world applications-* The second and third research objectives are addressed in this chapter. The existing assumptions and requirements of applying option contracts are tested using the real world findings which are provided in Chapter 6. The chapter also provides requirements and recommendations with regard to the application of option contracts in fruit supply chains.

Chapter Eight *Conclusions and limitations-* The chapter summarises the findings. It provides the conclusions to the research objectives, and the final conclusion to the research. Limitation of the research, theoretical and practical benefits of the research and the suggestions for future research are explained.

1.6 Publications

The researcher has had the opportunity to present some of the research results at a number of conferences. The papers were published in peer reviewed conference proceedings.

Ghalebeigi, A., Parsons, H. and Shi,P. (2012) Demand uncertainty in the Australian perishable food supply chain: a research agenda. *10th ANZAM Operations, Supply Chain and Services Management Symposium*, June 2012, Melbourne, Australia.

Ghalebeigi, A., Robinson, R., Shee, H. (2014) Option contracts in the perishable food supply chain: concept and practice. *21st EurOMA Conference*, June 2014, Palermo, Italy.

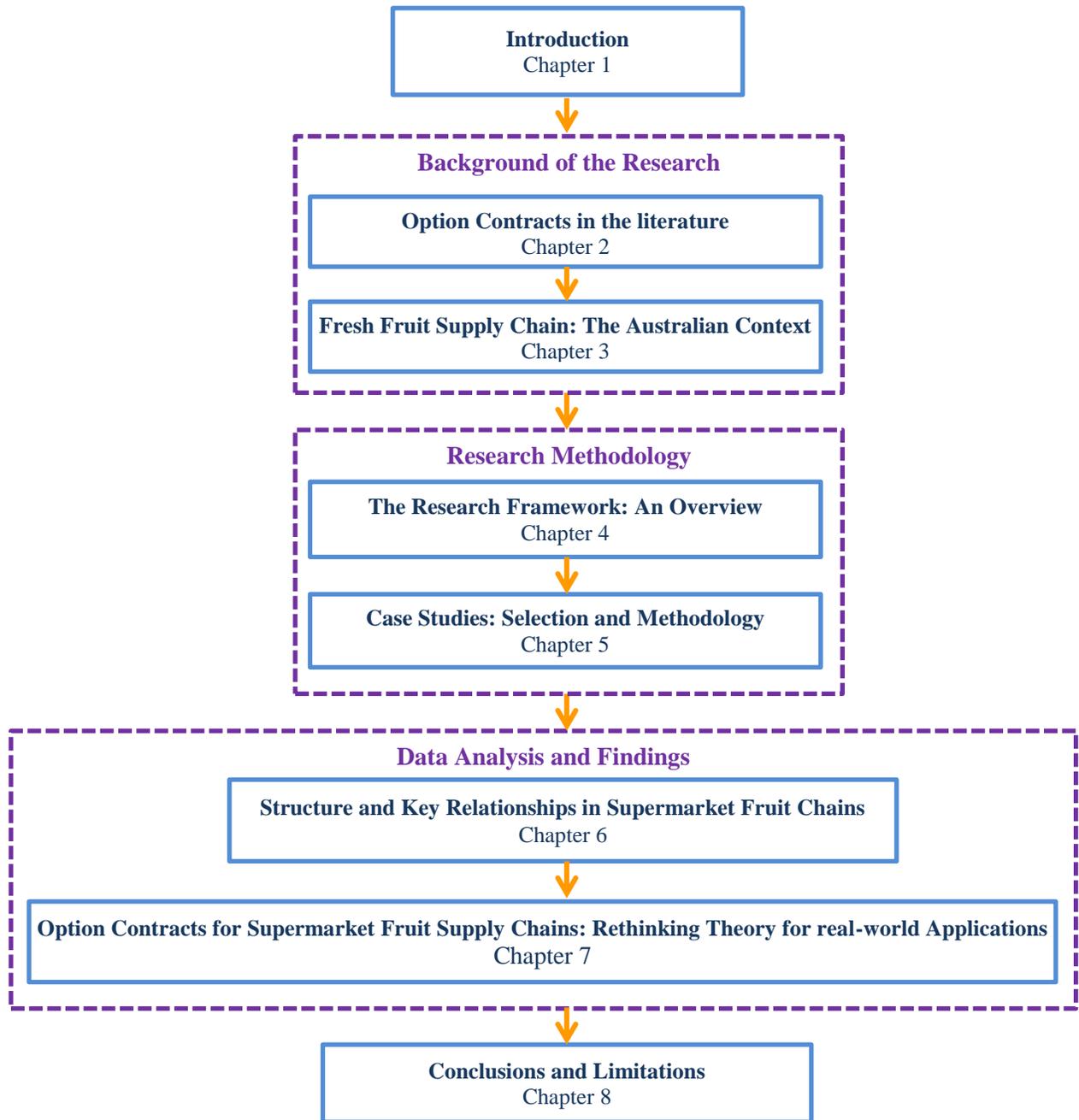


Figure 1-2 Thesis Structure

Chapter Two

Option Contracts in the Literature

2.1 Introduction

The previous chapter explained the problem of food waste within the supply chain even in the developed countries. Lack of coordination between the supply chain players was identified as the main reason for waste. The use of option contracts in the supply chain was suggested as a possible mechanism for enhancing chain coordination and the aim of this research is to investigate the applicability of option contracts in perishable food supply chains.

This chapter reviews the existing literature of option contracts regardless of what supply chains were being studied. First, however, it examines coordination mechanisms and flexible contracts more generally to produce some perspective on the development of option contracts in the supply chain. The chapter then focuses on the option contract in terms of its background, theoretical and mathematical developments, and option contracts in practice.

2.2 *Coordination mechanisms*

Food waste within supply chains in the developed countries such as Australia, as noted earlier, is the result of lack of coordination between different chain players (Gustavsson et al. 2011) and walk bys are example of waste due to lack of coordination. Walk bys, on the farm, is the result of the farmer's decision not to harvest the produce because the farmer believes that the cost of harvesting and transportation is more than the profit of selling the produce. This is often an issue in the Australian Northern Territory (Morgan 2009).

Lack of coordination between players in the supply chain may result in poor performance and related to inaccurate forecasts, excessive inventory and inventory costs, quality costs, and customer dissatisfaction (Arshinder, Kanda & Deshmukh 2008; Ramdas & Spekman 2000). The lack of coordination in the US food industry caused wastage of \$30 billion annually due to the mismatch between demand and supply, increasing the cost of stock out, markdown, sale preparation, obsolescence and disposal (Arshinder et al. 2008).

In a supply chain, there may be conflict between different entities because of the different interests and objectives of supply chain members. One member may dominate other members to achieve his/her own goal. Therefore, while an integrated solution may result in optimal system performance, it may not always be in the best interest of each individual players in the supply chain (Li, X & Wang 2007). Consequently, independent supply chain members prefer to act opportunistically and independently in ways that are often based on their private information to maximise their individual benefits (Cheng, Feng et al. 2006). A key issue in supply chain management is to design and develop mechanisms that can support the objectives of all individuals and optimise the overall supply chain performance (Li, X & Wang 2007).

Coordination in the supply chain can be defined as “the act of managing dependencies between entities and the joint effort of entities working together towards mutually defined goals”(Malone & Crowston 1994). The aim of achieving coordination in the supply chain is to improve performance of the supply chain in the best interest of all participants, from the producer to the consumer.

A coordination mechanism is defined as “an operational plan to coordinate the operations of individual supply chain members and improve system performance”(Li, X & Wang 2007). In the case of a decentralized or disintegrated supply chain, this action plan is an incentive scheme to consider what each member benefits from coordination given the need to meet the customers’ requirement.

Information technology and sharing (Lee et al. 2000; Moinzadeh 2002; Sanders 2008), risk sharing (Lai, Debo & Sycara 2009) and flexible contracts (Cachon & Lariviere 2005; Ding & Chen 2008; Fotopoulos, Hu & Munson 2008) have been considered as coordination mechanisms. Since an option contract is considered as a flexible contract, flexible contracts are discussed in detail in the following section.

2.3 Flexible contracts

Flexible contracts allow the buyer to adjust the order quantity during the sale season. They enable the supply chain, and specifically the retailer, to deal with demand fluctuations by increasing or decreasing their order quantity during the sale season. Flexible contracts are like incentive schemes, offered by one member of the supply chain, with consideration of profit for each member of the chain (Li, X & Wang 2007). In terms of adjustment, these are classified in three categories namely upward adjustment, downward adjustment and bidirectional adjustment (Wang, Q, Tang & Tsao 2006).

Upward adjustment gives the buyer the ability to increase the order quantity to overcome a likely rise in demand. If the buyer is able to decrease the order quantity after realising a huge decreasing demand, the contract is categorised as downward adjustment (Wang, Q & Tsao 2006). Bidirectional adjustment contracts are designed to deal with the demand fluctuation. With such a contract the retailer is allowed to increase/decrease the order quantity after observing an increase/decrease in demand. This enables the retailer to place an initial order but allows flexibility associated with demand uncertainty (Wang, Q & Tsao 2006).

There are different types of flexible contracts which provide coordination in the supply chain. Buyback (return), revenue-sharing, quantity-flexibility and sales-rebate are examples of flexible contracts (Cachon 2003; Cachon & Lariviere 2005; Katok & Wu 2009)

With *buyback* contracts the supplier offers the retailer a rebate on remaining products at the end of the season (Arshinder et al. 2011; Cachon 2003; Pasternack 2008; Zhang, Zhang & Chen 2010). Thus in this contract, the supplier assumes that it can reduce the associated risk of over-ordering by the retailer. By offering the buyback contract, the supplier hopes to reduce the production cost by stimulating the retailer to buy more products (Katok & Wu 2009). The supplier benefits from return policy when the cost of production is low. There is empirical evidence of using buyback contracts in industries such as publishing, computer hardware and software, pharmaceuticals (Katok & Wu 2009) and in the textile and fashion industry (Arshinder et al. 2011).

In the *revenue-sharing* contract, the supplier charges the retailer a lower wholesale price, but in return the supplier is paid a portion of the retailer gross revenue (Cachon 2003; Cachon & Lariviere 2005). Again, in this contract the supplier tries to increase the retailer's order quantity. Cachon and Lariviere (2005) demonstrated that supply chain coordination could be achieved with this contract in a two-echelon supply chain with a price-setting newsvendor. Revenue-sharing contracts are common in the video-rental industry (Cachon & Lariviere 2005).

In the *quantity-flexibility* contract, the supplier repays the retailer for his losses on unsold units. This contract fully protects the retailer on a portion of the retailer's order (Cachon 2003). This contract increases the flexibility in order quantity. Tsay and Lovejoy (1999) examined the quantity-flexibility contract and propose a framework for performance analysis. Quantity-flexibility contracts have been used by the IBM Printer Division (Bassok & Anupindi 2008), Sun Microsystems (Holloway et al. 1996), Solectron and Hewlett Packard (Tsay & Lovejoy 1999).

With a *sales-rebate* contract, the supplier gives the retailer a rebate on the units sold above a specific threshold. This contract is based, therefore, on the retailer sales to end customers (Taylor 2002; Wong, Qi & Leung 2009). Sales- rebate contracts are important in hardware,

software and auto industries. Compaq, Hewlett-Packard (HP), and IBM have offered sales-rebate contracts to their retailers to increase the sale volume. Microsoft, Lotus and Symantec are examples of software industries which have used the sales-rebate contracts in practice. In the auto industry, Chrysler, Ford, Mazda, General Motors and Toyota also offered this contract to their dealers (Taylor 2002).

The above mentioned contracts have been used when the supplier has the authority to influence the retailer's ordering behaviour in the supply chain. It is because of the exertion of power on the favour of the supplier. The supplier attempts to reduce the influences of demand uncertainty by offering various schemes of contracts to the retailers. These contracts stimulate the retailer to buy more products in return for an incentive offer.

However, in a highly competitive business world, the power has shifted from supplier to the retailer at the downstream end of the supply chain, which is the closest to the customer (Wang, X & Liu 2008). In addition, the nature of customer demand has changed. Manufacturers realised that they needed to consider customers' requirements to stay in the market. Since the retailers are at the end of downstream supply chain, they can understand the interests and requirements of customers. In addition, they have the ability to predict the amount of demand (Kebing, Chengxiu & Yan 2007; Wang, X & Liu 2008). In this new structure, the retailers play an important role in the supply chain. The power in the supply chain has been taken by them, because they are closer to the end customers. Retailers have the authority to determine the order quantity, which can be lower or higher than the optimal order quantity of suppliers.

Thus, there are three main characteristics for a retailer-led supply chain. First, the retailer has the power of determining the price that allows the retailer to act as a contract designer. Second, the retailer has an information edge and is the powerful downstream part of the supply chain and has access to information regarding demand which the supplier may not have. Third, production quantity is the decision variable that coordinates the retailer-led supply chain instead of order quantity (Wang, X & Liu 2007).

A new type of contract has been developed to deal with the fact of power shifting from supplier to the retailer. In the new structure, a contract must be offered by the retailer to the

supplier in order to coordinate the supply chain. Option contracts have been introduced in the supply chain as a contract offered by the retailer to the supplier in order to deal with high uncertainty in the chain. The purpose of the contract is to increase the order flexibility of the retailer by offering incentives to the supplier. Option contracts are discussed in detail in the following section.

2.4 Option contracts

2.4.1 Background of the option contract

The consumers' perceptions and expectations with regard to the quality, price, and demand in newly designed products are changing rapidly (Gurnani & Tang 1999). This results in shortened product life-cycles, increased time-sensitive product demand and outsourcing in the supply chain. In addition, consumers' unpredictable behaviour results in demand uncertainty, and consequently increases the difficulties in the ordering and purchasing decisions. Supply chains deal with long production lead times. For instance, the lead time between a retailer's ordering and delivery by the supplier in the apparel industry is 12 months on average (Fisher & Raman 1996). The production lead time in the toy industry could be as long as 18 months (Biyalogorsky & Koenigsberg 2004). The long production lead time brings more uncertainty to the supply chain because the demand at the beginning of production is not as accurate at the start of the selling season. Matching the demand and supply is a key challenge in every supply chain and specifically supply chains with long lead times (Liu, Z et al. 2014).

The option contract is designed to improve the demand and supply mismatch, and also to reduce the impacts of demand uncertainty on the retailer at the down-stream end of the chain by sharing part of the risk with the supplier. The supplier receives a premium as an incentive to accept the contract while undertaking some of the supply chain risk. The premium is non-refundable (Gomez_Padilla & Mishina 2009; Wang, X & Liu 2007). The premium is known as the option price, and the price which the retailer pays to the supplier to exercise the contract is known as the exercise price (Zhao, Y et al. 2010).

The idea of option contracts comes from financial markets, pioneered by Black and Scholes (1973). Option contracts are used in financial markets as a financial instrument to hedge the risk of trading in those markets. Following the successful use of options in the financial markets, the idea of using options in manufacturing supply chains as a means of risk management emerged.

Financial options are based on assumptions such as no-arbitrage and complete markets, both of which support computing the option price (Hull 2002). However, these assumptions and ideas cannot be applied to the optimising of flexible supply contracts, because they are often accepted after a negotiation process between two parties (Cheng, Feng et al. 2011). Furthermore, financial options are traded among different parties freely, but option contracts in the supply chain are agreements between two parties and there is no market to trade them (Hou & Qiu 2007). In financial markets, finding the optimum value of the option contracts is a critical problem this is because of trading the option contract in the market. However, in the supply chain context the value of option contracts is not the major consideration. There are other variables involved in the problem which will be discussed later.

In general, an option contract means a contract between two entities for a future transaction on an asset (Liu, Z et al. 2014). Options, specifically in share markets, give the owner the right of buying/selling shares at a specific price at a specific time in the future. When the owner of the contract has the right of buying shares, the option is named “Call Option”, and in the selling situation it is called “Put Option” (Hull 2002).

2.4.2 Option contracts in theory and mathematical modelling

An option contract gives the right to the retailer to purchase one more unit of product at a specific time at a fixed price. The level of flexibility provided by an option contract depends on the number of option contracts that the retailer has offered to the supplier. This design of an option contract in the supply chain is the same as that for the financial markets where the buyers usually buy 100 option contracts in one transaction. However, recently the design of the option contract has been customised for the supply chain context. In the

new context an option contract in the supply chain context allows the retailer to purchase up to a given quantity of a product during a specific time at a specific price (Barnes-Schuster et al. 2002; Cheng, Feng et al. 2011; Xu 2006). The supplier is committed to produce up to the level to be able to satisfy all orders when all option contracts are exercised (Wang, Q et al. 2012).

Since the option contract is the result of a negotiating process between supplier and retailer, the negotiating processes between them as seller and buyer have been modelled by way of option contracts. The supplier and retailer negotiate on prices, quantities and incentives. The outcomes of the negotiation depend on the negotiation power of the members and their level of risk acceptance. The Stackelberg game theory approach has been applied in order to model the negotiation process, assuming the supplier (seller) is the leader (Cheng, Feng et al. 2011; Spinler, Huchzermeier & kleindorfer 2002; Wang, C & Chen 2013; Zhao, Y et al. 2010).

The number of players in the supply chain changes the optimised value of option contracts. Two level supply chains with one retailer and one supplier was the focus of early research on option contracts. (Barnes-Schuster et al. 2002; Cheng, Feng et al. 2006; Cheng, Feng et al. 2011; Hou & Qiu 2007; Li, T et al. ; Liu, Z et al. ; Wang, C & Chen 2013; Wang, Q & Tsao 2006; Wang, X & Liu 2008; Xu 2006). Two level supply chains with two players have been extended to include more than two players. One manufacture and two retailers (Wang, Y & Zhang 2011), n suppliers and one aggregate retailer (Wu & Kleindorfer 2005) have been investigated in the literature.

More recently three level supply chains have been studied to investigate a closer scenario to real supply chains (Hou, Li & Qiu 2009). A three level supply chain with a manufacturer, a distributor and a retailer has been investigated by Liu, J, Li and Changqing (2011). In their model, option contracts are signed between manufacturer and distributor, and distributor and retailer. They concluded that the application of option contracts led to increased overall supply chain profit.

Optimisation of variables in the option contract is required to achieve channel coordination. This has been the main aim of studies. However, it has been examined from various

perspectives and each study seeks either for the optimisation of a new variable or a new assumption with an old variable.

In most studies, demand has been seen as an independent variable. Due to uncertainty involved in the demand decisions, it is mostly assumed that demand is a random variable with a fixed distribution function (Cheng, Feng et al. 2011; Donohue 2000; Wang, Q & Tsao 2006; Wang, Y & Zhang 2011; Xu 2006; Zhao, Y et al. 2010). However, uniformly distributed demand (Wang, Q et al. 2012), downward sloping demand curves (Burnetas & Ritchken 2005), price dependent stochastic demand (Hou & Qiu 2007), and demand information updates (Wang, X & Liu 2008) have been considered as more specific types of stochastic demand.

Burnetas and Ritchken (2005) examined the role of option contracts when the demand curve is downward-sloping. They derived required conditions in which the manufacturer prefers to use options. Wang and Liu (2008) added the assumption that the market information can be updated. The proposed option contract contained two option prices and one exercise price. The authors found that this type of contract coordinates the supply chain and increases the channel profit. They also claimed that with option contracts each party is in a win-win situation and the extra system profit is shared between them. The results showed that option prices and market information influence the retailer's ordering behaviour.

Wholesale price¹ is another independent variable in the option studies. It is defined as the price between the supplier and the retailer in the absence of the option contract. This price is assumed a fixed price before and after the option is introduced (Barnes-Schuster et al. 2002; Cheng, Feng et al. 2003) or exogenously determined and fixed (Erkoc & Wu 2005; Li, J & Liu 2008; Wang, Q et al. 2012; Wang, Q & Tsao 2006; Wang, X & Liu 2007). Wholesale price has not been considered as a dependent variable which needs to be optimised.

¹ It is critical to distinguish between wholesale price and retail price. Wholesale price is the purchasing price between the supplier and the retailer; however the retail price is paid by the consumers to the retailer.

The decision variables or dependent variables are either price or quantity variables, based on how the problem is defined. The variables shift from price to quantity if the problem perspective shifts from the supplier to the retailer. Price variables are option price and exercise price. Quantity variables relate to how much option contract to buy, how much to exercise, and how many normal orders to buy.

Option price and exercise price are the supplier's decision variables. The supplier usually makes a decision about these two variables according to the quantities received from the retailer. The supplier's perspective is the main concern in the studies with price variables. Option price and exercise price have been optimised in order to achieve channel coordination. In regard to coordination mechanism, two conditions for satisfactory coordination have been proposed. One is that exercise price and option price should be negatively correlated; the second is that the optimal production quantity must be lower than the optimal one in a centralized system (Wang, X & Liu 2007).

Initial order quantity (Q) and number of option contracts (q) are the key decision variables from the retailer's (buyer) perspective. As an example Wang et al. (2006) investigate the optimal decisions from the retailer's perspective in a single-supplier single-retailer supply chain, where the supplier has no flexible production mode due to long lead-time. To reach that aim propositions and closed-form formula are developed, and the initial order quantity (Q) and option quantity (q) are optimised. The buyer's optimal policy that includes exercising the options in hand, initial ordering and purchasing options are optimised where there is a capacity constraint for the supplier (Xu 2006).

Option contracts from both supplier's and retailer's perspectives have also been explored in the literature. Determination of option price, exercise price, order quantity and option quantity are the aims of these articles which attempt to model the negotiation process using a game theory approach. The supplier is considered as the leader and optimises the firm's profit when deciding on the option price and the exercise price. The manufacturer is the follower and has to optimise the order quantity and option quantity after accepting the supplier's proposed prices (Cheng, Feng et al. 2011; Wang, C & Chen 2013). The shifts in

position of retailer and supplier as follower and leader was investigated by Wang, X and Liu (2008).

According to the supply chain literature, there are two types of modelling for an option contract. In the first, researchers assume that the production mode of the manufacturer has two periods, possibly with unequal lengths and correlated demand. Therefore, the option contract gives the buyer (retailer) the ability to order additional units of the product before the start of period two after observing demand in period one. It is assumed that the first period is cheaper than the second one, so that the manufacturer prefers to use the first period to produce a higher quantity. The option contract has been also referred to as a two-production mode contract based on this definition in its early stages (Barnes-Schuster et al. 2002; Donohue 2000; Gurnani & Tang 1999). This option definition is followed by other authors such as Wang and Liu (2007), Wang and Liu (2008) and Zhao et al. (2010).

Figure 2-1 gives a view of how option works in a two-production mode. The ordering scenario is as follows:

- The retailer orders Q item at the beginning of the Period 1 at a unit *wholesale price*;
- Also, the retailer can purchase q options at a unit *option price* (P_o) to achieve flexibility;
- The supplier commits to produce up to the level at which all the options are exercised;
- The retailer can collect more demand information during Period 1 for the selling season;
- Any unsatisfied customer demand will be backordered and satisfied in Period 2;
- At the Period 2 the retailer can finally decide the exact orders, and decide how many options to exercise at a unit *exercise price* (P_e);
- The supplier delivers the final order to the retailer;
- The retailer can salvage the remaining quantities at a unit *salvage value* less than the price, if the actual demand is smaller than the purchased quantity.

According to the above scenario, the decision variables for the retailer are Q and q . When the problem is considered from the retailer's perspective, it is assumed that the price variables are known and given by the supplier. However, the quantity variables are

assumed to be known when the option contract is investigated from the supplier's point of view. The decision variables are P_o and P_e .

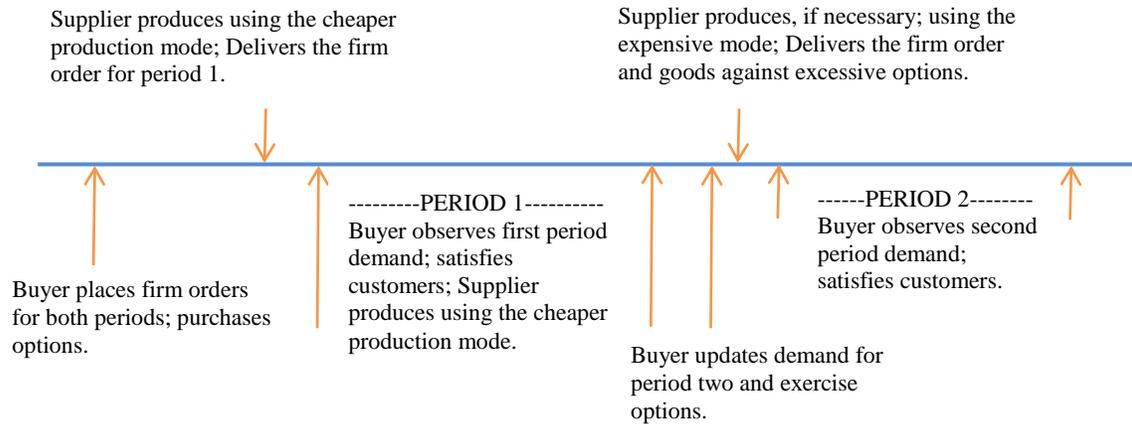


Figure 2-1 Retailer supplier decision sequence in a two-production mode, Source: Barnes-Schuster, Bassok and Anupindi (2002)

Capacity reservation also refers to the same definition of an option contract with the exception that it assumes that the retailer reserves the manufacturer's capacity by paying a reservation fee to him. High-tech manufacturing and electricity markets use the capacity reservation term (Erkoc & Wu 2005; Li, J & Liu 2008; Wu & Kleindorfer 2005; Wu, Kleindorfer & Zhang 2002).

Option contracts in two-production mode models have been defined in other directions. For example, a contract has been designed in a scenario in which a buyer commits to order for the First and Second Period. After observing the demand, the retailer decides the exact order quantity and pays penalties for the unpurchased but committed orders (Eppen & Iyer 1997).

The second type of models abandons the assumption that the supplier has a two-production mode. The supplier uses normal production mode, and there is no difference in cost of production. This approach has been followed by numerous authors including Wang and Tsao (2006), Wang et al. (2006), Wang et al. (2011), Cheng et al. (2006), Cheng, Feng et al. (2011), Hou and Qiu (2007) and Burnetas and Ritchken (2005).

The ordering scenario is similar to the first one but there is no second period available. The sequence of the model is as follows:

- **At the beginning of the time horizon:**
 - The supplier offers the price elements: wholesale price, option price and exercise price
 - The retailer places an initial order Q and purchases q option contracts;
- **During the suppliers lead time:**
 - The supplier produces $Q+q$ products;
 - The retailer updates the demand information;
- **At the selling season:**
 - The retailer exercises q_e options;
 - The supplier delivers $Q+q_e$ products to the retailer;
- **At the end of the season:**
 - Any leftover products may salvage at the *salvage value* less than the product value.

A schematic model of the above scenario is shown in Figure 2-2.

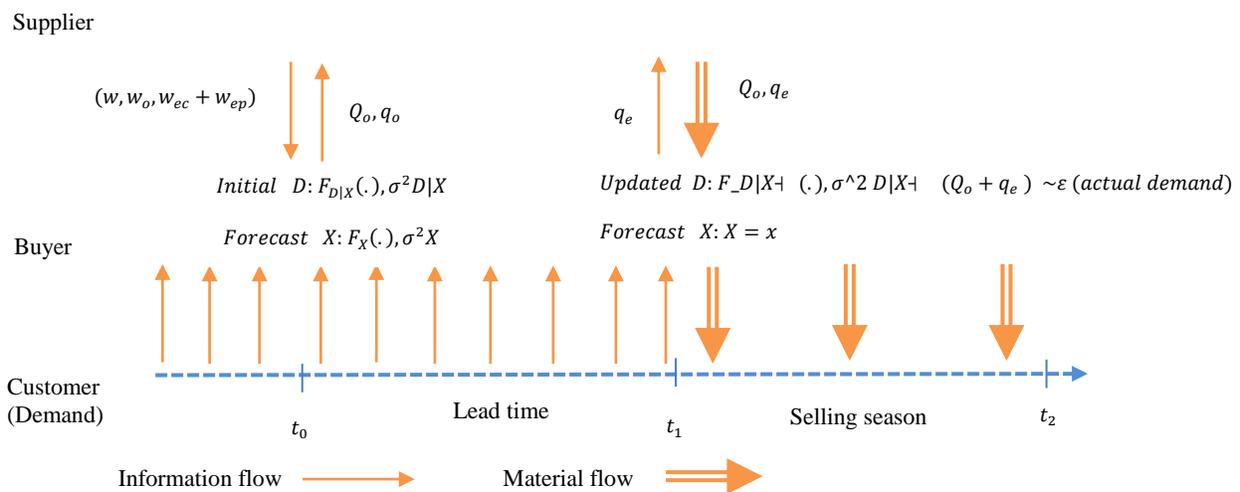


Figure 2-2 Retailer supplier decision sequence in a normal production mode, Source: Wang, Q and Tsao (2006)

The option contract has the potential to be exercised as both call options (upward adjustment) and put options (downward adjustment). This type of contract is referred to as “Bidirectional options”, and gives the right to the buyer of the contract to exercise the contract as either call or put depending on the updated demand. The bidirectional options

provide more flexibility to the retailer while he has to pay a higher premium to satisfy the supplier (Wang, Q & Tsao 2006; Zhang et al. 2010).

The retailer decides how to exercise the bidirectional options at the start of the selling season. If observed demand is higher than the initial order then the retailer exercises the call options at exercise price of the call option. In contrast, if the observed demand is lower than the initial order the retailer may exercise the bidirectional options as put options and returns the quantities. In exercising put options, the retailer is allowed to receive corresponding full or partial refund for returned items.

Modelling of bidirectional options requires determination of two exercise prices, one for call options and one for put options. Also, it needs to optimise three order quantities which are the initial order, the call option quantity and the put option quantity. The buyer's perspective in bidirectional options has been investigated and the buyer's profit function in a single-period, two-stage supply chain has been optimised. A lower bound for the option value in which the buyer's profit increases by using an option contract has been explored by Wang, Q and Tsao (2006). Cheng et al. (2011) also consider both call and put options in their study. The paper focused on presenting the optimal order policy of manufacturer and the optimal pricing decision of the supplier simultaneously. They showed that part of the risk of demand uncertainty is shifted from the retailer to the supplier. The main conclusion of their study was that they derived parity² between call and put options.

The assumption of trading options between several retailers in the supply chains is introduced by Wang, Y and Zhang (2011). This type of contract is called an independent option contract. A scenario of one supplier and two retailers are investigated while option contracts can be traded between retailers. Their result showed that option contracts increase the retailer's profit.

The competition between suppliers who offer option contracts to a buyer has been examined by Martinez-de-Albeniz et al. (2007) where a capacity reservation fee and an

² Call-Put parity is a known equation in the financial market, which provides the value of put option by having call option and vice versa. The parity in supply contracts has not been investigated since Cheng, Feng et al. (2011) study.

execution fee are the key decision variables. The supplier's pricing strategies when they are competing through price and flexibility are explored.

The basic aim of most of the authors in the literature has been to find the optimal parameters of option contracts while maximising (minimising) the retailer's and supplier's profit (cost) to achieve channel coordination. The cost elements included in the retailer's profit function are:

- Revenue of selling $Q+q_e$ products at retail price
- Purchasing cost of initial order at wholesale price
- Purchasing cost of q option contracts at option price
- Exercising cost of options at exercise price
- Holding cost of inventory
- Cost of lost sale
- Positive salvage value

One sample of elements in designing the retailer's profit function is set out below.

Profit = Revenue – buying cost – exercising the option – shortage cost – holding cost + salvage value

$$\Pi_{r1}(Q_0, q_0, q_e | x) = r \min(Q_0 + q_e, D) - q_e w_e + E[v_b(Q_0 + q_e - D)^+ - p(D - Q_0 - q_e)^+ | x],$$

where

$$w_e = \begin{cases} w_{ec} & \text{if } q_e \geq 0, \\ w_{ep} & \text{if } q_e < 0, \end{cases}$$

and

$$(Z)^+ = \max\{0, Z\}.$$

Since the demand is stochastic and the cost elements are dependent on the demand, the profit function is a probability function of demand. Stochastic dynamic programming, game theory and mathematical solutions (derivative) have been used in the literature to find the optimal policy (Wang, Q et al. 2012; Wang, X & Liu 2008; Wu & Kleindorfer 2005; Xu 2006; Xu & Nozick 2009; Zhao, Y et al. 2010).

This section provided the theoretical background and development of option contracts in the literature. The following section explores the option contract applications in practice.

2.4.3 *Option contracts in practice*

Option contracts have been examined in supply chains of apparel, sporting goods, toys and electronics. All these products are categorised as innovative products which have long production lead times and a short selling season. These characteristics lead to high demand uncertainty which cause coordination mismatch and adds extra costs into the supply chain. The investigation of option contracts in supply chain relations are based on three assumptions. First, the production needs a long production lead time which makes in-season replenishments impossible. Second, the selling season is very short and the retailers have to respond to the demand in a short season. This means that the product life cycle is also short. At the end of the selling season there is no chance of keeping the product to resell later. However, the products might salvage at a lower value. The third assumption is the existence of high demand uncertainty in the supply chain which is the result of the first two assumptions (Barnes-Schuster et al. 2002; Burnetas & Ritchken 2005; Wang, Q et al. 2012; Wang, Q & Tsao 2006; Wang, X & Liu 2007, 2008).

In addition to the above three assumptions, a further assumption of being a retailer-led³ supply chain has been added. The notion of shifting power from the supplier to the retailer underlines the need for a contract to coordinate the retailer-led supply chain. It has been shown that option contracts coordinate a retailer-led supply chain (Dayi, Fahong & Yinghua 2009; Wang, Q et al. 2012; Wang, X & Liu 2007, 2008).

Option contracts have been studied as tools of supply chain risk management. Shi et.al (2004) derived optimal replenishment policy for both the supplier and the retailer in order to manage the supply chain risk. It has been proven that option contracts can manage and cover the risk of supply chain caused by uncertainty (Cucchiella & Gastaldi 2006). The risk of option contracts for buyers have been studied by Wang et al. (2011). Zhao et al. (2010)

³ Wang, X and Liu (2007) explain three main characteristics for a retailer-led supply chain. First, the retailer has the power of determining the price that allows the retailer to act as a contract designer. Second, the retailer has an information edge. It happens because the retailer is the powerful downstream part of supply chain. The retailer has information on demand which the supplier does not know clearly. Last, production quantity is the decision variable that coordinates the retailer-led supply chain instead of order quantity.

have also added negotiation power and risk preference of each party to the former model and investigated how option contracts can coordinate the supply chain.

Option contracts have also been examined in the markets for non-storable goods or dated products with high price volatility such as electricity or transportation services. The pricing and valuation of option contracts were investigated by applying game theory approaches (Spinler & Huchzermeier 2006; Spinler et al. 2002; Wu & Kleindorfer 2005). In the electricity markets, option contracts were examined in the presence of a spot market. The supplier (seller) has the chance to trade in the spot market as well as signing a contract with the retailer. The two-period framework was applied to model the decisions. At the First Period they sign the option contract, and then in Period 2 they decide how much to deliver/exercise from the contract and how much to buy/sell on the spot market. This assumed the price on the spot market is known on the day that option contracts have to be exercised (Wu & Kleindorfer 2005). Option contracts in the electricity market have been explored within an auction situation. An auction scheme to set the optimal number of options to purchase has been designed and the problem of determining the number of options purchased from each supplier as a linear program is formulated (Schummer & Vohra 2003).

Recently, option contracts have been introduced into the food supply chains with perishable characteristics. It is argued that food supply chains satisfy the three assumptions of long lead time, short selling season and high demand uncertainty (Ahumada & Villalobos 2009). Besides, food supply chains are characterised as retailer-led supply chains with the supermarkets as the most powerful member of the chain (Burch, Dixon & Lawrence 2013; Burch & Lawrence 2007).

The fact of price reduction in perishable food produce has been added to the option contracts modelling (Zhao, L et al. 2009). Bidirectional options have been studied in a perishable food supply chain with fluctuating prices. It is assumed that the market demand is price correlated. It is shown that bidirectional options are useful to reduce the risk of uncertainty in the food supply chain and increase the profit of the whole supply chain for short life time products.

The fresh food produce are lost in quantities during the time. This fact as circulation lost has been investigated in modelling option contracts in fresh food produce by Wang, C and Chen (2013). Stackelberg model has been applied to determine the optimal option order by retailer and optimal option price by supplier. Their result indicate that in order to coordinate the supply chain the retailer cannot order only options, but that combinations of products and options are needed.

2.5 Option contracts in fresh food supply chain

As reviewed in the Section 2.4, option contracts have been studied in many aspects and from various perspectives through their applications in a supply chain context. The majority of the studies noted the theoretical background of the problem. They developed new models and modelling techniques to find out the optimal ordering policy or pricing strategies. The problem solving techniques have been developed in order to find the best global optimum.

Although the mathematical models were validated using numerical examples, none of these studies consider the actual, real world characteristics of supply chains. The behaviour of supply chain players may be less rational than that assumed in mathematical models and the predicted optimum will alter from the real world outcome. The relationships between the supplier and the retailer play an important role in the contractual agreements.

The real dynamics of supply chains have not been modelled as much as is required to understand the real world chains. Valuable evidence of using option contract in practice is provided by Böckem and Schiller (2008). A product-supply contract between the producer of electronic devices, Samsung, and the semiconductor manufacturer Fairchild is presented. This, arguably, is the only valuable case study in option contracts that describes the real terms in an option contract in detail. The contract quote from Böckem and Schiller (2008) notes-

“In their agreement (April 13, 1999), Samsung and its affiliates commit to use Fairchild as a preferred supplier of products (section 2.2 of the contract) for at least 3 years (section 2.3). Each year, Samsung must buy at least 701,941,000 “units.” The mixture of products

must be consistent with past practices (section 2.3). As the different goods are complementary inputs, this clause comes close to describing a default quantity in a single-goods setting. The contract then describes the rules of the renegotiation game as follows.

- *Price renegotiation stage:* Fairchild's take-it-or-leave-it offer (Contract section 6.1). No later than 10 business days prior to the end of a quarterly period, Fairchild may provide to Samsung an "Adjustment Statement" setting forth with respect to each product the average increase or decrease in the product's market price and a new purchase price. As promptly as practicable, Samsung must provide Fairchild with a statement of acceptance or dispute. The new purchase price becomes binding at 12:01 a.m. Seoul Korea time on the first day of each quarterly period.
- *Samsung orders the quantity (Contract section 5.1):* 10 days prior to the end of each month, Samsung must provide a three month rolling forecast for product orders to Fairchild. Whereas the forecast for the next month is binding, the forecasts for the second and third month may be changed by $\pm 10\%$ and $\pm 15\%$, respectively.
- *Verification stage (Contract section 6.2):* No later than 30 days following each quarterly period, Fairchild must send to Samsung documentations about the quantity of each product, the purchase price paid by Samsung and several other important details. Samsung must inspect, verify and dispute the accuracy of this statement as promptly as practicable, but no later than 15 business days after receipt."

Option contracts have been suggested for applications to fresh food supply chains. In addition, some of the characteristic of food products such as price reduction and circulation loss were added to the models. These studies only consider the mathematical aspects and requirements of modelling without focusing on the relationships between supplier and retailer. In addition, not all of the food supply chain characteristics were investigated in the modelling of option contracts.

There remain important and unanswered questions - Can option contracts be applied in practice in the food supply chain? Can option contracts coordinate the supply chain? Are the option contract requirements credible in the food supply chains? Are there any benefits of applying option contracts in the food supply chain?

Food supply chains despite their common characteristics need to be differentiated in terms of perishable product; because the supply chain players, activities and concepts vary from

product to product. Product type is a crucial item because it considers the shelf life of the product; and various shelf lives impact on the supply chain structure and strategies. In addition, the location of supply chains may differentiate the food supply chain activities and relationships. Fresh food supply chains are both product and location oriented. Therefore, to investigate applicability of option contracts in the food supply chains it is essential to conduct a case based research with detailed exploration of the supply chain activities, contractual agreements and supplier-retailer relationship.

This research fills the gap in empirical studies of the application of option contracts in food supply chains by conducting in-depth case study research in the context of Australian fresh food chains. Details of the research design and the selected case studies are provided in Chapters 4 and 5 respectively.

As noted, option contracts are proposed to be beneficial in a retailer-led supply chain. It is essential, therefore, to understand the notion of supplier-retailer relationships in the supply chain and the power balance in the relationships. In this context the work of Andrew Cox and his associates is of exceptional importance and the next section sets out briefly the key concepts related to supplier-retailer relationship as developed by Cox et al. (2004). It provides a background for a more detailed discussion of the issue of whether or not the perishable supermarket food chains are in fact retailer-led in Chapter 7 of the thesis.

2.6 The Cox buyer/supplier framework: a conceptual note

A supply chain is most commonly defined as the series of physical activities that transform the raw materials to finished product or service and deliver to the end-customer (Cox 1997). This definition of a supply chain focuses on the physical creation of goods and services and how they flow between firms. The main concern tends to be how the product flow can be managed to achieve operational efficiency. But, importantly, Cox notes the importance of the supply chain as “a series of *exchange relationships* between buyers and suppliers”. This perspective underlines the significance of the flow of value throughout the chain - in fact, a *value chain*.

The value chain is then defined as a series of *financial relationships* which commences with the end-customer purchasing the product or service. These financial relationships ultimately mean that each of the participants in the chain of supply will capture a share of revenues flowing from the end-customer. In other words, the exchange of money is mirrored by the exchange of goods and services. This exchange relationship is shown in Figure 2-3.

The important insight from this conceptualisation of the supply chain is that individual firms in the chain will enjoy different levels of ‘power’ in the chain and have the ability to exert control over the actions of other firms.

For Cox power is, as Maloni (2000) points out, ‘the ability of one firm to influence the intentions and actions of another firm’ and imbalanced power in the supply chain is likely to cause loss of relationship control and may lead to opportunism by the firms.

Cox et al. (2004) define the power in the dyadic exchange relationship between buyers and suppliers in the chain and suggests that each chain comprises a set of dyads. Each firm attempts to maximise its returns from the relationship according to the power circumstances that currently exist or could be created in the future. This power relationship between the buyer and seller is conceptualised in a simple matrix defined in Figure 2-4.

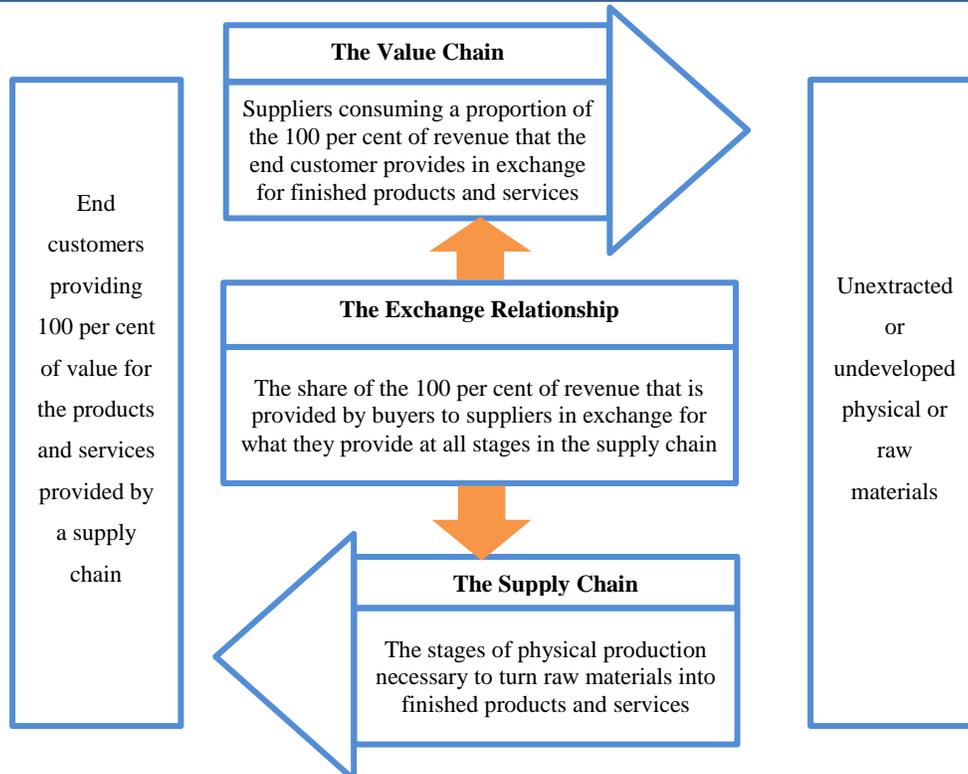


Figure 2-3 Supply chains and value chains, Source: Cox et al (2003) page 5

In terms of utility and scarcity as the two major variables in explaining the relative power of buyers and suppliers, the degree of power allocated to the buyers and suppliers can be described in terms of four options- buyer dominance, supplier dominance, buyer and supplier interdependence, or buyer and supplier independence.

Relative utility and scarcity of buyer's resources for supplier	High	Buyer Dominance (>)	Interdependence (=)
	Low	Independence (0)	Supplier Dominance (<)
		Low	High
		Relative utility and scarcity of supplier's resources for buyer	

Figure 2-4 Cox's power matrix, Source: Cox et al. (2004) page 40

From the buyer's perspective the utility of a supplier depends on the 'use value' or functionality of the supply provided. Scarcity refers to the number of suppliers available. A high level of scarcity in the power matrix indicates that there are few suppliers who are able to provide supply. The level of power the buyer can leverage toward the suppliers is

therefore less, compared to when there are many suppliers available in the market. From the supplier's perspective the utility of a buyer refers to the buyer's need for '*large, regular and predictable*' volumes. Bringing differentiation to the exchange relationship or establishing a brand to the supplier to build his own reputation are examples of buyer utility. Scarcity is a critical element for the supplier in order to be able to earn above normal returns (rent) in the relationship. It is achieved by providing low volume of commodity, by applying isolating mechanisms and by information asymmetry for example.

According to the levels of utility and scarcity, the potential exchange relationships in the dyadic relationships between buyer and supplier can be defined as buyer dominance, independence, interdependent and supplier dominance. These are defined as follows.

Buyer dominance: This would be the buyer's preference in a relationship. In this position, the buyer will set the critical decisions in the relationship such as the trade-off between the use value and cost and when future improvements are dependent on the buyer. This situation usually happens when there are relatively few buyers and many suppliers. Suppliers are competing in a contested market (Cox 2004).

Independence: When the power resources of both players are low the power relationship is one of independence. In this circumstance, the supplier normally could not differentiate between buyers in terms of their share of purchase. The buyers are all at the same level of value to the supplier. Besides, the supplier has only a few isolating mechanisms to stimulate the buyers and earn more revenue above normal revenues. In effect, neither party can leverage power on the other (Cox 2004).

Interdependence: The supplier and the buyer are interdependent if the power resources force them to share the value of the exchange relationship. Typically, this circumstance occurs when there are few buyers with a high percentage share of market and few suppliers have the ability of using isolating mechanisms to create barriers to market entry. Therefore both parties need each other and the circumstances favour long term commitments (Cox 2004).

Supplier dominance: The supplier manages the power in the relationship. The power is sourced by an isolating mechanism that brings competitive advantage to the supplier and enables him to close the market. There are few suppliers and many buyers that value the supplier's market. This would be the favourite position for a supplier and would allow above normal returns.

Cox suggests that power can be achieved by closing the market to competitors. Branding, property rights, dedicated investments, information asymmetry and control of available information, product and process innovations are named as the isolating mechanisms that assist a firm to leverage power toward other members in the chain.

The Cox perspective that power is exerted in dyadic relationships in supply chain is useful. But note that power relationships may be extended beyond only two players (in a dyadic relationship) to what he refers to as *power regimes*. Regimes are comprised of at least two interlocking exchange dyads (A-B and B-C). Each dyad then can be categorised based on its power relation which exists between players. For example the dyadic relation between A and B can be one of buyer dominance, supplier dominance, interdependence and an independent relationship. Power regimes of a supply chain with three firms are categorised as a double dyad exchange regime which is shown in Figure 2-5 (Cox et al. 2003).

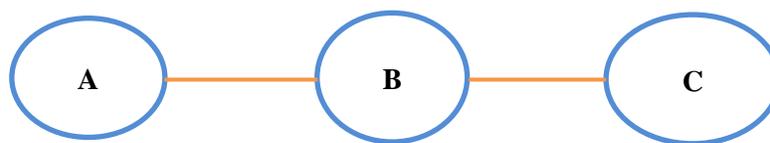


Figure 2-5 An example of double dyad exchange regime

The concepts of a power regime highlights that the power relations that determine the ability of firms to gain value may extend beyond a dyadic relationship to include others in the chain.

In the literature relating to agri-food supply chains it is argued that the power is skewed towards the large retailers (Hingley, M. K. 2005b), and agri-food supply chain and its relationships are power dependent (Hingley, Martin K 2005a). Wal-mart is a worldwide

example of a dominant supermarket (Bloom & Perry 2001), while in the UK, 75 percent of all sales in the supermarket sector is controlled by four firms (Adebanjo 2009; Lang & Heasman 2004). In the Australian market, Coles and Woolworths work similarly to Wal-mart. They have 79.6 percent of grocery retail market share of Australia. By adding IGA, almost 95 percent of the market share is led by these top three chains in Australia (*The Challenge to Feed a Growing Nation* 2010).

This research uses Cox's framework to investigate the dyadic power exchanges within the case study supply chains of Australian fresh food chains and detailed discussions are provided in Chapter 7.

2.7 Chapter summary

Option contracts have been suggested as a mechanism for enhancement of coordination between different supply chain players. This chapter provided the background to the option contracts and their theoretical and mathematical developments.

The chapter explored coordination mechanisms in general and flexible contracts in detail. It articulated the option contracts definitions, requirements, assumptions, and models. It showed the research gap by highlighting the shortcomings of the existing research in addressing the actual requirements of the supply chains. The chapter also set out the key concepts related to supplier-retailer relationship as developed by Cox (2004) in order to lay down the framework for further investigation of the power balance in this relationship.

The existing research has focused on theoretical developments and mathematical optimisations of option contracts parameters. This research fills the gap in empirical studies of the application of option contracts in food supply chains by conducting in-depth case study research in the context of Australian fresh food chains. Fresh food chains in Australia are explored in the next chapter. Details of the research design and the selected case studies are provided in Chapters 4 and 5 respectively.

Chapter Three

Fresh Food Supply Chains: The Australian Context

3.1 Introduction

The previous chapter underlined the benefits of option contracts in the supply chain and raised the issue of the lack of empirical studies in fresh food supply chains. Prior to conducting the research, the concepts of food supply chains must be studied and this chapter describes and conceptualises, in particular, the fresh food supply chain. In addition, it explains the context of Australian food supply chains; the types of the distribution channels; the trade structure and players in the market. Supermarket chains in Australia will then be identified and discussed.

3.2 Concepts of the food supply chain

The food supply chain is a generic concept, which covers all kinds of food products. All the food products are neither characterised with common attributes nor consist of similar supply chains. Figure 3-1 shows a segmentation of products including food products. Food products are perishable but not all the perishable ones are food products. However, some studies (Blackburn & Scudder 2009; Chen, Hsueh & Chang 2009; Wang, Y & Zhang 2011)

name food products as perishable products. Other researchers use the term food supply chain (Hong et al. 2011; Kumar et al. 2013; Roth et al. 2008; van der Vorst 2000; Wognum et al. 2011; Zhao, L et al. 2009) regardless of its differentiations. Agri-food supply chain term has been applied by others (Ahumada & Villalobos 2009; Aramyan et al. 2007; Blandon, Henson & Cranfield 2009; Fischer 2013; Fischer et al. 2009) to explain more specific types of food supply chains. Fresh produce has been applied by another group of researchers (Dabbene, Gay & Sacco 2008; Kaipia, Dukovska-Popovska & Loikkanen 2013) to be able to highlight the perishability factor. Precise terms such as fruit and vegetables, dairy, red meat, and beef (Boyabatli, Kleindorfer & Koontz 2011a; Boyabatli, Kleindorfer & Koontz 2011b; Fearne, Hornibrook & Dedman 2001; Issar et al. 2004; Mora & Menozzi 2005; Tarantilis & Kiranoudis 2002; Verdouw et al. 2010) have been used to address a specific supply chain and its characteristics.

An agri-food supply chain refers to all food produced with both long shelf life (grains, pulses, spices) and short shelf life (fruit and vegetable, meat, poultry, dairy). This research concentrates on fresh produce because of its short shelf life, which satisfies the research objectives and option contracts requirements. Fresh produce, however, can be consumed in two separate ways: as fresh produce or as processed food. These have different supply chains with different players, characteristics, and processes.

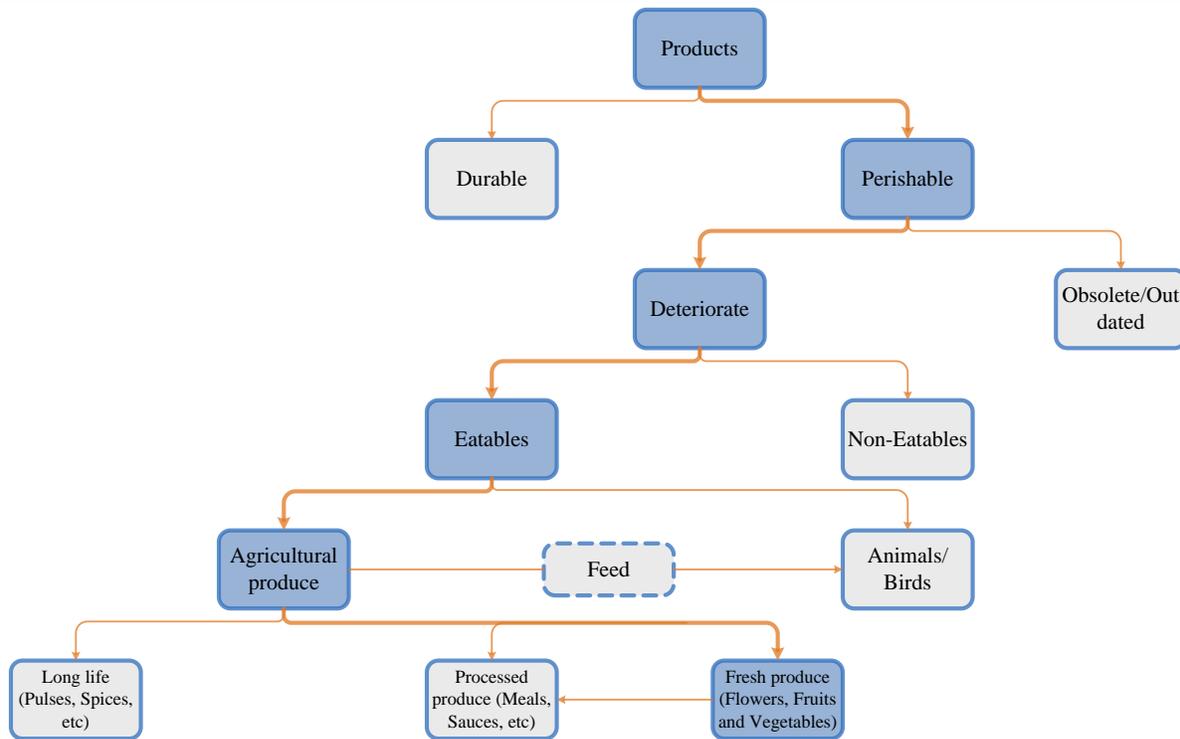


Figure 3-1 Segmentation of products including food products, Source: Shukla and Jharkharia (2013)

A schematic of processing food supply chain is shown in Figure 3-2.

The fresh food supply chain is complex due to continuous change in the quality of raw materials from harvest to consumer (Dabbene et al. 2008; Rajurkar & Jain 2011). They are, in particular, characterised by limited product shelf life and fluctuations in demand, supply and price (Ahumada & Villalobos 2009).

There are a limited number of studies that concentrate on the retail fresh food supply chain. These studies are frequently focused on particular produce and destinations. The study of melons (Blackburn & Scudder 2009), bananas in UK (Wilson 1996), apples and blueberries in the USA (King 2010), and pomegranates in India (Sudharshan, Anand & Sudulaimuttu 2013), for example.

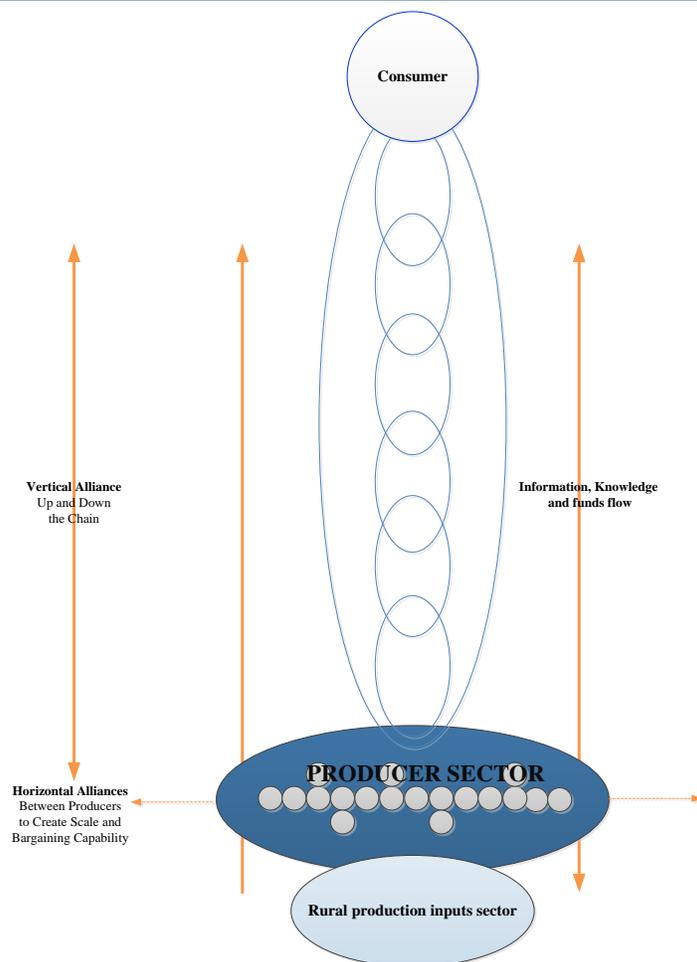


Figure 3-2 A schematic of processing food supply chain, Source: Thomas and Griffin (1996)

This research is informed by, and focuses on, the characteristics of food chains in an Australian context; particularly it looks carefully at defined fresh food supermarket chains in south-eastern Australia in order to understand, in some detail, the structure and dynamics of food chains- and, of course, the possible role of option contracts in perishable food chains.

3.3 Fresh food supply chain: the Australian context

In the Australian context, fresh food is consumed through two channels: through retail shops and through food sector outlets. Retail channels consist of supermarket chains,

Fresh food supply chains: the Australian context

convenience stores, grocery shops and food specialists. Takeaways, restaurants, hotels, and institutional consumption comprise the food sector (Spencer 2012).

Figure 3-3 indicates how fresh food channels distribute food to consumers.

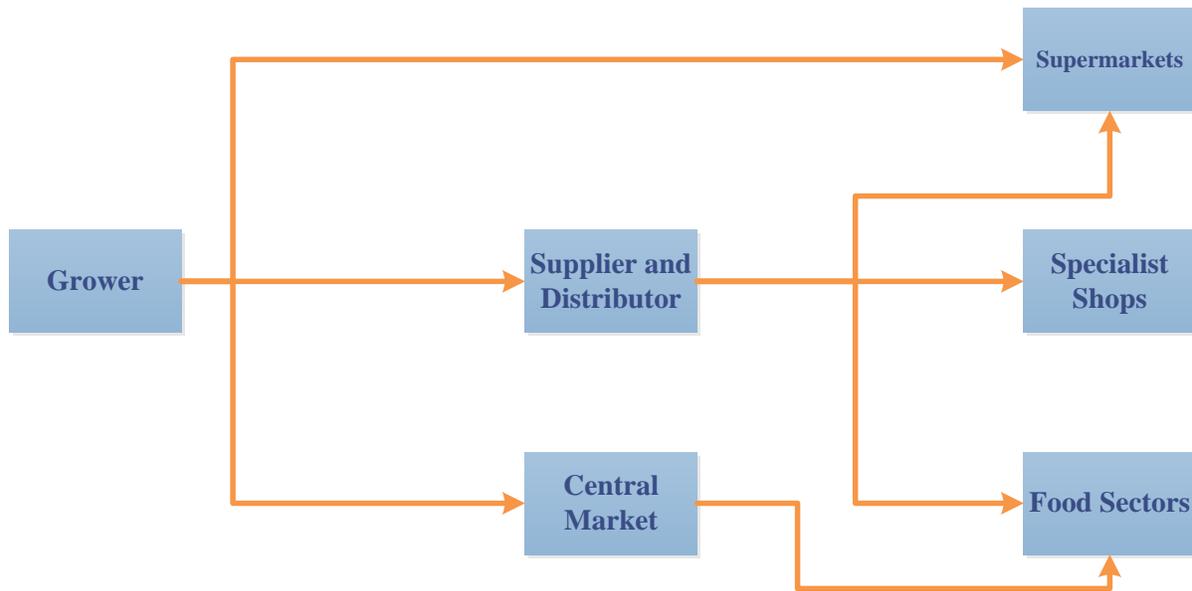


Figure 3-3 Channel distribution of fresh food to the consumers, Source: Spencer (2012)

In the following paragraphs the role of key players in the supply chain is described.

Grower- The grower is the starting point of the chain by producing fresh food. By definition, the grower owns the trees and the land. He is responsible for all the production processes such as planting, fertilising, pollination, pruning, harvesting etc. Growers trade their produce in three ways: through Supermarkets, food suppliers and distributors, and through the wholesale market. They either have a stand at the central market or use market agents to sell their products. In order to trade with the supermarkets they either do so directly or through the wholesale market. This is dependent on the type and volume of produce offered.

Wholesale market- The wholesale market (or central market) plays a key role in the distribution and pricing of produce to the retail markets such as food specialists,

independent retailers and food sectors although some supermarket chains trade at the central market for some specific produce.

Food Supplier and Distributor- The responsibility of the food supplier and distributor is to market and distribute the produce to the desired location. Suppliers do not own the trees and lands. Rather, they buy the fruit from the growers for sale in the market. They invest in the new varieties and get the right to market that specific variety. Their customers are supermarkets chains, independent retail outlets, and food sector participants.

Supermarket chains- Supermarkets buy on a national scale for distribution to their local stores. They forecast the consumers' demand, and to estimate volumes needed to meet their customers' expectations. They work on long term planning - seasonal, yearly, two years and even longer. They attempt to have their own supply market in order to reduce the level of uncertainty. They either purchase direct from grower or act in the wholesale market.

Retail shops, and specifically supermarkets and specialist shops, are the main shopping destinations for consumers and account for 75 percent of the total consumer demand. Details of household expenditure in all categories are shown in Figure 3-4. The significant household expenditures in the retail market underlines the importance of supermarkets and retail markets in the Australian fresh food supply chain. Supermarket chains are retailer-led supply chains and in the following section, the role of supermarket chains in Australia is described.

Fresh food supply chains: the Australian context

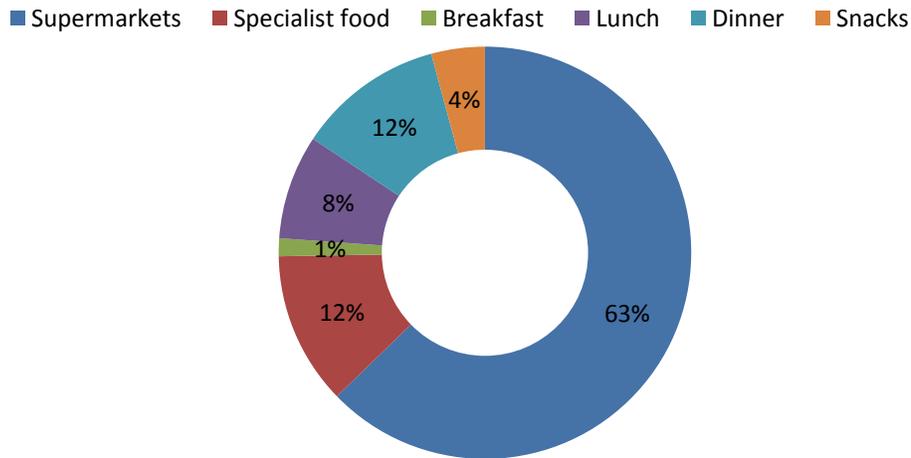


Figure 3-4 Details of household expenditure in Australia, Source: Spencer (2012)

3.4 Supermarket chains in Australia

The term supermarket refers to a grocery shop that has most of the following features (Burch & Lawrence 2007):

- Very much larger in size than the small grocery store;
- Wide variety of goods for sale, with foodstuffs as the most significant commodity;
- Self-service from goods displayed on open shelves;
- Pay at the checkouts;
- Part of a chain of similar outlets, which may be owned or franchised by one company.

According to this definition, Coles, Woolworths, IGA, ALDI and Food Works are classified as supermarkets in Australia. Note that the market share of these supermarkets is estimated to exceed 95 percent. A brief description of these chains is as follows.

Woolworths- Woolworths supermarket division, trading as Safeway and Woolworths had, by 2012, increased the number of shops to 872 (Rushdi 2012). This number had not increased as at August 2014(Woolworths 2014). Woolworths started the “Fresh Food

People” advertising campaign in 1987. It started sponsorship relationships with the Australian farmers to provide fresh food in their stores. According to their website, 100 percent of their meat and poultry, and 96 percent of their fresh fruit and vegetables are Australian grown (Woolworths 2013). Woolworths has an exclusive relationship with farmers who supply their demand nationally in accordance with strict quality, hygiene and safety standards.

Coles- Coles supermarket was established in 1914 in Melbourne, Victoria. It started to expand its retail business nationally in the late 60s. The number of supermarket stores operated under the Coles and Bi-Lo brands totalled 756 at the end of the financial year 2013 (Wesfarmers Limited 2013).

IGA- The concept of an IGA supermarket was introduced to Australia in 1988 from United States of America (USA). IGA (Independent Grocery Australia) emerged as a competitor, albeit a small one, to supermarket chains by supporting local businesses. IGA Distribution supplies shops under three brands, Supa IGA, IGA and IGA X-Press. These are varied in terms of size, range and customer profile. In total there are 1400 independently owned stores in Australia (IGA 2014). These stores are smaller in terms of size and variety of products compare with Woolworths and Coles.

Aldi- Aldi supermarket operates in Australia under the German ALDI brand, and is considered an international business in Australia. The first ALDI store was established in 2001. However, the company grew rapidly, and by 2012 had established 300 stores in Victoria, New South Wales (NSW), Queensland (QLD) and the Australian Capital Territory (ACT). According to the company's strategic plan, it will expand its business further by opening stores in Western Australia (WA) and South Australia (SA).

The two giant supermarkets, Coles and Woolworths, have almost 80 percent of the grocery market share in the country. By adding IGA, the three dominate the market having almost 95 percent market share. ALDI joined this market in 2001 and, as noted above, has grown significantly over the last decade or so.

Fresh food supply chains: the Australian context

These supermarket chains have different supply chain models and strategies. They compete with each other and other distribution channels to maximise their market share and profit. A schematic diagram of Woolworths' distribution channel⁴ is shown in Figure 3-5. There are three networks identified within the supply chain - a supplier network, primary and secondary networks. The supplier network is under the supplier's control. The primary network refers to the transportation from supplier, warehouse or port to the retailer's distribution centre. The secondary network includes transportation and distribution from the distribution centre to the retail outlets (Robinson 2009).

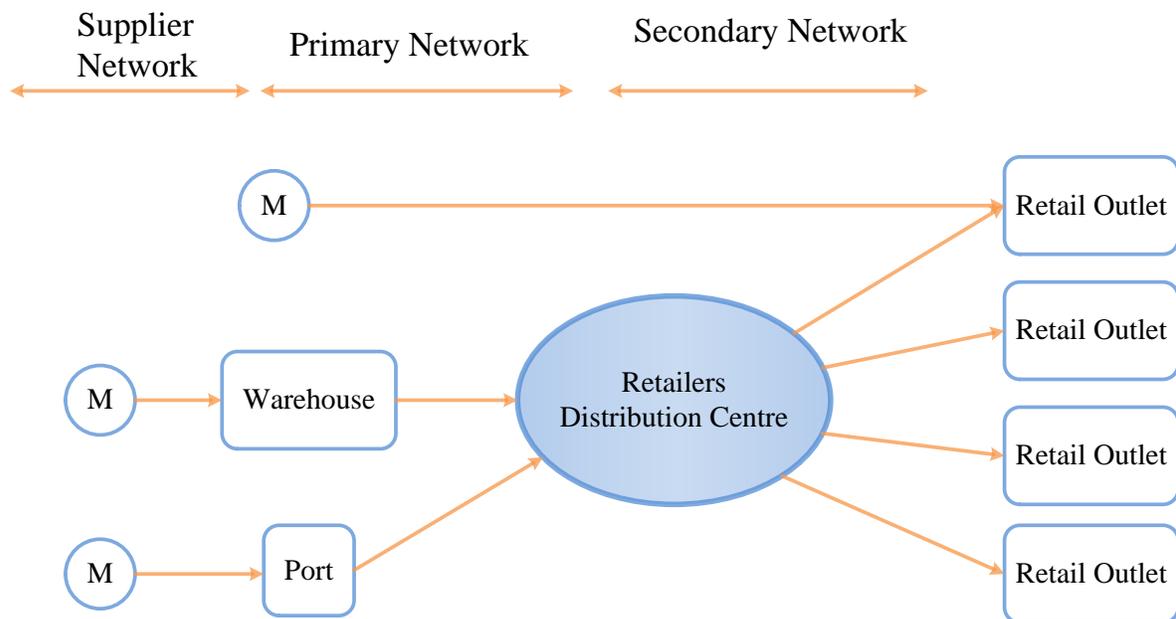


Figure 3-5 Schematic diagram of Woolworths' distribution channel, Source: (Robinson 2009)

3.5 Chapter summary

This chapter described and conceptualised the fresh food supply chain. It explained the context of the Australian food supply chains, the types of the distribution channels, the trade structure, players in the market, and supermarket chains in Australia.

⁴ This distribution is also applicable, in general term, to Coles; and elements of it apply to ALDI stores.

The chapter explored different definitions of food supply chains, and mapped out the segments and sub-segments of these chains. The role of key players including grower, wholesale market, food supplier and distributor, and supermarket chains in the Australian food supply chain was described. The term *supermarket* and supermarket chains included Woolworth, Coles, IGA, ALDI, and Food Works.

The chapter laid down the context of the research focusing on Australian food chains. In particular it looked at carefully defined fresh food supermarket chains in south-eastern Australia in order to understand, in some detail, the structure and dynamics of food chains and the possible role of option contracts in perishable food chains.

The next chapter identifies the research aims and objectives and articulates the research design and methods applied.

Chapter Four

The Research Framework: An Overview

4.1 Introduction

The previous chapters explained the problem of food waste in the supply chain, and option contract as a potential solution to the problem under investigation in this research. . In addition, the structure of Australian food supply chain and retail chains were described. The aim of the research was identified as investigating the applicability of option contracts in perishable food supply chains.

This chapter provides a framework for the research method to achieve the research aim and objectives. Prior to designing a framework, the research aim and objectives need to be defined in details. The following section discusses the research aim and objectives. The framework of research is then described by developing a systematic research design, followed by the research methodology and methods. At the conclusion, detailed information regarding data collection and analysis will be provided in order to achieve the research aim and objectives.

4.2 Research aim and objectives

The main aim of the research is to investigate the applicability of option contracts in the perishable food supply chain. In order to reach the aim of the research, there are some objectives that require clarification. The following describes the research objectives.

Objective one- Option contracts, when applied to real world examples, provide not only an analytical optimisation of variables and parameters but becomes a new approach in contractual agreements between the supplier and the retailer in the supply chain. In order to investigate the applicability of option contracts in the perishable supply chains, the exploration of current contractual arrangements and the relationship between the players in the supply chain is required.

The contract settings, for example, ordering processes, and price determination contribute to the contractual arrangements. Contract settings describe how the players set the contracts and what parameters they consider in the settings. Ordering processes underpins how the players deal with the impacts of uncertainty in the supply chain in the absence of option contracts. The process of price determination in terms of how and when the prices are set is a key element in the current arrangements. From the option contract point of view, ordering and pricing are crucial as the aim of theoretical studies is to determine the optimal order quantities and prices.

The contractual relationships between the suppliers and retailers in the supply chain can be explored by understanding the actual supply chain structure and the personal relationships involved in coordinated decision making within the supply chain. Investigation of contractual relationships enables the research to explore the influencing parameters in the contracts and can be added to the form of the option contract.

Objective two- The theories of option contracts are based upon set of assumptions which suggest that perishable food supply chains fulfil these assumptions (Wang, C & Chen 2013; Wang, Q et al. 2012; Wang, X & Liu 2007). However, they have not been tested in the real world applications. Therefore, in order to adopt an option contract in the perishable food supply chains, these assumptions require validation.

The first assumption is that an option contract must be applied in a retailer-led supply chain to achieve coordination. The second assumption is that the supply chain deals with high demand uncertainty. These two assumptions will be investigated in this research.

The third assumption is in respect of the option contract terms. These terms are defined in the option contract definition as follows - *an option contract gives the right to the retailer to purchase one more unit of product at a specific time at a fixed price subject to paying a premium to the supplier (Xu 2006)*. These terms are - fixed time, fixed price, specific time, and premium payment. The research task is to investigate whether it is possible to apply these conditions to the actual supply chain.

Objective three- Objective three is the consequences of the first two objectives. This objective suggests the required modifications to the current assumptions in the literature. Based on the observations of real world food chains, new requirements in applying option contract in the perishable food supply chains can be set

In general, the three objectives are designed in a way to achieve the research aim. The following statements summarised the research aim and objectives:

Research aim is to investigate the applicability of option contracts in the perishable food supply chain.

Research objectives are:

- To explore the current contractual arrangements and influencing parameters on the relationships between the players in the supply chain;
- To investigate the validity of option contract assumptions in the actual supply chain;
- To recommend modifications and new requirements in applying option contracts in the perishable food supply chains.

The next section defines the research approach in order to achieve the research aim and objectives. The rationale behind the design selection is also provided.

4.3 Research approach

Research design is defined as the science of designing and structuring the procedure of research (Vogt & Johnson 2011). Yin(2009) defines the research design as “ a logical plan for getting from here to there, where here may be defined as the initial set of questions to be answered, and there is some set of conclusions (answers) about these questions.”

Inadequate research design might lead to inappropriate results, which highlights the importance of research design investigations. The research design is based on the philosophical view to the approaches underlying the research. Although the importance of philosophical approach leading to research design is acknowledged (Creswell 2014; Crotty 1998; Saunders et al. 2011), there is no common research design applied by scholars.

Crotty (1998) applies four sequential phases which include epistemology, theoretical perspective, methodology and method. Epistemology identifies the notion of understanding of how we know what we know. The theoretical perspective explains the theoretical framework and logic of the research. Based on the assumptions and rules made in the first two steps the methodology can be chosen in a way to underpin the method applied in the data collection and analysis.

While Crotty (1998) applies four phases to research design, Creswell (2014) identifies three main components in research approaches. He identifies the broad research approach as the “plan or proposal to conduct the research, which involves the intersection of philosophy, research design, and specific method” (Creswell 2014). Applying Creswell’s framework, the philosophical worldview assumptions of the research, the research design related to the worldview, and the specific methods that transforms the approach into practice must be identified.

The interconnection of worldview, research design and research methods are illustrated in Figure 4.1 below. Creswell’s framework is applied in this research to structure the research plan or approach. The main components of Creswell’s framework are investigated in the following sections.

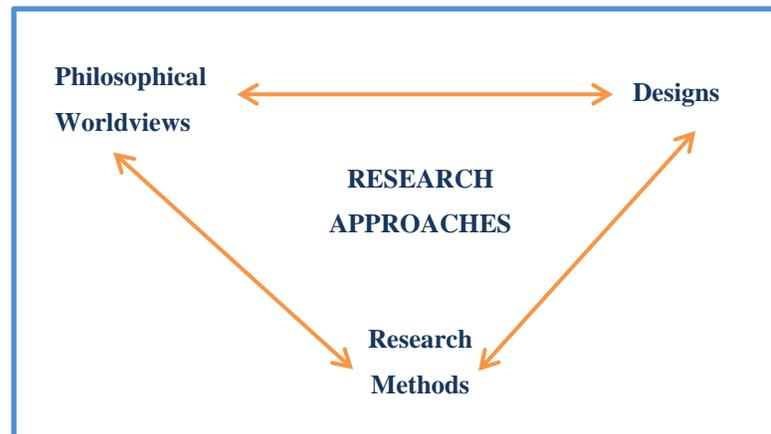


Figure 4-1 A framework for research- The interconnection of worldview, design and research methods, Source: Creswell (2014), page 5

4.3.1 Philosophical worldview

Philosophical ideas impact on the practice of research despite its hidden role (Slife & Williams 1995). Philosophical ideas explain why the researcher chose the research approaches for the research. Creswell (2014) defines the term *worldview* as “a basic set of beliefs that guide action”. The same concept is applied in different terms by others, as examples, paradigms (Lincoln, Lynham & Guba 2011), epistemologies and ontologies (Crotty 1998).

Philosophical worldviews are classified as *postpositivism*, *constructivism*, *transformative* and *pragmatism* by Creswell (2014). The main elements of each of the worldviews are shown in Table 4-1.

Table 4-1 Four worldview, Source: Creswell (2014) page 6

Postpositivism	Constructivism
<ul style="list-style-type: none"> ➤ Determination ➤ Reductionism ➤ Empirical observation and measurement ➤ Theory verification 	<ul style="list-style-type: none"> ➤ Understanding ➤ Multiple participant meanings ➤ Social and historical constructions ➤ Theory generation
Transformative	Pragmatism
<ul style="list-style-type: none"> ➤ Political ➤ Power and justice oriented ➤ Collaborative ➤ Change-oriented 	<ul style="list-style-type: none"> ➤ Consequences of actions ➤ Problem-centred ➤ Pluralistic ➤ Real-world practice oriented

The postpositivist worldview- The postpositivist assumptions are the traditional form of the research, and are applied particularly for quantitative research. This is underpinned by a belief that the truth is universal and causes determine outcomes or effects. The universal truths that govern the world are laws or theories that need to be tested, or verified, or refined in order to understand the world (Creswell 2014; Guba 1990).

The transformative worldview- The researchers who follow this worldview believe that the structural laws and theories cannot explain marginalised individuals in the society or issues of power or social justice, discrimination and oppression. These assumptions are underpinned by belief that the meaning or truth of a situation is arranged by subjects in a personal way (Creswell 2014; Crotty 1998).

The pragmatic worldview- “Pragmatism as a worldview arises out of actions, situations, and consequences rather than antecedent conditions” (Creswell 2014). This worldview emphasis is on the research problem and use of all approaches to understanding the problem. The knowledge of the problem is derived using pluralistic approaches (Creswell 2014; Patton 1990).

The constructivist worldview is a mixture of postpositivist and transformative worldviews. It argues that the truth results from the interplay of actors with their environment. Creswell (2014) states that “the goal of the researcher is to rely on the participant’s view on the

situation studied”. Consequently, different people in different places at different times construct their meaning based on their experience even though adopting the same concept (Crotty 1998).

4.3.2 *The world view of the research*

This research aims at testing the applicability of an option contract in Australian perishable food supply chains. Option contracts concern contractual agreements between the buyers and sellers within the context of a supply chain. The agreement established is dependent upon human relationships and business strategies which can vary between businesses and different locations.

Individuals enter into agreements seeking different goals. The application of option contracts in a fresh food supply chain could require different settings from those applicable in an apparel supply chain, for example. This is due to differences in people who play in the supply chain with different goals and experiments.

This research follows the constructivist worldview in order to reach the research aim and objectives. The experience of individuals in setting agreements, and consequently option contracts, rejects the view that there is a single objective truth with regard to the contracts. The possibility of applying a new method in food supply chains and how to apply the method depend on the supply chain structure which itself depends on the individual relationships and product characteristics.

4.3.3 *Research design*

The second stage of Creswell's framework is the determination of research design, refer to Figure 4-1. He advises *research designs* provide specific direction to the research approach (Creswell 2014). The same concept is termed *strategies of inquiry* by Denzin and Lincoln (2011). A research can be classified as qualitative, quantitative, and mixed method as the strategies of inquiries (Creswell 2014).

Quantitative designs are associated with the postpositivist worldview, and gather factual data in order to explore the relationships between facts. The quantitative inquiries have

assumptions of testing theories deductively. “The final written report has a set structure consisting of introduction, theory, methods, results and discussion” (Creswell 2014).

Qualitative research is an inquiry to understand and explore the meaning of individuals or groups associated with a social or human problem. “Those who engage in this form of inquiry support a way of looking at research that honours an inductive style, a focus on individual meaning, and the importance of rendering the complexity of a situation” (Creswell 2014).

Mixed method research is an inquiry combining both quantitative and qualitative research. Those who engage in this type of inquiry honour the assumption that the combination of qualitative and quantitative approaches provides more comprehensive understanding of the research problem than either of the approaches separately.

Qualitative research is applicable if an issue or a problem is not amenable to quantitative analysis. Exploration is required to identify the variables that can be measured, or voices that have not been heard. This research focuses on the actual relationships between the supply chain members and follows an inductive research approach exploring the actual situations and relationships between chain members and fits into the qualitative research method.

However, Creswell argues that the research design is not only determining the qualitative or quantitative type of the research, but directs the research methodology (Crotty 1998) which underpins the research questions and is influenced, to a certain extent, by the worldview of the researcher.

Creswell (2014) classifies alternative research methodologies according to the type of research inquiry. Table 4-2 illustrates the alternative research methodologies underneath of three types of research strategy of inquiries. The methodologies relevant to the qualitative research are defined in the following.

Table 4-2 Alternative research methodologies, Source: Creswell (2014) page 12

Quantitative	Qualitative	Mixed method
<ul style="list-style-type: none"> ➤ Experimental designs ➤ Non-experimental designs, such as surveys 	<ul style="list-style-type: none"> ➤ Narrative research ➤ Phenomenology ➤ Grounded theory ➤ Ethnographies ➤ Case study 	<ul style="list-style-type: none"> ➤ Convergent ➤ Explanatory sequential ➤ Exploratory sequential ➤ Transformative, embedded, or multiphase

The different approaches to qualitative research include *Narrative research* adopts a narrative chronology (Clandinin & Connelly 2000); *Phenomenological research* focuses on “describing the meaning of several individuals of their lived experience of a concept or phenomenon” (Creswell 2013). The aim of the researcher is to identify a phenomenon or common experience of several individuals; *Ethnography research* focuses on understanding of the patterns in the human activities and tasks in an organisation or culture. (Collis & Hussey 2009; Creswell 2013); *Grounded theory* which constitutes a qualitative research design in which the inquirer generates a general explanation (a theory) of a process, action or interaction shaped by views of a large number of participants”(Creswell 2013).

4.3.4 Research design of the research

Yin (2009), an advocate of the *case study* approach suggests an 'empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. This research adopts a 'grounded theory' and case study approach with a focus on the fresh food supply chain exploring the applicability of option contracts. Products in the perishable food supply chains are diverse, and product characteristics may vary. This means that an apparel supply chain, for example, is significantly different from that of a fresh food chain. The research, therefore, requires in-depth exploration of set of specific activities and relationships between the players in a particular, rather than a generic, supply chain. This demands a case study approach which is underpinned by grounded theory which is used as a research method within the case study methodology. The grounded theory method was used to

develop a framework for applying option contracts to the perishable food supply chain. The following section explains the case study methodology. It will also discuss the researcher's decision to adopt one or a multiple case study approach.

4.4 Case study research design

This research examines the applicability of option contract in Australia in the perishable food supply chains. The structure of supply chains and, as noted above, the relationships between the supply chain players, varies from product to product.

This section provides the required parameters in designing a case study research. The choice of single case study or multiple case studies is important to the design of the research.

4.4.1 Single or multiple case study

Case study research design starts with the choice of whether a single or multiple case study approach should be adopted (Gerring 2007). Yin (2009) suggests three rationales for single case study design. First is whether the case study represents the *critical case* in testing a well-formulated theory. The second rationale for single case study is when the case represents *an extreme or unique case*. The third rationale is the *revelatory case*, when the investigator has an opportunity to observe and analyse an inaccessible phenomenon.

Multiple case study design should not be applied when the study under investigation is critical, revelatory or unique case. However, it is appropriate when replication logic is valid and each case study predicts either similar results (a literal replication) or produces contrasting results for predictable reasons (a theoretical replication)(Yin 2009).

The importance of selection of case studies and designing the research is acknowledged by scholars (Creswell 2013, 2014; Gerring 2007; Yin 2009, 2012). The decision between single and multiple case studies is bounded with the nature of research and research objectives.

The replication logic is important to the research outcomes. The perishable food supply chains involve a variety of products with the common characteristic of perishability. There are other product characteristics, however, and the multiple-case study approach has been selected in conducting this research.

The next step is to choose the case studies among the perishable food supply chains. The selection is based on the option contract requirements discovered from the literature. The requirements are a retailer-led supply chain, seasonal products, long lead time of production, and high demand uncertainty. The first three requirements must be considered in the selection of case studies. However, demand uncertainty is a variable that requires investigation through the research.

Retailer-led supply chain- The field of research undertaken is confined to Australian perishable food supply chains. There are different chains in Australia involved with retailing food products. However, this study focuses on retailer-led supply chains, where supermarkets have a dominant position. As explained in Chapter Three, supermarket refers to a retail chain that has most of these features:

- Very much larger in size than the small grocery store;
- Wide variety of goods for sale, with foodstuffs as the most significant commodity;
- Self-serving from goods displayed on open shelves;
- Customers pay at the designated location (the checkouts);
- Part of a chain of similar outlets, which may be owned or franchised by one company.

According to this definition, Coles, Woolworths, IGA, ALDI and Food Works are classified as supermarkets and are the target of this study. Coles and Woolworths with almost eighty percent of market share are recognised as the giant retail chains in grocery products. Adding IGA to these two, the market share increases to ninety five percent (*The Challenge to Feed a Growing Nation* 2010).

However, investigation of all the above supermarket chains within the timeframe of the research is almost impossible. Therefore, one of the giant supermarkets in Australia has

been selected to participate in the research. Multiple case studies are selected among the supply chains involved in the supermarket chain of the study.

Perishable food supply chains include variety of chains such as fresh fruits and vegetables (FFV), meat, poultry, frozen food, dairy products and bread. All of these products are sold at the supermarket shelves in Australia.

Long production lead time- Not all of the perishable products require long production lead times. For instance, bread and dairy products are produced using continuous production mode which does not need a long production time. Therefore, frozen foods, meat and poultry and fresh fruit and vegetables still remain as potential choices.

Seasonal products- Seasonality is an effective parameter in application of option contracts. This parameter also impacts on demand uncertainty. Seasonality in perishable foods refers to period of availability times of products in one year. Fresh meat and poultry products and frozen foods are also not seasonal as they are available all year around for the consumers. The choices of case studies, which are compatible with the option contract requirements, are fresh fruits and vegetables. However, not all of the fresh fruits and vegetables are categorised as seasonal produce. Some are available in all times of the year such as potatoes, carrots, and apples. Figure 4-2 shows these requirements and potential relevant products leading to choose FFVs as the group of study.

Thus, the multiple cases must be chosen among seasonal fresh fruit and vegetables produces. The cases are chosen by applying Multi Criteria Decision Making (MCDM) approach. The selection of case studies involves various criteria among various alternatives which leads the researcher to apply MCDM approach. The details of MCDM approach and also description of criteria and alternatives are provided in the next chapter. The results of MCDM technique was four fruit supply chains as the case studies, which are strawberries, grapes, mangoes and peaches supply chains. All these four produce are seasonal, have long lead time of production and are sold at the supermarket shelves. The next section provides the methods applied in the research to collect and analyse the data.

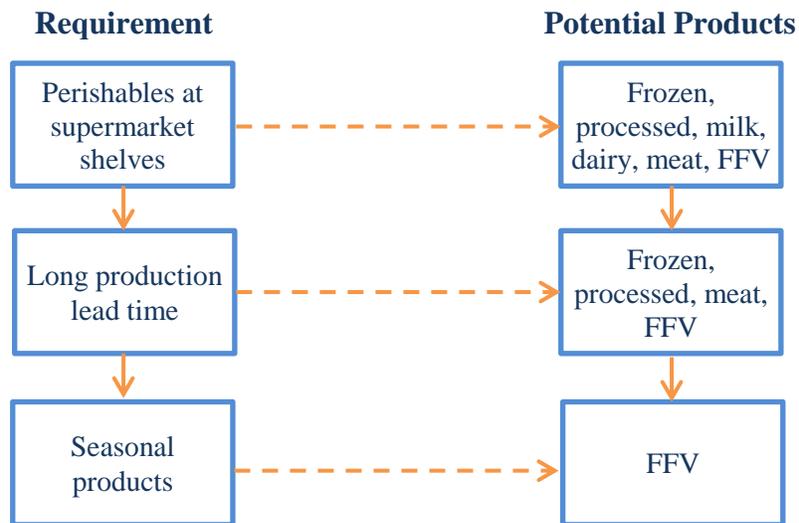


Figure 4-2 Schematic of requirements and potential products leading to choose FFVs as the group of study

4.5 Research method

Research method refers to how the research is going to be investigated or, as noted by Crotty (1988), the techniques or procedures applied to collect and analyse the data related to the research objectives. Different methods are applied in data collection stage in each strategy of inquiry. In qualitative research data can be collected by conducting interviews, observations, image and text analysis, open ended questions, and audio-visual data (Creswell 2014).

Minichiello, Aroni and Hays (2008) note that “in-depth interviewing is used to reach access to, and understanding of, activities and events which cannot be observed directly by the researcher”. In-depth interview fits the research objectives of this study because it tries to ascertain insight into the contractual relationships between the players, price negotiations, and ordering processes. In addition, in-depth face-to-face interviewing allows the researcher to explore additional details and ensure that respondents are interpreting the questions clearly.

The interviews for this research were semi-structured. This strategy was chosen because it provided flexibility in discussion and more valid explanation of the interviewees' thoughts and opinions (Minichiello et al. 2008). The case study protocol and interview questions were designed follow the recommendations of Wengraf (2001), Creswell (2013) and Yin (2009). The elements of case study protocol applied in this research are described below.

4.5.1 Case study protocol

The case study protocol provides information on data collection; information with regard to who will be interviewed; how and where interviews will be conducted and what questions will be asked in the interview.

Research participants- Research participants were chosen according to the structure of supply chain within the relevant supermarket. The participants were classified into four groups based and their role in the supply chain. Detailed information on each of the players in the supply chain will be provided in Chapter 6 where the fruit supply chains are described.

In the following the participants are briefly described to justify why they have been selected as research participants.

The first group is the supermarket category managers as the supermarket representatives. Category managers are in direct contact with the suppliers/growers, and negotiate and make decisions in terms of how much to buy at what price.

The second group of participants are growers. The growers must supply fruits to the supermarket directly or indirectly. They are chosen in order to provide their perspective on contractual agreements. The growers were selected through the supermarket list of growers.

Marketers are the third group of participants. After conducting interviews with the supermarket category managers, the existence of marketers in the supermarket chain were highlighted and became the third group of research participants. Since marketers do not play at the four case study supply chains (strawberries, grapes, mangoes and peaches), they were interviewed if needed.

The last group of participants are associations involved in each fruit supply chain such as Peach and Apricot Growers' Associations. The associations were selected to participate in the research in order to provide insight into the industry especially with regard to the role of supermarkets in the market.

Interview format- As mentioned before, the interviews were designed as semi-structured formats. The participants were able to slightly lead the interview into one of the research direction based on their experience on a unique occasion. The interview had an open character format with short questions, long answers which enabled the participants to tell their particular experiences. The interviews were conducted face-to-face to enable the researcher to interpret the questions more clearly as the concept of option contracts was completely new to the participants.

Interview place- The interviews were conducted at the interviewee's locations which included the head office of the supermarket, marketers' offices, wholesale market and farms. The researcher chose to conduct the interviews at the interviewee's location as this was satisfactory for and enabled the researcher to observe the processes especially at the farms.

Interview questions- Interview questions were carefully designed according to the research aim and objectives. The interview questions for all groups of participants were seeking the same objective although there were slight differences in the questions to enable the investigator to explore the role of each group in the supply chain. The questions were designed in four main themes, relationships in terms of ordering, relationships in terms of pricing, impacts of uncertainty on the supply chain, and waste observations in the supply chain.

The initial draft of questions was reviewed by a panel of experts in supermarket chains, in the fruit and vegetable industry and academic experts in supply chains. The questions were examined through a pilot study. The objective of the pilot study was to test the case study protocol and included the interview questions prior to the commencement of the actual study. The entire process from initially contacting the participant to recording the interview were included. Revisions were applied to the questions when needed.

Conducting the interviews- The interviews restricted to one per day and each interview took more than an hour. There was a reasonable time between interviews which enabled the researcher to listen and transcribe the recordings. This helped the researcher to modify and review the questions for the following interviews. The study aim is to explore the contractual relationships between the supply chain players. This enabled the inclusion of a new relevant theme which is common when following an open character interview (Yin 2009).

The participants were contacted by phone or email. After receiving initial interest to participate in the research, information forms were sent out to advise the research aims, their benefits of participating and expectations from the actual interview.

A written consent form was obtained from each participant prior to the interview and assurances that confidentiality would be carefully maintained throughout the interviews. The researcher confirmed that the identification of persons and their organisations would not be revealed.

4.6 Data analysis

This research has applied the grounded theory approach within the case study methodology. The grounded theory is used in the analysis of data as follows. All the required information relates to the option contract. The valuable information in the research is the description of the ordering processes, price negotiations, and contractual agreements between the supermarket, growers and marketers. Elaborative coding procedure was applied to enable the researcher to analyse the texts. “Elaborative coding is an analysis of textual data in order to develop theory further” (Auerbach and Silverstein (2003). Elaborative coding is a “top-down” process and is built on the previous theories. The goal in elaborative coding is to refine or modify the theory from the previous studies and the relevant text is selected with that goal in mind (Auerbach & Silverstein 2003).

Three phases were applied in elaborative coding which include six steps (Table 4-3). The coding seeks to find the relevant themes in the existing theories as well as discovering new themes in the contractual relationships between the supply chain players.

As there are four case studies in this research each was analysed separately. The analysis started with transcribing the interview recordings. Material which was either consistent with the old theories or suggested new ones, was selected for each interview. The interviewees were formed into four groups each with a different perspective on a common issue. The relevant text of similar players was then grouped and the material analysed in order to find either common themes or discover difference.

Table 4-3 Six steps for elaborative coding, Source: Auerbach and Silverstein (2003), page 105

Phase one: Making the text manageable
<ol style="list-style-type: none">1. Explicitly state your research concern, your theoretical constructs, and what you want to develop further.2. Select the relevant text for further analysis. Do this by reading through the raw text with Step 1 in mind, highlighting relevant text. Select text that is consistent with your old theoretical constructs, as well as text that suggest new ones.
Phase two: Hearing what was said
<ol style="list-style-type: none">3. Record repeating ideas by grouping together related passages of relevant text. Organise the repeating ideas with respect to old and potentially new theoretical constructs.4. Organising themes by grouping repeating ideas into coherent categories. As before, the organisation of themes should reflect old and potentially new theoretical constructs.
Phase three: Developing theory
<ol style="list-style-type: none">5. Elaborate old theoretical constructs by grouping themes into units consistent with them. Develop any new theoretical constructs by organising themes into meaningful units.6. Create a theoretical narrative by retelling the participants' story in terms of both old and new theoretical constructs.

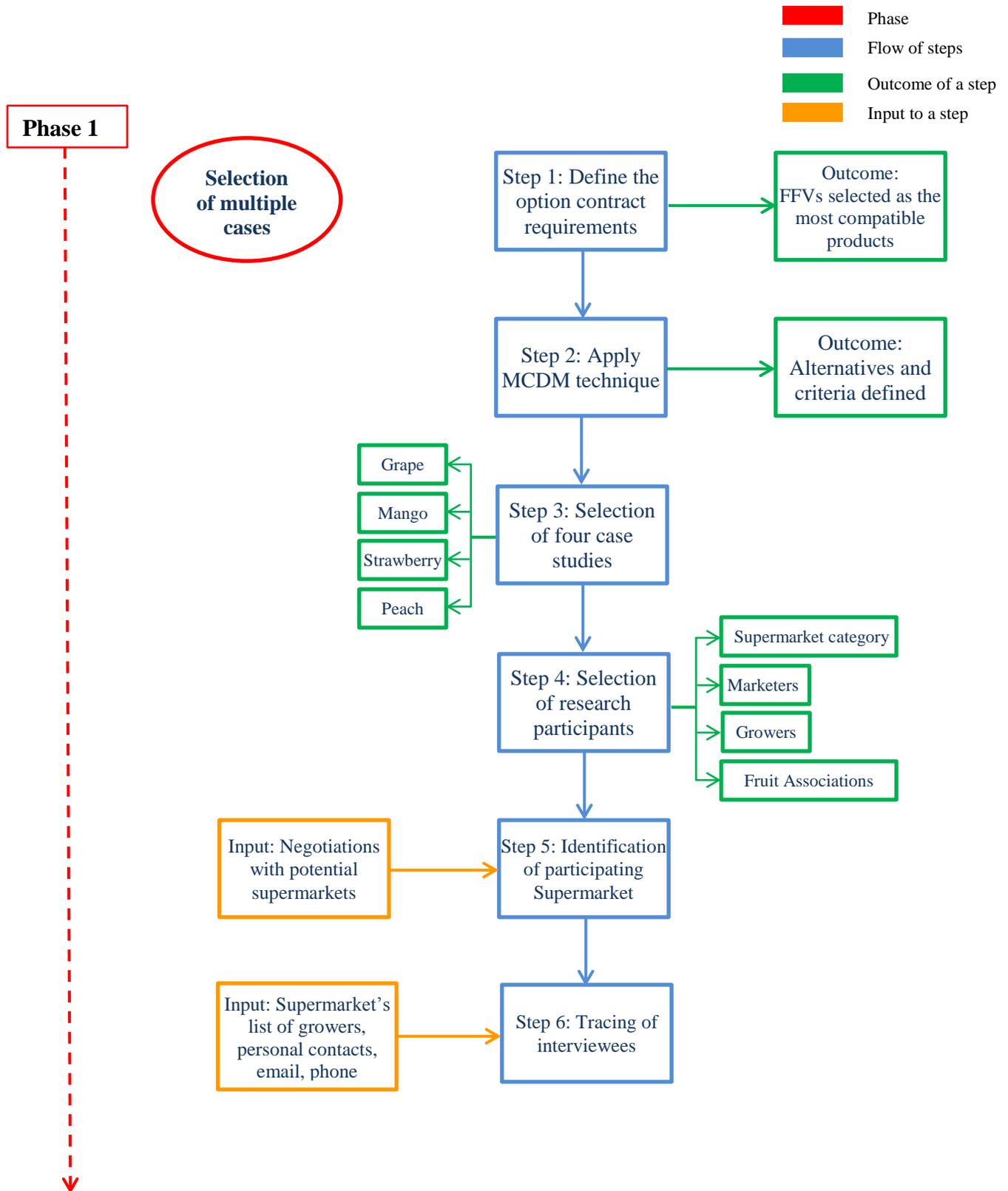
Finally the grouped themes from each case study - strawberry, mango, grape, and peach - were combined, compared and analysed. The aim was to find the common themes in the four case studies.

The results of the elaborative coding can be classified into two groups. First, is the descriptive analysis of the supply chain by illustrating the common and uncommon processes between the supply chain players. If applicable, the relationships are described in direct one-to-one relationships, for example the supermarket and the grower, or the marketer and the grower, or the supermarket and the marketer. This will be provided in Chapter 6.

The second group of results includes the analysis of the old and new theories. It states the examination of existing theory according to the actual supply chain relationships. The required modifications to the old theories are also the outcomes of the second group. In addition, the new theories (based on the new themes found in the analysis) which are required in the application of option contracts in the perishable food supply chains are discovered. These results are discussed in Chapter 7.

The framework of conducting the research from the starting point of the selection of multiple case studies to the end point of analysis and conclusion including the case study protocol are illustrated in Figure 4.3 below.

The research framework: an overview



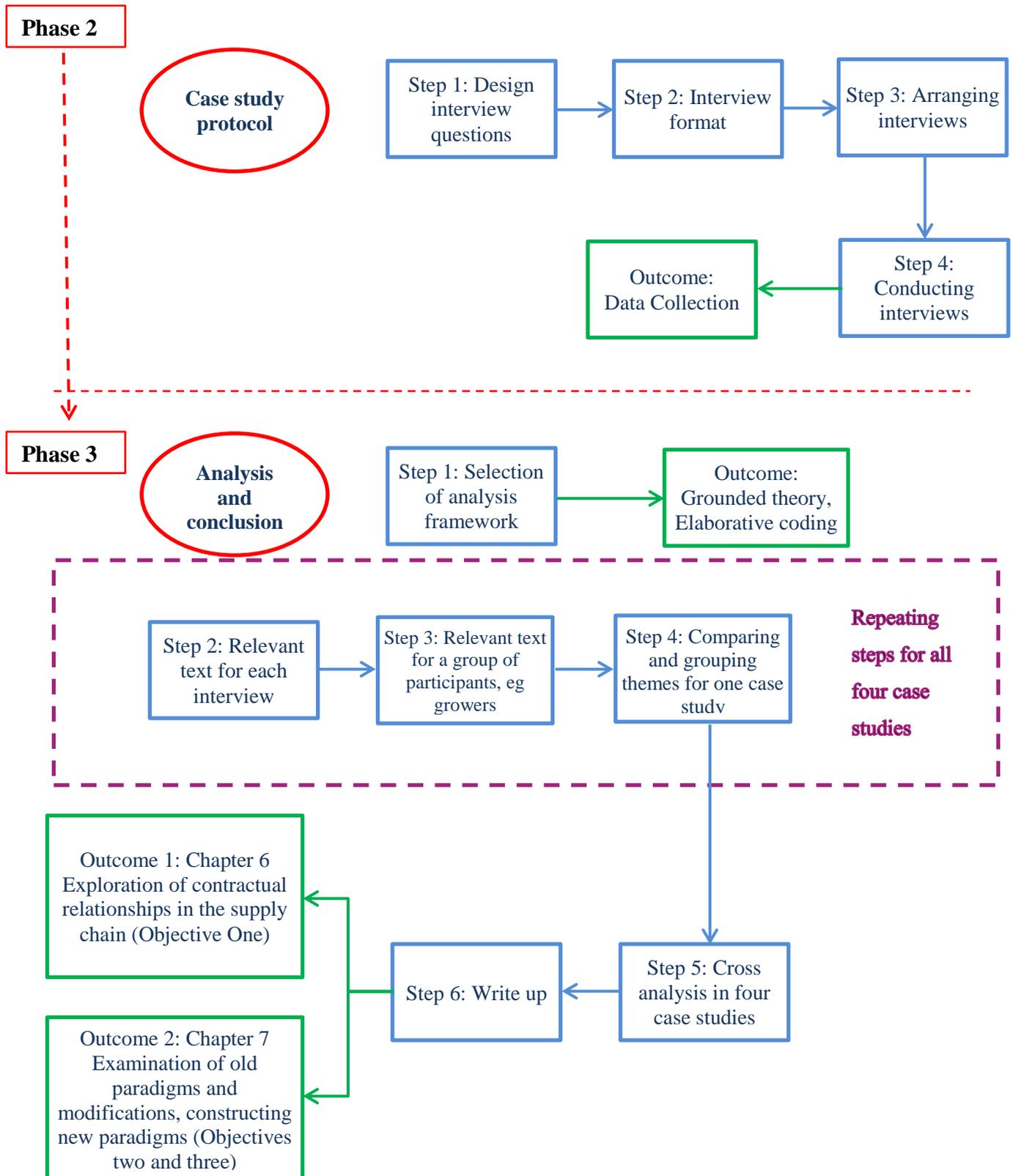


Figure 4-3 Framework of conducting research including three phases

4.7 Chapter summary

This chapter clarified the research aim and objectives in details. The aim of the research is to investigate the applicability of option contracts in the perishable food supply chains. Three objectives were defined in order to address the research aim. The first objective is to explore the current contractual arrangements and influencing parameters on the relationships between the players in the supply chains. The second objective investigates the validity of option contract assumptions in the actual supply chains. The third objective addresses the required modifications and new parameters that must be considered in applying option contract in the perishable food supply chains.

The research was designed according to the research objectives by applying a framework suggested by Creswell (2014). This research follows a constructivist worldview and a qualitative strategy of inquiry with application of case study design. Since the research is exploratory, grounded theory approach was chosen to be applied in the case studies.

A multiple-case study approach was designed to investigate the application of option contracts in real world supply chains. Four supply chains dealing with grapes, strawberries, mangoes, and peaches were selected. Interviews with supply chain players were selected as the research instrument for data collection and the design of the case study protocol.

Grounded theory and elaborative coding were suggested as the framework for data analysis. It was noted that each group of interviews for one produce should be analysed initially followed by cross analysis in four case studies.

Chapter 5 explains the Multi Criteria Decision Making (MCDM) technique applied in the selection of case studies. In addition, a brief description of selected case studies will be provided.

Chapter Five

Case Studies: Selection and Methodology

5.1 Introduction

A case study approach has been chosen as the main research method in this thesis to address the research aim and objectives. The previous chapter noted that the case studies must be selected from among Fresh Fruits and Vegetables in order to fulfil the option contract requirements. The aim of this chapter is to apply Multi Criteria Decision Making (MCDM) approach to select the appropriate Fresh Fruits and Vegetables (FFV) for case study analysis. This chapter explains in more detail the Multi Criteria Decision Making method addressed in Chapter 4. The method has been applied in this research in order to ensure the selection of the best compatible case studies with the research aim and objectives.

The MCDM technique is applied when there are several alternatives with several criteria, so that the decision making process becomes complicated. The chapter explains the MCDM technique, existing criteria, product categorisation and alternatives. After the case studies

are selected, the geographical elements, production volumes, and market structure are described in more detail.

According to the Australian Bureau of Statistics of agricultural commodities (ABS 2011), as the basic reference in Australia, there are thirteen groups of fresh fruits. Some of them also contain more than two types of produce, for example “stone fruits” consists of peaches, nectarines, apricots and plums. “Vegetables” also have five main categories, including one ‘other vegetables’ which has all of the other vegetables included.

The decision to select FFVs as the case studies must address the criteria according to the research aim and options contract requirements. To tackle the decision making problem and find the answer of which FFVs, Yin’s (2009) rationale has been applied to find out the most appropriate sampling logic. He argues against using sampling logic in choosing multiple cases, but suggests the selection logic should be done in such a way “that each case either predicts similar results or predicts contrasting results but for anticipated reasons” (Yin 2009 p 54). This logic is used in this research to select the multiple case studies among FFVs.

As a consequence, the need for applying an approach to rank the possible choices based on the criteria has emerged. To overcome the emotions behind the decision making process, the logical quantitative approaches was selected to minimise the risk of bias decision making. MCDM approach is appropriate and is used in this research to find the top ranked FFVs that represent the FFVs supply chain according to the option contract requirements. The technique is discussed in the following section.

5.2 Multi Criteria Decision Making

Optimal decision making is one of the core interests in operations research. MCDM is one of the approaches used in decision making problems with its main aim of evaluating and ranking the set of problems involved with multi criteria affecting each problem (Triantaphyllou et al. 1998). There are two main sets of models in the MCDM. The first one consists of multi objectives and is referred to as the Multi Objective Decision Making

(MODM) model. MODM is used when the set of the objectives and the decision space are continuous, which is not applicable to this research.

The second approach involving multi attributes in the decision making process is referred to as the Multi Attribute Decision Making (MADM) model (Triantaphyllou et al. 1998). The MADM mainly solves problems with discrete data space. Input data and parameters, and the possible outcomes impact on choosing the MCDM method (Ishizaka & Nemery 2013). The selection problem for this research is discrete; therefore the MADM method is applied. The main objective of MADM is to rank the set of alternatives based on the set of attributes. MADM approach is used to quantify the qualitative attributes. This reduces the bias associated with qualitative thinking. MADM can be classified into groups based on the data set. Data can be deterministic, stochastic or Fuzzy. The data set in this problem is deterministic. Therefore, the deterministic approach is used to calculate the alternatives' scores.

In addition, MADM approach is grouped into two based upon the number of decision makers. The decision maker may be single or multiple. In the single decision maker approach, only one person ranks the alternatives based on the set of attributes. This approach increases the risk of biased decision making that relies on one's opinion and is not applicable when the criteria scoring is involved in qualitative thinking. In contrast, multiple decision making reduces this risk by adding several viewpoints on the scoring table. All decision makers' opinions have the same value in this approach. Applying more than one decision maker provides more trusted results. In this research, a multiple decision maker approach has been applied to get trusted results.

In the MADM approach, the experts are required to weight the alternatives for each of the attributes. Therefore, there is a need to create a table showing alternatives vs criteria. By adding the weights associated with each alternative for the specific criterion the matrix of weight is generated by each expert. To design the table, the attributes and alternatives must first be defined. The following section describes this process.

5.2.1 Attributes selection

As noted, the attributes are chosen in such a way as to address the research aim. The aim of this research is to investigate the applicability of using option contracts in the perishable food supply chain. Therefore, option contracts requirements must be considered in defining the attributes. In addition, Chapter 1 raised the issues of food waste in the supply chains and noted that option contracts may be used to reduce waste. It is appropriate, therefore, to include wastage-related attributes.

Two requirements of option contracts are product related and refer to seasonality and to demand uncertainty. Wastage related criteria are volume of waste, short life time, price fluctuations and price range. Another attribute remains, which is related to the consumption of the produce. The sale volume indicates the popularity of the produce in the country and is important because it impacts on the economics of the supply chains. Each of these seven criteria is described below.

Seasonality- Seasonality is one of the option requirements. This attribute addresses this requirement and high seasonality refers to those produce that are considered more seasonal than others. Seasonality refers to the period of product availability in the market. Some of the seasonal FFVs can be found in the market throughout the year. This happens either due to the climate diversity in Australia or product storage facilities. Consequently, some seasonal produce face higher seasonality than others. The retailers need to decide and act quickly for a high seasonal produce if they want to respond to the end consumers' demand. The supply chain and specifically the retailers need to make maximise profit in the short period of product availability. According to the option contract literature, products with shorter availability in the season match the contract elements better. Therefore, high seasonality has been chosen as one of the attributes. The decision makers are asked to give the highest score for the produce they believe is highly seasonal.

Demand fluctuations- Demand uncertainty is a product-related option contract requirement. According to the literature, the product and supply chain have to deal with demand

uncertainty in order to apply option contracts. The higher the demand uncertainty involved in the supply chain the better results of option contracts.

Demand uncertainty in the fruit chain influences waste and its associated costs. Uncertainty of demand causes uncertainty in the decision making of the supply chain players. If the retailers retain FFVs inexact of the actual demand, then they have to either maintain cold temperatures to avoid deterioration or discard the produce because of appearance and/or quality standards. Both of the scenarios add extra costs to the supply chain and retailer.

Demand volatility is selected as an attribute to address demand uncertainty in the attributes table. The higher demand fluctuations addressed by the decision makers the higher demand uncertainty in the supply chain. The decision makers are asked to score this attribute for each product based on the wider range of demand volatility.

Volume of waste- Wastage within the supply chain negatively impacts the whole supply system. The higher the wastage volume the greater the cost to the supply chain. Since this research looks at the option contract as a mechanism to reduce the wastage in the supply chain, FFVs associated with the highest amount of wastage must be selected. This helps the study to focus on the higher portion of waste and find out how option contracts can be applied into specific FFV supply chains; also it could be expanded to the other FFVs. This criterion asks the expert to weight each product based on the volume of waste that they consider during each sale season. As a consequence, those products with high volumes of waste will be selected.

Short life time- This attribute has direct impact on the wastage amount. The shorter life time the more uncertainty is involved in the decision making process for the supply chain players and especially retailers. The quality of produce decreases over time and reflects their deterioration rate. The short life time makes the process more dynamic and the retailers must make quick decisions. They must sell more produce in the short time, otherwise the produce goes to waste and profits will be reduced. On the supermarket shelves the quality of produce appearance is an effective issue in determining shelf display time. The decision makers are asked to score the highest number to the produce with the shorter life time.

Price fluctuations- The produce price is not constant during the sale season and fluctuates during each season. This price volatility must be distinguished from concepts of the time value of money and inflation. These two concepts are investigated further over a longer time frame, not just several months. According to the FoodMap analysis (Spencer 2012) price fluctuations exist during the sale season. However, it is not in the same pattern and range for all of the produce. Some products face high price fluctuation and others are negligible. This volatility causes uncertainty in the supply chain. The end consumers usually select their needs depending on the retail price. The aim of this attribute is to rank the produce based on the price fluctuations, and not consider the price range, or the reasons behind the fluctuations.

Sale volume- This attribute shows the importance of produce in the Australian market according to the consumption volume. Sale volume is not a requirement to option contract neither is it related to the wastage amount. However, consumption of produce is relevant to the population demographic which differs from place to place. This attribute considers the economic aspect of the produce to be studied.

High price- Some enjoy different popularity among consumers which creates different price ranges. Some fruits are considered a good source of nutrition and vitamins, such as bananas, whilst others may be considered luxury fruits, such as stone fruits. The consumers' behaviour and demand influence the retail price. The product price impacts on the waste costs. Small amounts of wastage of an expensive produce is equal to large amount of wastage of the cheaper ones. The experts are asked to score the most expensive alternative with the highest number.

The next section defines the potential alternatives that could be added to the alternative column in the MADM matrix.

5.2.2 *Alternative selections*

The alternatives are chosen based on the research aims and objectives and for the Australian supply chains. The alternatives are confined to Australian grown produce. The ABS classification includes thirteen groups of fruits and five groups of vegetables. These

groups are defined in focus of the highest volume of Australian grown produce. All other FFVs are classified as others. In the following paragraph the potential seasonal alternatives are described.

Citrus Fruits- This group includes oranges, mandarins, grapefruits and lemons. Citrus fruits are winter produce in Australia. However, lemons, grapefruits and oranges are available in the markets all year around. These products are either stored for a long time or imported due to high consumers' demand. The stored fruits are provided to the market eventually even after the end of the harvest season. But, mandarins are only available in autumn and winter seasons for a limited time. Mandarins and oranges are selected from this group as representatives of the citrus group. Oranges are chosen because of their popularity in the market.

Pome fruits- Apples and pears are considered as pome fruits. Apples are known as a good source of nutrition. Therefore, they are available over the entire year by the use of storage facilities. However, some varieties such as 'royal gala' are in the market for a limited time. Pears and royal gala apples are selected as alternatives mainly because of their popularity and consumers' behaviour towards them.

Stone fruits- Stone fruits are delicate and luxury fruits. They are summer fruits available in Australia from November to April. Peaches, apricots, nectarines, plums and cherries are considered as stone fruits. The characteristics of these fruits are very similar to each other. Therefore, peaches and apricots are randomly selected within the stone fruits category.

Banana- In Australia bananas are very popular among families with children and are known as a good source of energy and nutrition. Bananas are available all the year around, although they are harvested seasonally. Bananas have been chosen among the alternatives due to their popularity and consumption volume.

Avocado- Avocado is a tropical fruit grown in the tropical areas of Australia. Avocado is a popular food, has specific attributes and is considered as a source of nutrition.

Mango- Mango is also a tropical fruit grown in northern Australia. It has specific features - its large size, its difficulty in handling, and its ripening process after harvest.

Grapes- Grapes are divided into two groups, table grapes and vine grapes. Table grapes are sold in the fresh fruit market, but vine grapes are only used by wineries. The production volume of vine grapes is relatively larger than table grapes. However, vine grapes are not compatible with the research objectives as they are not sold on supermarket shelves. Only table grapes are considered as an alternative in the ranking process and grapes in this thesis refer to table grapes. Grapes are seasonal and available in summer from November to May.

Berries- Berry fruits include strawberry, raspberry, blueberry and cranberry. Berries are sensitive produce requiring special care and temperature. The deterioration rate of berries is higher than other FFVs. Strawberries are selected as an alternative from the berries group given its larger production volumes.

Tomato and Cauliflower- According to the ABS classification of vegetables, tomato, potato, carrots, onions and mushrooms have the highest portion of production and consumption in Australia. All other vegetables are considered as ‘others’ category. Potato, carrots, onions and mushrooms are grown all the year around and therefore are not seasonal. Tomato has been chosen from the vegetable category. In addition, cauliflower is selected on the basis of expert opinions as an important vegetable. Cauliflower is categorised as the ‘others’ group of vegetables by ABS.

By selecting the alternatives and attributes, the matrix of MADM is created. The matrix is shown in Table 5-1. The next step is to collect and analyse the data.

Table 5-1 MADM matrix

Criteria	Seasonality	Volume of waste amount	Short Life time	Demand fluctuations	Price fluctuations	High price	Sale volume
Alternative							
Peach							
Mandarin							
Strawberry							
Tomato							
Orange							
Banana							

Mango							
Avocado							
Royal gala apple							
Apricot							
Cauliflower							
Pear							
Table grape							

5.2.3 Data collection and analysis

This section completes the MADM approach by addressing the issue of data collection and analysis. The selection of decision makers and how to approach them is described in the data collection subsection. The calculations and final result of MADM technique is then revealed in the data analysis subsection.

Data collection- As discussed in the introductory section, this research applies a multiple decision makers approach. To eliminate the impacts of personal decisions and emotions, all the decision makers are selected from the industry. The experts are required to be experienced in the FFVs industry and able to compare and score alternatives associated with the attributes.

The experts, therefore, are selected from the FFVs retail shops and supermarkets because they are in direct relations with the consumers and deal with the wastage at the store levels. The experts were selected randomly from local stores and supermarkets. The shops are located in different parts of Melbourne in order to reduce the demographic influences on the experts' opinions. Store managers of supermarkets, category managers of supermarkets, and local FFVs shop owners were asked to participate and four experts participated in the scoring process.

The experts were asked to weight each alternative for each attribute. The data has been collected by face to face questioning of the experts. After receiving the matrix table, they were asked to weight the specific attribute by alternatives one by one. The researcher provided more information if needed. The experts were asked to score the alternatives from 1

to 5, where 1 has the least relation and 5 the most. The interviews have been conducted in June and July 2012.

Data analysis- The decision making problem in this research is deterministic and a deterministic analysis approach was applied to find the top ranked produce as the case studies. The following subsection provides the general formulas used in data analysis.

Weighted Sum Model- The Weighted Sum Model (WSM) has been used to analyse the data. WSM is one of the most commonly used approaches in the deterministic problems (Triantaphyllou et al. 1998). This method represents the preferences of decision makers by a linear additive function. WSM is used when the preferences are independent and separated (Tzhang & Huang 2011).

Table 5-2 shows the general MADM matrix with attributes weights, where

- $A_i, i = 1, 2, \dots, M$ indicates the i^{th} alternative;
- $C_j, j = 1, 2, \dots, N$ indicates the j^{th} attribute;
- $W_j, j = 1, 2, \dots, N$ indicates the weight for j^{th} attribute;
- a_{ij} indicates the score of i^{th} alternative for j^{th} attribute.

Table 5-2 General MADM matrix with attributes weights

Alt.	Attributes				
	W_1	W_2	W_3	...	W_N
	C_1	C_2	C_3	...	C_N
A_1	a_{11}	a_{12}	a_{13}	...	a_{1N}
A_2	a_{21}	a_{22}	a_{23}	...	a_{2N}
A_3	a_{31}	a_{32}	a_{33}	...	a_{3N}
\vdots	\vdots	\vdots	\vdots	...	
A_M	a_{M1}	a_{M2}	a_{M3}	...	a_{MN}

The total score of the i^{th} alternative, scored by the k^{th} expert (TSA_{ik}) is calculated form the following equation:

$$TSA_{ik} = \sum_{j=1}^N a_{ij} * w_j \text{ for } k = 1 \text{ to } l \quad (5.1)$$

According to the equation 5.1, attributes in the WSM need to be weighted. The attribute weighting process is done by the researcher since the research aims and objectives have to be considered in this step. The most relevant attribute receives the highest score. The scoring scale, the same as for the alternative scoring, is from 1 to 5. Scores of alternatives multiplies to each associated weight to the attributes, and then TSA_{ik} is calculated.

The weight vector for the seven attributes in this problem is (5, 4, 4, 1, 5, 2, 3). According to the literature of WSM, it is suggested that normalised weights be used for the attributes. After normalising, the normalised weight vector becomes (0.208, 0.167, 0.167, 0.042, 0.208, 0.083, 0.125).

Equation 5.2 has been used to normalise the attributes weights, as follows:

$$w'_j = \frac{w_j}{\sum_{j=1}^N w_j} \quad (5.2)$$

It is assumed that each of the experts has the same weight in the ranking process. Therefore, the final score of alternatives equals to the average score of TSA_{ik} given by each decision maker. Therefore, the final score for each alternative can be calculated by the following equation:

$$TSA_i = \frac{\sum_{k=1}^l TSA_{ik}}{l} \quad (5.3)$$

where l stands for the number of experts in the decision making.

Table 5-3 provides a real example of the scored matrix by one of the experts. The weighted score of alternatives (TSA_{ik}) associated to this table is shown in Table 5-4.

Table 5-3 Example of scored MADM matrix by one of the decision makers

	seasonality	wastage	short life time	demand fluctuations	price fluctuations	price	sale volume
Peach	5	4	5	5	5	5	3
Mandarin	4	1	2	3	2	2	3
Strawberry	2	3	5	2	2	2	4
Tomato	1	1	2	5	5	5	5
Orange	3	1	2	2	2	2	3
Banana	1	2	2	5	3	1	5

Case studies: selection and methodology

Mango	5	3	5	5	3	5	3
Avocado	1	2	3	2	2	1	3
Royal gala	2	1	2	5	2	2	4
Apricot	5	4	5	5	4	5	2
Cauliflower	1	1	1	3	2	1	2
Pear	1	1	2	3	2	1	2
Table Grape	4	4	5	2	5	5	5

Table 5-4 Weighted scores for alternatives (TSA_{ik})

Alternatives	Weighted scores
Peach	4.583
Mandarin	2.417
Strawberry	2.917
Tomato	3.000
Orange	2.167
Banana	2.417
Mango	4.000
Avocado	2.000
Royal gala	2.208
Apricot	4.250
Cauliflower	1.417
Pear	1.583
Table Grape	4.500

The final results of the scoring (TSA_i) and sorted results are provided in Table 5-5.

Table 5-5 TSA_i before and after sorting

Before Sorting		After Sorting	
Alternatives	TSA_i	Alternatives	TSA_i
Peach	4.406	Peach	4.406

Mandarin	2.635	Apricot	4.125
Strawberry	3.49	Table Grape	4.125
Tomato	2.802	Mango	3.76
Orange	2.031	Strawberry	3.49
Banana	2.406	Tomato	2.802
Mango	3.76	Mandarin	2.635
Avocado	2.24	Banana	2.406
Royal gala	2.073	Avocado	2.24
Apricot	4.125	Royal gala	2.073
Cauliflower	1.688	Orange	2.031
Pear	1.979	Pear	1.979
Table Grape	4.125	Cauliflower	1.688

According to the table, the first five alternatives have the highest weighted score significantly above the average. These products are peaches, apricots, table grapes, mangoes and strawberries. Peaches and apricots rank first and second, due to their similarities. Both of these sets of produce are within the stone fruits category, acting similar in the market. In addition, the score of apricots and table grapes is exactly the same. For these two reasons, apricots can be removed from the list of case studies without missing any future information. The top four produce are selected to be investigated as the case studies in this research- peaches, table grapes, mangoes and strawberries. The following section describes each fruit specification in the Australian context in details.

5.3 Product description

This section describes each of the case study fruits selected using the MADM approach. This includes a brief description about geographical elements, production volume, and market structure. It also articulates specific information relevant to the research case studies.

5.3.1 Mango

Mango is a tropical summer fruit, growing mostly in the northern part of Australia. Queensland and the Northern Territory produce respectively 53% and 42% of mangoes in

Australia, accounting for 95% of total production (ABS 2011). Western Australia is the third State producing almost 5% of the total mango production. Other states produce none or less than 1%. The production of each state and its share of total production is noted in Table 5-6.

Australian mangoes are mainly consumed within the Australian market. The major consumers in Australia are located in Victoria, New South Wales and Queensland and means that there are long distances between the farms and the markets. This factor has a considerable impact on the supply chain activities and is discussed in the next chapter.

Table 5-6 Mango production volume in Australia, Source: (ABS 2011)

State	Production (tones)	Percentage
NSW	83	0.23%
Vic.	11	0.03%
Qld	19,456	53.07%
SA	31	0.08%
WA	1,681	4.59%
Tas.	0	0.00%
NT	15,397	42.00%
ACT	0	0.00%
Total	36,659	100%

Mango is an orchard crop and a mango tree does not produce fruit for the first four years. There are 8 different cultivars of mango available in Australia with the most popular and wildy grown ones being Kensington Pride and Calypso. Each of these cultivars has several varieties. The varieties of the same cultivar are different in some aspects. The relevant aspect for this study is the time of ripening. Trees with the same variety at one farm produce mangoes at the same time of the year. The farmers have approximately two weeks-time to harvest the variety; otherwise the fruit becomes over ripe and rots. Farmers usually grow several varieties of the same cultivar to be able to manage the short timeframe of harvest. In addition, it helps them stay in the market for the longer period of time and earn more revenue.

Mangoes in Australia are grown in several varieties which ensure a longer growing season in the year. Mangoes in general are available from September till March, with peak season between November and January (Mangoes 2013). Regional farms are located in Darwin, Katherine, Dimbulah and Bundaberg shown in Figure 5-1. Due to climate differences in each of these locations, the harvest times are different, which prevents cross harvesting⁵ in different regions, and therefore oversupply at a particular time. However, since mango production is highly temperature sensitive daily changes in weather can change the fruit arrival time in each region.

⁵ Cross harvesting happens when fruits of two different regions with two different harvest times, become ripe at the same time. This has become an issue mainly due to climate changes.

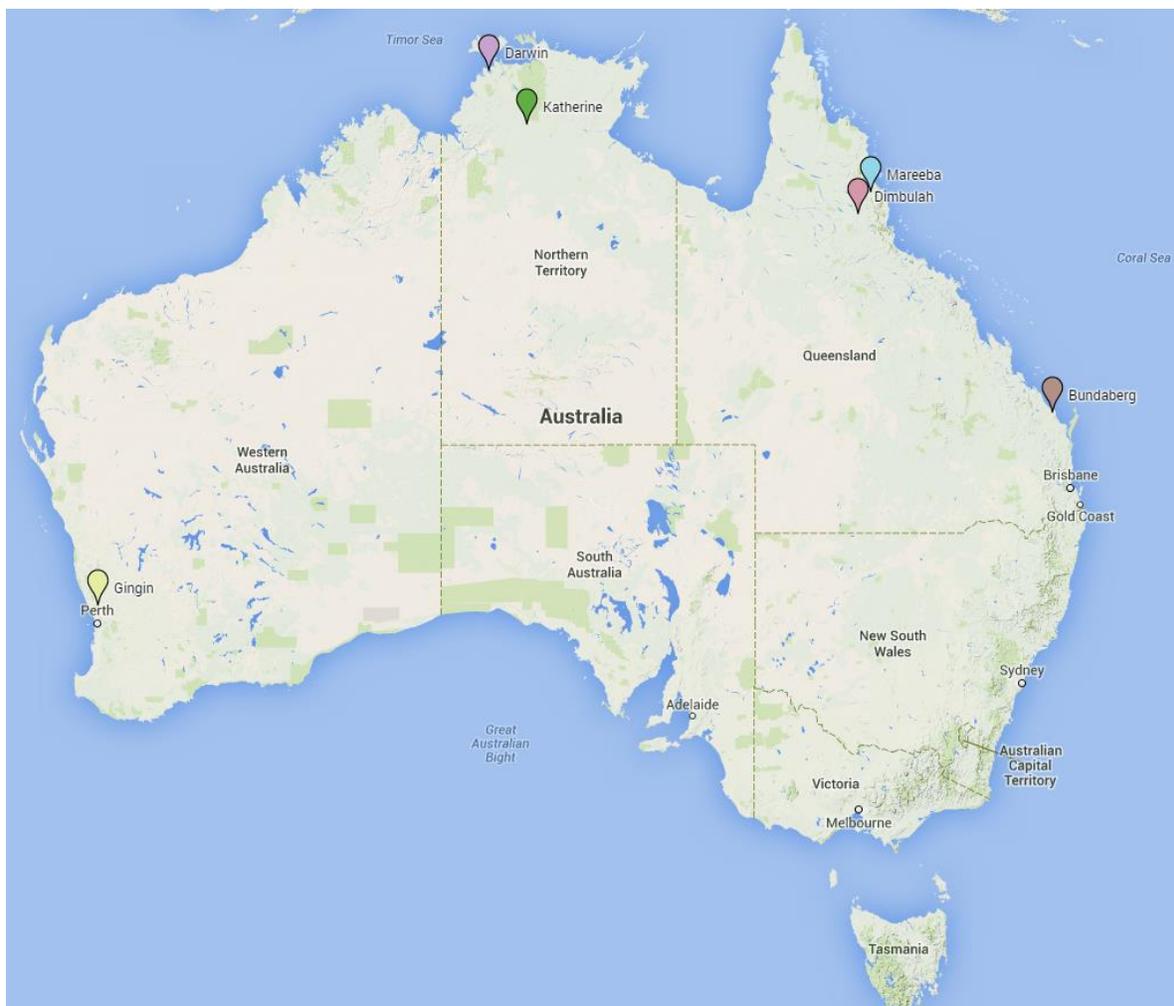


Figure 5-1 Map of farm lands: Mangoes

5.3.2 Table Grape

Table grapes⁶ are grown in most Australian States but the production volume and land area vary from State to State. Victoria with farms located in the Sunraysia and Robinvale regions produce the highest volume of table grapes in Australia. 72,450 tonnes were harvested in Victoria in 2012- 68% of the total grape production. NSW and QLD contribute almost the same volume- 13% and 11% of total production respectively (ABS). Table 5-7 provides the production volume and percentages for all States.

⁶ Table grape industry is completely separate from the vine grape industry due to the required varieties. This research investigates only the table grape industry.

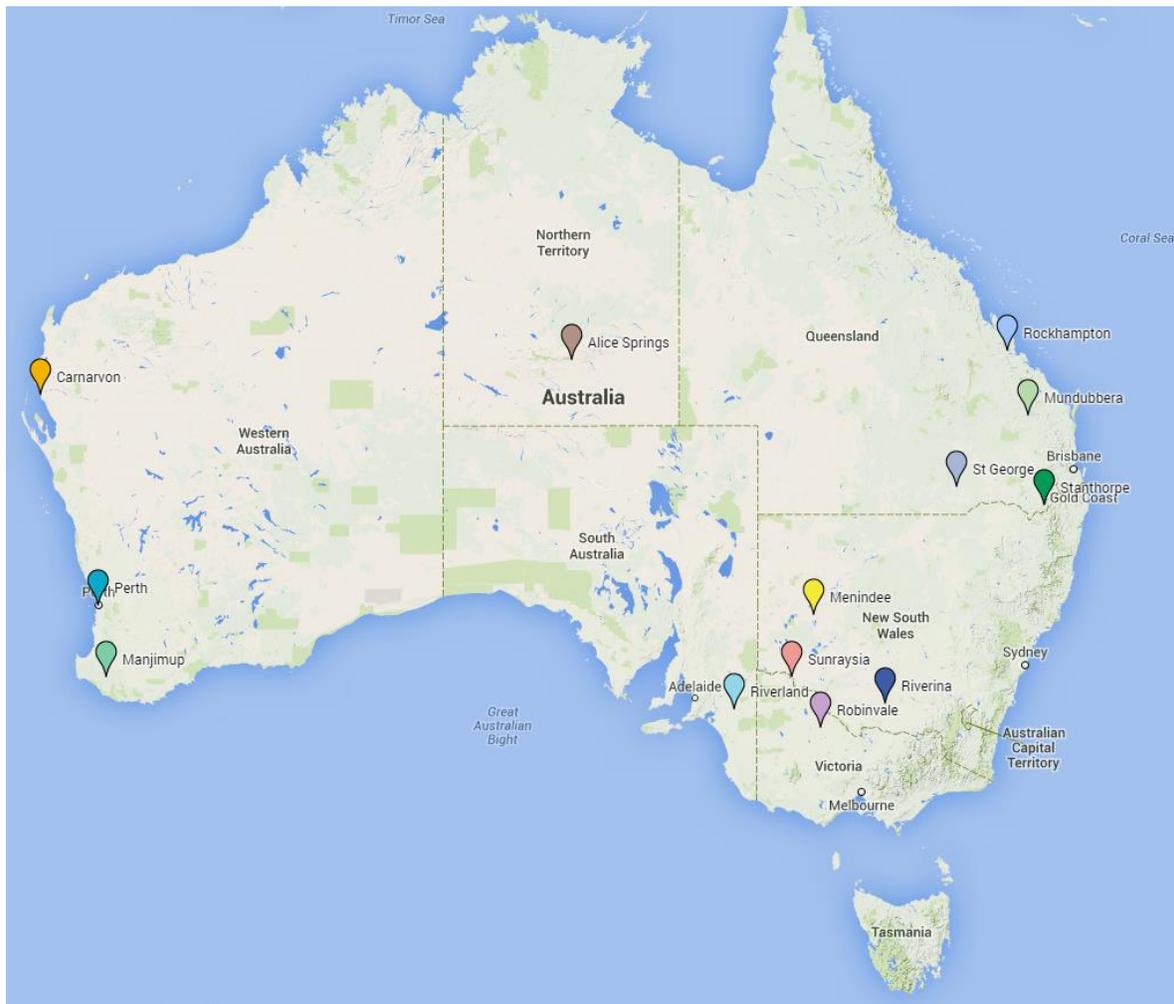


Figure 5-2 Map of farm lands: Table Grapes

Table grapes grown in Australia belong to three varieties- Black, Red and Green. The harvest time during the season varies over time and variety. This enables the industry to supply grapes⁷ over a longer period of the year. Grape seasons usually last for 7 months, starting from late October-early November and finishing in May-early June next year. The peak season for grapes usually starts in January and lasts to April⁸. The availability season of grapes by varieties are shown in Table 5-8.

⁷ Grape in this thesis always refers to table grape.

⁸ This information is not valid for WA.

Various varieties and cultivars in grapes display differences. The fruits are varied not only in terms of taste and shape, but also in terms of time of ripening in the season, and length of storage in cool rooms. Some varieties can be kept up to 12 weeks in a cool room; others may be kept for up to 2, 4 or 8 weeks. The ability to keep grapes in the cool rooms gives flexibility to the chain in terms of controlled supply to the market.

Table 5-7 Table Grape production volume in Australia, Source: (ABS 2011)

State	Production (tones)	Percentage
NSW	13,904	13.09%
Vic.	72,450	68.21%
Qld	11,761	11.07%
SA	1,799	1.69%
WA	4,766	4.49%
Tas.	0	0.00%
NT	1,536	1.45%
ACT	0	0.00%
Total	106,216	100%

Due to differences in both climate and grape varieties, the harvest times varies from farm to farm, and variety to variety. Farmers usually grow several varieties of the same cultivar to be able to manage the short timeframe of harvest. In addition, it helps them stay in the market for a longer period of time and earn more revenue. In addition, differences in harvest time prevent cross harvesting in different regions and oversupply during the season. However, since grape production is highly temperature sensitive, daily weather changes can change the fruit arrival time in each region. This causes cross harvesting and sometimes oversupply which affect the profitability of the farmers and retailers.

Table 5-8 Availability time of three grape varieties

Table Grape	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Black												
Red												
Green												

5.3.3 Strawberry

Strawberries in Australia are grown in most States except the Australian Capital Territory (ACT) and the Northern Territory (NT). Figure 5-3 shows the areas of strawberry plantations in Australia. Victoria produced 12,431 tonnes of strawberry in 2012 - 40% of the total production of strawberries. Queensland produced 11,110 tonnes or 36% of the total strawberry production (ABS). Other states grew less than 10 percent which were mainly consumed by the consumers in those States. However, there are times when strawberries are transported from those states to fulfil the customers' expectations in other States. Table 5-9 provides the production volume and relevant percentage for each State in 2012.

Table 5-9 Strawberries production volume in Australia, Source: (ABS 2011)

State	Production (tones)	Percentage
NSW	213	0.69%
Vic.	12,431	40.23%
Qld	11,110	35.96%
SA	2,652	8.58%
WA	4,074	13.19%
Tas.	417	1.35%
NT	0	0.00%
ACT	0	0.00%
Total	30,897	100%



Figure 5-3 Map of farm lands: Strawberry

Due to climate diversity in Australia strawberries are available all year around. The strawberry season usually starts from October and last till May/June in Victoria, and then Queensland season starts from June and lasts to October. This enables the industry to supply strawberries 12 months a year. However, this is not always considered an advantage for the market. Weather events change the availability season by weeks and sometimes months. It may also result in oversupplying in the market for a limited time which means the fruit from Queensland arrives when Victorian strawberries are in the market impacting market price and revenues for growers.

During the Victorian season, Victoria takes the lead in supplying strawberry for the eastern states. As a consequence, the market dynamics of Victoria set the primary prices for all of the eastern states. There are over 80 strawberry growers in Victoria combining small, medium and large growers. Small growers often enter the market for a short period of time.

However, large growers are able to supply over a longer period of time. During the Queensland season the supply focus shifts and prices are set from Queensland. From the consumers' perspective, strawberry is available during winter in Victoria; however in terms of pricing it is much higher than in summer.

Table 5-10 Availability time of strawberries in each State

State	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Vic												
Qld												
WA												
SA												
Tas												
NSW												

5.3.4 Peaches

Note that the industry sources do not specifically record and report the data relevant to peaches. The peach is categorised as stone fruit and due to the similarities in attributes and features in stone fruits, the data are reported at aggregate level. Therefore in this section, some information includes other stone fruits such as nectarines, apricots, plums, and cherries. However, the primary data analysis which will be described in Chapter 6 only includes peaches.

The location of peach and nectarine growing areas in Australia are shown in Figure 5-4. Victoria and NSW have the highest density of plantation area. With regard to production volume, Victoria produces almost 82% of the total peaches in Australia. The total Victorian production volume in 2012 was 49,470 tonnes followed by 5,187 tonnes in NSW (ABS). Table 5-11 shows the total production and percentages of peaches in all States.

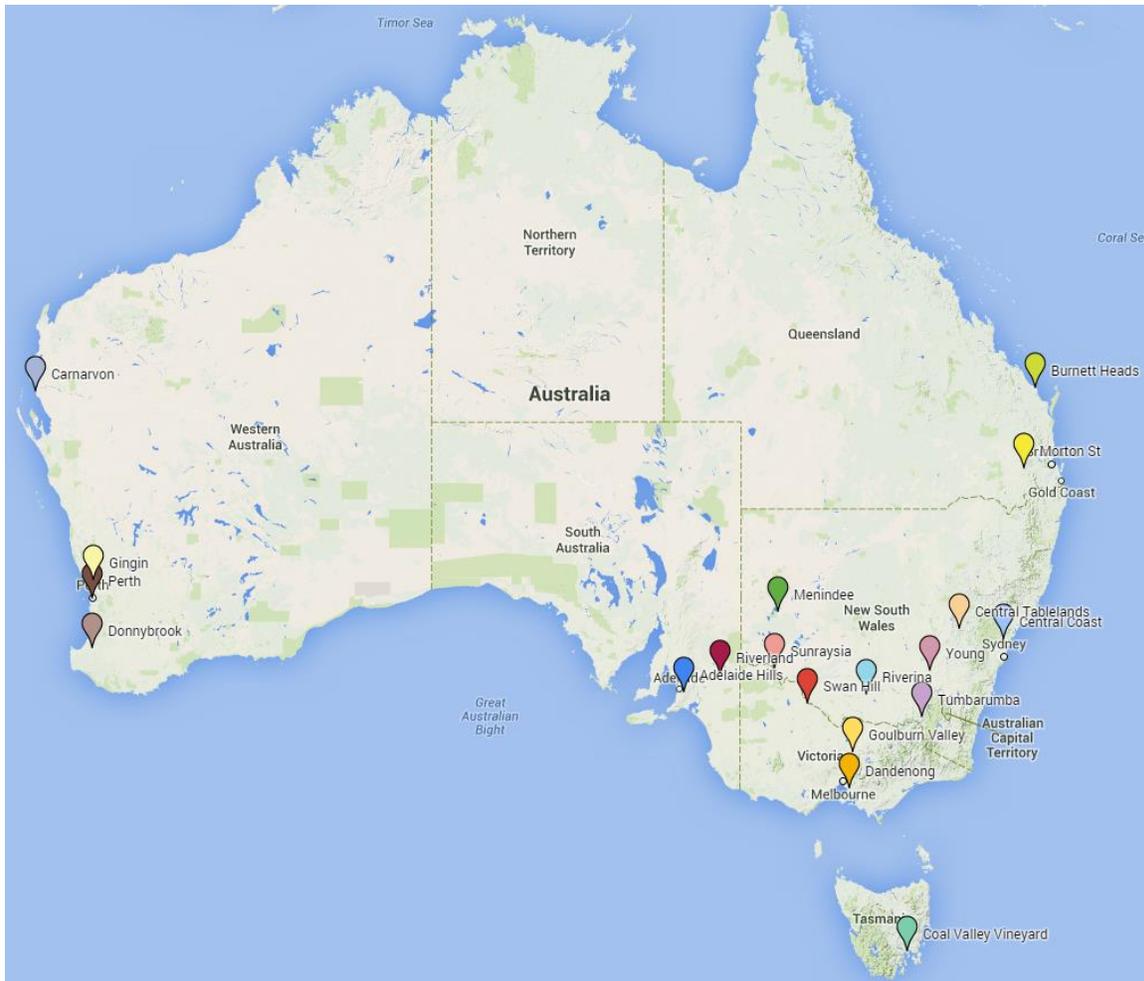


Figure 5-4 Map of growing region: Peach

Table 5-11 Peaches production volume in Australia, Source: (ABS 2011)

State	Production (tonnes)	Percentage
NSW	5,187	8.57%
Vic.	49,470	81.75%
Qld	1,744	2.88%
SA	2,088	3.45%
WA	1,890	3.12%
Tas.	135	0.22%
NT	0	0.00%
ACT	0	0.00%
Total	60,514	100%

The peach industry supplies two different markets - processing peach and fresh peach. These two types are completely different varieties. The processing peach is used in the canning industry. It is grown mainly by negotiations between the processing factories and the growers. The fresh peach varieties are not suitable for canning purposes. However, the processing varieties can be sold and consumed in the fresh fruit market. This changes the market dynamics and influences the price setting in the wholesale market. Growers prefer not to take the canning varieties to the fresh market. However, they have been forced to do so due to the oversupply in the canning industry. The production volumes of fresh peach and processing in Australia are shown in Table 5-12 and Table 5-13 respectively. Note that this thesis is concerned with the supply chain of fresh peaches.

Table 5-12 Fresh peach production volume, Source: (ABS 2011)

State	Production (tones)	Percentage
NSW	4,294	16.57%
Vic.	16,758	64.68%
Qld	1,683	6.50%
SA	1,404	5.42%
WA	1,637	6.32%
Tas.	135	0.52%
NT	0	0.00%
ACT	0	0.00%
Total	25,911	100%

Table 5-13 Cannery peach production volume, Source: (ABS 2011)

State	Production (tones)	Percentage
NSW	893	2.58%
Vic.	32,712	94.54%
Qld	61	0.18%
SA	684	1.98%
WA	253	0.73%
Tas.	0	0.00%
NT	0	0.00%
ACT	0	0.00%
Total	34,603	100%

Peaches in Victoria are grown in the Goulburn region shown in Figure 5-5. This area is in north Victoria more than 200Km far from Melbourne and the wholesale market.



Figure 5-5 Location of Goulburn valley, Victoria

There are two main varieties in peaches - white peach and yellow peach. In addition, each has different varieties which enables the industry to supply peaches over a longer period of the year. Harvest times of peaches are similar in different states. The availability of peaches in season is shown in Table 5-14. Peach is a summer fruit which is in the market from November to April in Australia. The growers grow different varieties to secure their business and supply for longer periods in the year. In addition, supplying longer periods helps maintain farmers' cash flow. Different varieties mature and are ready to harvest in different weeks of the season which enable them to harvest on time and split their work load.

Table 5-14 Availability time of peaches in season

Peach	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
White												
Yellow												

5.4 Chapter summary

This chapter articulated the selection of case studies for the research. Multi Attributes Decision Making was applied to select the appropriate Fresh Fruits and Vegetables for case study analysis. The case studies were selected according to these attributes: seasonality, volume of waste, price fluctuations, demand uncertainty, sale volume, short life time, and high price. Thirteen alternatives were considered and industry experts were asked to weight each alternative according to different attributes. Store and category managers of supermarkets, and local FFVs shop owners participated in the scoring process.

The collected data were analysed applying Weighted Sum Model to rank the alternatives, and four products with the highest score were selected to be studied in this research - peaches, table grapes, mangoes, and strawberries. As the supply chain of these four produce will be investigated in this research, their geographical elements, production volumes and market structure as background knowledge of case studies were described.

The following chapter looks at the supermarket chains of the case studies and describes the supply chain structures and relationships between players.

Chapter Six

Structure and Key Relationships in Supermarket Fruit Chains

6.1 Introduction

This chapter explains the case study findings by describing the supply chain structure and relationships between the players. The players are defined and their relationships in terms of ordering and pricing are investigated.

The literature argues that option contracts need long lead times, a short selling season and high demand uncertainty. Earlier studies have demonstrated that the first two requirements are credible in agri-food supply chains (Ahumada & Villalobos 2011; Blackburn & Scudder 2009; Cai et al. 2010), and is also evident by the product characteristics described in chapter five. But the question in demand uncertainties remains unclear and is addressed in this research.

This chapter is based on case study supermarket chains operating nationally with more than seven hundred stores within Australia. Four fruit chains of mangoes, strawberries, grapes and peaches are studied in the supermarket chain. As mentioned in Chapter 4, supermarket managers, growers, suppliers and representative of fruit associations participated in the interview program. This chapter addresses the responses of interviewees in regard to the

relevant issues of designing and applying option contracts. The chapter focuses on chain structure, processes and relationships. It answers the questions about how the supermarket manages the ordering process, how the supermarket and the suppliers set the price, what the key issues in the fruit supply chains are, and what the impacts of consumers' demand on the supply chain are. Answers to these questions, which are considered as findings in the thesis, will assist to answer the research question and investigate the research aim in the next chapter.

The quotes from interviewees are provided if necessary. To maintain confidentiality, they are addressed with the fruit initials- for example M1 refers to an interviewee in a mango supply chain.

All the description and discussions below are at a national level. The Supermarket refers to the whole organisation with all stores. The planning and orderings for example are for the national demand and supply. The store level planning and ordering, which is more an internal relationship between the Supermarket DCs and the stores, and are classified as secondary network (refer to Figure 3-5) are not discussed in this thesis, unless noted.

6.2 Supermarket fruit chains: a generic perspective

In this subsection, the supply chain is described and the various players and their roles in the chain are explained. This is based on the interviews with the players in four fruit chains as noted- the Mango, Peach, Strawberry and Grape chains. The supply chain players and their roles are consistent throughout the four case studies. Therefore, in this chapter all the descriptions and definitions are valid for all four case studies unless noted.

Supermarket refers to a specific supermarket which participated in this research. The name of the supermarket is confidential due to ethics considerations. Supermarket with capital S is used throughout the thesis to distinguish between the supermarket subject of the study and other supermarkets in Australia.

Category managers have been interviewed in the research as representatives of the Supermarket. The category manager of each produce within the Supermarket deals with the

growers and decides with whom to trade- in effect, the supplier. However they follow the Supermarket policy and strategies so that the interviews with category managers and their responses are used to represent the supermarket chain as a business not a person.

Direct grower refers to the growers who supply the Supermarket directly. These growers are large enough to be able to provide high quality produce for a longer period of time during the season. In addition, these growers own more orchards than the other growers that enable them to provide large volumes of fruit. Direct growers are also able to market other growers' produce to the Supermarket. They could play two roles in the Supermarket chain- as grower and supplier.

Marketer refers to one of the supply chain players that trades with the Supermarket. The suppliers do not own orchards, but they supply fruit to the Supermarket. Their role is to link the growers to the Supermarket by sending their crop to the Supermarket. The in-depth information about how the suppliers deal with the growers and the Supermarket will be provided in the following sections.

Indirect Grower refers to the small or medium size growers who supply the Supermarket through the *suppliers* or *direct growers*. These growers are able to produce quality fruit but because of the volume they produce, the Supermarket prefers not to deal with them directly.

Supplier refers to the businesses that supply fruits to the Supermarket directly including both direct growers and marketer. The term supplier is used in the thesis when the role of *marketer* and *direct grower* are similar. The Supermarket deals with the direct grower and supplier in the same manner. For example, the Supermarket ordering policy would be the same for both direct grower and marketer. These two players play the role of supplier to the Supermarket.

All the descriptions below are based at the national level of trading. The Supermarket category managers deal with the suppliers in such a way as to be able to supply fruits at the national level. It is notable that due to long distances between the east and west coasts of Australia, the Supermarket plans the western side independently from the eastern side. This research investigates the eastern side and national level refers to this area which includes the five capital cities of Melbourne, Sydney, Brisbane, Adelaide and Darwin. The

Supermarket’s western division acts in the same way as in the eastern side. The western side is capable of managing, producing and consuming the fruit at the same state, Western Australia. There is no movement of goods between eastern and western states.

The Supermarket’s purchasing strategy is direct supply from the suppliers in private negotiations. This strategy enables them to provide consistent quality fruit to their consumers. They reduce the uncertainty involved in quality and volume of produce by this strategy. In addition, each category manager deals with smaller number of suppliers which enables them to collect history of trading for each of them. The detailed description of how the Supermarket deals with the direct growers and marketers in terms of planning, ordering, pricing and quality will be provided in the next sections.

Figure 6-1 indicates the whole-of-chain fruit Supermarket chain. All the players from the beginning point of the chain to the end point of the chain, which is retail outlet, are shown in this diagram.

Indirect growers use third party logistics companies to transport the produce to the marketers. Marketers and direct growers also apply third party logistics companies to deliver the produce to the Supermarket’s distribution centres. The figure only shows one DC, but, there are in fact several DCs in the capital cities. The fruits then are delivered to the retail outlets according to the store’s demand. The Supermarket uses its own trucks for delivery to the retail outlets.

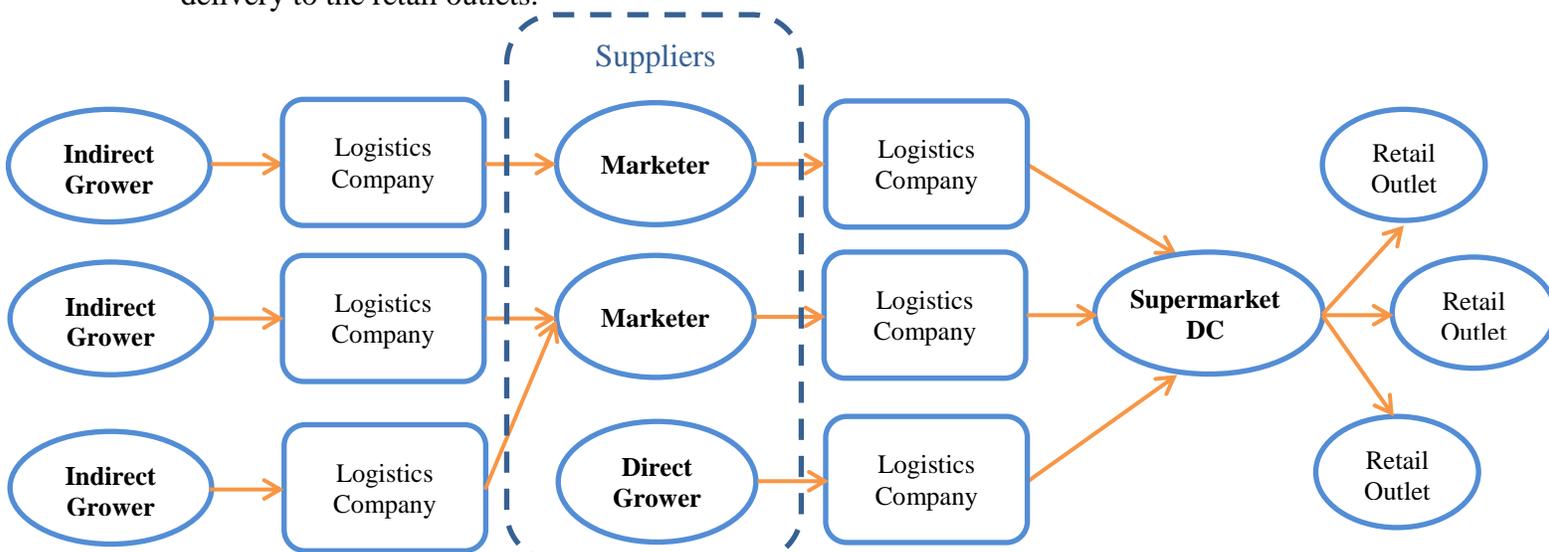


Figure 6-1 Schematic of whole-of-chain fruit supermarket chain

The third party logistics companies do not add value into the supply chain in terms of increasing the price. There is no purchasing contract between the suppliers and logistics companies. The transportation company receives payment based on the size and distance of transportation. Their role in the supply chain does not impact on the contractual relationships between the Supermarket and suppliers, and marketers and indirect growers. Therefore, they are not considered in this study as major players in the supply chain.

The relationships between the Supermarket DCs and the retail outlets are considered as internal relationships. This part of the chain also does not impact on the contractual relationships between the Supermarket and the suppliers. As a consequence, the major players in the chain are *Indirect Growers*, *Marketers*, *Direct Growers*, and *Supermarket*. These players are shown in bold colour in the figure above.

6.3 Supplier/buyer relationship in fruit chains

The Supermarket trades directly with the direct growers and marketers in private negotiations. The supply chain is a two-level supply chain with one grower and one supermarket when the Supermarket trades with the direct grower. The supply chain becomes a three-level supply chain with grower, marketer and the Supermarket involved in the chain. The schematic sequence of the players in the supply chain is shown in Figure 6-2.

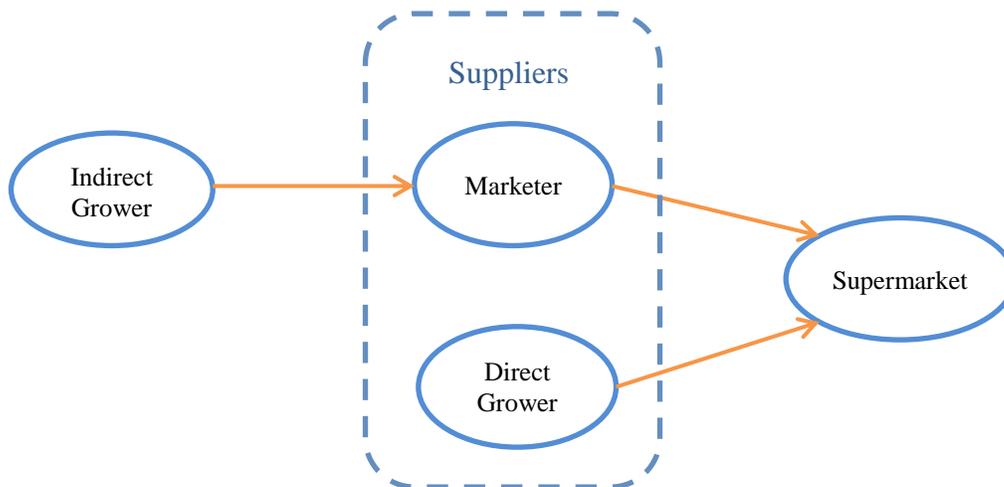


Figure 6-2 Schematic of players in the supply chain

Following Cox's framework (Cox et al. 2004), recognising players in the chain that exert power is crucial. Players in the chain are either sellers or buyers. The power can be examined in patterns of buyer/sellers in the chain. One buyer and one seller in the chain creates a single dyad relationship. On the other hand, a buyer becomes a seller when the firm plays in double dyad relationships. Cox describes these players as Janus-Faced.

Single dyad and double dyad supply chains and role of players are described in the following subsections.

6.3.1 *Single dyad chain relationships*

In a single dyad supply chain, the Supermarket deals with one direct grower in each exchange. The strawberry chain among the case studies follows single dyad chain relationships with only direct growers as the major suppliers to the Supermarket. Direct growers play in mango and grape chains with existence of marketers. Configuration of a single dyad chain with several direct growers is shown in Figure 6-3.

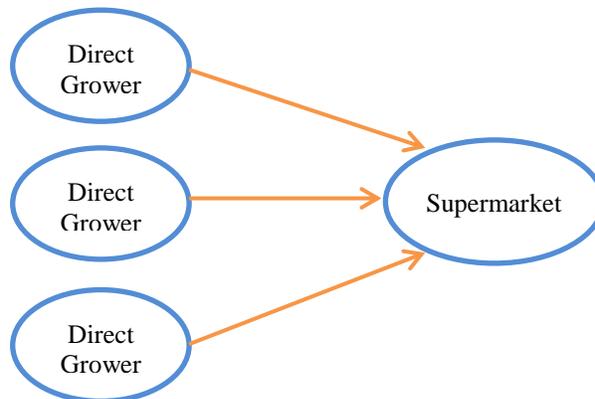


Figure 6-3 Configuration of a single dyad supply chain

Direct growers receive the order quantities directly from the Supermarket. Then they deliver the crops to the Supermarket's Distribution Centres (DCs). The third party logistics providers are used to transport the fruits to the DCs. As mentioned before, the transportation companies do not impact on the contractual agreements between the direct growers and the Supermarket. The Supermarket and the direct growers set the delivered

price, which includes the transportation costs at the growers' side. Applying third party logistics impacts on the chain relationships from other perspectives rather than contractual and pricing arrangements. These impacts will be discussed in the relevant following sections.

6.3.2 Double dyad chain relationships

When the supermarket trades with the marketer, the chain relationships change into a double dyad chain exchange. This is because the marketers do not own the orchards and they have to source their fruit from the growers.

Stone fruit chains follow the double dyad chain without existence of any direct growers. Mango and grape supply chains comprise both direct growers and suppliers. Double dyad chains are created when the growers are not large enough to be able to deal with the Supermarket. Therefore, the Supermarket applies a marketer role in the chain in order to deal with smaller number of suppliers. Since the marketers exclusively play in stone fruit supply chains, the following discussion describes the peaches chain as double dyad chain relationships.

The marketers in fruit chains are large companies that market several fruits and vegetables to the Supermarket chains. There are only four of them who supply stone fruits to the Supermarket. All the growers must market their fruit through these marketers unless they wish to change their strategy path- for example, by considering the export market or selling at the wholesale market.

The marketers play the Janus-faced role in double dyad chain relationships. They behave as buyers when trading with the indirect growers and behave as sellers when dealing with the Supermarket.

The role of marketers in double dyad supply chains can be compared to the role of market agents in the wholesale market. The marketer on behalf of the growers markets the fruits and receives their commissions according to the transaction.

The significant role of the marketer in the supply chain is to consolidate several growers' produce and deals with the Supermarket in terms of ordering and pricing. The schematic configuration of players in double dyad supply chain is shown in Figure 6-4. Each colour for the arrows indicates that the marketers deal with several growers and collect their fruit in order to supply to the Supermarket. The number of growers in a real chain is more than what is shown in the figure.

There is no obligation for the indirect grower to trade with one marketer. The indirect grower can choose to trade with more than one marketer as long as he is accredited by HACCP⁹ and is capable of providing consistent quality fruit.

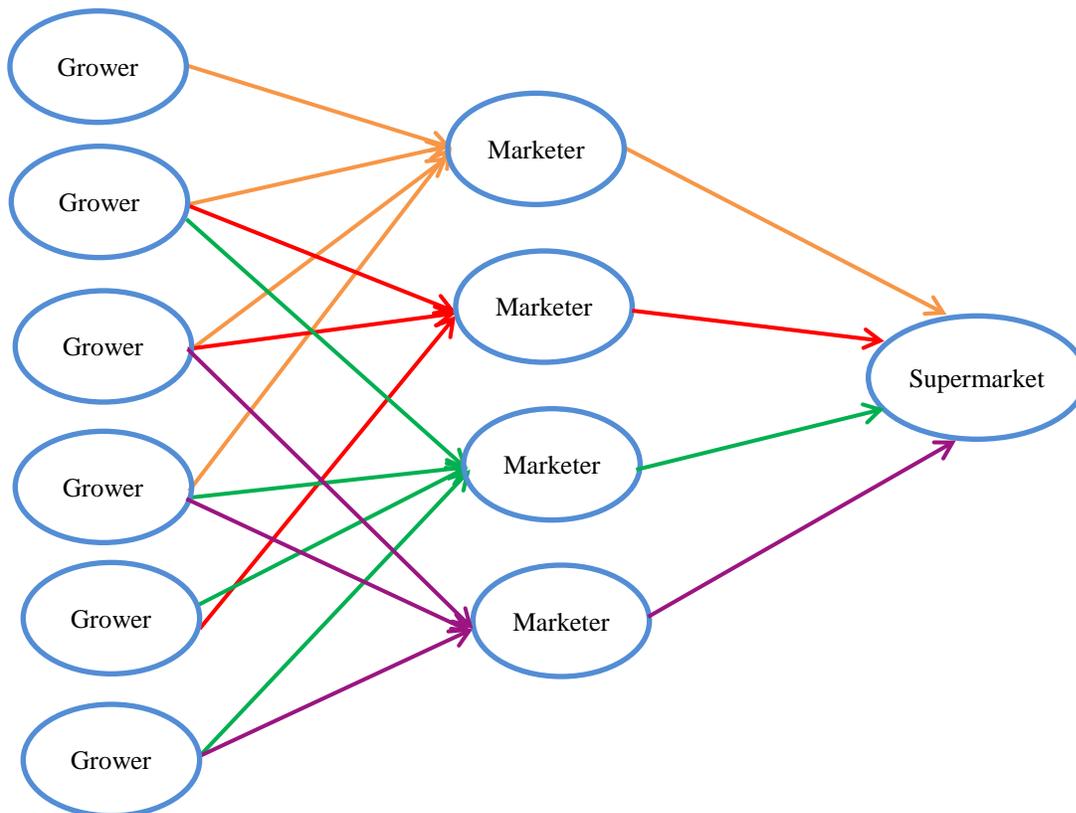


Figure 6-4 Configuration of double dyad supply chain

⁹ Hazard Analysis Critical Control Points

The fresh produce is transferred from the farm to the stores by trucks and sometimes trains (when the farms are located in the Northern Territory- as in the case for mangoes). The growers send the fruit to the marketer's warehouse; and the marketer then distributes the fruit to the desired Supermarket DC, which are usually located in the capital cities. The fruits then are distributed from the DC to the Supermarket stores upon store request.

In general, the suppliers in both single dyad and double dyad chains deliver the fruits to the DCs most likely using third party logistics companies. Distribution from DC to the stores is the Supermarket's responsibility and they use their own logistics systems. Distribution of fresh produce needs specific logistic facilities such as refrigerated trucks to be able to keep the produce at the required temperature. The details about the impact of logistics and its cost on the supply chain will be discussed later in this chapter.

6.4 Chain processes and the structure of the supply chain

This section describes details of the chain processes in single and double dyad relationships. Planning, information sharing, ordering, negotiations and pricing process, in-store promotions and quality maintenance are the key processes in the chain which all impact on the contractual relationships between the players. All these processes were explored in the interviews and the following subsections describe each in detail.

6.4.1 Planning, information and ordering processes in supply chain structuring

The planning process for each fruit follows a similar process. In the following paragraphs this process is first described and then analysed. This includes the process of planning and ordering between the Supermarket and suppliers¹⁰. The ordering process described in the following discussions covers the process to the Supermarkets' DCs. The processes of how the Supermarket accumulates all the store demand and also how it distributes the fruits from DCs to the stores are not described in this thesis. These are the Supermarket's internal issues and are outside contractual agreements between Supermarket and suppliers.

¹⁰ Suppliers include direct grower and marketer.

Planning and order negotiations happen between the Supermarket and the suppliers. The indirect growers are not directly involved in planning. They receive the information from the marketers and pass the required information to the marketers.

The planning process starts when the last season finishes. The first step is to receive the forecasts for next season from the forecasting team. Forecasting occurs internally to the Supermarket and produce by produce. Then the category managers determine commitments for each supplier based on their individual performance and reputation in terms of quality and volume of fruit.

The suppliers rely on the commitment by 90% accuracy and work through the year to make sure they will be able to supply the volume with the required quality during the season. Six to eight weeks before the season starts the suppliers update the Supermarkets in terms of volume and possibly quality. The growers¹¹ are able to estimate more precise volume as it gets closer to the season based on flower counting, fruit counting, number of plants and yield.

In addition, the Supermarket is able to update the consumers' demand when it becomes closer to the season. The updated information guides the grower to compare the forecasting demand and predicted fruit volume. Although fruit production is outside the farmers' control, the growers can decrease the amount of potential volume by pruning the orchards. The grower cannot manipulate the trees to fruit more, but they are able to decrease fruiting.

The planning and information sharing are started in the review meeting. This meeting is usually appointed four weeks after the last season finishes. The review meeting includes analysis of the numbers in terms of volumes, prices and default performance of the last finished season. Furthermore, the ability of production for the next season is discussed in this meeting. However, due to the lack of clear information regarding the production volume, the discussion about the accurate plan is postponed to the later meetings.

M1: At the end of every season we do our review meetings. We analyse the numbers in terms of the sales volume, average pricing, our default performance and how we met our agreed targets on delivery in full fresh and on time. We have key measures which we agreed with [the supermarket], and we review those end of the season. We review the targets that we've set from

¹¹ Grower refers to all growers including direct and indirect growers.

the previous year, we review how the products performed in the stores, the level of waste and that review will become the starting point for the planning for the current season.

G1: In terms of volume, We do that probably once a year. We have a formal conversation around that but certainly more regularly than that we would provide them with updates for the following season. So we are already starting to give them indications of what the crop looks like for next year as well as the current trading season.

Six to eight weeks before the season starts, the parties have another meeting referred to as the pre-season meeting. In this meeting which is closer to the starting day of the selling season, they refine the previous plan and decide about the number of trays and volumes in more precise detail. They try to plan the coming season in SKUs (Stock-Keeping Units) by DC destinations by week. Promotions are also discussed in this meeting. They agree on what volume they are going to promote in what weeks of the season.

In this meeting both the Supermarket and the supplier can provide clear information regarding the forecast of production volume and consumer demand, respectively. The farmers count the flowers on the trees to estimate the volumes in the season.

M1: As we get closer to the season we refine that plan. We break it down by SKU by state distribution facility by week.

Other interviewees confirmed the M1 statement.

M3: We have a preseason meeting where we talk about what they want for the season as far as some volume, some varieties. Then we just take the season on go. Generally probably about 6 weeks before the season starts we have the preseason meeting.

M2: As we get closer to the season we start to talk about what volumes we have. We know flower to fruit takes x amount of period.... We do a flower count. And we say we should have that amount of trays by that time.

P4: For peaches we do it about six month out, because it depends on how the tree flowers, how it responds, etc. We don't do it as far in advance not because they are not committed to what they supply because they don't have good understanding how the crops going to look like.

The planning for strawberries is slightly different. This is because strawberries are annual plants. The growers must plant the crops each year. They need to have a precise plan and decide about the number of plants they are going to grow for the next season.

S1: you look X amounts of trays have to be sold this year. Generally one plant grows about three punnets for a season. So we look at that. Different varieties of strawberries grow at different times. So what we do before start the season, we plant every year strawberries.

S2: The reason for that is for strawberries we need to purchase the plant. So you need to start basically from nursery. We hope to get 1.2 million trays of that produce. That means that we have to buy 800000 strawberry plants from nursery. That's how we go with strawberries.

The communication and information sharing between the suppliers and the Supermarket continues through the season more frequently in terms of the ordering process. The Supermarket during the peak season talks to the suppliers daily and asks for information about the available volume and quality of the produce. The intense and frequent information sharing between the parties remains crucial for the whole season.

M4: [W]e speak to the growers in the season every day, is the crop coming along, is it harvested, is it raining, is there disease, how's the transport, specially out of NT, because transports are nightmare. How does the fruit ripening? Is it ripening quickly slowly, because it really changes day to day?

S3: So pretty much what we do for strawberries, we flower counts four weeks in advance, so the flowers determine how many strawberries will come up in four weeks. So we do four week forecast, three week forecast and then two weeks out from the actual time they have to clean it, we send the order

The ordering process is weekly. More specifically, the Supermarket makes the orders on each Thursday to receive the produce on the following Wednesday at the DCs. The delivered fruits can be distributed to the stores and effectively on sale for the Thursday. The short ordering timeframe highlights two issues- first the very short life cycle of produce and second the variability in supply availability.

Although the supermarket and the supplier set the ordering plan and schedule prior to the season, there are always ongoing negotiations between them during the season.

Furthermore, even if the Supermarket and supplier consider this issue, uncontrolled weather events change the plan. In other words, the fresh produce season is very dynamic regarding the volume. It is essential for the parties to negotiate with each other. They talk to each other sometimes two or three times per day. They need to refine the plans promptly and decide about the changes.

The above description shows how the Supermarket and suppliers act and decide regarding the planning and ordering issues. They have close relationships which enable them to trust each other. The suppliers are not concerned whether the Supermarket purchases the committed volume. Similarly, the Supermarket believes in suppliers' loyalty. However, both parties are aware of changes in the planning due to supply uncertainties. Weather can change the plan and available volume by days or even weeks.

Their kind of relationship allows both of the Supermarket and supplier to have flexibility in ordering. During peak seasons, if the suppliers or direct growers have more fruit than what the Supermarket requested, then they communicate with the Supermarket and negotiate to increase the ordering quantity. When a supplier cannot supply the requested order due to natural events, the Supermarket negotiates with other suppliers to increase their order quantity.

Despite the flexibility sometimes the suppliers cannot manage to respond to the increased request. This is because the suppliers do not exclusively supply to the Supermarket and they are committed to supply to other supermarkets.

The marketers and indirect growers have similar relationships in terms of ordering. Marketers select which growers they tend to trade with according to the growers' history of supply. Their decision is approved by the Supermarket since the indirect growers' fruit quality has to be confirmed by the Supermarket. The marketers meet and talk with the indirect growers during the off-season. This is, first, to indicate the required fruit volume and planning schedules to them, and second, to inspect the farms in term of the quality standards and growing process.

M3: We work with 4 growers. It is enough because you have to have a specific grower to pack for [the Supermarket]; you cannot just have a grower. These guys grow good products, they have been with [our business] for 15 years.

The marketers are in constant touch with the indirect growers during the season. They receive updated information about the available volumes and quality of crop from the indirect growers. The marketers collect information from all growers and notify the Supermarket of the available volumes. The final order quantity from the Supermarket is passed on to the indirect growers. The indirect growers pack the fruit and deliver it to either the marketer's warehouse or to the DCs- the delicate fruits with high rate of deterioration (such as stone fruits) are delivered directly to the DCs, and mangoes are delivered to the marketer's warehouse at such a time as to allow for ripening.

6.4.2 *The role of negotiations and the pricing process*

Price is a crucial item in this business. In the review and pre-season meetings, both parties discuss the volume and quality; but price is not negotiated in the early stages. It is decided, in fact, week by week based on the availability of the crop.

Price is set through a negotiation process for each weekly order and not at pre-season meetings, although the cost of production is approximately known. Fresh produce prices are supply rather than demand driven and the amount of available produce has a negative impact on the prices. This means that during peak times prices decrease in response to high volume.

The price negotiations begin with the suppliers. The Supermarket receives all price offers from the suppliers and then makes a decision about the choice of supplier. If the suppliers do not agree with the Supermarket's price offer they negotiate with them again. However, most of those interviewed believed that the price offers are in the same range from both parties.

P2: There is a called [Supermarket] supply portal, we log into that and put our volumes per state, what's available, our price. And we are generally pretty close, we talk negotiations, it might be 50 cents or dollar. Sometimes they might ask for \$25 and we say we give you \$26. You

know, it is generally very close. We all in tune with where the market is, what the volumes are, and what the weather is doing. I reckon we are on the same page; it is very close any way.

P1: Price's driven by week to week pricing during the season by supply and demand of course, where the market is weather impacts. So that's where the negotiation side of it comes in also throughout the season. and when you talk about apples and pears, they stored in a room so they are not going anywhere, but stone fruit's changing every day, bit of rain, heat, whatever weather impacts everything you do. So that's where the negotiations come in. I think everyone just like to set the price for the season but that just not possible because if heat's pretty high, the price goes up, demand goes up.

S1: we are not in the farm every day so like a stock market every day fluctuates we do a week on week slaps of prices and those prices are according to the volumes we have.

The main parameter in pricing is the available volume. The Supermarket and suppliers will follow a 'promotion strategy' when supply volumes are large and will lower prices for fruits in order to stimulate consumer demand. Promotions and their impacts on the chain are discussed in the next section.

Prices fluctuate during the season according to available volumes. In general, the prices at the beginning of the season are high due to supply shortage. Only a small percentage of farm regions produce fruits at the beginning of the season; but closer to peak times the available volume increases and prices decrease. After the peak season the prices increase as volumes decreases until the season ends.

G2: Normally in the first half picking prices are very high, and then it comes back every week. The price drops, because there are more and more fruit and more and more regions start to pick which will have an impact on the pricing. By the time it gets to the main region which is in Sunraysia in Mildura, by that stage it sort of fluctuates. By the time you have one sort of basic price and it fluctuates if you get promotion. And you try to give them better price and trying to shift more volumes. The price is all driven by how much fruit you have got to sell.

M3: At the start of the season it is extremely high, as you get in to the season it calms down and as you come to the end of the season it spikes up again.

M1: High price at the start of the season, high price at the end of the season, and wide fluctuations in between.

Price fluctuations during the season depend on the characteristics of the produce. Some fruits like mangoes, apples, pears, grapes can be stored for several weeks to months. The need for prompt sale is low, although inventory costs must be factored into price. This encourages the suppliers to apply a 'promotions strategy' for these fruits also. Some other fruits are more delicate (such as strawberries and stone fruits) and have to be sold and consumed in a short period of time. Pricing for these fruits are more volatile and are supply driven.

Prices are supply driven, but supply volume is dependent on weather events - high temperatures, rain, and sun exposure can impact the available volume. Severe unexpected weather events such as floods and cyclones may impact farms in the longer term. This can ruin enormous volumes of supply and therefore increase the price during the season.

Clearly, supply availability has a significant impact on price; but this is not the only parameter of concern in the pricing process. From the Supermarket's perspective, providing consistent high quality produce to the consumers is even more crucial than price. Quality impacts on pricing negotiations and as noted, the Supermarket trades with a limited number of suppliers in each produce category. They prefer to maintain a long term relationship with the suppliers. For most suppliers having a long term relationship with one of the major retail chains in Australia is considered more important than selling fruit at slightly higher prices.

The indirect growers are not involved in the pricing negotiations. The marketers negotiate on behalf of the indirect growers, and pass the price associated with the order quantity to them. The marketer receives the information about the projected supply in the next week from all the growers and it is the marketer's responsibility to consolidate all forecasts and negotiate the price with the supermarket. The grower does not deal with pricing. He receives the order and prices for the order from the suppliers and will normally accept the price.

The marketer has to offer a price which is both competitive with that of other marketer's offers, and is in the favour of the indirect growers. The marketer signs a contract with the

indirect growers in terms of the minimum return to the indirect growers- which gives stability of return to the indirect growers.

P2: We have to sign a contract with growers at the start of the year as far as a minimum return. For example we agree not to return the grower under \$17. So we are bound by that contract. I need to take that into the consideration, [also] I need to take that into consideration where the market sits.[...] the main thing for us is the return for the grower, because our business cannot survive without grower.

P2: If I know that for example at the wholesale market the price is \$30, then I need to sell to the supermarkets at \$27 to give them the advantage for competition.

6.4.3 In-store promotions and the impacts on the supply chain process

Promotions are an inevitable strategy in the fruit retail chain with the objective of selling as much as possible in the peak season. The Supermarket encourages the consumers to purchase more fruit by promoting it at lower prices. Promotion volumes for each fruit are agreed before the season though timing is uncertain. Peak season promotions benefit both the Supermarket and the supplier- enabling the suppliers to sell the fruit in bulk and avoid waste and the Supermarket to pay a lower price for the fruit.

G2: You sell much more fruit when you're on promotions rather than off promotion.

Promotions normally occur over several weeks in the season and the Supermarket schedules the promotion in each state week by week. For suppliers who supply nationally to the Supermarket, this is a considerable benefit.

Promotions affect the demand significantly. The Supermarket observes an immediate increase in demand in the promotion week. The week after the promotions, however, the demand decreases significantly. This is because the consumers usually buy bulk in promotion weeks. Also, the increase in price after promotion will affect the customers' perception. This is an issue especially for stone fruits and mangoes, which are considered as luxury fruits in consumers' mind. Demand for strawberry, grapes, apples, and bananas are slightly different for these fruits are either used in cooking or consumers believe in their nutrition.

Promotions also affect the demand in other fruits at the promotion week. Fruits are in competition with each other. Even various varieties of one kind of fruit are competing to gain consumers' demand. This fact is discussed in detail in Section 6.6.

6.4.4 Quality maintenance as a key issue

Maintaining the quality of fruits within the supply chain is a key task. Fruits are perishable, and the quality of the crop decreases over time. This fact influences the entire supply chain activities including the relationships between the Supermarket and the suppliers.

The Supermarket has recently changed its trading strategy. It used to trade at the wholesale market to supply fruits into its stores. They had to purchase fruits on the day at the market price and available quality. The Supermarket changed the trading strategy from wholesale market to private marketing to be able to provide consistent quality produce and in order to achieve its quality goals, introduced Standard Specifications to the suppliers. The Standard Specification document determines the requirement of the produce in terms of its eating and appearance quality. Farmers also have to provide a high quality and premium grade product to size and shape specifications as required in the specification document.

The following subsection describes the quality checks required and the consequential impacts of quality on the supply chain.

Definition and description

The standard specification document includes two groups of standards. The first group relates to the eating quality of the fruit. The defects associated with these standards are considered to be major defects. Rots created by fungi and bacteria are major defects and impact both consumers health, and reputation of the Supermarket itself. The second group of standards defines the appearance quality of the crop and includes the size, shape and colour of the fruit. The defects associated with these standards are considered to be minor defects. They do not damage the eating quality of fruits, but they are likely to impact on the visual experience of the consumers. The Supermarket only accepts first and premium grade fruit in order to provide a consistent visual experience to the consumers. Introducing strict

standard specifications forces growers and suppliers to apply tight grading processes, and only select the best crop in the boxes delivered to the Supermarket DCs.

Pre-season activities

Quality is a subject that is discussed in both the review and pre-season meetings. The reputation of the supplier is correlated to quality consistency and rejection rates. In the review meeting the Supermarket and the supplier study the historical record of the quality checks of fruits at the DCs and list the reasons for rejection, and minor and major defects. This quality review achieves two main aims. It enables the Supermarket to decide the next season's commitment of the supplier; and it provides an opportunity for the supplier to request changes in the standard specification document before the season starts.

MI: We have a document specification. As part of the review process we reanalyse that every year in conjunction with [the Supermarket]. And determine whether we need to make changes. So were we happy with specification? Did it work for both of us? In line with the consumer's data [that] we have is there any change with the consumer expectations? Do we need to lift the gain on specific attribute? Can we reduce the tight constraints?

Changes in quality standards caused by major defects are unacceptable because of the likely impacts on the consumers' health. In contrast, changes in the appearance quality standards are allowed and need to be discussed with the Supermarket. Minor defects are often caused by uncontrolled weather events- the amount of rain in the season, temperature fluctuations during the day and/or the night, and wind conditions may lead to minor defects. The size and shape of crop may also depend on weather conditions. As a consequence, the supplier is able to request a revision of the standard specification document. The request can be made in the pre-season meeting or when weather events occur. The suppliers are able to predict the crop size and shape by studying the growth of fruit on trees and can request a variation from the standard specification document prior to the start of the season.

MI: In terms of quality we do that as a part of review process. We agree on new changes before we get to the season, and we move forward on that basis.

M1: The size profile (the percentage of the crop that is in the individual count sizes) that varies from year to year depending on the growing conditions. As part of the review process we look at the previous year, we look at all the information that is available to us on our forecasting and the known impacts. Then we propose to [the Supermarket] size profile changes, which we agree or disagree on. 9 out of 10 [the Supermarket] take what we tell them.

In-season activities

The crops are quality checked on arrival at the DC by quality control officers who apply specifications and control the quality of fruits according to the specification document. They randomly check the boxes and test the fruits. If the quality of the fruit satisfies the standards, the produce will be unloaded at the DC; if it does not, either the whole batch or a portion of it will be returned to the supplier. The rejection process may involve negotiations between the Supermarket and the supplier about the reason and volume of the rejection. The following scenarios are not unusual.

Scenario One- The rejection is because of major defects in the fruits. The supplier understands that the Supermarket does not accept any variations to the major defects and must take the responsibility for supplying unacceptable fruit. The supplier pays the transportation cost. If the crop is severely damaged, the supplier asks the Supermarket to dump the consignment.

M1: They're highly unlikely to accept an increase in major defects. Major defects are rots. Things that Mother Nature do impact on consumer experience so we don't expect them to change on major defects. They have very little tolerance for expanding that little.

Scenario Two- The rejection is because of minor defects and exists as a small percentage of the total volume. This might occur because of careless grading- mixing smaller size fruit with the required size, for example, or putting damaged fruits in the box. The supplier accepts the rejection and pays the transportation cost. The destination of rejected fruit consignment could be either the warehouse or the wholesale market based on the conditions of the crop. If the rejected fruit is still good enough to be sold in the wholesale market, it is likely to be transported to the suppliers' stand at the wholesale market. The appearance

quality standards acceptable by the buyers at the wholesale market are lower than the Supermarket's and the fruit may be sold, preventing waste.

If the rejected crop is not ready to be sent to the wholesale market, then the supplier asks the Supermarket to send it back to the warehouse. An example is the fruit is not ripe enough to be sold.

M2: Unfortunately, the first week of the supply we did not ripen them at the right quality. The stages of ripeness, which will give them time to go through their process to sell that fruit to the consumer to have a ripe mango. I think we gave them one stage backwards. It was too green, where you as a consumer had to wait another 2-3 days to consume the fruit. That fruit was rejected and then we make sure other orders will go right.... We took that rejection to the wholesale market and then sold it there. It was not a quality issue; it was just a bit of wrong time framing.

Scenario Three- The rejection is due to minor defects in most of the fruit. This may happen because of a significant weather event affecting all the crops from the same region. The whole market including the Supermarket chain, other retail chains and central market are affected and negotiations will recognise this factor.

Although the possibility of revisions would be considered in the pre-season meeting, the Supermarket and the supplier cannot be sure that they have considered all aspects of minor defect in the revision process. Weather events can influence the crop's appearance quality during the season and a request on variations can be made during the season. As mentioned, the suppliers and the Supermarket are in close contact and share any available information regarding the production process. When weather events happen and damage the fruits, suppliers may ask the Supermarket to go to the farms and observe the situation. This helps the Supermarket to make an informed decision about the variation request. If the Supermarket agrees with the request, the definition of the premium and first grade will be changed and a new document is sent to the DCs for quality checks. The supplier prevents the possible rejections in the future by revising the document. The considerable uncertainty of weather events is the reason why the Supermarket accepts the changes in the standards

and variations may be effective either for a specific period of time or up to the end of the season.

M1: At any time outside that review we have ability with [the Supermarket] to seek a temporary variation to any specification that we have. For example we might review the previous season and agreed there is no need to new change. All of the sudden we have a period of high wind or high rain which impacts the visual quality of the fruit, and it may look a bit softer or may be some addition pink spot from insect damage. [The Supermarket] will sit and discuss with us the ability to accept a high degree of those minor defects

M3: If we see in the growing that there are issues, we will bring [the Supermarket] to the farm. We put a variation sometimes; variation means that we can alter specification. We put more marking [and] spots.

G2: The size of crop which we did this year for a specific variety, in the spec doc they want 16mm fruit and this year the fruit was smaller than normal we did a variation on the specification and change it from 16mm to 15mm.

Providing consistent quality fruit is the marketer's responsibility in the relationship between the marketer and the indirect grower. The marketer uses field representatives to check the quality of the crop and ensure that the sugar level, size, shape and other quality issues meet the required standard specifications.

M3: We know what expect is for premium fruit; we try to meet that from farmers when they are growing products, what they are doing to make sure they can achieve as many premium as they can.

P2: We have system in place there with [Supermarket] requirements, our requirements. We have a field rep who goes around tests the sugars, tests pressures, makes sure it's not exceeding the amount of defects that are allowed in that pack. And obviously it can't be every grower every day

The marketer inspects the quality when the fruit arrives at the warehouse. If it is compatible with the Supermarket quality requirements, the marketer accepts the fruit; if not, the fruit is returned to the farm. The indirect grower has to pay for the transportation costs. The impacts of quality rejection on the costs at the supply chain are discussed in 6.5.

Quality is a serious issue in the fruit chains; but despite the tight quality standards required by the Supermarket fruit deterioration plays an important role in the supply chain. Although the suppliers check to maintain the quality during all stages such as growing, picking and packing, uncertainty about quality must be considered as a challenge in fruit chains. This is the key difference between deteriorating produce and other non-perishable products such as toy and apparel which becomes an additional requirement in applying option contracts in the fruit chains.

6.5 Supply chain costs

The process of producing fruit and delivering it onto the store shelves involves costs. This cost is split between all the players in the supply chain and in this section, all the costs involved in the supply chain are explained from grower, supplier and Supermarket perspectives. The cost parameters are crucial in this research because in order to design and implement option contracts it is necessary to understand all the relevant cost parameters to be applied in cost functions.

6.5.1 Key factors impacting growers costs

From the grower's perspective, costs are related to investment, maintenance, harvest, packing, storage, transportation and quality.

Investment costs may require significant amounts of capital- but these tend to be relatively infrequent. They are required for upgrading infrastructure, building new facilities for cooling and packing, purchasing new orchards, and breeding or purchasing new varieties. Fruit trees such as stone fruits only fruit for up to 10 years and it takes 3 to 5 years for a tree to start fruiting. There will likely be a need for ongoing investment over the period. For annual crops such as strawberries the investment is an annual cost as the grower must either purchase plants from nurseries or grow seedlings himself. Both scenarios are costly. Grapes, on the other hand, do not need annual investment since each grape vine lasts for many years. However, if a grower wants to supply new varieties, he must purchase the plants and invest the associated costs.

G2: We continue investing; buying properties, invest in infrastructure, new varieties. Every year, last year bought 100 acres around Mildura to bring new varieties on. We built bigger cool rooms, bigger packing facilities. Every year we reinvesting into the business.

The required investment capital may come from various sources and will be related to turnover, reputation and relationships. Some of the interviewees noted that they use their own capital to invest on the farm. Direct growers who have more land and higher turnovers are able to fund their own investments. They prefer not to use bank loans to ensure freedom from the control of the banks.

In some cases the Supermarket may directly fund the direct grower to assist with the provision of facilities to protect the crops from weather events. This co-investment is under the condition that the grower will supply exclusively to the Supermarket. The grower highlights this co-investment as a win-win situation for both himself and the Supermarket. From the grower's point of view, it reduces supply uncertainty caused by weather events and exclusive supply to the Supermarket reduces the uncertainty in selling the crop. He is assured, also, that all the fruit grown will be purchased in the season.

The indirect growers, who are small to medium size growers, not only do not have enough capital for self-investment but cannot benefit from the Supermarket investment because they do not trade directly with the Supermarket. They must either use bank loans or ask their marketers to fund them. There is some evidence that the marketer will invest into the growers' farms by purchasing new varieties for the farm. In return the grower must market all the fruits through that marketer.

In terms of bank loans, the grower interviewees noted that they could receive bank loans more quickly simply because of their links with the Supermarket.

G2: We don't receive funding from supermarkets. But we get funds from banks because we supply [the Supermarket]. They know our business plan and they know we supply [the Supermarket] so they work with us.

The relationships between direct growers and Supermarket, and suppliers and growers in terms of investment highlight the fact that their businesses and relationships are based on both trust and long term relationships. It takes up to 8 years to breed and get fruit from a

new variety so that in the absence of long term relationships such investments are almost impossible.

Investment costs could be claimed to be an indirect cost of production and should not be considered in an option contract. However, it is important in terms of players-relationships in the supply chain. This will be discussed in the next chapter where the assumption of a retailer-led chain is tested.

Fruit growing continues throughout the year. During the off season the growers must maintain the plants in conditions which guarantee the quality of produce in the season and involves pruning, fertilising, pest control, watering, and quality checks to ensure sugar levels, sizes and shapes. All of these tasks are recognised as production costs in the pre-harvest stage and represent major cost factors in the production of fresh produce. Growers usually fund these activities from the cash flow from the last season to investment into the new season.

Because fruit picking is labour intensive growers have high capital costs at the time of harvest; and timing is important to avoid waste in fruit. The first payment from the Supermarket is received at least 14 days after the first order is delivered to the DC. Therefore, the growers must be able to pay at least 14 days of labour costs. During peak times growers may recruit up to 150 workers to be able to pick the fruit.

Cash flow plays an essential role for the fruits that need ripening after harvest, such as mango. The ripening process takes about two weeks so that the indirect growers must pick, pack and send mangoes to the marketer's warehouse two weeks prior to the first delivery. The marketer receives the payment from the Supermarket two weeks after the first delivery. Consequently the indirect grower is paid at least four weeks after first dispatch from the farm, requiring large cash flows and represent a major challenge for indirect growers.

Often the marketer assists the indirect grower by lending funds to meet labour costs. The marketer then deducts these costs when the indirect grower has supplied the required volume of fruits.

M3: We also give growers upfront payments to help them. What happens is when you first start harvesting; they have to pay a lot of wages. They may have 100-150 pickers for example on a week to pick the fruit. Then they have to pack it all and send it. By the time they do this probably about 2 or 3 weeks before any fruit is actually sold. When the fruit comes to us, it takes 7 days to ripen. So you are looking at 2 weeks before selling the fruit, which is two weeks before these guys get money. We may give them \$100000 up front and they can give the wages and then we will deduct that off when we pay for the sale. Actually we do not deduct it at the beginning. We know that grower is in market for 6 weeks, we get it back at the end of the 6 weeks.

There are still costs involved after the fruit has been picked. Fruits are then graded and packed in warehouse sheds located at the farms. Grading and the packing process are also labour intensive. Furthermore, the warehouse must be kept at strict temperature requirements which adds energy and facility costs.

Mangoes in Australia are produced in the Northern Territory and North Queensland and at long distances from the demand market. In this case, the fruits are picked mature but the ripening process takes place at the warehouses located in the capital cities. Direct growers own their warehouses and are capable of ripening mangoes. Therefore, in the mango case study the costs of the ripening process should be added to the production costs. Indirect growers are free from responsibility for ripening costs and it is the marketer's responsibility to ripen mangoes before delivering to the Supermarket DC. The ripening costs in this case must be considered as the marketer's costs.

Transportation costs are met by the sender- direct growers pay for the logistics costs of delivering fruits to the DCs, indirect growers pay to deliver the crops to the supplier's warehouse, and the supplier pays to deliver orders to the DCs.

Because of long distances between growing regions and demand markets in Australia, the transportation costs vary among destinations. Pricing and calculating the associated costs for each state would bring complexity to the businesses. Suppliers and the Supermarket set the prices nationally and ignore differences in transportation costs.

G2: Not always the prices are different from destination to destination. Because we supply nationally we normally look at the Sydney price. And then based on that, we do Brisbane at the

Structure and key relationships in supermarket fruit chains

same price, and Adelaide and Melbourne at the same price. Because for example Sydney is \$2 per kilo, Brisbane is 3\$ per box on freight, and Adelaide is 1\$ per freight. That's why we use Sydney as the base price. And then charge other states at the same price.

The mode of transport differs depending on farm location. Trains are sometimes used to deliver mangoes from NT to Melbourne and Adelaide; but for farms located in Victoria, New South Wales and Queensland trucks are the most common mode of transport. Trucks are usually refrigerated to keep fruits at the required temperature conditions.

All the grower interviewees noted that they use third party transport providers. The third party logistics role is to deliver fruit to the DCs and they do not impact on the contractual agreements. But they play a key role in ensuring the freshness of fruits. If quality loss happens during the transportation in large volumes then the Supermarket and the supplier try to involve the transportation company in lost fees. In some cases produce passes the quality check at the DC but after a short time the quality loss appears. If the quality loss occurs due to lack of care in the transportation stage then the Supermarket informs the supplier. They negotiate the issue and decide according to the volume of loss. In most of the scenarios the Supermarket pays for the loss costs, but asks the supplier to inform the logistics company to make sure this will not happen in the future.

M1: If product has been temperature abused during transport, we won't see it at the DC. They won't see it when they receive the product. But in the day they receive at stores it will show up. We know what the potential abuses in the supply chain are. If something like that happen, we are more than happy to talk about and track back the problem.

M1: It is rarely that [Supermarket] says to us we lost 1000 of trays and ask for refund. It is most likely about 40 trays and they ask could we share the cost, and help them to get the product and money back.

This response of the Supermarket to the quality loss caused by the logistics companies highlights the value of long term relationship from the Supermarket's point of view. The priority is for long term relationships rather than for short term dollar gains from fines.

In addition, using third parties for logistics purposes is beneficial in terms of cash flow. The growers receive the crop prices 14 days after delivery and they pay the logistics companies

30 days after the delivery. This gives them 14 days allowance to have cash flow which is useful for them.

The cost of quality is a critical one for the grower and can be looked at in terms of preventive costs and rejection costs. Preventive costs include the tasks that growers attempt in order to prevent any kind of quality loss before delivering the fruit. These tasks are for example quality checks at the farm such as measuring the sugar content of the fruit, size control and grading. All the preventive costs can be included in the production costs.

Rejection costs on the other hand are standalone costs generated by the standard specification document. As noted (Section 6.4.4), the Supermarket rejects low quality produce caused by minor defects. The transportation cost involved in the rejection process is paid by the suppliers. It will be their decision to either send the crop to the wholesale market or return it to the farm for more investigation or possible repacking for the Supermarket. Both scenarios create costs to the suppliers.

For indirect growers the process of rejection is somewhat different due to the product needs and the marketer–indirect grower relationship. The marketer always checks the quality of fruit at the warehouse. If the fruit does not satisfy the quality requirement in terms of size and appearance, the crops are returned to the grower. The indirect grower pays the transportation cost. However, if the fruit is accepted at the marketer’s warehouse arrival, then all the rejection costs caused by the Supermarket will be on the marketer side and the grower will not need to deal with that.

Those fruits, such as mangoes, which need ripening are always received unripened at the marketer’s warehouse. The scenario is valid for mangoes; but for other kinds of fruit without ripening requirement like strawberry, grape and peach, may sometimes be delivered direct to the DC from the farm during the peak season. This is to decrease the time of supply and response to the market demand. In that situation, the marketer could not check the quality of the crop. The rejection costs will then be the responsibility of the indirect grower.

Grower costs can be classified into four main groups: investment, production, transportation and quality. There is some evidence of collaboration and co-investments with the Supermarket and the direct grower, and marketer and indirect grower. The production, transportation and quality costs have to be considered as grower costs.

6.5.2 *Marketers costs*

Marketers are large businesses that supply multiple fruits and vegetables for all the retail chains. They also trade at the wholesale market. These marketers run warehouses and are able to store fruits. They add value to the chain and receive profit from these transactions. Regardless of how these businesses are managed or how big they are, they seek profit in the business; clearly this is related to how they manage these operational costs.

From the marketer's perspective, costs in the supply chain are related to internal operations, investment, transportation, and quality. Costs of internal operations include inventory costs, ripening, overhead costs and staff costs. The marketer must sometimes store the fruits at the warehouse to be delivered in the next few days. Providing the storage temperature conditions are costly and be considered as inventory costs. Marketers need staff to be able to supply several fruits and vegetables for several retail chains, trade at the wholesale market, collaborate with hundreds of growers, and breed new varieties- all these activities require capital. When marketers negotiate the price with both the Supermarket and growers they include all of these operational costs in a way to make margins from the transactions.

One of the key roles of marketers is to invest in new varieties. Breeding new varieties might take years and need research. The marketers usually buy the new varieties from overseas and plant them in Australia. They receive the right of marketing for any new type of variety they invest in. This means that any grower who plants that variety has to market the fruit through that marketer. Supplying a new variety in the market brings competitive advantage to them against their competitors. In addition, it helps growers place more confidence in their marketer. It shows how the marketer value on the growers revenue. Introducing new variety in the market is always associated with uncertainty. It needs investments and planning and how to introduce the new variety into the market. They

have to introduce the new crop step by step, with lots of marketing involved. The small and medium growers do not have both access and funds for marketing a new variety. Therefore, they rely on what the marketer does. If marketer is successful, it will be a winning situation for both the grower and the marketer.

The supplier requires the Supermarket's support in the introduction of new varieties. The Supermarket must agree on the characteristics of the variety. It should be consistent with the Supermarket standard specifications. The marketing stage also needs the Supermarket support- for promotions for a new variety, for example, or for advertising a new crop in the catalogue. The marketer pays the costs; but he receives long term benefits from both the grower and the Supermarket, indicating the value of trust and long term relationships between parties.

Transportation costs for the marketer are the same as those for the direct grower. The marketers are responsible for delivering the crops to the DCs, usually using third party service providers. The third party companies do not add extra costs to the chain. The suppliers pay the third parties 30 days after delivery which gives them flexibility in their cash flow.

The cost of quality in the marketer's warehouse is both a prevention cost and a rejection cost. Prevention costs refer to the quality check tasks- for the appearance quality, size and grading- that they apply when the fruits arrive at the warehouse from the farm. These costs are hidden in the operational costs. The marketer has to pay the rejection costs if the fruits are rejected by the Supermarket and the marketer has received the item at the warehouse. The fruits could be either transferred from the DC to the wholesale market or be returned to the warehouse. As noted earlier, if the fruits are delivered directly from the farm to the DC without the marketer's inspection then the indirect grower will pay for the costs.

6.5.3 Supermarket costs: the cost of operation and the cost of waste

The Supermarket costs include the internal operational costs, the distribution costs from DCs to the stores, in store storage cost and waste costs. Not all of the costs related to the Supermarket impact directly on the contractual relationship between the Supermarket and

suppliers. The Supermarket as a business entity has many operational costs including distribution costs, the cost of ordering, and the cost of storage and facilities. However costs related to wastage during the distribution and marketing processes could be the result of low quality fruit supply- which is why the Supermarket applies tough quality standards based on the standard specifications. It tries to reduce wastage costs by applying preventive tasks from the farm and make sure the farmers are able to provide the quality fruit as much as possible. Grapes for example, have high waste at the store level. This is because grapes fall from stems, and bunches are fruitless so that, to prevent loss in stores, the Supermarket applies the strategy of selling grapes in individual bags. This strategy generates costs to the growers; but long relationships with the growers make such changes easier. The Supermarket may also assist in providing bags for the growers.

Although, the standard specifications are serious, the Supermarket applies exemptions on weather event quality losses- which again highlights the value of long term relationships.

The costs of the supply chain have been discussed in detail from the grower, supplier and Supermarket perspective. There may be other costs involved in the supply chains, but these do not impact on the contractual agreements and are not, therefore, discussed in the thesis. One other cost is, however, important in cost functions in the literature- salvage value- and is discussed in the next section.

6.5.4 Salvage value in the supermarket fruit chain

The definition of salvage value in the literature is to have the opportunity of selling the remaining product at the end of the season (or after exercising the contract) at a lower price. Salvage value with this definition is always considered in relation to the supplier economics- gives him the opportunity to sell the unsold items and prevent loss. Salvage value with exactly the same definition is not valid in the fruit supply chain. Fruits have a very short life time and have no salvage value when over-ripe or rotten.

In fruit chains ‘salvage value’ may have a different meaning defined in terms of alternative use. Excess fruit, not required by the Supermarket, may in fact be sold to food processing companies; to cattle farms; or donated to charity organisations like FoodBank.

There are occasions when the Supermarket cannot buy the crop from the grower because of either oversupply or low quality standards. The growers report they have two options for selling the crop. First send the fruit to the wholesale market, and second send them to the food processing factories. The first priority is the wholesale market because they can achieve higher revenues. Although, the price at the wholesale market could be cheaper than the Supermarket price, the wholesale market cannot be seen as a salvage value option. The differences between those two prices are fairly low and negligible. This has conflicts with the salvage value assumption in the literature, which states that the salvage value price should be lower than the selling price.

Therefore, in terms of salvage value the next possible option will be food processors. Food processors ask for bulk fruit without packages in low prices. Despite the low revenue from selling to the food processors, it is still a better option than dumping the fruits with no market. Recently, due to the strong Australian dollar the food processors prefer to import fruits in cheaper prices. Therefore, this will not be an option to make profit from low grade fruit. The strawberry grower could sell the fruits to a jam factory located in Victoria, but for the last four to five years the jam factory did not purchase any strawberries and imports fruits instead.

It is essential to add that sending the fruit to the food processors is still an option for some of the fruits. For example mango growers can deliver some mangoes to the mango processors companies to make puree and juices. This is because the price of purchasing mango from a local grower compared with the import price is more profitable for the food processors.

One of the grape growers mentioned that he sends the loose grapes to the juice making factories without receiving payments. He believes they do a favour to collect their bins of loose grapes. Dumping the fruit in the ground requires time and budget and they prefer that the fruits are collected by juice makers free of charge.

Peaches do not have a chance to be consumed by the food processors. The canning and juice industry requires a specific variety of peach. The variety of fresh peaches cannot be

consumed in the canning industry. Therefore, peaches are consumed by cattle farms. There is no payment from the cattle farms.

The marketers and Supermarket send their fruits to the charity organisations like Foodbank Victoria. The charities distribute food for homeless people. They consume the fruits as fresh or in cooking. The Supermarket stores realise the remaining fruit will not be purchased by consumers due to its appearance loss and they ask the charity organisations to collect the fruit. In terms of salvage value to the business, there is no payment from the charity. However, the Supermarket or the supplier can request refund in their taxes as donations.

M3: The other thing is the food bank is next to us. We can donate fruit as well. If we know there are too much in the market, and we are not going to market them we just donate it. The donation is actually a tax right off. They write off the value of product and claim on tax.

As conclusion, the salvage value in the fruit supply chain is either negligible or complicated in calculation. Applying tax returns as salvage value makes the calculation complicated, because the Supermarket or marketer donate several types of fruits in one delivery. The exact amount of donation for one kind of fruit is not known. It is complex to find how much of the tax return is related to specific produce. Since the option contract is applied for trading one fruit, it is highly complex and complicated to consider the salvage value at the Supermarket side the same as the literature.

Furthermore, the possible salvage value is happened at the farms and to the growers. Development of option contract in fruit supply chain requires consideration of salvage value at the grower's side not the Supermarket.

From the growers' perspective, the reason of sending fruits to the food processing companies and cattle farms is to avoid waste at the farm. They prefer not to call this opportunity as salvage value.

6.6 Option contracts and consumers' demand: the key relationship

Option contracts require high demand uncertainty in the supply chain in order to be effective. The perspectives of interviewees regards to the consumers' demand were asked in the interviews. The questions attempted to highlight the demand patterns and reasons of demand fluctuations. This section describes the findings regarding consumers' demand patterns from different angles in the supply chain, the potential reasons, and also the dependency of demand, supply and price will be discussed.

Consumers' demand for fruits can be investigated into two time frames. The first time frame studies the demand during one season. The second time frame explores the demand patterns from season to season over the years. Since fruits are seasonal, demand for one specific fruit could vary from this season to the next season.

Consumers' demand fluctuates during the season. This causes uncertainty into the supply chain. The fluctuations are observed in all four studied fruits; however the patterns and reasons vary from fruit to fruit.

G2: Demand is very fluctuated during one season, November till Christmas it's a very busy time. You can sell a lot of fruit but the availability is an issue. There are not many people growing in these regions, that is why usually prices are set high. Regions are northern territory and central QldWhen we get to sunraysia which is 75-80 % of the Australian grape are produced here usually early mid-January. From January to Easter is the pick time for selling the fruit. It's a busy time with a lot growers and fruits.

Demand is weather sensitive. The average daily temperature of the season impacts on the consumers' demand for summer fruits. Grape and strawberry growers and marketers report that consumers demand for more grapes and strawberries in sunny and warm days. If the summer is reasonably warm, then they observe demand increasing. The interviewees believe this is because grapes and strawberries are easily eaten fruits with people gatherings and picnics.

Another factor impacts on the demand during the season is cooking reality shows such as Masterchef Australia. These TV programs affect demand by introducing new recipes using

fruits. A temporary jump in demand occurs as consumers demand that produce to make the recipe. The interviewees express that this sometimes make difficulties in fulfilment of consumer demand as the demand increases over supply.

Other key factors to demand are supply volume and price. Supply availability and price have reverse relationship to each other. The more supply is available, the less price is paid. Therefore, consumers are stimulated to purchase more fruit and demand increases.

Demand is price sensitive. This means the price fluctuations influence on demand. Lower prices on luxury fruits such as stone fruits and mangoes increases the demand. However, price fluctuations could not impact on essential fruits such as apples and bananas. Consumers tend to purchase these fruits despite high prices.

Fruit demands are also highly interdependent. This means demand for one fruit impacts on the other fruits demand. Consumers select limited kinds of fruits among the similar ones. Considering the diversity of varieties for each fruit, there are many options available for the consumers to choose. Competition between the produce is generated due to similarities in taste and nutrition. The demand for one produce is highly correlated to the demand for other produce.

For instance, the summer season of 2013 was a productive season for peaches in Australia. The price of peaches dropped below other similar products such as pears. Due to the price and affordability, customers were encouraged to buy peaches more than pears. The pear industry faced low demand. Then the price of pears dropped dramatically to compete with the peaches' price, even lower than the cost of production. The growers did not pick the fruits and left them on the trees. The Victorian pear growers dumped more than half of their crop.

Cross advertising also impacts on fruit demand. This means promotions on other food products could increase demand in one type of fruits which matches taste with other foods. For example, promotions and price reductions on ice-cream might increase the demand for strawberries. This is because consumers like to eat them together or make a dish with both products.

Although fruit demand fluctuates during the season depending on the weather, price, quality and promotions, the demand for specific fruit from year to year follows the same pattern and is predictable, according to the interviewees. They have observed increase in demand in past decade which is mainly the result of population growth.

The interviewees believe that the demand fluctuations are a result of supply changes, and therefore is supply driven. The retail chains change the consumers demand in fruits by supplying cheaper fruits, higher qualities or even promoting new varieties using celebrity cooks' recipes.

The finding of the demand in fruit chains and its impacts on option contract will be discussed in the next chapter where the demand uncertainty requirement is tested.

6.7 Chapter summary

This chapter described the supply chain structure and its players. Direct grower, indirect grower, marketer, supplier and Supermarket as the main players in the chain were clearly defined. The Supermarket trades directly with the direct growers and marketers in private negotiations. The supply chain is a single dyad with one grower and one supermarket when the Supermarket trades with the direct grower. The supply chain becomes a double dyad with grower, marketer and the Supermarket involved in the chain.

The chapter explored the details of the chain processes in single and double dyad relationships. These processes, which impact on the contractual relationships between the players, were identified as planning, information sharing, ordering, negotiations and pricing, in-store promotions, and quality maintenance.

All the costs involved in the supply chain were explained from grower, supplier and Supermarket perspectives. The cost parameters are crucial in this research because in order to design and implement option contracts it is necessary to understand all the relevant cost parameters to be applied in cost functions.

Consumers' demand was also investigated in this chapter. Demand patterns from different angles in the supply chain, the potential reasons, and the dependency of demand, supply and price were discussed.

The next chapter applies the findings of this chapter to examine the option contracts requirements in actual fruit supermarket chains. The main requirements are: being a retailer-led supply chain, having high demand uncertainty, and being able to set fixed price, fixed amount and fixed time of exercising contract. Further, the extra requirements which need to be considered in designing an option contract in fruit supply chain will be identified and discussed.

Chapter Seven

Option Contracts for Supermarket

Fruit Supply Chains: Rethinking

Theory for Real-World Applications

7.1 Introduction

The previous chapter explored in considerable detail the structure, process and relationships which characterise perishable fruit supply chains for a very large, nationally significant Australian supermarket chain. It detailed important aspects of chain structure, and it noted the essential issues associated with the supplier/supermarket relationships.

Against the background, the present chapter returns to the key proposition offered in this research- can option contracts, particularly useful in some industry sections, be designed to be applicable and beneficial for applications to supermarket fruit supply chains. This chapter focuses on challenging the assumptions on which theoretical studies (for example these of Wang, C & Chen 2013; Wang, Y & Zhang 2011) have been based; identifying the required modifications; and on exploring the new parameters that need to be included in developing option contracts for perishable food supply chains.

The chapter structure reflects these issues and falls into two major parts. Part A addresses the key conceptual problems and examines and challenges the theoretical assumptions on

which option contracts are based. Part B focuses on the critical need for parameter adjustments and notes a number of recommendations that may be required if option contracts are to reflect real-world chain structures and processes. Part A and Part B address research objectives two and three respectively.

Part A- Theory and Practice: Key Conceptual Problems

There are three theoretical assumptions on which option contract studies are based. The first is that the chain is a retailer-led supply chain; the second is that demand uncertainty is a critical characteristic of the chain; and the third is that particular contractual terms including issues related to a fixed amount, a fixed time, a fixed price and premiums are necessary and important.

The first assumption, that the chains with which this research is dealing are retailer-led supply chains is challenged by using Cox's framework of supplier/buyer relationships as noted in Chapter 2. This is a critical assumption and requires in-depth analysis of the upstream part of the supply chain where the Supermarket deals with the suppliers. The following section focuses on this issue.

7.2 Are supermarket fruit supply chains retailer-led?

It is not surprising that supermarket food supply chains are regarded as retailer-led chains given the perception of supermarkets as the most powerful member of the chain.

The role of the retailers in the food supply chain in common with other supply chains until recently was to market the products of producers. This situation was transformed in the US and Europe in post war years, mainly due to mass consumption demand for high quality products. As a consequence, an intense competitive retail market emerged in the food supply chains (Burch & Lawrence 2005). The transformation resulted in power shifts from producers to the retailers in the food supply chains. The reasons and consequences of power shifting have been widely discussed in the literature (Burch & Goss 1999; Harvey, M, Quilley & Beynon 2002; Wilkinson 2002). These studies reported two main reasons for the

shift in power. First the role of distribution of product which brings a monopsony power to the retailer and forces the producers to sell their product to the limited number of retailers. Second, the introduction and fast growth of supermarkets' "own brand" products.

Food supply chains have become a retailer-led supply chain with the supermarkets in the downstream part of the chain exerting exceptional power over the chain. Supermarkets forecast the consumers' expectations based on their up-to-date demand information and with this knowledge have become more powerful than their suppliers and play a dominant role in the supply chain. Consequently, supermarkets control the entire activities of the supply chain such as supply and demand forecasting, purchasing, production, distribution and information flow in the chains. They determine what, where, and to what standards the product is produced, and also where it is to be sold (Burch & Lawrence 2007).

Note, however, that the emphasis of this thesis is not on supermarket 'food supply chains' but on 'perishable fruit supply chains' handled by supermarkets; and it argues that in this context the research has shown that there is a critical need to look more carefully at the supplier-buyer relationships upstream from the supermarket in the supply chain. The following paragraphs focus, therefore, on demonstrating the power relationships between the supermarket and its upstream suppliers.

Andrew Cox, as noted in Chapter 2, uses a simple 'power matrix' as a useful reference framework for focusing on issues of buyer-supplier power in supply and value chains. Figure 7.1 provides a useful summary of, and insights into, the characteristics of buyer/supplier relationships under conditions of buyer and supplier dominance and on conditions which indicate the need for cooperation (interdependence) or for non-cooperation (independence) - the numbers of buyers and suppliers in the market, their degree of dependence, the search and switching costs of change and information asymmetry- in determining power relationships.

Option contracts for supermarket fruit supply chains

		Buyer Dominance	Interdependence
HIGH	Attributes of buyer relative to supplier	<ul style="list-style-type: none"> ➤ Few buyers/many suppliers ➤ Buyer has high % share of total market for supplier ➤ Supplier is highly dependent on buyer for revenue with limited alternatives ➤ Supplier switching costs are high ➤ Buyer switching costs are low ➤ Buyer account is attractive to supplier ➤ Supplier offerings are commoditised and standardised ➤ Buyer search costs are low ➤ Supplier has no information asymmetry advantage over buyer 	<ul style="list-style-type: none"> ➤ Few buyers/few suppliers ➤ Buyer has relatively high % share of total market for supplier ➤ Supplier is highly dependent on buyer for revenue with few alternatives ➤ Supplier switching costs are high ➤ Buyer switching costs are high ➤ Buyer account is attractive to supplier ➤ Supplier offerings are not commoditised and customised ➤ Buyer search costs are high ➤ Supplier has moderate information asymmetry advantage over buyer
		Independence	Supplier Dominance
LOW		<ul style="list-style-type: none"> ➤ Many buyers/many suppliers ➤ Buyer has relatively low % share of total market for supplier ➤ Supplier is not dependent on buyer for revenue and has many alternatives ➤ Supplier switching costs are low ➤ Buyer switching costs are low ➤ Buyer account is not particularly attractive to supplier ➤ Supplier offerings are commoditised and standardised ➤ Buyer search costs are relatively low ➤ Supplier has only limited information asymmetry advantage over buyer 	<ul style="list-style-type: none"> ➤ Many buyers/few suppliers ➤ Buyer has low % share of total market for supplier ➤ Supplier is not at all dependent on buyer for revenue and has many alternatives ➤ Supplier switching costs are low ➤ Buyer switching costs are high ➤ Buyer account is not attractive to supplier ➤ Supplier offerings are not commoditised and customised ➤ Buyer search costs are high ➤ Supplier has high information asymmetry advantage over buyer
		LOW	HIGH
		Attributes of supplier power relative to buyer	

Figure 7-1 Attributes of buyer and supplier power in the power matrix, Source: Cox (2001), page 14

Clearly, buyers would prefer to have the choice among many sellers; and suppliers would prefer to have choice among buyers. In such conditions, power is easily exerted. Where buyers and suppliers have mutual interest in what each offers, cooperation may be appropriate. Where neither buyer nor supplier has interest in the other the parties can act independently.

Cox’s notion of ‘power regimes’ -an extended network of dyadic power relationships- provides further insights into the upstream relationships between the supermarkets (as the buyer) and its suppliers (direct growers, indirect growers and marketers).

Defining the ‘power matrix’ and the ‘power regimes’ for the supermarket fresh fruit chains have underlined the buyer/supplier power relationships upstream from the supermarket and cast doubt on the chain as a retailer-led chain. The research findings are noted here in more detail.

The Supermarket changed its trading strategy in purchasing fruits almost five years ago. It decided to decrease the uncertainty associated in the chain by shifting its trade strategy from the wholesale market to private negotiations. In so doing it restricted the number of suppliers in its chain; but in effect it also moved away from a ‘buyer dominance’ power position to one which encouraged, potentially, some supplier power. Now, the supermarket trades with the marketers and direct growers in private negotiations (see Chapter 6).

In its relationships with the direct growers the supermarket upstream chain is a single dyad supply chain; but the upstream chain which involves the indirect grower, marketer and the Supermarket represents a double dyad supply chain. The power networks differ and are reported here as two separate models.

The single dyad supply chain

The single dyad supply chain refers to the supply chain in which the supermarket trades with the direct grower and is shown simply in Figure 7-2.



Figure 7-2 Dyadic relationships in single dyad supply chain

Are the direct growers becoming more independent of the supermarket? There appear to be a number of indicators which suggest that this may be the case. These indicators are suggested by some characteristics noted in Cox’s power matrix.

There are limited numbers of direct growers in the supply chain who are able to provide the produce in the desired quality. The numbers of buyers in the market who are able to compete with the Supermarket in terms of the volume of purchasing are few; search costs for the Supermarket are relatively high as the Supermarket has selected the direct growers based on the long past history of the growers; the Supermarket has to deal with the new growers for several seasons (not just for some weeks) to be able to collect the supply history of the grower; switching costs from a direct grower to a new one are high because of the quality parameters and new grower failure in providing consistent quality fruit is a failure for the Supermarket and results in losing market share to the competitors.

The direct growers do not confine their customers to one major supermarket chain. They decrease the level of dependency and increase the information transparency by trading in other markets as well. They have a stand in wholesale markets in most of the capital cities to stay updated about the price in those markets. Some of the direct growers supply their fruit to the other retail chains in Australia. This helps them create competitiveness among the retail chains in both prices and order quantities. Those direct growers, who supply exclusively to the supermarket, try to maximise the level of dependency of the Supermarket by expanding their business- for instance, by expanding their farms to be able to supply greater quantities of fruits or investing in farms in other regions to be able to supply fruits for a longer period of time in the year.

Branding is another way of becoming independent from the Supermarket. Direct growers invest in new varieties and obtain the right of marketing. Therefore, the Supermarket has only one option if it wants to buy that brand. In most cases, the direct growers select the variety with the Supermarket's support in understanding information about consumer's taste. This means the Supermarket is willing to sell the specific brand and this makes the supermarket more dependent to the direct grower. According to one of the interviewees:

We are in the position where [the Supermarket] wants to and needs to deal with us. We are the sole supplier; it's a vertically integrated supply chain and we control every step of the process.

The direct grower has privileged information in regard to the available volume. On the other hand, the Supermarket has exclusive information about the consumers demand and is

able to stimulate consumer purchases. Information symmetry exists and it cannot be concluded that the parties can leverage power by means of information.

The Supermarket has lost power in pricing, but in return the supply of consistent quality fruit is assured in the chain. This leads them to achieve more revenue by keeping customers in their stores and not losing them to the other competitors. The direct growers' ability in providing high, consistent quality produce is attractive and valuable to the Supermarket. Although the direct growers have become more powerful in the relationship, they still need the Supermarket in order to maintain current revenue. The Supermarket is able to sell enormous amounts of fruits due to its market share. In addition, the payments are guaranteed when the buyer is the Supermarket. Consequently, the Supermarket account is attractive for the direct grower.

The attributes of buyer/supplier power suggest that there are few buyers and few suppliers. The Supermarket has a relatively high % share of the total market of the direct grower; the direct grower is highly dependent on the Supermarket for revenue with few alternatives; the Supermarket switching costs are high; the Supermarket account is attractive to the direct grower; the direct grower offerings are not commoditised and customised; the Supermarket search costs are high, and the direct grower has moderate information asymmetry advantage over the Supermarket.

These characteristics suggest that the power has shifted towards the direct growers in the new purchasing strategy. However, it does not mean that the direct grower has more power than the supermarket. In fact, the supermarket and the direct growers have become interdependent; and relationship between the supermarket and the direct grower has shifted from a buyer dominant ($B > A$) to an interdependent ($A = B$) position.

The double dyad supply chain

When the supermarket trades with the marketer the supply chain is transformed into a double dyad supply chain. Since the marketers do not own the orchards, they have to source their fruit from the growers. The sequence of players in the supply chain is shown in Figure 7-3.



Figure 7-3 Dyadic relationships in double dyad supply chain

Each dyadic relationship needs to be studied separately in the double dyad supply chain. The following paragraphs, explore the relationships between the indirect grower (A) and the marketer (B); the power relationships between the marketer (B) and the Supermarket (C) and the power balance in the whole chain.

The power balance between the indirect grower (A) and the marketer (B)

The indirect grower plays the role of supplier and the marketer is the buyer in the dyadic relationship between these two.

The number of indirect growers who are accredited with HACCP¹² standards and meet the Supermarket's quality standards are more than the marketers- for instance there are only four marketers in the peach supply chain with more than 15 indirect growers. It suggests that the marketers can exert power toward the indirect growers by shifting from one to other growers; but due to quality parameter and long-term relationships between the parties, the marketers prefer not to shift between the growers.

As noted earlier (Chapter 6), the selling prices are set by the marketers, and the grower follows the request. The indirect grower believes in trust in the relationships. Since the prices are set in a private negotiation process, the growers do not know what price the marketers are paying to other growers. The growers prefer not to share the price with each other, because they are afraid of ruining the trust in the relationship with the marketer. The lack of transparency in pricing is in favour of the marketer, which adds to their power.

The marketer's account is highly attractive to the indirect growers, as the purchasing and normal revenue are guaranteed. The indirect grower is dependent to the marketer in selling the produce and gain revenue. In one of the interviewee's belief, marketers are managing their business in a professional manner. He believes that during peak season with having

¹² Hazard analysis and critical control points

different varieties of stone fruits, such as white peach, yellow peach, plum, and apricot, it would be extremely hard to manage all the produce and sell them at the best price without the marketers. Besides, since the indirect growers are not large enough to trade with the Supermarket directly, they are in need of marketers to be able to sell their produce to the Supermarket. Supplying even indirectly to the Supermarket brings a privilege to the indirect grower which they do not like to lose. The ability to receive bank loans because of supplying indirectly to the Supermarket is an example of such privileges.

The marketer has the information edge of the available volume, because he receives all the information from several indirect growers. The advantage of accumulating the information gives the power of determining price and order quantity to the marketer.

Indirect grower's switching costs are relatively high. Replacing a marketer with another marketer or even finding a new market requires time. The grower is unable to switch the marketer in a short time and during the season because he loses the market and will not be able to sell the produce. The switching costs for the marketer are also relatively high. This is because of the required quality by the Supermarket which disables the marketer from shifting between the growers.

If marketers lose growers, then their ability to supply fruits to the supermarket decreases dramatically. This results in losing the market share and consequently profits until finding a replacing grower. Although these two are dependent on each other, the level of dependency is not the same. Applying Cox theory which argues that the power enables the member renting more revenue, the power network between these two cannot be an interdependent one.

The attributes of dyadic relationship between the indirect grower and the marketer suggest that there are few marketers/many indirect growers, marketer has high % share of total market for grower, indirect grower is highly dependent on marketer for revenue with limited alternatives, indirect grower switching costs are high, marketer's account is attractive to the grower, indirect grower has no information asymmetry advantage over the marketer.

It is concluded that the power relationship between the marketer and the grower is buyer dominant ($B > A$), with the marketer as the powerful member. Note that the indirect grower has relatively more power in the dyadic relationship with the marketer compare to the position they had with the Supermarket in the old purchasing strategy. Shifting strategy to the private negotiations is in favour of the indirect grower as well as the marketer and the Supermarket.

Power balance between marketer (B) and the Supermarket (C)

The marketer plays the role of supplier and the Supermarket is the buyer in the dyadic relationship.

The relationships between the marketers and the supermarket are similar to the dyadic relationship of direct grower and the Supermarket. The marketer has gained power by changing trade strategies. The supermarket shifted power to the marketer while prioritise the consistency in produce quality.

There are few acceptable marketers by the Supermarket quality standards. The supermarket trades with all marketers in the market to be able to respond to the consumers' demand. They tend to maintain the relationship with all marketers as these are the qualified suppliers who are able to provide high quality produce.

The marketer has the edge on information about the available volume. On the other hand, the Supermarket has the edge on information about the consumers demand, and is able to stimulate consumers toward purchasing. In terms of information asymmetry it cannot be concluded that the parties can leverage power by means of information.

Searching costs for the Supermarket are relatively high as the Supermarket has selected the marketers based on their ability of supplying quality produce. The supermarket has to deal with the new marketer for several seasons not just weeks to be able to collect the supply history. Switching costs from a marketer to a new one is high because of the quality parameter. The failure of new marketer in providing consistent quality fruit is a failure for the Supermarket, and consequently losing the market share to the competitors.

The marketer attempts to increase the level of dependency of the supermarket by investing in more FFV categories. Then he is able to sell more kinds of fruit and vegetables to the Supermarket. This influences the long-term relationships and trust between these two businesses.

In addition, the marketer does not confine its customers to the one major retail chain. Although the marketer has separate departments for each retail chain and keep the relationship confidential to some extent, the prices are shared between the departments. This helps them to increase the transparency in the market, and brings competition among the customers- retail chains.

We look at the diverse market rather than just one supermarket. [...] We never base our great business decisions on one customer.

From the marketer's perspective, the structure of their business toward the Supermarket in the market with consideration of competitors is multi-monopsony matrix as shown in Figure 7-4. The competitive retail chains are shown in this figure.

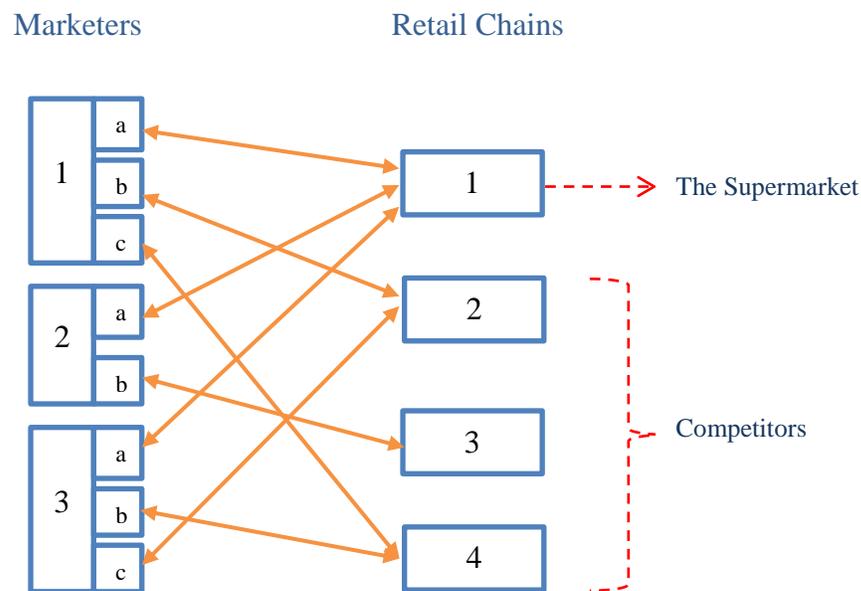


Figure 7-4 Multi-monopsony matrix or relationship between marketers and Supermarket with consideration of competitors

The prices are set in a private negotiation process between the marketer and the Supermarket. One marketer does not understand what the price is in negotiations between

the Supermarket and other marketers. Indeed, the Supermarket is the only one that has the valuable information of volumes and offered prices from the marketers. The Supermarket has the opportunity to determine the price and order quantities in its best favour.

The attributes of dyadic relationships between the marketer and the Supermarket explains that there are few buyers/few suppliers, the Supermarket has relatively high % share of total market for marketer, marketer is highly dependent on Supermarket for revenue with few alternatives, Supermarket switching costs are high, Supermarket account is attractive to marketer, marketer offerings are not commoditised and customised, Supermarket search costs are high, and marketers have moderate information asymmetry advantage over Supermarket.

The power matrix of marketer and supermarket follows an interdependence (B=C) relationship, because of the explained attributes. Marketer is dependent to the supermarket to be able to market the produce; the supermarket is dependent to the marketer to be able to provide high quality produce at the store shelves.

Based on the above findings and discussion, the assumption of being retailer-led supply chain in the upstream part of the fruit chains is argued. The marketers and direct growers are as powerful as the Supermarket. They influence order quantities and prices. They tend to charge above average in the relationship. Sharing power between the suppliers and supermarket is the result of the perishability parameter in produce. The Supermarket at the end of the supply chain has to share the power with the suppliers in order to be able to respond to the consumers' expectations, which is fresh quality fruit.

The assumption of retailer-led supply chain might be credible when Supermarket deals with suppliers for non-perishable grocery products.

7.3 Demand uncertainty

Demand uncertainty is a requirement in applying an option contract. Option contract is designed to cope with the uncertainty involved in the customer demand. Innovative products such as apparel, toy and electronics are always facing demand uncertainty as new

products with unknown demand is introduced into the market. The existing literature believes that the perishable food products are also dealing with demand uncertainty. This section tests the occurrence of demand uncertainty in the fruit supply chains. Besides, other types of uncertainties affecting the supply chain are discovered.

As described in Chapter 6, consumer demand has increased from year to year due to population growth. Apart from that, the fluctuation in demand in long time horizon is negligible. However, demand fluctuates during each season and adds uncertainty into the decision making. Competition between fruits, promotions, cross advertising, reality shows and prices are counted as the reasons of demand fluctuations.

Fruit prices are supply driven rather than demand driven. This highlights the role of supply uncertainty in the supply chain. Therefore, supply uncertainty and its impacts in the supply chain needs to be discovered in order to develop option contracts.

Quality of fruits, available volumes, beginning time of the season, season duration and even prices are unpredictable parameters before the season starts. These are all affected by weather events. Mother Nature and weather events are uncontrolled factors in fruit production, which brings high level of uncertainty to the supply chain.

As noted in Chapter 6, the supply quantity is an uncertain variable until the season begins. Even during the season the weather events can impact on fruit production and on supply quantity.

One of the unique characteristics of fruit supply chains is supply uncertainty. The uncertainty involves quantity, quality and also time of availability. Other products like apparel need long production lead time, but the quantity of products that a company can make is certain and dependent on the capacity of the system.

For example, banana farms in Australia located in Queensland were affected by flood and cyclone in 2011 and 2006, respectively. These natural events disabled the growers to supply bananas to the market. Another impact of natural disasters is on transportation. The road could be closed for several days. Since fruits are decaying over time, even if the crops survive from the natural events the logistics would be an issue.

Supply uncertainty impacts the supply chain from various angles. These impacts can be studied by the type of weather events. Severity of weather events has different supply uncertainty impacts. If unforeseen weather event such as flood and cyclone happens in the season, then large quantity of crops are affected, and sometimes the growers are unable to provide any produce. However, if the weather changes are not severe such as temperature changes in days and nights, or heavy rain in one day, the impacts of weather is in short term. This means the supply is delayed or rushed by several days, or the available volume changes in small quantities for the coming weeks.

The supermarket does not apply a fine in the situations when the supplier is unable to supply determined fruits due to weather impacts. He understands the impacts of supply uncertainty in the supply chain and does not believe in punishing the farmer for something which is beyond his/her control.

The fact that there is no written agreement between the supermarket and the suppliers indicates that both parties are mindful of supply uncertainty. They do not lock themselves in contract terms which are dependent upon uncontrolled weather events.

The idea of option contract is to agree on the certain amount of products (order quantity) and use of allowances (option quantity) to cope with the uncertain demand in the selling season. This idea is based on the hidden assumption of supply certainty. For instance, in the apparel supply chain the probability of emergency events that disable the production line is negligible. The option contract therefore can decrease the risk of demand uncertainty in the supply chain.

However, the level of uncertainty in supply is much higher than demand in fruit supply chains. This fact could challenge the idea of applying option contract in perishable food supply chains.

Option contracts can be applied in the perishable food chains if the contract terms and definitions focus on the supply uncertainty rather than demand.

The option contract could be designed from the supplier's perspective to be able to cope with supply uncertainty. It should be defined as: the right of the supplier to sell the fruits up

to a certain quantity to the supermarket. Then in the oversupply situation the supplier has the right to sell more fruits to the supermarket, and exercise the contract as Call. In the undersupply situation, the contract will be exercised as put and the supplier has the right to sell less fruits to the supermarket. The supplier has to pay a premium to the supermarket in order to receive the right of exercising the contract. The supplier would not agree to implement the contract in the undersupply situation when the farm is affected enormously. The supplier already lost revenue due to lack of supply, what would be the benefits of paying premium to the supermarket to get the right of selling less produce?

The above question is raised when application of premium is notified. Premium in the option contract will be discussed in the following section.

7.4 Contract terms

Option contracts, the same as other contractual agreements, are based on some terms and conditions in the contract. These terms are usually hidden in the contract definition. According to the option contract definition, option contracts give the right of purchasing fixed amount of products for a fixed price at the fixed time. The term “fixed” must be explored in the perishable food supply chains in order to explore the possibility of having such terms in the contract.

Furthermore, option contracts assign a payment to the contract receiver (most likely the supplier). The payment is called premium and is to ensure a secure payment and encouragement to the supplier to accept the contract. Premium can be interpreted as the price that the retailer pays to the supplier in return for increasing the order flexibility. Premium is another contract term that is investigated in the supermarket fruit supply chains in this thesis.

7.4.1 Contract term one: Fixed amount

To understand whether fixed amount is applicable in the supermarket fruit supply chain, current policy of ordering and order quantities must be analysed. As described in section 6.4.1, the Supermarket and the suppliers set the total amount of quantities for the season

with 90% accuracy. The total quantities are in weekly orders. Applying weekly timeframes for orderings highlights the impacts of supply uncertainty. They are unable to decide the ordering quantities for a longer period than a week because of two reasons. First, uncertainty due to weather impacts does not allow them to predict longer periods accurately. Second, relates to a short life time, which prevents them from keeping fruits for longer periods.

Ordering quantities even in weekly orders are significantly flexible compared with the determined schedule. The weekly orders are finalised couple of days before the orders are scheduled to be delivered. Orders are finalised according to the available volume which is an uncertain parameter depending on the weather.

The ordering quantities are flexible for both parties not only the Supermarket. During the peak times the only goal for the fruit suppliers is to deliver the fruit into the shelves. They put requests to the Supermarket to increase the order quantities. All the suppliers in the interviews said they are confident enough that the Supermarket will always accept the increase in the orders. The predetermined order quantities, time frames and even pricing all become the second priority during the peak times.

Existing flexibility is the result of supply uncertainty and short shelf life time in the chain which are the unique fruit chains specification. Both parties are aware of the weather impacts and supply uncertainty. Since the supply is significantly uncertain, the parties have to be flexible in order quantities. Otherwise, the fruits might get wasted in the oversupply situation. Also, the Supermarket cannot apply fines or punishments if the supplier is unable to fulfil the Supermarket's predetermined order quantities. Mother Nature impacts on the supply chain. The existence flexibility is inevitable and helps them decrease the impact of supply uncertainty on the chain.

The existence of supply uncertainty in the chain delays or rushes the available volume by weeks. Option contract if applied in weekly timeframe can cover the availability fluctuations. This means the increase or decrease in available volume could be defined as quantity of option contracts exercised as call or put options.

To conclude regarding the fixed amount, supply uncertainty plays a significant role in determination of order quantities. It is almost impossible to set fixed quantities prior to the season start. The potential ability of supermarket to sell the fruits based on the history of demand could be considered as an indication for the supply chain to target the required fruits.

7.4.2 Contract term two: Fixed time

Option contracts are designed to ensure certain time delivery of the products to the retailer. Fruit production is full of uncertainties due to weather impacts. Time relevant parameters such as the season start day, duration of the season and periods of peak time are all weather dependent. It is impossible to determine the exact day of the starting season because even the temperature can change the date.

This highlights the impacts of supply uncertainty on designing option contracts. The contract must accommodate time fluctuations in order to apply the actual agreements. Since the grower is not assured to meet the fixed time, due to supply uncertainty and weather events, then fixed time may cause profit loss for both the grower and the supermarket. They will not enter to an agreement when it makes difficulties for them.

7.4.3 Contract term three: Fixed prices

The option contract is an agreement that determines the price prior to the start of the season.. In addition, the price is a fixed parameter in the agreement. These factors are discussed in this section.

Prices are affected by supply volume and quality. It is a supply driven parameter rather than demand despite the other innovative products. Prices for fruits follow a reverse bell shape pattern as shown in the figure below¹³. This means the prices are high at the beginning of the season, eventually it comes down and by the peak time the prices are at the lowest possible level. Then toward the end of the season the prices start to increase, but rarely reach that of the beginning of the season. The wide fluctuations in prices are the result of

¹³ This figure is a schematic of price over time and not based on the real data.

supply availability. Supply availability in contrast follows the opposite shape of the price. It starts with low volume; during the peak time is at the highest volume and then eventually goes down.

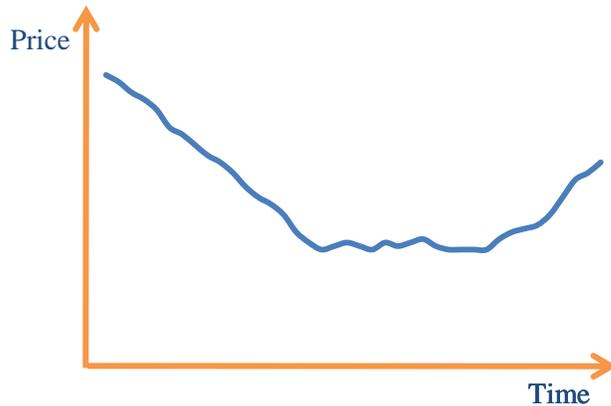


Figure 7-5 Schematic of price over time

Prices cannot be set at the fixed amount because of the fluctuations. Setting the price in a range that covers the highest and lowest prices are difficult because the upper and lower limits are uncertain and unpredictable, second the wide range of price does not help the parties in the chain. It adds more uncertainty to the agreement although applying weighted average price could be a solution. However, the notion of fixed price could make problems for the chain.

The parties would not enter in an agreement with fixed price due to in season wide price fluctuations. The underlined supermarket chain is one of the retail chains in the market. The supermarket lose the competitive advantage if they enter to a fixed price agreement.

Price needs to be set prior to the season in order to fulfil option contract requirements. However, as described in section 6.4.2, prices are finalised during the season and week by week. The weekly pricing are allocated independently and based on the availability of fruit. The reason behind the weekly pricing is high supply uncertainty. The prices are supply driven and supply is affected by weather impacts which add uncertainty to the available volume.

Only one of the growers was willing to enter into an agreement where the price is determined before the season starts. This grower plants the crops under a covered and protected area which decreases the impacts of weather changes. For this direct grower, the amount of available strawberries by weeks is reliable and accurate. Furthermore, he can calculate the cost of production. Then he will be able to enter into an agreement with a fixed price. Albeit, the fixed prices must follow the reverse bell shape pattern. Otherwise, even this grower would not enter to the agreement. This highlights the impact of supply uncertainty into the pricing.

It has to be added to this case scenario, this direct grower is an exclusive grower to the Supermarket, and could fulfil more than fifty percent of the Supermarket demand.

Other suppliers and growers believe that fixed prices lessen both their confidence and the Supermarket' in the relationship. It adds risk of losing market share and profit. If the price in the market becomes lower than what the supermarket is supposed to purchase from the suppliers, then the supermarket either lose market share or profit. The supermarket will lose in price competition with the other retail chains.

There are three more factors in the pricing: order quantity, promotions and quality of fruits. The suppliers agree on price based on the order quantities received from the Supermarket. If the Supermarket orders in reasonable volume then the suppliers would agree on the lower price. This is because the higher order volume guarantees less waste at the farm and they can send out the fruits more expeditiously.

There is a similar situation with the quality of fruit for the Supermarket. The importance of delivering consistently high quality fruit to the consumers forces the Supermarket to pay a little higher price for the produce. The order quantity and quality are considered as hidden qualitative factors in the pricing, which indicate the value of negotiations in the supply chain.

Promotions, as described in section 6.4.3, are offered to encourage the consumers to buy more produce during the peak time. Promotions affect demand and prices. The prices in

promotion weeks are agreed independently as the market price. The usual pricing rules are not valid in promotion prices.

If sudden weather events during the off season or season do not happen, then applying the promotions are assured. But similar to the regular prices, promotion prices and time of exercise cannot be fixed prior to the season.

Promotions are novel to the development of option contracts. Promotions are not applied on the sale plans of other innovative products such as toys, apparel and electronics. Promotions are accepted by supply chain participants because this is the best way to sell the fruits in the peak time, otherwise the fruits overripe and become waste. The very short shelf life time and decay over time differentiate the fruit supply chains from other products. Option contracts without considering the promotion plans in the fruit supply chains are not effective.

The suppliers agree on selling their produce in lower prices to enable the Supermarket to beat the competitors. Although it certainly affects the total revenue of the suppliers, benefits of long term relationship with the Supermarket covers the loss.

7.4.4 Contract term four: premium

The philosophy of adding premium to the agreement is to design a win-win situation for both parties. Predetermined contracts such as option contracts are designed to cope with the uncertainty in the future. However, these trades are associated with risk because the future brings uncertainty. One of the parties may lessen the existence risk by offering the contract. This will add extra risk to the other party. The premium in option contract is to reduce the added risk to the second party in the agreement.

The application of option contract in the fruit supply chains is still unlikely because of the applied premium in the contract. Finding the optimal premium is challenging in the fruit chains. Since the flexibility already exists in the supply chain for both the supplier and the supermarket, finding an optimum which satisfy the desire of both parties is a key question. The supermarket, as the person who makes the contract offer, has already flexibility in ordering to deal with the demand uncertainty without a payment. Therefore, the optimal

premium for the supermarket at the moment is zero. The supermarket is not convinced to apply an agreement in a way to pay an extra to achieve the current flexibility. The premium on the other hand is in favour of the supplier. This is why finding the optimal premium in favour of both parties is challenging. The supplier's desire will be to shift to a no premium payment when making the offer to the supermarket to enter the option contract.

Premium could solve the problem of cash flow in the beginning of the season for the grower. It is a solution in terms of funding, but the parties do not apply premium since it brings commitments to the relationship. The supermarket is willing to financially assist the grower and in return receives the exclusive right of purchasing the fruits according to the amount of fund assisted.

The premiums in the option contract when applied in the fruit chains can be observed from different angles. As mentioned in the cost parameters in Chapter 6, the fruit productions require investments in the new orchards and varieties. There were several co-investments between growers and the supermarket. These can be defined as the premium in the contract. However, it is quite complicated to calculate the long investments in the short term agreements.

Part B- The Critical Need for Parameter Adjustments

Not all the parameters proposed in the literature can be applied in option contracts in supermarket fruit supply chains. Besides, there are some more parameters identified in this research that must be considered in developing option contracts in supermarket fruit supply chains. Part A challenged the theoretical assumptions of option contracts using real-world supermarket chains. Part B addresses the third objective of the research and discusses the adjustments and modifications required the development of option contracts for supermarket fruit supply chains. The adjustments fall into two groups - adjustments in option contracts equations; and adjustments related to time-frame and market scope.

7.5 Parameter adjustments in option contracts equations

The research indicates that there are three specific factors or relationships that require re-thinking – the issue of salvage value in perishable fruit chains; the questions of interpretation and specification of quality costs; and the problems associated with long-term, rather than immediate as short-term issues.

7.5.1 Salvage value

One of the model assumptions in the literature is associated with a chance of salvage value of the product - this was discussed in Chapter 6. It is noted that salvage value at the supermarket is negligible due to the perishability and decay factor of fruits. There is no chance of selling a decaying product. However, as mentioned in Chapter 6, the supermarket and the marketers have the opportunity of donating the produce to charity organisations and claim tax refunds at the end of the financial year. Calculating salvage value from the tax is a complex problem, because there is no clear information about the quantity and value of donations split by produce type. They donate fruits and vegetables in bulk. As a consequence, salvage value at the supermarket must be either ignored or considered as tax refund in the calculation.

7.5.2 Quality standards

Quality, as described in section 6.4.4 was identified as a key parameter in the relationships. It was identified that quality standards influence the order quantity and pricing processes. Furthermore, maintaining quality up to standard specifications generates costs- preventive and rejection- to the whole supply chain and players. It is critical to consider the role of quality and its associated costs to the supply chain in option contracts when developing for supermarket fruit supply chains.

The immediate suggestion is to add the quality term and its conditions to the contract and exercise the contract subject to providing the desired quality. But this will empower the supermarket, which is not in favour of growers. This is a challenge in considering quality in

the contract terms, because if the contract needs to simulate the actual parameters in the supply chain, the quality term must be considered in the contract conditions.

Quality costs must be added in the cost function in order to find the optimal order quantity and prices of option contracts in the supermarket fruit supply chains. According to the details of costs discussed in Chapter 6, rejection cost is the extra parameter in the function which has not been considered in the existence literature. Rejection costs must be added into the cost functions when calculating the optimal option price for the supplier (seller), because as noted in the previous chapter the rejection costs are on the supplier's. Rejection costs could be either zero for one order delivery or at its highest possible amount subject to the quality of fruit delivered to the DCs.

7.5.3 Short term vs long term relationships

Long-term relationship plays an important role in most of the decisions made by the Supermarket and the suppliers. It puts other key decisions in the shade.

Long-term relationship is inevitable in the nature of the relationships in the fruit chains. Fruit production needs long-term investment plans- sometimes up to eight years. The Supermarket and the direct grower or the supplier and the grower have to follow a long-term relationship based on trust to be able to compete in the market.

Fruit productions have considerable longer off season periods compared with the sale seasons in one year. The growers maintain the farm and crops in three quarter of the year to be able to receive revenue in the remaining months. Both players must believe in long-term relationships otherwise it would be impossible to continue the business.

Long-term relationship is important to the Supermarket because of the quality requirements. The growers and suppliers learn over time how to grow the crops to meet the quality requirements of the Supermarket. The Supermarket continues trading with the current suppliers in order to achieve consistent quality crops. The consistency of crops will change if the Supermarket shifts between growers. It takes years to educate the grower regarding the quality requirements. It is not beneficial for the Supermarket to switch and shift among the suppliers. It was noted that the cost of switching for the Supermarket is

high in the relationship; this encourages the Supermarket to maintain a long-term relationship with the suppliers.

The growers and suppliers must be assured by the Supermarket that they can achieve reasonable profit by providing quality fruits. The assurance is accumulated by trading over the time. The growers and suppliers noted that they are confident enough that the Supermarket always purchases the committed amount and also extra amount of fruit from them.

The long-term relationship builds trust between the Supermarket and the suppliers. Trust as honesty and benevolence in the relationship decreases the threat of information asymmetry and performance ambiguity.

Trust as the consequence of the long-term relationships brings stability to the business especially for the growers. If the grower only trades at the wholesale market then he must wait for the unpredictable uncertain buyers to purchase his produce. There is always significant risk associated with trading at the wholesale market, but the long-term relationship always guarantees a certain amount of fruit (in absence of weather events) to be purchased by the Supermarket. Furthermore, long term relationship with the supermarket gives the opportunity to the suppliers to invest in the varieties that consumers demand most. Supermarkets can collect and analyse the demand information at the stores, and pass this information to the suppliers to invest more in the preferable variety.

Consistency in quality is another advantage of long-term relationships. Consistency brings win-win advantage for both the Supermarket and the suppliers. The Supermarket is assured of consistent quality fruit which do not ruin the consumers' perception and expectations. The suppliers also can establish their brands on varieties and become more familiar to the consumers.

The suppliers establish a brand by introducing a new variety in the market. As mentioned in Chapter 6, the suppliers achieve the marketing right of new varieties which they bring to the market. The branding becomes a key issue for these varieties. They need to invest in the variety using branding and advertisement strategies. The suppliers rely on the Supermarket

for the branding projects to be successful. The supermarket has the exclusive access to the downstream part of the chain and, therefore, can stimulate the consumers into the new variety, examine their taste on the new variety and finally collect useful information which can assist the supplier to plan for the future.

Branding raises the issue that fruit chains are changing in terms of the product specifications. For both industry participants and the consumers, peaches, for example, are not just peaches. The brand made the peaches becomes valuable in a supply chain and consequently in consumers' perceptions.

The absence of a written contract between the Supermarket and the suppliers is another indicator of long-term relationships and highlights the significant role of trust in the relationship. Application of a contract that requires being written into agreements limits the freedom and flexibility in decision makings.

An option contract may increase profit in the supply chain in a short time horizon- for example the profit in the current season. However, the supermarket and suppliers apply long-term agreements such as eight years. Therefore, the option contract could be effective in the fruit supply chain only if the long-term relationship and its consequences are considered in the contract development.

7.6 Time-frame and market scope adjustments in option contracts

The new structure of supply chain and purchasing strategy has changed the power balances in the upstream part of the supply chain. The supermarket is not the only powerful member in the chain. It has discussed that the direct grower and marketer have established an interdependent relationship with the supermarket. The indirect grower still has lower power in the relationship. His tasks are decided by the marketer and supermarket. He does not play a role in decision makings specifically in regard to prices.

Supply uncertainty has been discovered as a decisive parameter in the fruit supply chains. The main reason of uncertainty is weather events which are uncontrolled factors in the supply chain. Supply uncertainty impacts on scheduling, pricing, order quantities and even

relationships between players. It has been shown if the chain is capable of reducing impacts of weather impacts (such as the example provided for strawberry supplier), then the supply uncertainty involved in the chain decreases. Therefore, option contract would be effective.

Perishability and consequently very short life time are unique characteristics of perishable food supply chains which impact on the supply chain. It forces the players to decide and act promptly in terms of ordering and pricing.

Quality of fruit even in terms of shape and size is significant in establishing the relationship between the supermarket and suppliers. The supermarket desires for a level of appearance quality which is provided by a limited number of suppliers.

Supply uncertainty and perishability in the chain do not allow the players to apply fixed term contracts. It decreases the supermarket's competitive advantage in the market. It decreases the grower's confidence in the relationship as he would not be able to provide produce in a certain amount at a certain time.

Lastly, long-term relationship has been observed as a significant parameter in the relationship. It does not influence on the option contract development directly. However, it must be investigated as the option contract does not apply long time horizon of planning.

7.6.1 Time-dependent and time-sensitive contracts

Option contract in weekly timeframe

Ordering quantities and prices are set in a weekly timeframe. Option contract must be designed in weekly timeframe in order to respond to the real world conditions. Each contract for the week must determine the order quantity (Q), option quantity (q), premium price (p_o), exercise price (p_e) and wholesale price (p).

Advantage- The modelling is compatible with the real conditions. It satisfies the players in the chain in terms of covering the supply uncertainty consequences on price.

Disadvantage- For a season with at least twenty active weeks and consequently twenty option contracts, all the optimums must be calculated. In addition, the players every week must decide whether to exercise the contract. Although the weekly model covers the price

fluctuations, there is no guarantee of application of the optimal parameters of a contract as weather impact changes the supply availability by weeks.

Option contract in seasonal timeframe

The supermarket can predict total number of produce they can sell in the next season. This is based on the past history data. Therefore, the supermarket is capable of determination of order quantities. As noted in Chapter 6, the parties set the plan in ninety percent accuracy before the beginning of the season. The remaining ten percent can be considered as option quantities the supermarket needs to purchase. However, the price determination would be a challenge, as the price fluctuates during the season widely.

Advantage- There is only one contract to be developed for the whole season. The demand prediction would be more accurate with a season timeframe rather than weekly.

Disadvantage- It could not cover the price fluctuations during the season.

7.6.2 Adjustments related to market scope

Option contract from the supplier's perspective

Since the fruit supply chains are affected by supply uncertainty more than demand uncertainty, design an option contract from the supplier's perspective could decrease the impact of supply uncertainty.

How- The supplier offers the option contract to the supermarket. He buys the right of selling fruits to the supermarket with an allowance to increase or decrease (call or put) the quantity. In a season with oversupply the supplier is in favour to exercise the contract in call situation and sell $Q+q$ fruits.

Advantage- It is compatible with the real conditions which the grower has the flexibility in increasing the order when oversupply observes in the supply chain.

Disadvantage- The supermarket is not willing to enter to such contract with each supplier as it adds the uncertainty of available fruit- each supplier must decide whether to exercise the contract or not so the supermarket could not be certain about how much to order and how much to receive.

Quality standards in the contract

Regardless of how the contract is modelled, quality standards must be added in contract terms. Furthermore, the cost of quality must be calculated in the cost functions in order to find the optimum contract parameters.

Option contracts designed for the whole market

Losing competitive advantage in the market was one of the main reasons that interviewees count why an agreement with fixed price is not suitable for the supply chain. If option contracts are applied among other retail chains then all players apply fixed price agreements and trade in the same line. The competition between the retailers is then with respect to who pays higher premiums, purchases more quantities, and applies higher fixed prices.

7.7 Chapter summary

This chapter focused on challenging the assumptions on which theoretical studies have been based; identifying the required modifications; and on exploring the new parameters that need to be included in developing option contracts for perishable food supply chains.

There are three theoretical assumptions on which option contracts studies are based. The first is that the chain is a retailer-led supply chain; the second is that demand uncertainty is a critical characteristic of the chain; and the third is that particular contractual terms including issues related to a fixed amount, a fixed time, a fixed price and premiums are necessary and important.

First, the assumption of being retailer-led supply chain in the upstream part of the fruit chains is argued. The marketers and direct growers are as powerful as the Supermarket. They influence order quantities and prices. They tend to receive revenue above average in the relationship. Sharing power between the suppliers and supermarket is the result of the perishability factor in produce. The Supermarket at the end of the supply chain has to share the power with the suppliers in order to be able to respond to the consumers' expectations, which is fresh quality fruit.

Second, demand fluctuates during each season and adds uncertainty into the decision making. Competition between fruits, promotions, cross advertising, reality shows and prices are counted as the reasons of demand fluctuations. However, fruit prices are supply driven rather than demand driven. This highlights the role of supply uncertainty in the supply chain.

Third, the option contracts are based on a fixed amount, fixed time, and fixed prices. However, the quality of fruits, available volumes, beginning time of the season, season duration, and prices are unpredictable parameters before the season starts. The high level of uncertainty in supply challenges the idea of applying fixed terms in option contracts in perishable food supply chains. Therefore, option contracts can only be applied in the perishable food chains, if the contract terms and definitions focus on the supply uncertainty rather than demand.

There are more parameters identified in this research that must be considered in developing option contracts in supermarket fruit supply chains. Salvage value and quality costs are the parameters included in current form of option contracts that need to be adjusted and reconsidered according to the requirements of real world fruit chains.

The research also unveiled the importance of long term relationships in these chains. Option contracts may increase profit in the supply chain in a short time horizon- for example the profit in the current season. However, the supermarket and suppliers apply long-term agreements as much as eight years. Therefore, the option contract could only be effective in the fruit supply chain if the long-term relationship and its consequences are considered in the contract development.

Potential developments were recommended in this chapter for option contracts in order to make them more compatible to the fruit supermarket chains. The recommendations include: option contracts in weekly timeframe, option contracts in seasonal time frame, option contracts for the supplier, quality standards in the contract, options contract to be traded in the entire market with all retail chains.

The next chapter outlines the findings and conclusions according to the research objectives. Research limitations and avenues for future studies are also suggested in the next chapter.

Chapter Eight

Conclusions and Limitations

8.1 Introduction

Lundqvist et al (2008) have argued that almost half of the food harvested for human consumption is wasted in supply chain even before it reaches the consumers; and certainly, as Heffernan (2010) has pointed out, there may be significant food wastage during production and processing. Food waste in Australia is estimated to be 3.3 million tonnes annually, worth about AUD \$5.3 billion (Heffernan 2010).

Clearly, many factors are responsible for creating food waste, but this thesis suggests that uncertainty in decision making and lack of coordination between different players in the supply chain may point to the inadequacy and inefficiency of contractual agreements between supply chain firms as critical factors in the problem of food waste. Particularly, the lack of *flexibility* in sale agreements between farmers and retailers, for example, may contribute directly to crop waste at the farm gate as well as to downstream waste at the retail outlets. Flexible contracts, on the other hand, enable the supply chain more generally and the downstream retailer more particularly, to deal with demand fluctuations and uncertainty by increasing or decreasing order quantity during the sale season.

More recently in supply chain analysis option contracts – a particular form of flexible contracts and applied widely in financial market analysis and in electronics, apparel and toy

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market supply chains and used as a mechanism to manage the cost related to the supply chains caused by demand uncertainty – have been applied to food supply chains (Wang, C & Chen 2013; Zhao, L et al. 2009). An intensive literature review indicated the sophistication of rigorous mathematical and theoretical framework – not unusual for the detailed analysis required by option contracts – and suggested the potential value for the application of option contracts to food supply chain analysis. But it was also clear that, almost without exception, the studies had either not understood the complexities of real-world supply chains or had been unable to define and measure appropriate variables and parameters – so that the results had failed to reflect real-world supply chain operations.

This thesis seeks therefore to focus, first, on the dynamics and mechanisms of selected real-world supply chains; and second, to evaluate option contracts against this background of detailed analysis. More particularly, the thesis has investigated, in detailed case study research, the applicability of option contracts in high volume, high value selected perishable food supply chains – characterised by high level of perceived uncertainty – and oriented to the needs of one of Australia’s nationally significant supermarket chains. A Multi Criteria Decision Making technique (see Chapter 5) further narrowed the research to intensive investigation of four major fruit supply chains to the retail outlets of the national supermarket firm located in, and serving, all eastern states of Australia. The analysis involved the supermarket’s supply chains for mango, strawberry, peaches and table grapes as they existed in 2013 and 2014 and required extensive interviews of individual supermarket chain managers, fruit marketers, suppliers, growers and appropriate fruit associations representing industry interests.

This chapter is structured to reflect the highlights and key findings related to the three research objectives established at the beginning of the study –

- to explore the current contractual arrangements and influencing parameters on the relationships between the players in the supply chain (Objective 1);
- to investigate the validity of option contract assumptions in the actual supply chain (Objective 2);

- to recommend modifications and new requirements in applying option contracts in the perishable food supply chains (Objective 3).

8.2 The research findings: an overview

8.2.1 Current contractual arrangements and the key parameters of the relationships between players in the supply chain

As noted, optimising complex mathematical functions for option contracts is a meaningless exercise in the underlying contractual relationships in real world supply chains are not understood and adequately described. The following discussion demonstrates the complexities that exist in the perishable fruit supply chains considered in this research; and it argues that any application of option contracts to these chains must take into account issues relating to the seven key problems as set out in the following paragraphs.

Supply chain structure: There are four categories of players in the supermarket fruit supply chain: direct growers, indirect growers, marketers, and supermarket category managers.

Figure 8-1 illustrates the key elements in the supply chain structure.

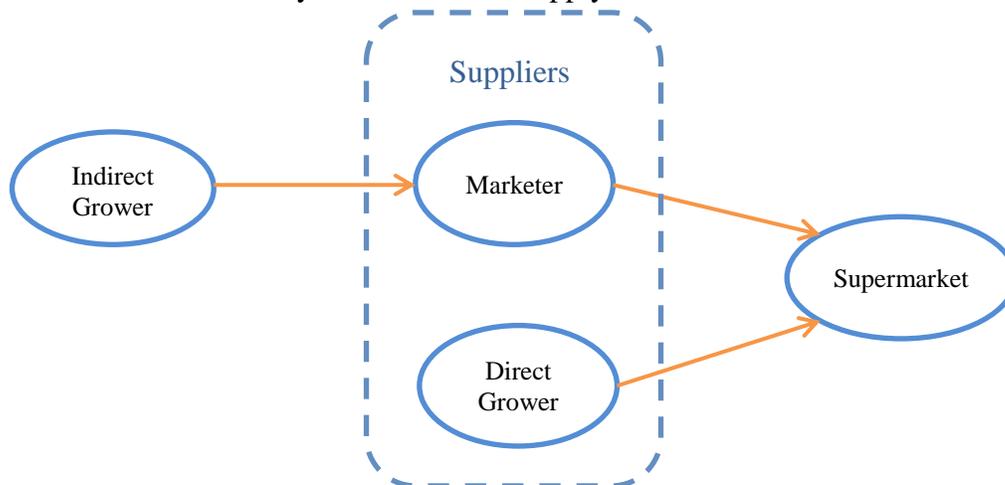


Figure 8-1 Key players in the supermarket fruit supply chains

When the supermarket trades with large growers who are able to supply huge volumes of fruits, a single dyadic relationship is created. On the other hand, a double dyadic relationship is created when the indirect grower is involved in the trades with the marketer as the intermediate player between the indirect grower and the supermarket. The marketer's

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roles in the supply chain are to decrease the number of small and medium size growers involved in the relationship with the supermarket.

Planning and ordering: The planning process for the next season starts shortly after the current season finishes. The supermarket category managers and suppliers¹⁴ plan an initial total commitment for each individual supplier in the review meetings. The planning and ordering negotiations become more frequent as it gets closer to the season. By two to three weeks before the commencement of the season the plan has become more accurate and includes the weekly order quantities for each supermarket's distribution centre.

Ordering negotiations continue on a daily basis during the season. Due to the short life cycle, supply availability and weather events the suppliers and supermarket have to refine the plans promptly and decide on any changes. Information sharing and trust are two crucial factors in the ordering negotiations.

The ordering process between the marketer and the indirect growers is the same as that between the supermarket and marketer. The marketer is in contact with the indirect growers on a daily basis during the season and receives information regarding the volume of availability from each indirect grower. The marketer is then able to pass estimation of the supply volumes to the supermarket. Again, information sharing, trust and intensity of contacts are critical.

Price negotiations: Price is never reviewed or discussed for the next coming season in the review meetings but it is decided weekly during the season. The suppliers initiate price negotiations and offer a price related to the available volume for the next week to the supermarket. The supermarket makes the supplier/price/volume decisions and enjoys bargaining power on the basis of information asymmetry which it enjoys.

Indirect growers are usually not involved in the pricing negotiations with the supermarket. The marketers negotiate on their behalf and pass the price associated with the order quantity to them. The indirect growers often accept the price. The marketer signs a contract with the indirect growers in which the minimum return to the growers is guaranteed. In

¹⁴ Supplier refers to both direct growers and marketers.

negotiation with the supermarket the marketer has to consider, therefore, the minimum return to the indirect growers plus an appropriate profit margin.

Quality maintenance: Maintaining the quality of fruits within the supply chain is a key task. Fruits are perishable and their quality decreases over time. This fact influences all supply chain activities including the relationships between the Supermarket and the suppliers.

The supermarket has changed its emphasis on purchasing strategy to one involving private negotiations in order to provide consistent quality fruits to the consumers. It announced a document called standard specifications, which determines the requirements of produce in terms of eating and appearance quality. According to this document, the suppliers must provide high quality and premium grade fruit to the supermarket.

Quality impacts on the prices, costs of production and the relationships between the players. The growers¹⁵ have to maintain the quality throughout the year from the early stages to final stages of picking, packing and grading to make sure they provide first grade quality fruit to the supermarket. These activities add extra costs to the growers.

The supermarket decides the suppliers' total commitments for the next season based on the quality of fruit that the supplier provided in the current season. The amount of rejections is a decisive factor in this relationship.

Supply chain costs: Investments, maintenance, harvesting, packing, storage, transportation and quality are costs to the growers. Investment costs may require significant amounts of capital- but these tend to be relatively infrequent. They are required for upgrading infrastructure, building new facilities for cooling and packing, purchasing new orchards and breeding or purchasing new varieties.

The required investment capital may come from various sources and will be related to turnover, reputation and relationships. Direct growers who have more land and higher turnovers are able to fund their own investments. However, in some cases the supermarket may directly fund the direct grower to assist with the provision of facilities to protect the

¹⁵ Growers refer to both direct and indirect growers.

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crops from weather events. This co-investment is on the condition that the grower will supply exclusively to the supermarket. From the grower's point of view, it reduces supply uncertainty caused by weather events and exclusive supply to the supermarket reduces the uncertainty in selling the crop.

The indirect growers, who are small to medium size growers, not only do not have enough capital for self-investment but also they cannot benefit from the supermarket investment because they do not trade directly with the supermarket. They must either use bank loans or ask their marketers to fund them. There is some evidence that the marketer will invest in the growers' farms by purchasing new varieties for the farm. In return the grower must market all the fruits through that marketer.

The collaboration agreements between the supermarket and direct growers, and marketers and indirect growers highlight the importance of a long term relationship between these parties. The investments may take up to eight years to produce revenue returns.

The cost of quality includes costs related to crop protection and to the costs of rejections and are added to the growers' costs. The growers have to maintain the quality during all stages of production, picking and packing. If a batch of fruits is rejected by the supermarket due to lack of quality, for example, the grower has to pay the return costs of transportation to the warehouse or wholesale market.

From the marketers' perspective, costs in the supply chain are internal operations, investments, transportation and quality. Investments costs for the marketers include research and development of new breeds and varieties. This requires time and fund. On the other hand, the marketers invest in plant breeding in order to get the right of marketing for that specific variety. They gain power and market advantage by having the exclusive right to market the crop.

The marketers' quality costs also include the costs of crop protection and rejection. The costs associated with the ripening of mangoes, for example, are the marketers' responsibility. They have to maintain the quality for the two-week time period that they keep mangoes in their warehouse. In addition, they sometimes receive the fruits at the

warehouse for future delivery. These activities require quality control and are costly – and the marketer has to pay for the transport of rejected fruits to their warehouse or wholesale market.

Supermarket expenditures are relevant to the internal operations of the firm rather than being related to supply chain costs. Supply chain costs sustained by the supermarket include wastage costs during distribution and in-store. This wastage may result from poor quality fruit and is a strong reason for the supermarket to apply strict quality standards and crop protection strategies from farm to store.

Salvage value: All the players have the opportunity to salvage remaining fruit - but there is not always profit involved for all players in the fruit supply chains. The level of earned salvage value depends on the player and type of the fruit - peach growers, for example, do not have salvage value opportunity and may not be able to send their fruit to canning and juice companies because of special variety specifications. Not unusually they send over-ripe fruit to cattle farms for free.

Marketers and supermarkets also have the opportunity to donate fruits to charity organisations and in return receive tax benefits at the end of the financial year. Unfortunately, calculating the specific salvage value is complicated because all fruits are grouped together and it is not possible to calculate how much of the tax refund is relevant to a specific type of a fruit¹⁶.

Consumer demand has been investigated in the research because it is of relevance in defining option contract requirements. Demand in fruit supply chains is related to two time frames - a short term frame refers to the demand in one season; and a longer frame is relevant to the demand patterns from one season to another season over several years.

Consumer demand fluctuates even within a single season and causes uncertainty in the supply chain. Certainly, weather impacts demand and daily temperature affects demand especially for summer fruits - strawberries and grapes, for example, demand increases in sunny and warm weather. Reality cooking TV shows can temporarily increase the demand

¹⁶ The supermarket may be able to make these calculations but in any case they would be treated on a 'commercial-in-confidence' basis.

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by introducing new recipes; and cross advertising - the promotion of ice cream could increase the demand for strawberries and other type of berries.

Demand is price sensitive in some fruits. This means lower price stimulates the consumers to purchase more and therefore demand increases; and higher price has the reverse impact. Demand for mangoes and stone fruits are highly price sensitive; but demand for essential fruits such as apples and bananas, which consumers believe on their nutrition, have less dramatic price impacts.

The demand for fruits tends also to be interdependent and the demand for one fruit impacts on the demand for another fruit. Promotions on one fruit increase the demand for one fruit and decrease the demand for other similar fruits.

In general, fruit demand is unpredictable in the short term for reason related to weather, price, quality and promotions; but the demand for specific fruit from year to year tends to follow similar pattern and is predictable even given population growth.

8.2.2 Options contract theory and real-world supply chains: Key Conceptual Problems

The previous section provided insights into the operations of selected perishable (fruit) supply chains focused on a major supermarket's retail outlets. This section, reporting on the stated research objective two, questions the validity of the assumptions which underlie option contracts theory in the light of our detailed analysis.

The theory of option contracts is based upon a set of fundamental assumptions. The first assumption is that an option contract must be applied in a retailer-led supply chain in order to achieve the required level of coordination. The second assumption is that the supply chain must be characterised by high demand uncertainty. The third assumption is in respect of the option contract terms - fixed time, fixed price, specific time, and premium payment. As noted earlier, our literature review suggested that studies assumed that perishable food supply chains met these assumptions. The following paragraphs question the validity of these three key assumptions for the supermarket-oriented perishable food chains examined in this study.

Are supermarkets perishable fruit chains retailer-led supply chains? The assumption that the perishable food supply chains examined in this study are operating as retailer-led chains was investigated by detailed application of the Cox framework (see Chapters 2 and 7). Cox's power matrix was applied to reveal supplier/buyer relationships in the chain and underlying patterns of dominance. The power relationships were investigated in both single dyad and double dyad supply chains by using four criteria – the number of buyers and suppliers in the market; the level of dependency among them; search and switching costs; and information asymmetry advantage or disadvantage.

The analysis of power between the direct grower and the supermarket in a single dyad supply chain suggested that there are few buyers and few suppliers; that the supermarket has a relatively high % share of the total market for direct growers; that the direct grower is highly dependent on the supermarket for revenue and has few alternatives; supermarket switching costs to new suppliers are high; that the supermarket account is attractive to the direct grower and direct grower offerings are not commoditised and customised; that supermarket search costs are high, importantly, the direct grower has moderate information asymmetry advantage over supermarket. Therefore, the dyadic power between the direct grower and the supermarket reflects an interdependent (A=B) relationship.

The investigation of power balances in the double dyad supply chain required exploration of the power relationships between two dyads in the supply chain. The first exchange relationship is between the indirect grower and the marketer, the second dyad is between the marketer and the supermarket.

In the marketer/indirect grower relationship, the marketer plays the role of buyer (B) and the indirect grower (A) is considered as the supplier. The attributes of this dyadic relationship suggest that there are few marketers and many indirect growers; the marketer has a high % share of total market for grower; that the indirect grower is highly dependent on the marketer for revenue and has limited alternatives; that the indirect grower switching costs are high; that the marketer's account is attractive to the grower; and that the indirect grower has no information advantage over the marketer. It is apparent, therefore, that the

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power relationship between the marketer and the grower is one of buyer dominance ($B > A$), with the marketer as the powerful member.

In the supermarket/marketer relationship, the marketer (B) plays the role of supplier and the supermarket is the buyer (C). The attributes of dyadic relationships between them suggest that there are few buyers/few suppliers; the supermarket has a relatively high % share of the total market for the marketer; the marketer is highly dependent on the supermarket for revenue with few alternatives; the supermarket switching costs are high and the supermarket account is attractive to marketer; the marketer offerings are not commoditised and customised and the supermarket search costs are high; and the marketer has moderate information advantage over the supermarket. The power relationship between marketer and supermarket is thus one of interdependence ($B = C$). The marketer is dependent to the supermarket to be able to market the produce; the supermarket is dependent to the marketer to be able to provide high quality produce at the store shelves.

Based on the above findings, it is clear that these particular chains indicate upstream interdependence. The marketers and direct growers are as powerful as the supermarket and influence order quantities and prices. The supermarket has to share the power with the suppliers in order to be able to respond to the consumers' expectations, which is fresh quality fruit. It is clear that collaboration delivers advantage to both suppliers and an obviously powerful retailer.

Are perishable fruit chains characterised by demand uncertainty? As noted, demand uncertainty is a key assumption in option contracts theory. The research suggests that consumer demand has increased year on year reflecting population growth; but long term demand is reasonably predictable. Short term, within season, demand on the other hand is almost invariably uncertain and in some seasons may be exceptionally volatile and adds uncertainty into the decision making process. Competition between fruits, promotions, cross advertising, reality TV shows and prices underline short term demand fluctuations; but a key factor impacting demand fluctuations during the season is the price of produce. Fruit price is supply rather than demand sensitive - the more supply available in the market the lower the price and, predictably, with lower prices the demand increases. This

predictable increase in demand cannot be considered as uncertainty in the supply chain and in any case the increase in demand while the supply increases favours both growers and the supermarket.

Supply availability is significantly dependent on weather events which are uncontrolled factors in fruit production. Supply uncertainty is a critical characteristic of fruit supply chains and uncertainty directly impacts on both volume and quality of produce.

Since the level of uncertainty in the supply is higher than the uncertainty of demand, the idea of applying option contracts in fruit supply chains is challenging. Option contracts must be designed to deal with supply uncertainty in the fruit supply chains. It might be defined as the right of the supplier to sell the fruits up to a specified quantity to the supermarket. However, there are still issues with such a definition. The supplier has to pay a premium to the supermarket to receive the right of selling. In an undersupply situation, then, the supplier has the right to sell a lower volume of fruits to the supermarket. The supplier already faces a loss in revenue due to shortage, what would be the benefit of premium payment to receive the right? Since in the current relationship there is no fine and punishments for supplying less fruit to the supermarket, then the use of option contract cannot be beneficial for parties.

Are the contractual terms required by option contracts theory appropriate for perishable fruit supply chains? There are four terms in the option contract definition that need in-depth investigation in order to explore applicability in the fruit supermarket chains. These terms are fixed amount, fixed price, fixed time and premiums.

Setting a fixed volume of fruit to be supplied in the contract prior to the season is especially risky because of the high supply uncertainty involved in the supply chain. The growers are not able to predict the supply volume before the season starts. They can ‘flower count’ the trees and provide estimation of the volume of fruits but the estimate is subject to changes due to weather events. Order quantities are changed even during the season, and the final order quantity is set a week before the arrival date to the distribution centres.

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In the current relationship between the suppliers and the supermarket, both parties are allowed to change the order quantity as they get closer to the actual time. The supply chain would not be able to manage the supply uncertainty in the chain without flexibility in ordering. Again, premium payment is not a useful requirement in the contract for the supermarket. The supermarket already has flexibility in the current relationship without extra payment. Therefore, the supermarket is not convinced to enter to a contract that gives the flexibility, which he already has, in return to extra payments.

Time relevant parameters for the production of fruit – such as the start day of the season, duration of the season and time of peak season vary from year to year. This is also due to weather events. Having fixed time requirements in the option contract cannot be applied in the fruit supermarket chains and a flexible time frame for the start of the season would be more compatible with the fruit supply chain characteristics.

Option contracts set fixed prices for both exercising price and wholesale price. These parameters are determined prior to the season. As explored in the objective one, the prices are supply driven and variable throughout the season. Determination of a fixed wholesale price for the entire season prior to the start of the season is not satisfactory for any chain player and would decrease their confidence in the market.

Price fluctuations are the results of supply uncertainty and if the impacts of uncertainty could be reduced then applying fixed prices is applicable in the fruit supply chains. Strawberries can be grown under the cover and reduces the impacts of weather impacts and supply uncertainty. Production under cover is new proceeding through collaboration between the strawberry grower and the supermarket. In this way, the grower believes the cost of production can be determined more precisely according to the supply volume. This grower was willing to enter into a periodic fixed price contract that considers the bell shape pattern for the price - high at the beginning of the season, decreasing in the peak season and increasing by the end of the season. Decreasing the impact of supply uncertainty is not possible for most fruit supply chains. So that entering to contracts with fixed a price is not applicable in these fruit chains.

As noted previously, premium payments in option contracts are designed to stimulate the contract offeree to accept the contract while there will be an increase in the risk associated in the trade. The premium payment from the retailer (contract offeror) to the supplier (contract offeree) brings the flexibility in ordering to the retailer. In the fruit supply chains, the supermarket (offeror) already has the flexibility in ordering. Therefore, the supermarket is not convinced to pay the premium in the contract.

However, the supermarket is willing to financially assist the direct growers. The purpose of supermarket is assurance on quality fruit supply not the flexibility. The financial collaboration between the parties strengthens the long term relationship between them.

Our discussion suggest that the three assumptions underlying option contracts theory - retailer-led supply chain, demand uncertainty, and contract terms - are not valid in the fruit supermarket chain. However, modifications and parameter adjustments may be able to customise the contract to be applicable in the fruit supermarket chains. These modifications and adjustments are the purpose of objective three which are investigated in the following subsection.

8.2.3 Applying option contracts in perishable fruit supply chains: adjustments for real-world chains

Option contracts have been shown to be elective in financial markets and in numerous other supply chains which exhibit significant uncertainty. More recently, and as noted, a number of studies have suggested their use in food supply chains. Closer, detailed case study analysis reported in this thesis has suggested, however, that fresh food supply chains – and, in this study, supermarket-oriented fresh fruit supply chains of national significance in Australia – are far more complex than routine option contracts applications indicate. In this section we draw together, briefly, a number of adjustments that are required if option contracts are to appropriately mirror real-world chains.

These adjustments fall into two groups and discussed in turn in the following paragraphs (though are more fully examined in earlier chapters).

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The need for parameter adjustments in option contracts equations: The research indicates that there are three specific factors or relationships that require re-thinking – the issue of salvage value in perishable fruit chains; the questions of interpretation and specification of quality costs; and the problems associated with long-term, rather than immediate as short-term issues.

Salvage value at the supermarket is negligible due to the perishability and decay of fruits - there is little chance of selling ‘old fruit’. However, the supermarket and the marketers have the opportunity of donating the produce to charity organisations and claim tax refunds at the end of the financial year. Salvage value at the supermarket, therefore, must be either ignored or considered as a tax refund in the calculation.

Quality standards influence order quantity and pricing processes. Maintaining quality up to standard specifications generates costs- both preventive and rejection costs- to the whole supply chain and each player. It is critical to consider the role of quality and its associated costs to the supply chain in option contracts for supermarket fruit supply chains. The immediate suggestion is to add the quality term and its conditions to the contract and exercise the contract subject to providing the desired quality. However, this term would shift the power towards the supermarket - which may not be acceptable to the growers. In addition, quality costs must be added in the cost function in order to find the optimal order quantity and prices of option contracts. This research suggests that one important cost is the rejection cost that needs to be added into the cost functions when calculating the optimal option price for the supplier (seller), because these costs are borne by the supplier. Rejection costs for one order delivery have been reported to vary between zero for no rejection and the total value of the order for 100% rejection.

This research has revealed the significance, in major supermarket-oriented fruit chains, of long term relationships; and as discussed earlier, the supermarket may often be involved in longer-term funding of breeding, planting and sustaining new fruit varieties. Under these circumstances both the retailer and the grower may benefit from higher yields and higher fruit quality over the longer term. However, Option contracts have a short-term time frame and target to increase the temporary and short-term profit of the supply chain. The

long-term nature of the supply chain is in conflict with the fundamentals of current forms of option contracts and change in the current form of option contracts needs a significant shift from short-term targets to long-term gains.

The need for time-frame and market scope adjustments in option contracts for perishable fruit supply chains: This research has shown that long term relationships, trust, quality standards, perishability, supply uncertainty, zero salvage value and high price fluctuations are the characteristics of the fruit supermarket chain that should be considered in contract design and development. However, it would be complicated to consider all the requirements in the contract and some of the characteristics are in conflict with fundamentals of option contract.

The research recommends some potential developments for option contracts in order to make them more compatible to the fruit supermarket chains. These fall into two groups – time-dependent and time sensitive contracts; and contracts related to market scope (Chapter 7).

Time-dependent and time-sensitive contracts

Contracts based on a weekly time frame: In this framework ordering quantities Ordering quantities and prices are set in a weekly timeframe to respond to real world conditions. Each contract for the week must determine the order quantity (Q), option quantity (q), premium price (p_o), exercise price (p_e) and wholesale price (p). The modelling is compatible with the real conditions. It satisfies the players in the chain in terms of covering the supply uncertainty consequences on price. The disadvantage in a season with at least twenty active weeks, twenty option contracts and consequently the optimums must be calculated. In addition, the players every week must decide whether or not to exercise the contract. Although the weekly model covers the price fluctuations, there is no guarantee of application of the optimal parameters of contract as weather impact changes the supply availability by weeks.

Conclusions and limitations

Contracts based on a seasonal time frame: The supermarket can predict the total volume of produce they can sell in the next season based on the past history data. Research shown it is capable of determination of order quantities within ninety percent accuracy before the beginning of the season. The remaining ten percent can be considered as option quantities the supermarket needs to purchase. However, the price determination would be a challenge, as the price fluctuates during the season widely. The advantage is that there is only one contract to be developed for the whole season. The demand prediction would be more accurate in a seasonal timeframe rather than in a weekly time frame. The disadvantage is that it could not cover the price fluctuations during the season.

Contracts related to market scope

Option contracts designed from a supplier perspective: Since the fruit supply chains are affected by supply uncertainty more than demand uncertainty an option contract designed from the supplier's perspective could decrease the impact of supply uncertainty. The supplier would offer the option contract to the supermarket. He buys the right of selling fruits to the supermarket with an allowance to increase or decrease (call or put) the quantity. In a season with oversupply the supplier is in favour to exercise the contract in a call situation and sell $Q+q$ fruits. Such a contract would be compatible with the real conditions in which the grower has the flexibility in increasing the order when oversupply occurs. The disadvantage would be then for the supermarket. Such a contract with each supplier would add the uncertainty of available fruit- each supplier must decide whether to exercise the contract or not so the supermarket could not be certain about how much to order and how much to receive.

Option contract designed for the whole market: Losing competitive advantage in the market was one of the main reasons why interviewees agreed that a fixed price contract is not suitable for the supply chain. If option contracts are applied among other retail chains then every player applies fixed price agreements and trade in the same commodity. The competition between the retailers is then based on who pays a higher premium, purchases greater quantities and applies higher fixed prices.

8.3 *Limitations*

The research started with the premise that option contracts can be adopted in fresh food supply chains. Option contracts are widely and successfully applied in financial markets and toys, apparel and electronics supply chains. The research looked into real world fruit supply chains of a nationally significant supermarket chain in Australia. Growers, marketers, fruit associations, and supermarket managers participated in the research and demystified the chain structure, processes and key relationships.

The research showed that the classical forms of option contracts are not capable of dealing with the complexities present in real world supply chains. It, in fact, raised more questions than answers. Questions such as: How can classical short term option contracts be redesigned to embrace long term relationships? How to deal with high supply uncertainty? And how to consider quality standards in the contract?

Option contracts require fixed term parameters agreed prior to the season. These fixed terms include fixed time, fixed amount and fixed price. However, in a real world fruit chain these parameters cannot be fixed due to very high supply uncertainty. Option contracts optimise the short term profits. The real fruit chains are based on long term agreements and relationships between supermarket and growers due to the need for long term investment in breeding and marketing new varieties, and maintaining high quality.

This high quality also raises more complexity in the chain that has not been addressed in the classical forms of option contracts. Supermarkets only accept produce with certain level of appearance quality. There are extra costs in the chain relevant to this quality requirement that should be considered in the new forms of option contracts.

In addition to these circumstances, there are current trends in the market to which the future research needs to respond. Since more than ninety percent of produce in Australia are locally grown, this research focused on the relationships between local growers and supermarkets. However, if the overseas growers join the supply chain, the future research would be needed in designing option contracts accommodating this need.

Conclusions and limitations

The new farming trends are another avenue for future research. It has been shown that the seasonality of produce is a requirement in applying classical option contracts. The seasonal fruit chains are impacted by supply uncertainty. New trends of farming in controlled environment such as hydroponic methods eliminate the impacts of supply uncertainty in the chains and therefore, would pave the way for applications of option contracts.

This research faced limitations. It investigated the applicability of option contract in the Australian supermarket fruit chain. Australia is a vast country with limited local consumers (approximately twenty million population) which might impact on the relationships, structure and operations of the supply chain. The applications of option contracts in fruit supply chains in other countries could result differently.

In addition, this research looked at the local market and local growers. However, considering imported produce from global markets especially in countries with high volume of imported produce would raise different aspects of the supply chain, which in fact need further investigations.

Another limitation of the research is the application of an original and basic technique of MCDM. This can be improved by applying other eclectic MCDM techniques to find the best appropriate case studies.

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Appendix A

Food Supply Chains and Food Security

This research explores the applicability of option contracts in the perishable food supply chains. If option contract can be applied then the coordination between the players in the supply chain is assumed to be reduced. This will result in reducing food waste within the supply chain. Food waste at its higher level contributes to food insecurity. Therefore, this appendix explores the relations between food security and food supply chains.

Ericksen (2008) provides a conceptual framework for food security. Hence food security is a complex issue with interaction of interdependent components; a food system approach has been applied. Ericksen (2008) introduces the concept of 'food system' for a comprehensive analysis of how food organisations and all other participants contribute to food security. This framework includes feedbacks and interactions among drivers and considers multiple outcomes (Figure A-1). In addition, it considers food system outcomes which contribute on three major issues including food security, environmental security and social welfare. He also claims that applying a broad framework of food systems that has interactions with economic and social drivers result in food security and "sustainable environmental management".

Food systems are defined as set of activities from production to consumption. Food systems value more on processing and marketing within food security concept. In the Ericksen's framework, food system activities are the start point of the cycle, which leads to the outcomes. Food system activities, according to Ericksen, are Producing, Processing, Distribution and Retailing, and Consuming. Food system activities and its outcomes are shown in Figure A-2. These activities have been studied enormously with the objective of achieving food security by increasing food availability, access and utilisation (Cannon 2002; Lang & Heasman 2004).

Producing food includes all agricultural activities to produce fresh produce or raw materials. This ranges from the process of obtaining inputs, such as seed, land, water and labour, to caring for the growing and then harvesting fresh, nutritious and healthy produce. There are variety factors which influence on the producing process. These factors can be divided into two groups. First group is macro factors such as agriculture technology, government policies and subsidies, and climate conditions. Second group includes the supply chain factors such as input prices, grower-retailer relationships and competition between chains in regard to quality, quantity and price.

Packaging and processing activity transforms the raw foods before sending to the retail market. This activity can change the food appearance, storage life and nutritional value. Although this step adds value to the produce, it does not cover all of the fresh produces. These activities might be different for each produce with distinctive results.

Distributing and retailing activity includes all activities to move fresh produces from one place to another place and to the markets. There are factors that impact on this activity such as transportation infrastructures, trade policies, market regulations and storage requirements. Some of these factors are in the macro levels such as transportation infrastructure. However, other factors such as market regulations and storage requirements can be considered and improved in the supply chain level.

Consuming food depends on the customer behaviours and preferences. This activity involves selecting and buying, preparing, eating and digesting tasks. This item is beyond the supply chain management and considered as a subject in social science and nutrition science.

Among all food system activities, the first three are related directly to each other and the common goal of them is to pass the nutritious and healthy produce to the end customers. They create a chain of activities to achieve their common goal. To get an insight into the chain of activities, the emergence of studying food system activities within the supply chain concept has raised. To conclude on the framework, this is the first time that food supply chain (hidden in food system activities) is addressed in the food security concept. Food supply chain in the context of food security is still in its infancy stages. However, it has

Appendix A

been in the concern of business, agriculture and marketing areas. In the following, food supply chain concept and its characteristics are explained.

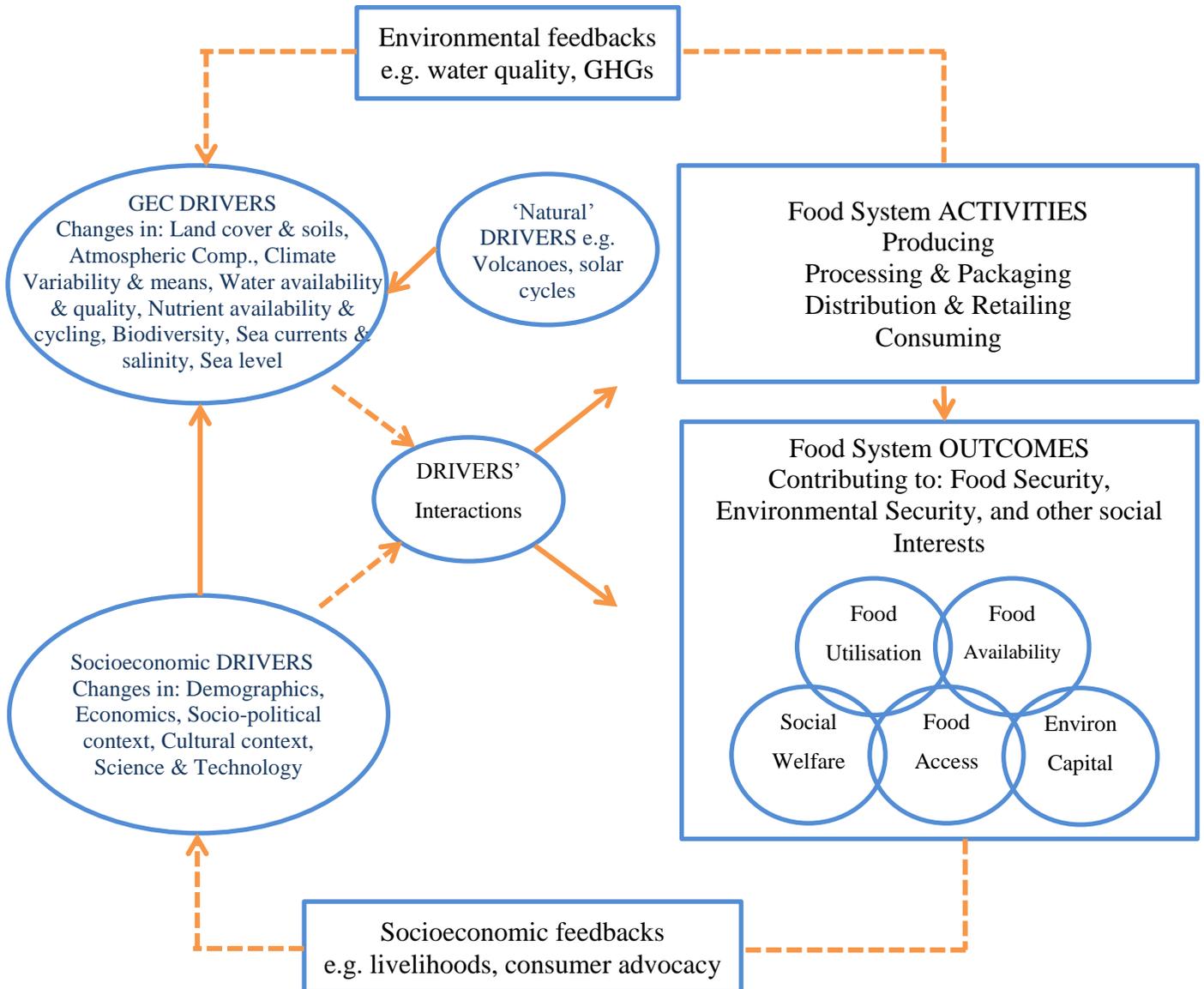


Figure A-1 Food systems and their drivers, Source: Ericksen(2008)

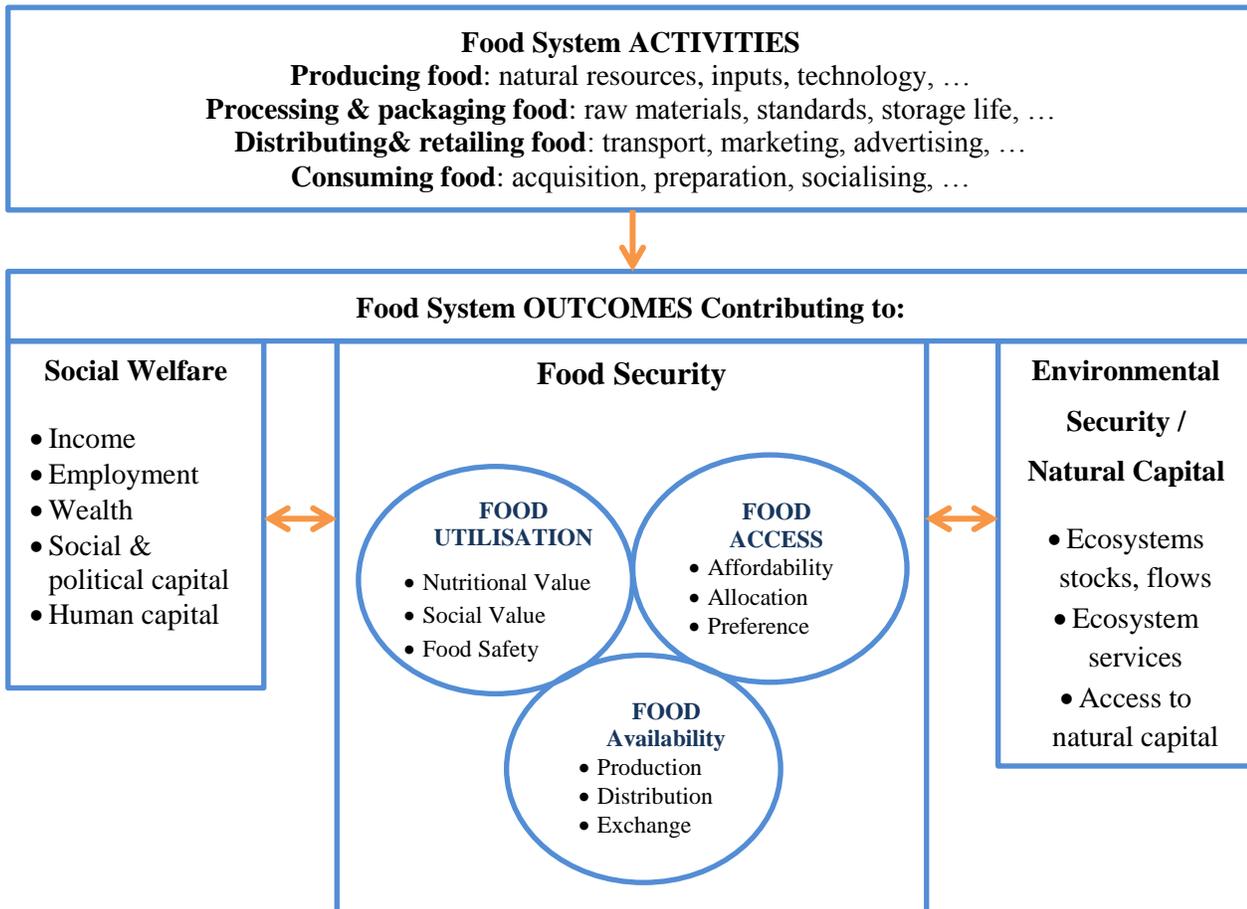


Figure A-2 Components of food system, Source: Ericksen(2008)

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Appendix B

Interview Information Package

INFORMATION TO PARTICIPANTS

INVOLVED IN RESEARCH

You are invited to participate

You are invited to participate in a research project entitled “Option Contracts for Supermarket Fruit Supply Chains: Theory and Practice”.

This project is being conducted by student researcher Ms. Aida Ghalebeigi as part of a PhD study at Victoria University under the supervision of Professor Ross Robinson and Dr Himanshu Shee from the Institute for Supply Chain and Logistics.

Project explanation

The fresh food market is affected by fluctuations in demand. Due to this demand fluctuation, supermarkets face difficulties to determine the exact order quantity. Consequently, they might order more than actual consumer demand, which results in waste and additional unnecessary cost. Almost 3.3 million tons of food have been wasted annually in Australia, which is worth about AUD \$5.3 billion. The unnecessary waste can impact each point of food chain, from growers to supermarkets and consumers.

This research aims to propose a new contract arrangement between growers and supermarkets to reduce wastage and its implied cost. The project focuses on perishable fruits strawberries, stone fruits, peaches and grapes to identify the reasons for and characteristics and aspects of demand fluctuations. Growers, supermarkets and customers would benefit from applying the outcomes of this research that will establish the validity of a new contract arrangement resulting in less wastage, lower costs and lower prices.

What will I be asked to do?

You are asked to participate in an interview and talk about the issues relating to buying and selling of fruit produce. Furthermore, you are asked to share your perspectives on the potential ways of dealing with fluctuations in demand. The interview will last for no more than an hour.

What will I gain from participating?

You will be informed about the results of the research. The results include issues about the attributes of buying and selling of fresh products in Australia. It will show how to deal with demand fluctuations to reduce the wastage amount, costs and retail price. In addition, ways of using the new contract arrangement will be revealed. The results of this study will benefit the whole perishable food product industry from growers to supermarkets and consumers, as well as society generally through better use of resources required in growing and distributing fresh produce.

How will the information I give be used?

The information gathered from you will be used to determine the characteristics of demand and issues relating to the selling and buying of fresh products. In addition, the characteristics of the Australian perishable food supply chain, from farms to supermarket shelves, will be explored through the analysis of interviews. Consequently, the optimal way of using the proposed contract arrangement will be introduced to maximise the profit of each party.

What are the potential risks of participating in this project?

The interview will be conducted under a strictly observed commercial confidentiality and a confidential agreement. No potentially sensitive questions will be asked. The data and your name will be kept confidential. Your name and the name of your organisation only appear on the consent form and will be removed from all data analysis. Only the investigators and research student have access to the information gathered. Also, any publications of results will not refer to individuals, and only meaningful aggregates that hide your commercial details will be used. Consequently, there is no potential risk for participants.

How will this project be conducted?

To undertake this research project, information from participants in the perishable food supply chain is required to be collected. To get a balanced insight to the issue, this research will consider the issue from the different viewpoints of all participants. Therefore, face-to-face interviews will be undertaken with growers, managers of supermarkets and representatives of corresponding food associations.

Who is conducting the study?

Institute for Supply Chain and Logistics, Victoria University, Melbourne, Australia

Chief Investigator: Professor Ross Robinson

Email: ross.robinson@vu.edu.au , Tel: 03 9919 8575

Associate Chief Investigator: Dr. Himanshu Shee

Email: hermione.parsons@vu.edu.au, Tel: 03 9919 4077

Student Researcher: Aida Ghalebeigi

Email: aida.ghalebeigi@live.vu.edu.au, Tel: 0432 219 619, 03 9919 6265

Any queries about your participation in this project may be directed to the Chief Investigators listed above.

If you have any queries or complaints about the way you have been treated, you may contact the Research Ethics and Biosafety Manager, Victoria University Human Research Ethics Committee, Victoria University, PO Box 14428, Melbourne, VIC, 8001 or phone (03) 9919 4148.

CONSENT FORM FOR PARTICIPANTS INVOLVED IN RESEARCH

Information to Participants

We would like to invite you to be a part of a study into demand fluctuation in the Australian perishable food products. Demand fluctuation is a key source of waste, and this research will investigate the application of a new contract arrangement, which is called an option contract, to minimise the influences of demand uncertainty on Australian perishable food products.

This research will collect information from a variety of people in the perishable food supply chains. The interviews will be undertaken with growers, supermarket managers, fruit suppliers and representatives of food industry associations to get an insight into the issues relating to demand fluctuation and its influence on the supply chain.

The interviews will be conducted on the basis of strictly observed commercial confidentiality. Your name and company name will only appear on this form and will be removed from all data analysis and future publications. Further, all information will be presented in meaningful aggregate, so no other party can see into your business.

Certification by Subject

In concordance with research ethics of Victoria University,

I, ----- from -----

certify that I am at least 18 years old* and that I am voluntarily giving my consent to participate in the study:

“Option Contracts for Supermarket Fruit Supply Chains: Theory and Practice” being conducted at Victoria University by: Professor Ross Robinson and Dr Himanshu Shee.

I certify that the objectives of the study, together with any risks and safeguards associated with the procedures listed hereunder to be carried out in the research, have been fully

explained to me by Ms. Aida Ghalebeigi and that I freely consent to participation involving the below mentioned procedures:

- A face to face interview at my office

I certify that I have had the opportunity to have any questions answered and that I understand that I can withdraw from this study at any time and that this withdrawal will not jeopardise me in any way.

I have been informed that the information I provide will be kept confidential.

Signed: -----

Date: -----

Any queries about your participation in this project may be directed to the researcher Professor Ross Robinson.

Phone: 03 9919 7743

If you have any queries or complaints about the way you have been treated, you may contact the Research Ethics and Biosafety Manager, Victoria University Human Research Ethics Committee, Victoria University, PO Box 14428, Melbourne, VIC, 8001 or phone (03) 9919 4148.

[*please note: Where the participant/s are aged under 18, separate parental consent is required; where the participant/s are unable to answer for themselves due to mental illness or disability, parental or guardian consent may be required.]