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A quantitative analysis of global kiwifruit trade

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Abstract/ Summary

New Zealand is currently the third largest global producer of kiwifruit and thus plays an important role in the international market. Exports of kiwifruit are also of significant horticultural value for New Zealand and in 2007 the kiwifruit industry accounted for export values of NZ$790 million.

The global kiwifruit market has experienced substantial changes in recent years and is likely to change significantly in the near future due to developments in production sources, adjustments to trade policy settings and shifts in consumer preferences. The New Zealand kiwifruit industry needs to consider what the impacts of these changes might be so that future strategies can be constructed effectively.

Little quantitative modelling has been done in New Zealand to consider the impacts of changes to the global kiwifruit industry. The major contribution of this research was the development and calibration of a kiwifruit industry-specific partial equilibrium trade model. The model was then used to examine the impacts on New Zealand producers of these trade-related changes in the global kiwifruit market. Three relevant scenarios were developed for this purpose. They include a drop in EU demand through the introduction of a stricter Sanitary and Phytosanitary policy, an expansion of the Chinese kiwifruit industry where production is doubled by year 2013 and finally a trade liberalisation scenario where current import tariffs on kiwifruit were removed worldwide.

It is clearly observed, through both the Chinese expansion scenario and the trade liberalisation scenario, what a potential impact and future role China has as a world market player. Increased availability of Chinese kiwifruit appears to affect New Zealand producer returns and exported quantities negatively, albeit not as significantly as the EU introduction of an SPS policy. A trade liberalisation scenario, on the other hand, proves to increase New Zealand grower returns significantly for all varieties.

Key terms: International trade, kiwifruit, New Zealand, KIWI, China, SPS

Sammanfattning

Nya Zeeland är för närvarande världens tredje största producent av kiwifrukt och spelar därmed en avgörande roll på den internationella marknaden. Export av kiwifrukt är även av signifikant hortikulturellt värde för Nya Zeeland och exportvärden uppgick till NZ$790 miljoner under 2007.

Den globala kiwifruktsmarknaden har utsatts för avsevärda förändringar under senare år och lär sannolikt förändras markant inom den närmsta framtid med utvecklingen av produktionsmetoder, anpassning till olika handelspolitiska initiativ samt skift i konsumtionsmönster. Nya Zeelands kiwifruktsindustri bör beakta potentiella effekter av dessa förändringar så att framtida strategier kan konstrueras effektivt.

Få studier fokuserade på kvantitativ modellering har utförts, som inkluderar effekterna av förändringar inom den globala kiwifruktsindustrin. Denna studie bidrar huvudsakligen till nuvarande litteratur genom utvecklingen och kalibreringen av en partiell handelsjämviktsmodell specificerad på kiwifruktsindustrin. Modellen har använts för att undersöka effekterna av handelsrelaterade förändringar på Nya Zeelands kiwifruktsproducenter. Tre relevanta scenarier utvecklades i detta syfte. De inkluderar en nedgång i EUs efterfrågan genom introduktionen av striktare veterinära och fytosanitära (SPS) åtgärder, en expansion av Kinas kiwifruktindustri genom en fördubbling av landets produktion till år 2013 och slutligen ett handelsliberaliseringsscenario där en världsomfattande avreglering av nuvarande importtullar på kiwifrukt utfördes.

Det kan tydligt observeras, genom både Kinas expansionsscenario och handelsliberaliseringsscenariot, vilken potentiell effekt och framtida roll Kina har som aktör på världsmarknaden. Ökad tillgänglighet av kinesisk kiwifrukt förefaller påverka Nya Zeelaändska producentintäkter negativt, dock inte like signifikant som EUs introduktion av striktare SPS-åtgärder. Ett handelsliberaliseringsscenario, å andra sidan, påvisar en avsevärd ökning av Nya Zeeländska producentintäkter för samtliga sorter.

Nyckelord: Internationell handel, kiwifrukt, Nya Zeeland, KIWI, Kina, SPS

Table of Contents

1 Introduction

The New Zealand kiwifruit industry may have to face several trade-related issues in coming years as the global industry is confronted with strategic and structural challenges. These changes include different regulatory requirements on kiwifruit production methods and the growth in production in several competitor countries. New Zealand is currently the third largest global producer of kiwifruit and thus plays an important role on the international market. Exports of kiwifruit are also of significant horticultural value for New Zealand. Therefore, the objective of my thesis is to quantify and analyse the possible effects that these changes might have on the kiwifruit industry especially in New Zealand.

Kiwifruit is grown and traded internationally and the world market is dominated by a few main players. The world's three largest producers have until recently been represented by Italy, New Zealand and Chile. China has recently overtaken Chile and New Zealand as the largest producer. Trends in global exports are consequently heavily influenced by the production levels in the top producing countries. A significant part of this thesis will therefore consider potential changes in those countries with the largest impact on the world kiwifruit market.

The thesis initially concentrates on a descriptive analysis of the growth and structure of the kiwifruit industry in New Zealand and overseas. It investigates some of the most relevant trade-related issues concerning the global industry in general and the New Zealand kiwifruit industry in particular. In particular the growth and potential changes in Chinese and EU industries will be assessed. The thesis will then review the economic theory and the literature to assess how these changes may affect the kiwifruit industry. A new kiwifruit trade model will be described, using industry specific countries and varieties based on the Lincoln Trade and Environment Model (LTEM). It is a partial equilibrium trade model, which can simulate effects that various domestic agriculture and border policy changes would have on price, supply, demand and net trade.

The thesis will focus on trade-related issues facing the global kiwifruit industry through a trade modelling approach. This work appears to be the first application of such a method to analyse trade issues affecting this specific industry. This research will utilise an established method (the LTEM) and the core of the thesis will concentrate on scenarios concerning a potential EU import ban on conventional kiwifruit, a trade liberalisation scenario and a case of Chinese industry expansion. In every case the impact on New Zealand producer returns will be estimated.

1.1 Hypotheses

The specific hypotheses being assessed are as follows:

1. **A drop in EU imports and consumption, due to a stricter Sanitary and Phytosanitary (SPS) policy, of all New Zealand kiwifruit will decrease New Zealand kiwifruit export values.**

The expected result of this scenario, according to theory, would suggest that the drop in EU consumption will reduce imported quantity of kiwifruit. Producers in the EU are better off, since the SPS policy restricts imports and thereby protects domestic producers from international competition. Consumers in the EU are worse off, due to fewer products at a higher price. Producers in the exporting country (New Zealand in this case) suffer from reduced exports and

hence lower returns. New Zealand producers are hence negatively affected by a potential EU introduction of a stricter SPS policy.

2. An expansion in Chinese production will lead to reduced NZ producer returns.
If China, being considered as a major producing and exporting country, contributes to an increased supply of kiwifruit on the world market, theory suggests that world prices of kiwifruit will be reduced due to the significant increase of supply. If New Zealand kiwifruit is considered homogenous with Chinese kiwifruit, and compete for the same market share, a Chinese expansion will have a negative impact on New Zealand producers in terms of lower returns.

3. A trade liberalisation scenario will reduce New Zealand producer returns.
This scenario will be examined through changing all import tariffs in all relevant countries in the model to zero. With all import barriers eliminated worldwide, an increase in import demand will occur. Exporters respond to the change by offering exports at a higher price. World prices in kiwifruit consequently increase and, as a result, New Zealand producers are better off through higher producer returns.

1.2. Description of chapters

This thesis is organised into nine chapters. Chapter one introduces the research problem, the objective of the thesis and finally the specific scenarios developed in order to fulfil the objective.

Chapter two provides a detailed background of the history and development of the New Zealand kiwifruit industry. Other significant players on the global market are introduced along with the current issues concerning the international industry.

Chapter three presents the rationale for trade and the theoretical consequences of relevant trade restrictions.

Chapter four defines the analytical framework of this research and conclusively presents the most relevant structure.

Chapter five reviews present literature relevant to this research and how similar studies have been carried out in the past. The chapter is divided into two parts. The first part presents literature focused on the kiwifruit industry. The second part reviews analytical approaches used in relevant trade modelling analysis. It explains how they contribute to this study and also provides an understanding of the gaps in the literature where this research will be of significant value.

Chapter six explains the methodology used in this research. It discusses underlying theory of the industry-specific trade model developed, data sources and assumptions.

The main scenarios investigated in this research are presented in chapter seven.

Chapter eight describes the results of each scenario and provides a further understanding of the outcome through a discussion.

The final chapter presents the key conclusions of this study and the implications of these results for the New Zealand kiwifruit industry and policymakers, and subsequently discusses limitations and recommendations for future research.

2 Background

This chapter will provide an extensive analysis of the growth and structure of the New Zealand kiwifruit industry. It subsequently puts New Zealand in an international context by describing the country's role on the global market and describing other players with a significant impact on the world industry. The chapter concludes with an introduction to the essence of the thesis: the potential strategic and structural challenges ahead.

2.1. History

2.1.1. Early history

Actinidia Chinesis, the botanical name of the plant, was first found along the border of the Yangtse River valley in China (Yerex and Haines, 1983). The first foreign collectors of the plants were of British and American origin, discovering and sending the first plants home in 1847 and 1904, respectively. One of the Englishmen chose to call the fruit "Ichang gooseberry" consistent with the name of the city Ichang, where the botanical findings were first made. The name was later changed to simply "Chinese gooseberry", to clearly illustrate its country of origin (Yerex and Haines 1983).

During the 1920s and 1930s in New Zealand, the still unpopular vine was generally planted in random unoccupied spaces, mainly because it was easy to grow and had an ornamental value. It gained some minor appreciation on the New Zealand market for three reasons: it was the only fresh fruit that ripened in June or July (in New Zealand), it was easily managed and it had a novel and characteristic appearance and flavour. The first commercial plantings were established in 1937, according to official records (Yerex and Haines, 1983).

In 1940, because of the Second World War, the New Zealand Government decided to ban all imports of fresh fruits, effectively forcing people to search for substitutes on the domestic market. There were only a few varieties of apples in winter, which contributed to the sudden interest in Chinese gooseberries (Yerex and Haines, 1983).

In the 1960s, New Zealand shipments of not only fruits, but also plants and seeds, were being carried out to new destinations such as Germany, Italy, Spain, India, South America, Morocco, Israel and South Africa. Plants were quickly distributed worldwide and by the early 1970s New Zealand nursery keepers struggled to meet foreign demand (Yerex and Haines, 1983).

2.1.2. Kiwifruit in New Zealand: the development of the industry

The progression of new kiwifruit plantings was relatively slow in the 1970s but advanced dramatically in 1979 when almost 1500 hectares were planted within a year. Over the period of 1972 to 1982 sales activity and farmland values increased dramatically (Johnston and Sandrey, 1990) and demand for land for the purpose of planting kiwifruit increased by 54 percent between 1983 and 1986 (Lees 1993). This followed as a consequence of the existing and expected high market returns during this period (Johnston and Sandrey, 1990).

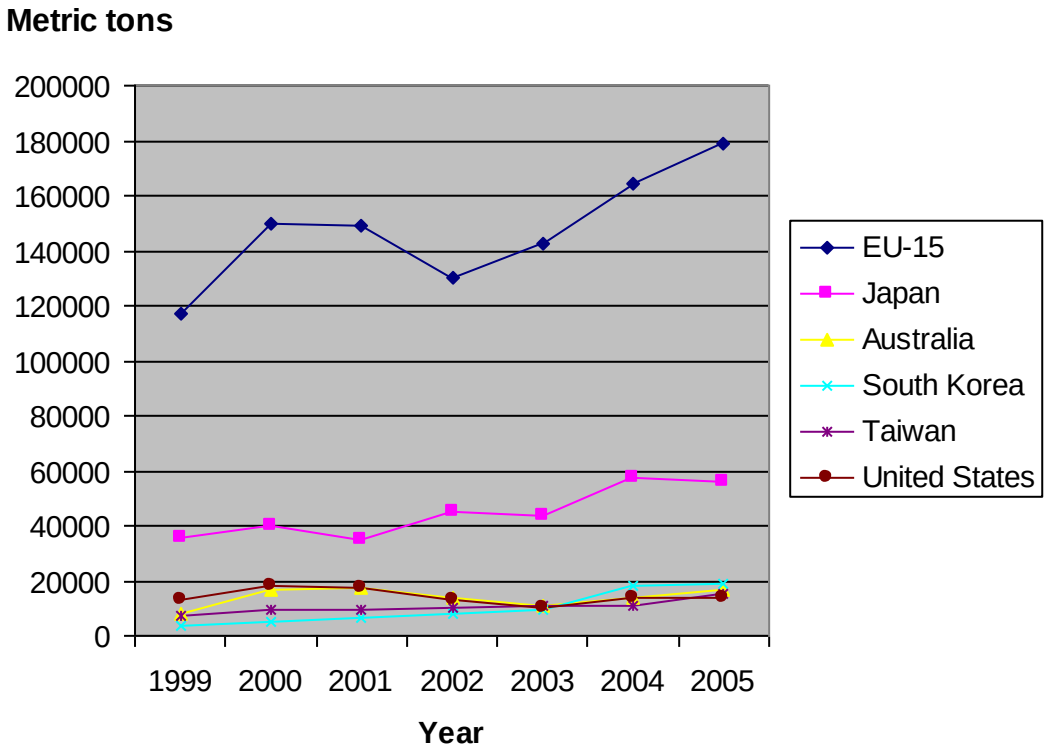
The original plantings of kiwifruit were almost entirely concentrated to Te Puke in the Bay of Plenty and by 1973, the Bay of Plenty area accounted for 90 percent of total domestic production

(Zespri, 2004). However, as land got scarce in the region, land prices increased in the early 1980s. Other areas were consequently explored and developed for kiwifruit production. Land prices in other regions such as Auckland, Northland, Nelson, Hawkes Bay, Poverty Bay, Lower North Island and Waikato were significantly lower and thus invested in to a greater extent (Yerex and Haines 1983). It was not until the 1990's that total orchard yield started to approach commercial levels (Lees, 1993).

In the 1970s the proportion of total production that was exported was only 60 percent, mainly because the domestic market absorbed much of the fruit and the management and marketing efforts towards the global market were still in their development stages. By 1978, exports had increased to over 80 percent of total output and continued to increase during the 1980s (Lees, 1993).

In 1993, the average orchard size was small. Eighty percent of farms were less than five hectares, 40 percent were less than two hectares and smaller orchards were also common (Lees, 1993). In 2006, New Zealand had approximately 3200 kiwifruit orchards with an average size of 3.43 hectares (Belrose Inc, 2006). Most orchards are still situated in the Bay of Plenty with its 8600 hectares of kiwifruit[1], accounting for 72 percent of the country's total production. The area of planted kiwifruit in this region has increased by six percent since 1994 compared to a two percent decrease for New Zealand in general (Statistics New Zealand, 2002).

Figure 1: New Zealand kiwifruit exports 1999-2005.



Source: (Belrose Inc, 2006)

[1] as at June 2002.

Europe (EU-15) and Japan are by far the most valuable export markets for New Zealand kiwifruit. In 2005, 56 percent of New Zealand kiwifruit (by value) was sold in Europe and 18 percent was sold in Japan (Belrose Inc, 2006).

Early investments

A couple of decades ago New Zealand agriculture experienced a major change in the composition of agricultural production as the interest in growing kiwifruit dramatically expanded. Citrus and tobacco plantings were transformed into kiwifruit orchards and dairy farms were sold in favour of finding land to plant kiwifruit. Entrepreneurs and professional investors contributed to the investment rush between 1979 and 1983 (Zespri, 2004).

The New Zealand industry developed rapidly in the 1980s, stimulated by high commodity prices and tax incentives. Several investors borrowed heavily in order to buy orchards at prices based on forecasts of continued high producer returns. However, returns fell dramatically in 1987 forcing many new growers out of business. In addition, orchard values fell, leaving growers with minimal equity, or even worse, no equity at all. With interest rates (and hence debt servicing costs) simultaneously increasing to record levels, the industry was in need of restructure to stay viable (Lees, 1993).

Lower orchard values after 1986 enabled new entrants on the market to borrow less to establish an orchard and enter with high equity. Interest rates were also significantly lower and these factors combined allowed the industry to be viable, even with lower market returns (Lees, 1993).

Since kiwifruit plants take up to six years to reach full production, the increase in plantings did not affect supplies until the late 1980s. The results of investments in the 1980s became clear in 1990 when production statistics showed an increase of 400 percent from 1982 (Lees, 1993).

Orchard profitability

Orchard profitability is one of the most significant factors behind changes in the industry and the government plays an important role through its financial policies including interest rates, taxation, exchange rates and inflation (Lees, 1993).

In 1976, orchard profitability was at its highest, presenting real returns of 27.83 New Zealand dollars[2] per tray. Returns have decreased steadily ever since because of increased kiwifruit volumes on the world market and, in the 1970's, also because of high inflation compared to other main markets (Lees, 1993). Returns peaked in 1982, which was subsequently reflected in land values in the Bay of Plenty expanding by over 800 percent between 1972 and 1982 (Johnston and Sandrey, 1990). Following the 1982 peak in per-tray return, the demand for land increased and kiwifruit plantings grew by over 54 percent in three years. The devaluation of the New Zealand dollar against the yen and the deutschmark combined with a relatively low crop compared to the previous season generated high New Zealand dollar returns in 1986 (Lees, 1993).

The emergence and development of competitors in Italy, France, Japan and the USA proved to have long-term negative effects for New Zealand producers (Lees, 1993) and lead to a significant

[2] Calculations were based on the base year of 1991.

decline in world prices for kiwifruit between 1982 and 1988 (Zwart and Moore, 1990). By 1988, an even larger threat appeared with the development of a Chilean kiwifruit industry, representing direct competition with New Zealand's marketing season from April to December (Willis, 1994).

Another challenge for the global kiwifruit industry occurred between 1987 and 1989 and was caused by monetary instability (both in interest rates and exchange rates) and an expansion of world supply. The latter reduced producer returns for existing producers such as New Zealand (Willis, 1994).

2.1.3. Impacts of New Zealand reforms (in the mid-late 1980s)

In July 1984, the New Zealand Government introduced an extensive economic liberalisation programme that would allow the economy's overall efficiency and sustainable growth rate to increase by reducing or simplifying total government interventions. The pressure for reform was derived from a number of problems threatening the New Zealand economy, including the agricultural sector. The country's overseas debt was growing, industries illustrated poor growth performance and agriculture was heavily dependent on governmental compensation, support and border protection (Wallace, 1990). The unsustainable situation in the agricultural sector led to an increased supply of low value commodities, an industry separated from actual market demand, inappropriate use of resources and inhibited innovation (Sayre, 2003). When the United Kingdom entered the European Union in 1973, New Zealand lost significant market access to its dominant export market for dairy. The United Kingdom had always taken special consideration of agricultural products from its fellow Commonwealth member, but was to be part of an even larger trading agreement leaving New Zealand with lower guarantees. Combined with existing agricultural protectionism overseas, this would result in major impacts on New Zealand's agricultural export returns (Rayner, 1990).

New Zealand was one of the first developed countries to completely deregulate its agricultural sector by removing all forms of price supports and subsidies in 1984. At first, the reform had a strong impact on the sector and on farm profitability. Land values, commodity prices and farm profitability finally stabilised or at least increased steadily in 1990, after a difficult transition period of six years (Sayre, 2003).

Overseas exchange rates and inflation

Exports of kiwifruit, and consequently New Zealand producer prices, have always been dependent on financial situations in export markets. The level and volatility of foreign exchange rates play a significant role in determining the returns to New Zealand kiwifruit producers. A depreciating home currency (i.e. the New Zealand dollar) has – ceteris paribus – a favourable impact on domestic farmers who export, since it implies that overseas sales are worth more in terms of New Zealand dollars. However, the precise consequence of a currency change on commodity prices and returns is dependent on which countries those commodities are exported to (Reynolds and Moore, 1990).

The two main currencies influencing and partly determining New Zealand producer prices of kiwifruit are the European euro and the Japanese yen, currently accounting for more than 74 percent of New Zealand's total export sales (Belrose Inc, 2006). Between 1980 and 1986, the New Zealand dollar was heavily devaluated against both the then deutschmark and the yen. The New Zealand currency was finally fully floated in mid-1985. Between 1986 and 1993, the New

Zealand dollar fell by 14 percent against the deutschmark and 11 percent against the yen (Lees, 1993). The pre-float devaluations and subsequent floating of the New Zealand dollar significantly affected the domestic kiwifruit industry during these years by maintaining a certain level of returns for growers while being challenged by falling prices and rising margins overseas. After the liberalisation of the country's economy the value of the New Zealand dollar strengthened in 1987, leading to a decrease in exports, which consequently affected the profitability of New Zealand farmers. The removal of agricultural subsidies a few years earlier also influenced the low orchard profitability between 1987 and 1989 (Zwart and Moore, 1990).

The New Zealand economy suffered from relatively high inflation throughout most of the 1980's, which rose significantly above the average of most trading partners between 1984-1988 (Wallace, 1990). The Consumer Price Index (CPI) increased by an average annual rate of 15 percent and inflation peaked in 1986 at a level of 18 percent. The horticultural products price index followed a similar development, peaked however in 1985 and increased annually by 5 percent until 1990. This resulted in a decrease in real kiwifruit prices by 76 percent between 1980 and 1991 (Lees, 1993).

High interest rates throughout the 1980's had a major effect on the profitability and viability of the kiwifruit industry. As previously mentioned, investing growers had to borrow heavily to afford covering initial orchard development and production costs. High inflation and government deficits forced interest rates to a peak in 1987 at a level of 18 percent. An industry suffering through a high amount of debt at a high level of interest could only survive through compensating high returns via a substantial export yield. However, since kiwifruit takes five to six years to reach full production, the newly-developing orchards did not manage to achieve satisfactory harvests in time. Not only did the kiwifruit producers suffer from record high debt servicing costs, but they also struggled with falling kiwifruit returns and decreasing orchard values. As a result, many producers were forced into an equity crisis (Lees, 1993). Orchard costs, however, had decreased by 66 percent between 1982 and 1991 (Lees, 1993).

Interest rates and inflation fell dramatically between 1987 and 1993, relieving the industry from high debt servicing costs, which allowed growers to stay viable under lower returns. Gains in commodity prices and a small decline in the real exchange rate after 1988 improved the terms of agricultural trade and the New Zealand kiwifruit industry (Lees, 1993).

As international competition increased, more pressure was put on the New Zealand kiwifruit industry to continuously perform better than its competitors. The decline in world price for kiwifruit, due to more players and further supply on the global market, had a negative impact on the domestic industry. With increased world competition in the 1990's the selling period for the New Zealand kiwifruit industry was constricted to a shorter period where New Zealand had to sell more kiwifruit and also directly compete with European summer fruit (Lees, 1993). According to Zwart and Moore (1990), the need for a stronger position in the marketplace and the lack of appropriate incentives in the previous licensing system caused the demand for a statutory marketing board to control industry exports.

2.1.4. Current industry structure

In 1970, the need was expressed by growers and the industry for an agency to promote kiwifruit worldwide. As previously mentioned, the export share of total production only accounted for 60 percent and the establishment of a global management and marketing agency was believed to be able to increase that quantity (Lees, 1993). The Kiwifruit Export Promotion Committee (KEPC)

was established in 1970 to make marketing of the fruit more professional. This was going to be achieved through a promotion fund, based on money extracted from a compulsory levy of ten cents per tray (six cents from the grower and four cents from the exporter) (Lees, 1993). Multi-language brochures were produced emphasising the advantages of the fruit with some technical information and the history behind the fruit. These catalogues were subsequently delivered to retail stores (Zespri, 2004). Since the KEPC was the only kiwifruit organisation at the time, it ended up operating further than its original purpose and acting as an important decision maker in the industry (Lees, 1993).

The New Zealand industry developed quickly in the 1970's and so did the number of potential exporters interested in promoting New Zealand kiwifruit overseas. This consequently put the growers in a vulnerable position, as the grower-funded marketing no longer was in their direct control and could be exploited by anyone interested in making profits as an exporter (Lees, 1993). The need for coordination between marketing and promotion had become apparent and potential exporters needed to be better controlled. Based on this need the New Zealand Kiwifruit Authority (NZKA) was founded in 1977, represented by five growers, two exporters and a government nominee. The primary purposes of the authority were to licence exporters, promote the fruit and to set standards for quality, grading and packing. The funding of the authority was set up as previously. The three major export companies in the 1960s – Turners and Growers, Fruitgrowers Federation and Auckland Export – still remained the main players on the global market. Together they accounted for over 60 percent of New Zealand kiwifruit exports (Lees, 1993).

After the peak in grower returns in 1982, they kept falling and the need for a changed marketing system grew stronger (Lees, 1993). A report by Coopers & Lybrand in 1988 investigated the marketing, selling and distribution system of the industry and concluded that there was an urgent need for a restructure if potential earnings of kiwifruit exports were to be reached. This could only be accomplished if a new marketing strategy was implemented. In 1988, the NZKA was reformed into the New Zealand Kiwifruit Marketing Board (NZKMB) and the New Zealand Kiwifruit Marketing Regulations were established to allow the NZKMB as the single seller of kiwifruit internationally, except for Australia (Lees, 1993).

In 1992, the NZKMB radically overestimated the value of the crop that year, which resulted in overpaying growers early in the season and subsequently incurring a debt of over NZ$93 million (Ministry of Agriculture and Forestry, 1996). The financial difficulties arising from this problematic situation put pressure on the Government to review the entire structure of the kiwifruit industry. Consequently, the Government instigated a three-stage review process.

The development of the NZKMB

The first step emphasised the need for grower representation within the industry. Through changing the NZKMB into a corporate structure, the growers would be given direct equity involvement. The new company structure would not only provide total grower control but would also encourage potential partners and investors from outside of the industry to take part as stakeholders (New Zealand Kiwifruit Growers Inc Forum, 1995). Growers were previously represented in the industry through representatives on the NZKMB and through the Fruitgrowers Federation (Campbell, Fairweather and Steven, 1997). In order to provide growers with more authority within the industry an independent grower representative forum was established in 1993 (New Zealand Kiwifruit Growers Inc, n.d.). The New Zealand Kiwifruit Growers Incorporated (NZKGI) now represents growers in discussions on industry issues. The forum

consists of representatives from all over the country and has played an important role in negotiations concerning topics such as contract options and payment systems (Zespri, 2004). During the industry review, the NZKGI was given the important roles of appointing members of the NZKMB and representing the group to which the Statutory Board is responsible (New Zealand Kiwifruit Growers Inc Forum, 1995).

Collaborative marketing

In October 1994, the University of Auckland presented an independent marketing review to the kiwifruit industry. Several recommendations from this report were taken into consideration during the ongoing review of the kiwifruit industry and came to establish the second step of the industry review: restructuring the marketing within the industry.

The report suggested that strategic marketing development should focus on "retail marketing rather than commodity trading" (Brookes, Cartwright and Domney, 1994). It was also recommended that the scale of the industry should be increased globally, through sourcing of internationally grown kiwifruit and by linking New Zealand kiwifruit to other fruit markets (Brookes, Cartwright and Domney, 1994).

These recommendations suggested a development of a joint marketing strategy, which would be implemented by a marketing subsidiary separate from the NZKMB. The Kiwifruit Industry Review adopted most recommendations and subsequently suggested that export marketing should be collaborative and performed by a marketing subsidiary to the NZKMB, cooperating with innovative organisations and marketing firms. This committee should be formed in order to receive and process applications and to make recommendations to the statutory NZKMB (New Zealand Kiwifruit Growers Inc Forum, 1995).

The review distinguished several specific advantages of having a marketing subsidiary separated from the NZKMB to control and carry out the international marketing operations. Firstly, transferring any commercial issues from the tasks of the NZKMB to a specific marketing subsidiary would contribute to the execution of a more reliable and accountable power of corporate governance. Secondly, the new structure would improve the overall focus of the organisation, since the NZKMB would concentrate exclusively on statutory, legal and policy issues and the subsidiary would concentrate on international marketing, rather than one organisation managing all activities and issues facing the industry. It would also enable the marketing subsidiary to enter potential joint ventures and appoint collaborative marketers without distracting from the core business (New Zealand Kiwifruit Growers Inc Forum 1995). The NZKMB was consequently transformed into the new entities Kiwifruit New Zealand (KNZ), managing the statutory issues, and the Zespri International Ltd controlling the international marketing of the industry (Campbell, Fairweather and Steven, 1997).

The third part of the industry review included several additional suggestions of how the industry could improve its overall performance. The recommendations were not as explicit as in the first two stages of the review, but provided a framework for how to develop the best production structure. It suggested that marketing and production management should be separated as far as possible and that the current marketer (NZKMB) should be restructured into a 'marketer focused' organisation. This separation would encourage the marketer to predict market requirements and behaviour and the supplier to meet market demand and product quality (New Zealand Kiwifruit Growers Inc Forum, 1995).

The future regulatory environment would provide growers and other players with more flexibility concerning time options of supplying fruit to marketers. The removal of any legal distinction between packhouses and growers would encourage the development of contractual relationships between NZKMB and 'supplier entities' (Campbell, Fairweather and Steven, 1997). A supplier entity is a group of growers and post harvest facilities (such as packing, coolstorage and ship loading) cooperating to deliver a certain volume of packed kiwifruit with a certain quality (Ministry of Agriculture and Forestry, 2002).

The industry review also stated that the responsibility of fruit standards and quality assurance would belong to the NZKMB, but that the grower would be responsible for picking the fruit at the best time, with the incentive of receiving premiums or being punished with penalties, depending on the quality of the fruit (New Zealand Kiwifruit Growers Inc Forum, 1995).

The ZESPRI story

The name ZESPRI was chosen with the purpose to establish a new image for kiwifruit worldwide, based on a protected trademark (Zespri International Limited, 2005). The industry was fully re-structured in 2000 and the NZKMB was converted into the public company Zespri Group Ltd, in which the growers became shareholders. This was in accordance with the Kiwifruit Industry Restructuring Act 1999. The possession of shares was originally restricted exclusively to grower suppliers (New Zealand Fruitgrowers Federation, 2004), whereas these days a significant proportion of shareholders are no longer supplying fruit (Ministry of Agriculture and Forestry, 2005). In November that year, the growers approved the creation of a cooperative style mechanism within a commercial operating structure (Regulations Review Committee, 2002).

In this restructuring phase of the industry the Kiwifruit Export Regulations were established recognising ZESPRI Group Ltd as a single desk exporter. This exclusively authorised ZESPRI Group Ltd to export and market New Zealand kiwifruit overseas, excluding the Australian market (Hardie Boys, 1999). According to the Kiwifruit Industry Restructuring Act 1999 (New Zealand Government 1999) and the Kiwifruit Export Regulations 1999 (Hardie Boys, 1999), Kiwifruit New Zealand was established as the regulatory board controlling Zespri Group Ltd and its compliance with the single desk structure (Ministry of Agriculture and Forestry, 2005).

The Kiwifruit Export Regulations were tightened in 2004 by the Horticultural Export Authority (HEA). Australia was the only market that ZESPRI did not control as a statutory export monopoly. However, the Australian market had to be regulated as well since the country had become a gateway for illegal kiwifruit shipments further to other New Zealand export markets, such as China, undercutting New Zealand's prices (USDA Foreign Agricultural Service, 2004). Every exporter is now entitled to apply to HEA for export licenses to Australia (New Zealand Horticulture Export Authority, 2004).

ZESPRI was determined to move the New Zealand kiwifruit industry away from the stagnant kiwifruit category into competing with the entire market for fresh fruit (Zespri, 2004). The different varieties competing on the international market today include the ZESPRI™ Green (green), the traditional Hayward cultivar; ZESPRI™ Green Organic (green organic), grown to meet the quality standards of the company; ZESPRI™ Green Jumbo, falling under the category of larger kiwifruits; ZESPRI™ Gold (gold), the newer variety with yellow flesh and sweeter flavour (Zespri, 2004).

The New Zealand kiwifruit industry has developed and grown significantly over the past decades since its inception. In 1975 exports were valued at NZ$4.3 million and in 1990, the value was NZ$539 million – New Zealand's sixth largest food export sector at the time (Campbell, Fairweather and Steven, 1997). In 2005, exports to over 60 countries were worth NZ$720 million and was by far the most valuable horticultural export product in New Zealand[3] (HortResearch 2005). In 2007 kiwifruit exports were worth NZ$790 million (Statistics New Zealand, 2007).

Distribution channels

Over the last couple of decades specialisation has occurred in the New Zealand kiwifruit industry. The orchards used to manage both growing and packing, but with a continuously expanding production the supply chain has been divided into separate specialised units to enable the management of larger quantities. The orchards now concentrate only on growing kiwifruit and special packhouses and cool storages are dedicated to the downstream steps in the supply chain.

The number of packhouses has continuously decreased since 1988 due to intense competitive pressure (Campbell, Fairweather and Steven, 1997). and in 1991 only 22 percent of them packed less than 25,000 trays annually. As production increased, so did the size of the average packhouse. Most had an upgraded capacity of 200,000 trays by 1991 (Lees 1993) and also managed a significant number of orchards. The packhouses either leased orchards to guarantee sufficient supplies or they solicited growers to be part of a packhouse cooperative. The first stages of the kiwifruit supply chain have thus changed during the last decades from being based on family-owned entities managing several tasks, into separate units with different economic interests (Campbell, Fairweather and Steven, 1997).

Coolstore facilities enable an extension of the packing season through the storage of fruit in bulk to be packed at a later point (Campbell, Fairweather and Steven, 1997). The number of coolstores has not increased significantly since 1988, but most of them have expanded their capacity to receive a larger input of fruit (Lees, 1993).

2.1.5. Industry strategies

As described above, New Zealand has developed its kiwifruit industry over several decades and currently enjoys a competitive advantage in several areas. A few of the main strategies and production programmes leading to these advantages are described below and some of them constitute the reason for the relatively high international price premiums that New Zealand kiwifruit benefits from today.

KiwiGreen

The New Zealand kiwifruit industry had to confront a severe crisis in 1990-1992 when Italian retailers threatened to take the entire industry to court. They argued that New Zealand kiwifruit contained pesticide levels exceeding local standards, while New Zealand claimed that they in fact were well within the requirements for European regulations. Since Italy belonged to one of New Zealand's most important export markets with annual fruit imports of three million trays,

[3] Kiwifruit NZ$ 720 million, wine NZ$433 million and apples NZ$387 million HortResearch (2005).

for the value of NZ$30 million, the decision had a severe impact on the New Zealand industry. The kiwifruit industry formed a partnership with HortResearch, aiming to develop an integrated pest management (IPM) programme, called KiwiGreen, to reduce the use of chemicals through careful and comprehensive inspections (Growing Futures, n.d.).

Research towards an IPM programme had started already in the 1980's to control the number of pests through the use of less environmentally harmful sprays (Campbell, Fairweather and Steven, 1997). The long-term goal with the new programme was to convince all kiwifruit orchards producing export fruit to apply the environmentally sustainable KiwiGreen system as soon as feasible. The first trial production of 262 000 trays under the new management scheme was successfully accomplished in 1992. During the following years the number increased continuously[4] and in the season of 1996/1997 all kiwifruit exported from New Zealand were produced using the new KiwiGreen system. It has been used nationwide within the entire industry ever since. Such a fast and efficient adoption of a new production programme by an entire industry, without government intervention, was considered unique for its time (Growing Futures, n.d.). The system was expanded in 2000, under the name Zespri System, introducing additional environmental factors, hygiene and ethical trading practices, inspecting the entire supply chain from orchard to market. The production management system now also includes requirements on environmentally friendly coolstores and transports, certain temperatures during transport, managing reject fruit and the use of recyclable packaging. The stages of the system are monitored and audited by the Ministry of Agriculture and enables the traceability of commodities (Zespri, n.d.). The implementation of KiwiGreen has contributed to the advantage that New Zealand kiwifruit can be sold at relatively large premiums, compared to other countries.

Traceability

Competitive global trends and challenges influence product quality and safety throughout the supply chain and in international food trade. As a consequence of growing concerns from food scares, consumers and other stakeholders are putting pressure on requirements about how food is grown and managed on its way to the consumer, in terms of agricultural practice, animal welfare and environmental impact (Opara and Mazaud, 2001). Satisfactory food quality requires a certain level of transparency throughout the supply chain, which acts like a guarantee to the consumer (Opara and Mazaud, 2001). Several agricultural management programs and regulations have been implemented worldwide recently to ensure a certain level of quality and safety demanded by consumers (Opara and Mazaud, 2001) and the KiwiGreen system is one of them.

Traceability refers to the availability of information of all processes and stages of the supply chain, which certifies the origin and journey of a specific product. Traceability adds value to the quality and safety regulations by providing "the communication linkage for identifying, verifying and isolating sources of non-compliance to agreed standards and customer expectations" (Opara and Mazaud, 2001).

[4] 4.7 million trays in 1993, 6.8 million trays in 1994 and 63 million trays in 1996/1997.

Implementing EurepGAP standards

In May 2003, Zespri gained the certification for having a Produce Marketing Organisation[5] system that meets the requirements of the internationally recognised standards of EurepGAP. According to the regulations, growers must comply with terms such as minimising the damaging impact on the environment, reducing the use of agrichemicals, using appropriate resources and recognising an acceptable level of health and safety for workers (Patel, 2003).

EurepGAP was established in 1997 as an initiative by mainly British and continental European retailers to take more responsibility and react to concerns from both consumers and producers. The consumers were worried about product safety, environmental sustainability and labour principles and producers were concurrently interested in developing a common certification standard. The EurepGAP consists of a set of normative standards and internationally recognised certification criteria that demonstrate compliance with consumer-focused Good Agricultural Practices (EurepGAP, n.d.). Many of the principles within EurepGAP are not new to New Zealand growers, as they are incorporated in the already practiced Integrated Crop and Pest Management (ICM and IPM) systems (Agriquality, n.d.).

The Gold story

The story of ZESPRI™ Gold began in the late 1970s when seeds for the research project of developing a new variety were collected in the Beijing Botanical Gardens in China. These were subsequently planted in the research orchard in Te Puke, New Zealand. A couple of years later further seeds were collected in China. These seeds and the second generation of the earlier collected seeds were crossed because of their attractive characteristics. They created fruits with yellow flesh and sweet flavour and large luscious fruits. A generation later in 1992 one single plant was selected from this new family (Zespri, n.d).

The first stage was completed and next followed the development of the characteristics of the new fruit. Commercial considerations like taste, colour, size, storage and shelf life had to be taken into account. In 1997, almost 400 hectares of Te Puke land was dedicated to the new variety and the first 4000 trays were exported the following year. In 2000, the kiwifruit was launched and received the name ZESPRI™ Gold (gold); Plant Variety Rights were taken out in order to protect it internationally. The purpose of developing gold was never to substitute it for the green variety, but rather to act as a complementary product to extend the options for customers and consumers (Zespri, 2004). New Zealand is the world sole exporter of golden kiwifruit and this variety currently accounts for almost 18 percent of total kiwifruit exports from New Zealand (Belrose Inc, 2006).

Twelve month supply

Plantings of green and gold kiwifruit grown under the ZESPRI brand have currently been established in eight different countries. The fruit must reach the premium brand and quality standards established by ZESPRI in order to be sold on the respective markets. Italy and Japan are experiencing successful Gold plantings in particular, whereas the Californian growers are

[5] A Produce Marketing Organisation is a co-operative or a group of growers with a legal entity to manage the EurepGAP implementation for associated and contracted growers (EurepGAP, n.d).

suffering from inability to reach the quality standards. Approximately 840 hectares of the gold cultivar are currently planted for commercial purpose in Italy, USA, Chile, Japan, France and Korea. Trial plantings have also been established in Australia and China (Zespri, 2004-2005).

In efforts to develop a twelve-month supply system for ZESPRI's green and gold varieties, Italy has been selected as a major partner. In the season of 2005-06 Italy produced two million trays of green kiwifruit and 1.2 million trays of gold kiwifruit for the account of ZESPRI (Belrose Inc, 2006).

ZESPRI is taking advantage of its premium brand by planting high quality fruit in other countries and thereby securing supply from those ZESPRI plantings when kiwifruit will not be available from New Zealand. Other marketers have duplicated this strategy of essentially supplying the market with more fruit from a single brand than what is provided at the moment. Their challenge is consequently to ensure that there is a sufficient demand among consumers to meet the extra supplies.

In 2006, ZESPRI announced their ability to export their gold variety from New Zealand between June and August and from Italy between December and January. The gaps in between will be filled by exports from Chile, where ZESPRI recently started growing gold (Freshinfo, 2006).

Aragorn

Aragorn is the processing subsidiary of ZESPRI, formed in 2002 (Gardiner, 2004), which focuses on transforming particularly gold kiwifruit. Aragorn is not part of the fresh whole fruit programmes of ZESPRI. The company processes kiwifruit into food ingredients and preparations. Aragorn will remain a unit under development over the next couple of years, concentrating on growing the markets in Europe and Asia. In these markets, ingredients developed by Aragorn have been mainly used in dairy, beverage and dessert products (Zespri, 2004-2005).

Taste Japan

The importance of taste in consumer preference and repeat purchase levels has long been advocated by marketers and reinforced through consumer research. Such research conducted on the Japanese market some years ago clearly demonstrated that Japanese consumers prefer high dry matter fruit and were also willing to pay more for taste (McAneney, n.d.). Dry matter strongly influences the taste of the fruit and is defined by the ratio of dry weight to fresh weight of the fruit (Zespri, 2005). These specific consumer preferences were clearly supported by a 50 percent decline in exported volumes of the green kiwifruit over the last decade (from 15 to 7.4 million trays in 2001) (McAneney, n.d.). Japan is an important and valuable market for ZESPRI. As the highest earning market in the world they are willing to pay premium price for kiwifruit (Zespri, 2004) and should therefore be considered a significant source of profit. The Japanese taste issues gave rise to founding the programme *Taste Japan*, which was implemented in 2001. Research proved that Japanese kiwifruit consumers would pay 12 percent more in sales price for an extra one percent improvement in dry matter. Research was carried out to establish the relationship between dry matter levels and orchard management and subsequently provide guidelines of how to improve dry matter content. It was confirmed that dry matter is influenced by the supply of carbohydrates, which for example depends on the amount of sunlight captured (Zespri, 2005). Under this programme, kiwifruit growers that manage to grow high quality fruit

are rewarded with a payment premium (USDA Foreign Agricultural Service, 2004). ZESPRI aims to increase the dry matter content of the entire kiwifruit crop in New Zealand by encouraging growers to apply growing programmes maximising dry matter content (USDA Foreign Agricultural Service, 2005).

Taste issues in 2004 seem to have been partially solved in 2005, when total volumes sold in Japan reached almost 16 million trays. In 2004, ZESPRI expanded its program to other markets, including Korea, Taiwan and China, by introducing the *Taste Zespri* campaign (Zespri, 2004-2005).

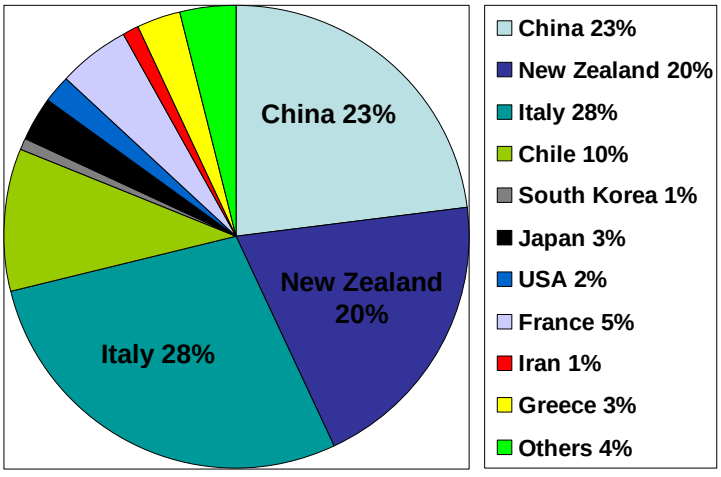
Thus far, the history and development of the New Zealand kiwifruit industry has been described. A number of historical global and domestic events and 'shocks' have played a significant role in shaping the nature of the New Zealand kiwifruit sector. Today, New Zealand enjoys a price premium advantage on the world market that can be explained and justified through industry specific strategies and a well-developed production management system.

2.2. Overview of New Zealand and world markets

2.2.1. Size of global market

Two thirds of the total world production of kiwifruit enters the global market and relatively few main players account for the vast bulk of international trade in kiwifruit. The OECD member countries accounted for almost 85 percent of world imports of kiwifruit in 2004 (Belrose Inc, 2006) and world exports are currently dominated by Italy (35 percent), New Zealand (32 percent) and Chile (15 percent) (HortResearch, 2005). All players in the international marketplace are highly influenced by and dependent on circumstances and trends in the individual markets.

Figure 2: Top ten kiwifruit producing countries 2003-05



Graphic: (HortResearch, 2006)

The world's three largest producers have until recently been Italy, New Zealand and Chile. China has overtaken Chile and New Zealand in the production stakes, but the original three countries are currently still the three largest exporters and account for more than 80 percent of total global exports. Since China has a relatively large domestic market to supply, the country's future potential on the export market is yet unknown (Belrose Inc, 2006).

Italy and New Zealand have constantly been the top two exporters. Since the 1992-93 season Italy has been leading the exports in ten seasons and New Zealand in five. Italy's exports exceeded New Zealand's until 2004, when New Zealand supplied the global market with more kiwifruit than Italy. The third largest exporter, Chile, has produced a stable and slightly increasing export volume. Iran's export volumes have grown from a small base to become the world's fourth largest exporter in 2004. Greece's exports have fluctuated significantly over the recent years due to poor weather conditions affecting the crop and subsequently export numbers. Three other export countries, France, the United States and Spain, have presented relatively stable statistics from 1999 and onwards. China has grown from providing the global market with insignificant numbers of fruit to become the second largest producer and the ninth largest exporter in the world in the 2003-05 period (Belrose Inc, 2006). In 2005, all three major exporters sent most of their exports to the European market (EU-15), yet differed in their second most significant export market. Italy focused on the rest of Europe and Russia, whereas New Zealand and Chile concentrated on the Asian market and North America respectively (Belrose Inc, 2007).

2.2.2. EU's role in world trade

Out of the producing and exporting countries in the EU, Italy has always been, and remains, the largest kiwifruit producing nation with a significant influence on the world market. The EU also constitutes the largest consuming market in the world.

Italy is the leading supplier of kiwifruit on the international market. Italy's kiwifruit marketing strategy differs considerably from the one in New Zealand and is performed by numerous organisations of different structures and sizes. Since there are no trade barriers within the European Union, Italy's domestic market effectively consists of 460 million European citizens. This can be seen as an immediate advantage, but Italy has also encountered some difficulties in applying a nationwide control over exported volumes and quality. This is a concern that the centralised New Zealand system controls better. To increase its competitiveness, Italy has recently invested in improving every stage of the supply chain through introducing the latest technology, strong brands, new varieties and forming alliances with suppliers in other countries such as France and Chile (Belrose Inc, 2006).

Italy experienced a large over-supply in the 2004-05 season, which resulted in the price of Italian fruit falling by over 30 percent on the European market. This issue had large implications on the entire international kiwifruit industry and illustrates the impact and important role of Italian circumstances internationally. Italy's latest contribution to new kiwifruit varieties is the *Summerkiwi* cultivar. This fruit can be harvested up to 40 days before the Hayward variety, which provides Italy with the opportunity to supply the world market with fruit earlier than relevant competitors (Belrose Inc, 2006).

2.2.3. China's role in world trade

While the rest of the world has steadily increased kiwifruit plantings, China has increased kiwifruit production more than tenfold over the past decade. In 1999, the total production of kiwifruit from China reached 165,000 metric tonnes and was estimated to have reached 400,000 metric tonnes per year by 2006. If productivity approaches the level of other countries, Chinese annual production could potentially reach 700 000 metric tonnes per year (Huang and Ferguson,

2001). Currently, almost all domestically produced kiwifruit is sold within the country and between one fifth and one third is being processed. Exports presently account for only two percent, a number that is likely to change as existing orchards mature (Huang and Ferguson, 2002). China is facing a few challenges mainly concerning quality issues and coordination of marketing and production (Huang and Ferguson, 2001). The country also needs to be prepared for a significant production expansion within the next few years and consequently improve present storage and transport facilities (Belrose Inc, 2006). Another issue concerns planting more commercially demanded varieties. At present, the Chinese kiwifruit industry produces varieties that are not as desirable to either Chinese or international consumers (Huang and Ferguson, 2001). Even though the Hayward variety has not been extensively planted in China, the country is still the world's fourth largest producer of the variety, which could have a significant impact on world trade as more Hayward orchards are being planted (Huang and Ferguson, 2002).

Chinese kiwifruit production did not become globally significant until the late 1990s and is growing rapidly (with production more than trebling since 1999). In 2003-2005 official statistics positioned China as the second largest producing country in the world. The industry concentrates on supplying the domestic market first of all and then on export markets. Only small volumes have been exported to Asian markets and some trial shipments have been sent to European and North American markets (Belrose Inc, 2006).

The industry faces two main obstacles to exporting its kiwifruit. Firstly, the majority of commercial plantings are of less desirable varieties (not Hayward). Secondly, the production is divided among many small sections managed by individual farmers. This has caused difficulties in controlling the chemical use and compliance with quality requirements (Belrose Inc, 2006).

Several indicators suggest that trade (both imports and exports) of kiwifruit with China could grow rapidly over the next couple of years. Since the country previously managed to solve the quality problems facing the apple and pear industries (Belrose Inc, 2006), it is likely to perform similarly in the kiwifruit industry. The effects of both increased economic standards and the rapid spread of supermarket chains are likely to create a strong Chinese demand for supplies of fresh fruit all year around (Belrose Inc, 2006). This could potentially benefit New Zealand, from where China imports several thousand tonnes of kiwifruit annually already (Huang and Ferguson, 2001).

China has invested in several breeding programmes, focusing on new varieties suitable to the Chinese growing conditions. These have resulted in two new cultivars; the *Jintao*, which is more or less equivalent to the New Zealand gold variety and commercialised in Italy, and the *Red Sun*; with hairless green skin, yellow flesh and red locules. The latter variety is expected to reach production of commercial levels in 2007 (Belrose Inc, 2006). Since the Jintao variety is notably similar to the New Zealand gold variety, they could be seen as direct competitors for the same market shares. Even if New Zealand enjoys plant variety rights to the gold variety, and the Gold and Jintao are hence not completely substitutable, they will still both be considered as golden kiwifruit in this research.

2.2.4. Other main players

Chile

The kiwifruit industry of this South American country was profoundly damaged in the 1980s by an overexpansion that led to a stagnated production in the 1990s. The plantings expanded again

in the early years of the new millennium. Chile carries out marketing through a number of exporting firms, like the Italians, and in the 2005 shipping season exports from 128 different companies were identified (Belrose Inc, 2006). The larger export companies have allied with Northern hemisphere traders and established marketing and promotion contracts with major retailers (Belrose Inc, 2006).

Chile is currently striving to get the domestic quality standards, Chilgap, recognised as equivalent to EurepGAP and thereby upgrade the country's international competitiveness. The Chilean government has also aggressively pursued free trade agreements with countries worldwide over the last couple of years to improve market access of Chilean fruits (Belrose Inc, 2006). Chile is still the third largest exporter of kiwifruit, but for how much longer is unclear, since China appears to have the capability to compete for international market share.

France

Many small producers form the French kiwifruit industry and the export marketing is divided between four large exporting firms. Just like Italy, France benefits from the geographical advantage of having the largest consuming countries as neighbours within the EU, thereby facing zero tariffs into these key markets. The country remains vulnerable to competition from Italy and was heavily affected by the Italian expansion in the 2004-05 season. France is currently the world's sixth largest exporter (Belrose Inc, 2006).

Greece

Due to several years of crop failures starting in 2001, Greece lost its position as an important player on the European market. However, the country regained its status in 2004, unfortunately concurrent with the excess supply in the Italian market sold at minimum price. Due to relatively low production costs Greece managed to survive the setback and maintain access to the markets in Eastern Europe and in Russia. Consumers in these countries and domestically are increasingly demanding higher quality food products, due to advancing economic standards. This puts severe pressure on the Greek kiwifruit industry and in order to maintain its market share in those countries fruit quality needs to be improved to meet demand (Belrose Inc, 2006).

The United States

Kiwifruit plants were originally exported to the United States from New Zealand. The first commercial grower was established in 1960 in California, the state where 95 percent of total U.S. kiwifruit production is represented (California Kiwifruit Commission, 2000). In 2005, the domestic kiwifruit crop had increased with 55 percent compared to the last season. This new situation introduces the country to challenges of both increasing domestic consumption and expanding exports. Since the country recently increased its awareness and concerns regarding health, diet and obesity matters, the kiwifruit industry should have an essential message to get across (Belrose Inc 2006). Domestic marketing and promotion efforts should focus on and emphasise the unique health benefits of the kiwifruit (Belrose Inc, 2006).

2.2.5. Trade restrictions

International trade in kiwifruit is currently distorted by several measures. Import tariffs constitute the most common trade restriction, and are imposed by several major importing countries. China imposes a relatively high import tariff of 20 percent (New Zealand Ministry of Foreign Affairs, 2006), although it is possible that these tariffs may be reduced on New Zealand imports once the near-complete New Zealand-China Free Trade Agreement is concluded. Kiwifruit imports to the United States and the EU face tariffs of 8.5 percent and 8 percent respectively (European Commission 2006), (Ministry of Agriculture and Forestry, n.d.). Japan's import tariff reaches 6.5 percent (USDA Foreign Agricultural Service 2000). Other countries with high import tariffs include Taiwan (25 percent) (New Zealand Fruitgrowers Federation, 2003) and South Korea (46.5 percent) (New Zealand Fruitgrowers Federation, 2003). The latter two will not be considered in this research due to their relative insignificance on the international market.

Another commonly exercised non-tariff policy falls under the classification of a Sanitary and Phytosanitary (SPS) measure, established by the WTO. This is an agreement recognising what measures a government can execute in order to protect domestic animal and plant health and food safety (World Trade Organisation, 2005). According to Voss (2005), these are very efficient measures in order to prevent substandard kiwifruit from entering currently health aware and environmentally and safety concerned markets and are the reason for several trade disputes in progress. Biosecurity policies are common SPS measures. Biosecurity is a major issue for isolated islands and countries as Australia, Japan and New Zealand. Although their isolation acts as a natural deterrent to biosecurity risks, these countries also actively protect and control against several pests and diseases in order to avoid the potentially severe economic consequences that the introduction of these might have on their domestic agricultural industries (Anderson, 2004).

An example of such SPS non-tariff barriers is the introduction of a stricter phytosanitary measure in Japan, which was executed through increased fumigation of imported New Zealand organic kiwifruit at the Japanese border (Ministry of Agriculture and Forestry, 2002). New Zealand has, since 2000, had ongoing disputes with Japan concerning the trade restriction targeting imported organic kiwifruit. These measures were argued to comply with the regulations established in the SPS agreement within the WTO and Japan fumigated imported commodities more frequently than other WTO members (New Zealand Fruitgrowers Federation, 2002). In order to avoid any possible risks Japan chose to fumigate large imported shipments, and according to New Zealand (2002), routinely started fumigating imports that even contained insect species already present in the country (New Zealand Fruitgrowers Federation, 2002).

2.2.6. New Zealand production trends

The kiwifruit industry in New Zealand was the earliest and among the most proactive players to position itself on the global market. The country is consequently the second largest producer and exporter of kiwifruit today. From starting out as an insignificant source of returns/investment in the early 1970's, the New Zealand kiwifruit industry expanded dramatically to become a highly important agricultural sector and the sixth largest export earner in 1991 (HortResearch, 2005) and subsequently the most valuable horticultural exporter in 2007 (NZ$790 million) (Statistics New Zealand, 2007). Marketing and exports are carried out by the single desk seller Zespri Ltd. This constitutes a significant advantage to New Zealand, through the combination of resources and marketing efforts. The New Zealand strategy is also subject to ongoing trade disputes within the World Trade Organisation, where it is considered by some WTO members as a State Trading

Enterprise and hence a trade distorting measure that may be subject to removal as multilateral trade negotiations progress.

Trends by variety

The Green kiwifruit variety remains the most widely produced and consumed kiwifruit variety. By 1997 all New Zealand kiwifruit was grown under either KiwiGreen or organic production systems. Plantings have been established overseas in order to ensure a twelve month supply of New Zealand kiwifruit. Most of these orchards (mainly in Italy) are joint ventures between New Zealand supplier groups and overseas landowners (New Zealand Ministry of Foreign Affairs, 2006).

The volumes in the organic kiwifruit sector remains steady despite a few issues smaller fruit size and more significant yield fluctuations. The organic grower returns for the 2005 crop was NZ$1.88/tray higher than for Green kiwifruit (NZ$5.46/tray) (New Zealand Ministry of Foreign Affairs, 2006). Through extensive market research the programme *Taste Japan* has aimed at increasing sales of kiwifruit on the Japanese market. The strategy implemented to reach this goal includes increasing the dry matter content of the kiwifruit crop. Growers are encouraged to do so through higher returns of fruit with dry matter (New Zealand Ministry of Foreign Affairs, 2006).

The Gold kiwifruit sector is expanding more than the other varieties and, as mentioned earlier, overseas plantings have been established of this variety as well (Freshinfo, 2006). For Gold kiwifruit the grower returns for the 2005 crop was NZ$2/tray higher than for Green kiwifruit at NZ$5.46/tray (New Zealand Ministry of Foreign Affairs, 2006). The plant variety rights and brand name are owned by ZESPRI, which makes it impossible for competitors to replicate. However, it does not prevent them from inventing other new varieties that could compete for the same market share. Research and breeding programmes like these are being carried out in both Italy and China, where new cultivars have also been developed (Belrose Inc, 2006).

Change in export markets

As outlined above, traditional kiwifruit producers and exporters such as Italy, New Zealand and Chile are facing significant changes in global market conditions. The most fundamental challenge for these countries is the rapidly increasing global supply of kiwifruit and the potential for losses in market shares as other producers such as China become more prominent. In addition, the global marketplace for soft fruits more generally is becoming increasingly crowded – creating additional competition for kiwifruit exporters. It is argued that the global kiwifruit industry should focus on marketing and promotion in both its traditional rich country markets and newer emerging country markets (Belrose Inc, 2006) in order to remain competitive and profitable.

With China as an upcoming competitor on the world market, the distribution of market shares among current players are most likely to change. China has already passed New Zealand's production statistics and indications suggest that the country's role as an exporter will increase significantly as well. This will subsequently affect New Zealand's market share in current export markets.

Countries such as Chile (New Zealand's most noteworthy competitor in the Southern hemisphere) are currently undergoing free trade negotiations with several countries. Free trade

agreements that give New Zealand's competitors preferential market access to significant kiwifruit consuming markets could potentially damage New Zealand export returns.

Intense New Zealand marketing has been carried out in important export markets. *Taste Japan* has already proven successful in Japan where ZESPRI's market research and marketing efforts have resulted in significantly higher volumes sold. The campaign has therefore continued in other countries as well (Zespri, 2004-2005).

2.2.7. Producer price for exporters

Out of the net exporting countries, New Zealand is currently the country that enjoys the highest producer price on all varieties. These prices include the premiums that the New Zealand industry, due to several industry developed advantages (such as KiwiGreen, the twelve moth supply system and plant variety rights of Golden kiwifruit), can add to a regular price. Because of the higher premiums, New Zealand has always been the country other exporters compare their price standards against (Belrose Inc, 2006). Italian producers have received a relatively lower price than New Zealand in 11 years out of 15 between 1990 and 2004. Italian producers were hence price leaders for four of these years. New Zealand has managed to maintain the price premium, despite the higher transfer costs New Zealand suffers in order to reach the Northern hemisphere. U.S. prices have struggled to keep a high level over the past decades and did not reach acceptable levels until 2003, after a gradual increase from the lowest levels in 1992. Greece targets most kiwifruit exports towards lower-income markets, which consequently affects the level of prices received by producers. Chile is another significant exporting country which also faces high transfer costs to the Northern Hemisphere. The producer prices in Chile have always been lower compared to both Italy and New Zealand and constitutes almost as little as a tenth of New Zealand's producer price in 2003 (Belrose Inc, 2006). The values for producer prices in 2003 reflect the price levels for different varieties and different countries. The position of the different countries relative to each other, in terms of producer prices, gives an indication of the price situation for most years (not just 2003). See appendix for further information on basedata for all countries in 2003.

Table 1: Producer prices for net exporters in 2003

	Producer price (US$)			
Varieties	New Zealand	Italy	Greece	Chile
Green	1715	1115	677	128
Gold	2120	1438	874	165
Green organic	2141	1572	955	180

Source: Food and Agriculture Organisation of the United Nations (2006).

Quantities for exporters

As mentioned earlier, significant world production of kiwifruit is carried out in a few countries. These producers (apart from China) heavily dom inate foreign trade as well. Quantities produced and distributed on the world market have increased steadily over time, with a few exceptions of dramatic seasonal peaks. Some years' unexpected increased production subsequently affected world prices significantly. See appendix for further information on the base data for all countries in 2003.

Table 2: Quantities produced for net exporters in 2003

	Quantities produced (metric tonnes) for net exporters			
Varieties	**New Zealand**	**Italy**	**Chile**	**Greece**
Green	261	323	125	60
Gold	31	0	0	0
Green organic	8	16	6	3

Source: Food and Agriculture Organisation of the United Nations (2006).

Table 3: Quantities traded for net exporters in 2003

	Quantity traded (metric tonnes) for net exporters			
Varieties	**New Zealand**	**Italy**	**Chile**	**Greece**
Green	237	208	111	15
Gold	31	-2	0	0
Green organic	7	-6	6	2

Source: Food and Agriculture Organisation of the United Nations (2006).

New Zealand appears to be most dependent on trade out of the net exporting countries as 237 out of 261 metric tonnes of green kiwifruit contributes to exports. Italy is the largest producer but consumes about one third of its produced green kiwifruit domestically. Chile does not produce as much, but is also heavily dependent on exports.

2.3. Key current and future market drivers

The global kiwifruit industry is undergoing changes on both the demand and supply sides and some of the issues will be further discussed in the following section.

2.3.1. Supply side

Some countries are now implementing a variety of strategies to prepare for increasing global supplies and to address the threat of losing global market shares. Unless carefully managed, some of these strategies may create further demand/supply imbalances, at least in the short-term, and the industry needs to take caution in order to avoid these problems.

New Zealand and Italy have initiated growing programmes in foreign countries in order to secure a twelve-month supply of products with their brand. With many different marketers now following similar strategies, the effect will be increased global supply of kiwifruit in every month of the year.

Italy has recently commercialised the *Summerkiwi* variety, which can be harvested long before the Hayward. This could give a timing advantage before competitors but there might be an issue with early supplies simply adding to the overlap of supplies between the Northern and the Southern hemisphere. With more kiwifruit on the market, the prices will drop causing reduced returns for the global industry.

The most fundamental challenge the industry will be confronted by shortly is the increasing global supply of not only kiwifruit, but also of other competing fruits. It is argued that the global kiwifruit industry should focus on marketing and promotion in both its traditional rich country

markets and newer emerging country markets (Belrose Inc, 2006). As mentioned earlier, China constitutes the country with the most potential to increase the supply of Green kiwifruit on the world market in the nearest future.

Not only is total supply expected to increase, but productivity and technological improvements are most likely to improve as well. This is currently being experienced in most producing countries.

The import tariff is still the most widely applied trade restriction within the kiwifruit industry. However, other non-tariff trade barriers such as the SPS measure are becoming more commonly used and one of the focus points of this research will be how a potential introduction of such a trade barrier would affect the New Zealand kiwifruit industry.

The major retailers now dominate the food distribution system. This brings into question whether multiple players can continue to operate effectively in the supply chain. Retailers require continuous communication between them and the supplier and the existence of numerous players in the market makes this more difficult. The competition is tough and the marketers increasingly need to confirm to retailers the ability to build enough cooperation and communication into the present supply system in order to become the preferred supplier (Belrose Inc, 2006).

There are also domestic industry structure challenges for the New Zealand kiwifruit industry at the moment. First of all there are an increasing number of corporations working as intermediate suppliers to ZESPRI. These are constantly growing and there are presently negotiations in progress between two of the largest supplier cooperatives, Satara and EastPack, to merge and thereby create the largest kiwifruit packing and cool storage business in the country (Freshinfo, 2006). As these companies become larger, it is possible that some of them may seek to extend their own access to international markets, rather than selling through ZESPRI. ZESPRI is therefore under constant pressure to perform better than potential substitutes for growers (Belrose Inc, 2006).

A considerable risk to intellectual property rights owned by ZESPRI is China's use of illegal use of counterfeit labels. The ZESPRI label has been copied and put on Chinese kiwifruit in certain domestic markets. The counterfeit attempts are of concern for both Golden and Green kiwifruit. Commercial plantings of Gold kiwifruit in China will consequently not commence until local Chinese laws are able to protect the intellectual property rights (HortNews, 2004).

Some of these trends and challenges are not necessarily specific to the kiwifruit sector. They also apply to other horticultural sectors, and are perhaps best addressed through joint action and global cooperation. This has recently been recognised by the fresh apple and pear industries in the Southern hemisphere where, following a significant downturn, better sharing of information now benefits all global players (Belrose Inc 2006). The kiwifruit industry has so far not experienced the very severe conditions faced by the apple and pear industries, but the indicators are identical; increased supplies and increased power of retailers and distributors (Dalgety, 2003).

2.3.2. Demand side

Trends in consumption are changing globally. Consumers demand not only products that benefit health, but also products that have been produced in an environmentally friendly manner. The market therefore puts pressure on producers to implement strategies and production systems that

minimise the negative affect on the environment. Terms such as carbon footprints, food miles and sustainability work as incentives for producing countries to continuously perform better.

Producers also need to respond to the higher demand of product diversity and the constant demand for novelties and substitutes to current commodities. Research and breeding programmes are being developed worldwide in kiwifruit producing countries to meet consumer preferences. New Zealand, Italy, China and Chile belong to the world's top producers and have all recently developed new varieties that differ from each other.

Multilateral and regional trade liberalisation is also of current interest of many countries relevant to kiwifruit trade. New Zealand and China are currently taking part in negotiations regarding a Free Trade Agreement. Chile, New Zealand's direct competitor, is another country currently seeking new trade partners after signing an Association Agreement with the EU in 2002 (European Commission, 2004).

The second reason why the New Zealand kiwifruit sector may face significant change is due to the nature of its single desk seller structure. ZESPRI, with its single point of entry system, has been mentioned in multilateral trade liberalisation negotiations within the World Trade Organisation (WTO). Some countries, such as the United States, regard the single point of entry strategy as being discriminatory and trade distorting and consider that it should be made illegal under the WTO trading rules[6].

2.4. Conclusion of chapter

New Zealand was the first country to start growing and selling kiwifruit commercially. This chapter has examined the formation and early development of the New Zealand kiwifruit industry. It describes how it endured the deregulation of the agricultural sector in the 1980s and how other economic factors affected the industry. It goes through how the development and improvement of the New Zealand industry structure has lead to the establishment of ZESPRI. Recent strategies have differentiated New Zealand as an innovative market player that enjoys price premiums on all exported kiwifruit.

The main issues for New Zealand consist of production threats from China, both in terms of increasing quantity and varieties; trade restrictions such as SPS measures and a potential loss of the single desk seller structure. This chapter introduced the development of the global industry and its challenges ahead. The global kiwifruit market is changing rapidly on both the demand and supply sides, and is therefore a good candidate for further qualitative and empirical investigation. The following chapter will provide an understanding of the underlying trade theory and how it explains the potential issues.

[6] However, at the time of writing, the outcomes of current WTO negotiations are unclear. It is possible that the negotiations may go "on hold" for a period of time, in which case, the immediate pressure on ZESPRI may be delayed (Ministry of Foreign Affairs and Trade 2007).

3. Trade theory: Theoretical framework

Countries may choose to participate in international trade because of the following two reasons: non-availability of factors of production (natural resources) and demand for product differentiation (different quality) (Gandolfo, 1998). The reasons clearly contribute to the gains from trade and explain how the countries benefit from free trade rather than autarky. The following section on the theory of trade will elaborate the issue and explain how and why countries gain from trade.

3.1. Theory of trade

3.1.1. Mercantilism

The first economic philosophy of *mercantilism* was established as some European countries developed into modern nations where trade had a significant importance and value. The core of this theory was essentially that a country could become rich and powerful by exporting more than it imported. Mercantilists also supported strict government control on all economic activities by encouraging national output and employment through restricted imports and stimulated exports. The export surplus would be exchanged for precious metals such as gold and silver, which were considered real national wealth indicators. This theory implied that a country only could gain from trade at the expense of another, since it is impossible for all trading countries to have an export surplus. Because mercantilism advocated economic nationalism and severe government regulation the early theory was to become heavily criticised by several trade economists in the following centuries (Salvatore, 1999).

3.1.2. Adam Smith

Adam Smith (1776) established in *The Wealth of Nations* that countries would gain from shifting from a situation in autarky to free trade. His argument was based on the law of absolute advantage, which suggests that if a country has an absolute cost advantage in the production of one commodity and the other country has an absolute cost advantage in the production of the other, both countries would gain from free trade if specialising in the production thereof and subsequently exporting these commodities (Gandolfo, 1998).

3.1.3. Ricardo

In 1817 David Ricardo published the *Principles of Political Economy and Taxation*, where the trade law of absolute advantage was developed into the law of comparative advantage. The law of comparative advantage was first illustrated as a two-nation, two-commodity world and demonstrates how a country could gain from trade through specialising in the production of the commodity in which it is relatively cost efficient compared to the other country. This country would subsequently export the commodity in which it has a lower opportunity cost and import the commodity in which it does not. Opportunity cost is defined as the value of other potential options given up for a certain alternative (Seitz, Nelson and Halcrow, 1994). The theory also assumes, given one country has a comparative advantage in producing one commodity, that the other country consequently must have a comparative advantage in producing the other commodity. This differs from Smith's principle of absolute advantage: even if a country has an

absolute disadvantage in producing both commodities, it can still be beneficial for that country to specialise in the production of the least inefficiently produced commodity. Both countries are hence better off specialising in their comparatively advantageous commodity, even if one country enjoys absolute advantage in the production of both commodities. Ricardo explained his theory through the difference in labour productivity and that countries engage in trade because of different levels of technology (Salvatore, 2005).

J.S. Mill (1848) developed the equation of international demand, with which it is possible to calculate the terms of trade by establishing that the value of exports from one country equals the value of imports of another country. The value of supply and demand will therefore adjust to equalise and represent each other. This was further elaborated by Alfred Marshall (1879) in his theory of international reciprocal demand, by which he introduced the graphic illustration and tool of Marshallian offer curves, or supply and demand curves, to graphically indicate the different terms of trade (Gandolfo, 1998).

3.1.4. Heckscher-Ohlin

The previous section explained classical theory through international differences in comparative advantage. The reason why these characteristics appear was further developed by Eli Heckscher and Bertil Ohlin. They established that the comparative advantage of a country, and thus trade, originates from different factor endowments, by assuming a market with two commodities, two countries and two factors of production (Krauss and Johnson, 1974). The book *Interregional and International Trade*, published in 1933 (Salvatore 1999), presents an extension of standard trade theory. The fundamental assumptions behind this theory are that factors of production are immobile between countries (mobile between industries though) and that these factors are used differently in the production of two different commodities. The difference in technology between countries is explained by different levels of capital (Leamer, 1987). The core of the general Heckscher-Ohlin (H-O) theory was further developed and explained in four different theorems; the *H-O theorem*, which predicts the patterns of trade; the *factor price equalisation theorem*, which explains the effect of international trade on factor prices; the *Stolper-Samuelson theorem*, which states the relationship between changed production and real returns; and the *Rybczynski theorem* illustrating the impact a change in factor endowment will have on output (Leamer, 1987).

The first theorem, according to Heckscher and Ohlin, seeks to explain the reason behind comparative advantages by suggesting that a country will use its relatively abundant resource to produce and subsequently export a commodity. The commodity that requires the intensive use of the relatively expensive and scarce factor of production will consequently be imported. This theorem thus develops the classical theory of comparative advantage by explaining trade patterns and relative commodity prices through the physical availability of factor endowments among nations. The theorem is therefore often referred to as the factor-proportions or factor-endowment theory and also emphasises the differences between commodities through the intensities of which these factors are used (Salvatore, 2005).

The factor price equalisation theorem, developed by Lerner and Samuelson, states that international trade will contribute to an equalisation of homogenous factor prices across trading nations. The theorem thus proves that as trade expands the difference is reduced between wages of the same type of labour and earnings of the same type of capital (Salvatore, 2005).

The Stolper-Samuelson theorem describes how a rise in the relative price of one commodity will increase the real returns of the factor that is used intensively in the production of that commodity. This will consequently lead to a decrease of real returns of the other production factor (Choi et al. 2003). Real returns, influenced by free international trade, will therefore increase in the factor used intensively in production and decrease in the factor of production used less intensively.

The Rybczynski theorem assumes production of two goods under constant factor and commodity prices. This implies that an increase in one factor endowment will consequently increase the production of the commodity in which that factor is used and decrease the output of the other commodity. So, an increase in a factor endowment generally causes one industry to expand at the expense of the other (industry) (Choi and Hartigan, 2003).

The assumptions behind Ricardian theory are rather restrictive and the theory of comparative advantage is limited in terms of immobile factors of production between countries. The H-O theory is similarly restricted utilising the same assumptions. Despite these restrictive assumptions the H-O theory still belongs to one of the most dominant frameworks for analysing trade. However, the assumptions changed over time in order to facilitate the development of further trade theories, which are often referred to as the neoclassical theories.

3.1.5. Modern trade theories

The fundamental assumptions of classical trade theory include perfect competition and homogenous commodities across countries. However, reality illustrates an opposite situation where commodities are differentiated and market structures diverge from the theory of perfect competition by being based on structures such as monopolistic competition and oligopoly (Gandolfo, 1998).

Falvey (1981) developed a theory based on vertical differentiation, which explained how production is not homogenous, but that commodities differ in quality and consumers require different qualities based on their income level. The second point of this theory suggests that capital is specific to each industry, rather than homogenous, and because of its specificity also immobile (Gandolfo, 1998). The theory thus suggests that demand differs between countries and provided demand cannot be met with domestic production, a country is better off engaging in trade.

Krugman (1979) developed the theory of horizontally differentiated goods, which refers to products of the same quality but with different characteristics that are valued differently among consumers. This theory is based on the assumption that consumers generally enjoy variety. This is explained in Barker's (1977, cited in (Gandolfo, 1998)) variety hypothesis. He argues that "as real income increases, purchasers are enabled to buy more varieties of a product; and since a greater number of these extra varieties are available from abroad rather than at home, the share of imports in demand tends to increase". The variety hypothesis originates from the theory of demand based on the characteristics of goods according to Lancaster (1966, 1971, cited in (Gandolfo, 1998)). This theory argues that the characteristics available are more relevant to the choice of consumers rather than the commodity itself.

A theory explaining preferences, developed by Dixit, Stiglitz (1977, cited in (Gandolfo, 1998)) and Spence (1976, cited in (Gandolfo, 1998)), suggests that behind the demand for differentiated goods lies the attractiveness of variety as such. This implies that consumers prefer intermediate

combinations of all possible differentiated commodities. This theory has been used by Krugman to explain international trade in differentiated goods based on monopolistic competition (also neo-Chamberlinian monopolistic competition). It is observed that both approaches of differentiated products lead to an equilibrium of monopolistic competition, where different firms produce differentiated products and possess monopolistic power without necessarily earning monopolistic profits (Gandolfo, 1998).

3.1.6. Porter

Classical trade theory explains national success and trade flow based on factor endowments. However, classical trade theory was further developed by Michael Porter to explain how globalisation of competition and the power of technology also contributes to trade. He stresses the need for a new theory that explains "why a nation provides a favourable home base for companies that compete internationally". This theory should also develop other motives but the cost theory to explain why companies in some nations are more successful to create advantages based on quality, specific characteristics and product innovation (Porter, 1998).

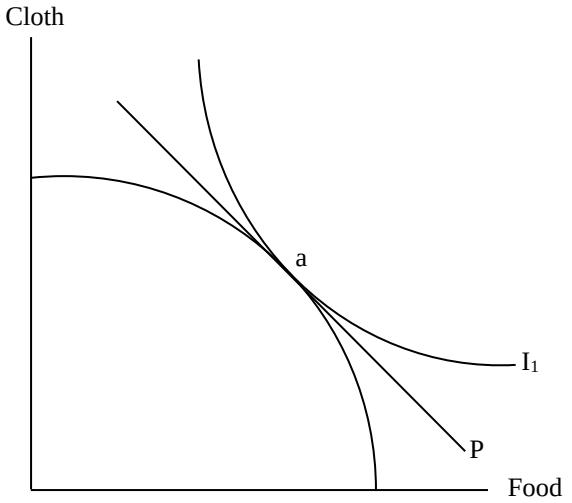
In *The Competitive Advantage of Nations* (1990), Porter argues that "national prosperity is created, not inherited" and that a country's competitiveness is not created by or dependent on natural endowments, but rather on the capacity of its industry to improve and innovate. The theory of competitive advantage therefore differs from the classical theories of relative advantage and trade. Porter continues by claiming that companies benefit from competition and pressure from rival companies and that competitive success is gained through differences in national value, culture, government policy and history. These factors constitute the primary impacts on a nation's productivity, and contribute to a more modern concept of competitiveness (Porter, 1998).

3.2. The gains from trade

Trade theory suggests that countries have the opportunity to specialise in the production of the commodity in which they are relatively efficient, export it and consequently import the commodity in which they have a comparative disadvantage. Specialisation therefore allows for both countries to reallocate resources into relatively efficient production. This efficiency implies that more commodities are produced and consumed under free trade rather than in a situation of self-sufficiency.

The gains from trade can be demonstrated by depicting a production possibility frontier with an indifference curve and thereby representing both supply and demand, as in figure 1. The production possibility frontier illustrates the maximum production of two commodities with given resources and the indifference curve depicts the combination of commodities rendering a given level of utility. In autarky, the single country reaches equilibrium in point *a*, where the indifference curve (I_1) is tangent to the production possibility frontier at the same point as the price line (P), which illustrates the relative price between the two commodities. In equilibrium the relative price hence equals the marginal rate of technical substitution (the slope of the price line) and the marginal rate of transformation (the slope of the production possibility frontier). This point demonstrates the maximum utility of consumers and the maximum profit of producers and thus the point where production equals consumption. The production possibility frontier is curved because of diminishing marginal returns (each additional unit of input yields a diminishing level of output) as the production inputs are substituted for each other (Salvatore, 2005).

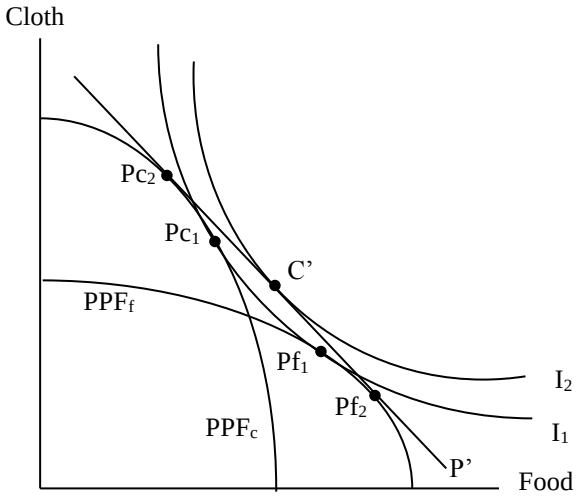
Figure 3: Single country in autarky



Source: Salvatore (2005).

By introducing a second country to trade with the first country, higher levels of production and consumption can potentially be reached. With trade, production increases in both countries, since it allows them to specialise in their relatively most efficient production. The production of the two countries is subsequently demonstrated by two different production possibility frontiers (PPF_f and PPF_c), due to relative efficiencies in different places, but since preferences are homogenous for both countries the same indifference curve applies. Because of different relative efficiencies, the countries move from the production points Pc_1 and Pf_1 to produce at the points Pc_2 and Pf_2 respectively, closer to complete specialisation, presenting two different price ratios. The indifference curve has shifted outwards (from I_1 to I_2) and the new common point of consumption is therefore determined by C'. With trade, only one price line appears (P'), tangent to the highest possible indifference, presenting the new international terms of trade. Both countries will conclusively benefit from trade in terms of more commodities and a higher utility (from I_1 to I_2) (Salvatore, 2005).

Figure 4: Two countries trading



Source: Salvatore, D. (2005).

As long as the international terms of trade are different compared to the autarky price ratio, the potential welfare of a country is higher with international trade than without it. The effect of trade is essentially to increase the price of exportable products and hence promote a reallocation of resources towards the relatively efficient industry and thereby raising the relative price of the factor used intensively in that production. The real income of that production factor is increased while the income of the factor used in production of the importable good is consequently reduced. Free trade can therefore be considered to benefit one factor of production while reducing production, and hence the factor of production, of the other. The change in social welfare determines to what extent a country is better or worse off in a situation with free international trade (Krauss and Johnson, 1974).

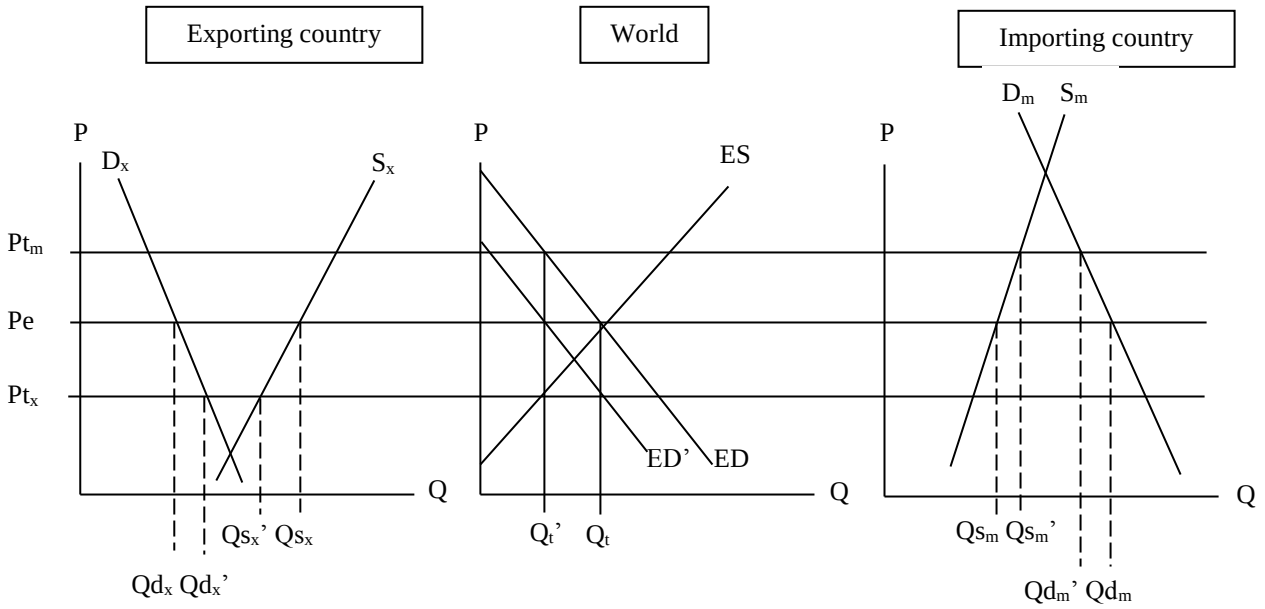
3.3. Impact of trade restrictions in the kiwifruit market

In previous sections the gains from free trade in terms of maximised world production and consumer utility have been discussed. Although free trade is argued to make countries better off, almost every country imposes some type of restriction on international trade. The following section will introduce some of the most commonly used restrictions within the global trade of kiwifruit and their general effect on the international market. A theoretical as well as a graphical analysis of how a restriction effects production, consumption and trade will be presented in each case.

3.3.1. Tariffs

The tariff is one of the most widely and historically used trade restrictions (Salvatore, 2005). Tariffs may be specific, ad valorem or compound. The *specific* tariff is introduced as a fixed amount of money on every traded unit, the *ad valorem* tariff is a fixed percentage on the value of the traded commodity, and the *compound* tariff is a combination of both (Salvatore, 2005). Imposing a tariff can be expressed by shifting the price in the market from free trade equilibrium, which is depicted in the following graph, where an import tariff is imposed by the importing country.

Figure 5: Global effect of an import tariff



Source: Salvatore, D. (2005).

P_e is the initial price in free trade equilibrium, which changes by the tariff and becomes Pt_m in the importing country and Pt_x in the exporting country. The price in the importing country increases with the tariff and decreases in the exporting country due to reduced excess demand (ED to ED') for their commodity. The government gains revenue collected through the tariff. Production in the exporting country decreases from Qs_x to Qs_x' (because of less exported products) and increases from Qs_m to Qs_m' in the importing country (due to a less competitive domestic market). Consumption, on the other hand, increases in the exporting country from Qd_x to Qd_x' (more commodities at a lower price) and decreases from Qd_m to Qd_m' in the importing country (less commodities at a higher price).

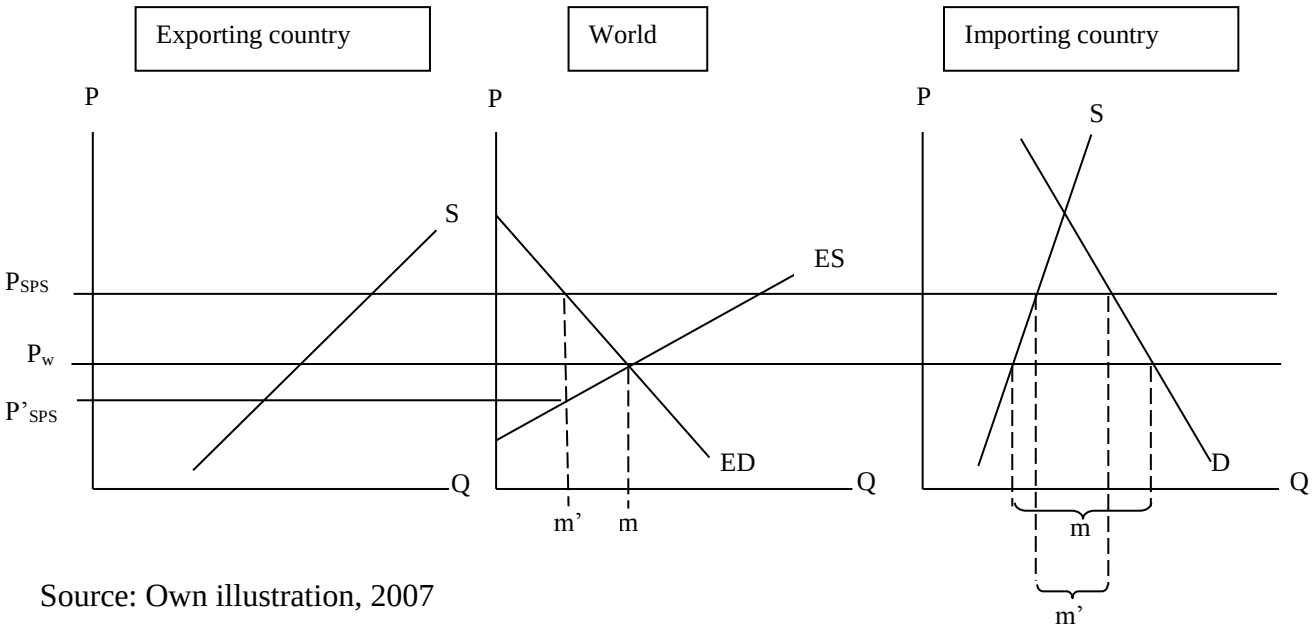
3.3.2. Sanitary and Phytosanitary policies

International trade in kiwifruit is currently distorted by several measures. Import tariffs are still the most commonly exercised policy, but another import restriction that has been used more frequently falls under the classification of a Sanitary and Phytosanitary (SPS) measure, as defined by the WTO (World Trade Organisation, 2005). The SPS Agreeement is an agreement recognising what measures a government can execute in order to protect domestic animal and plant health and food safety. Member countries of the WTO are allowed to set their own standards, provided that the regulations are scientifically justifiable. If countries use international standards, guidelines and directives, they should unlikely be challenged legally in a WTO dispute. Introducing an SPS policy may be legitimate when it is considered necessary to protect human, animal and plant life and health. The measure is considered inappropriate (or illegal) if it discriminates between countries with similar conditions and standards. If an exporting country can justify that health protecting measures applied to exports achieve the same level as in the importing country, the importing country is expected to accept the level of protection in the exporting country and hence accept imports (World Trade Organisation, 2005). According to Voss (2005), SPS measures are considered highly efficient in order to prevent kiwifruit below domestic standards from entering a health-aware and environmentally and safety concerned

market. Countries can use the measure to legally prevent substandard commodities from being imported. This could be relevant if imported kiwifruit proves to contain certain pests that are not domestically found or wanted or if pesticide levels prove to be too high for domestic standards. Issues like these are the reason for several trade disputes in progress.

To satisfy WTO obligations, SPS measures have to be introduced based on scientific principles, but the temptation to use them illegitimately seems to have been expected from the first negotiations in the Uruguay Round (Anderson, 2004). Member states set their own appropriate protection levels and have the right to determine levels that are higher than international standards (Anderson, 2004). The policy itself could be executed as a restriction on imports and depicted as an import quota, imposing a limit on the amount that can be imported. Although an import quota is a quantitative restriction (on imports) and an import tariff is imposed as a price-based measure their effects are similar in that they restrict supply to the domestic market.

Figure 6: Global effect of an SPS measure



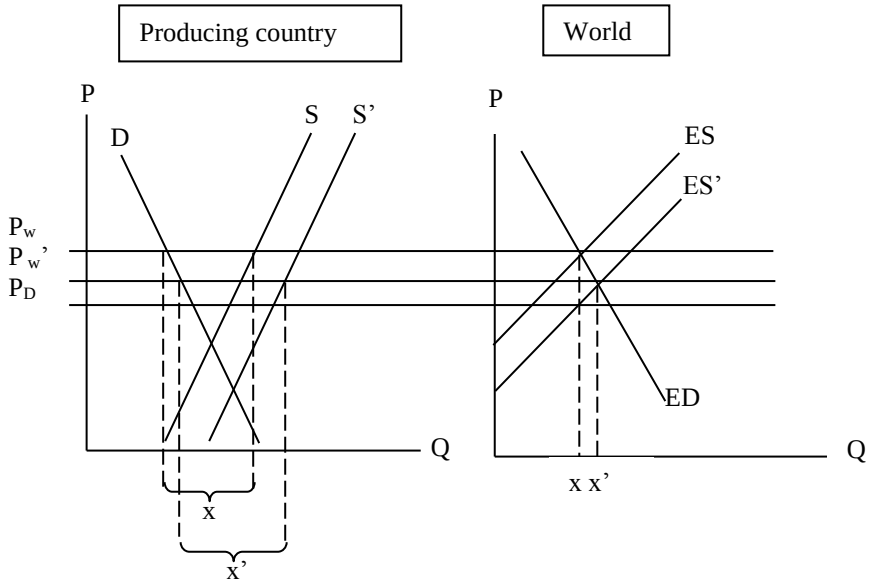
Source: Own illustration, 2007

Producers in the importing country are better off, since the SPS policy restricts imports (from m to m') and thereby protects domestic producers from international competition. Consumers in the importing country are worse off, due to fewer products at a higher price (P_{SPS}). Consumers on the world market receive more products at a lower price (P'_{SPS}). Producers in the exporting country suffer from reduced exports and hence lower returns.

3.3.3. Supply increase

Factors other than tariffs or other trade policies can impact the market, causing a new equilibrium to appear. Another trade-related issue concerning the global kiwifruit market is the consequence of a significant increase in production by a producing and exporting country. An increase in the volume of a major producing and exporting country will have a significant impact on the world price of the produced commodity, provided that the commodities from different producing countries are considered homogenous and that there is no change in demand.

Figure 7: Global effect of a supply increase



Source: Own illustration, 2007

Domestic consumers in the producing country are better off because of more products at a lower price. On one hand an increase in supply consequently reduces the world price (from Pw to Pw'), which could have a negative impact on producer surplus domestically. On the other hand, more exported products are demanded (x to x'), which improves the situation for domestic producers. Hence, producer welfare depends on by how much the price reduces. The consumers in the rest of the world are better off with more commodities at a lower price whereas producers suffer from the reduced market price because of more competition.

Trade restrictions in the kiwifruit industry encompass more than just the tariffs and SPS measures focused on in this chapter, but quotas for example do not have a significant impact on the kiwifruit market (or for New Zealand exporters) and is therefore not further detailed in this research. Due to unavailability of data, subsidies and consumer support[7] will also be excluded in this research.

3.2. Conclusion of chapter

The New Zealand kiwifruit industry, which is country reliant on trade, is currently challenged by several trade-related issues that may have a significant impact on the global market. The previous section reviewed the major and most common trade related issues impacting the global kiwifruit industry and applied trade theory to facilitate the comprehension of these threats and challenges.

Some of the agricultural and trade policy issues will become more apparent in the nearest future and the risks, in terms of different trade restrictions, will be assessed through the development of potential scenarios and subsequently supported by a quantitative modelling analysis. The following chapter will include an assessment of the analytical framework relevant to this research and the selection of an appropriate approach.

[7] Producer subsidies are excluded only due to lack of data, not because of insignificance to the industry; as producer and consumer supports most likely exist within the global kiwifruit industry.

4. Defining equilibrium theory:Analytical framework

The previous section examined trade theory, the development thereof and finally the potential effects of trade. The analysis of the implications of trade related issues concerning the kiwifruit market on New Zealand producer returns require the application of an international trade model.

Different endowments and consumer preferences are the main motives to why nations trade. It is thus possible to examine effects of trade related changes using an either general or partial equilibrium analysis of supply and demand. Following, a presentation of the two different equilibrium theories is given in order to compare and contrast the advantages and disadvantages with using either an economy-wide general equilibrium (GE) approach or a partial-economy partial equilibrium (PE) approach. Both frameworks seek to determine equilibrium prices and quantities on specific markets that are affected by different policy measures. The timeframe of the two approaches can vary from short-term to long-term and can specify a comparative static (at a certain point in time) or dynamic (process over time) solution (van Tongeren, van Meijl and Surry, 2000).

4.1. General equilibrium theory

GE theory aims to explain supply, demand and prices by examining the economy as a whole taking into account all interrelated segments and industry sectors as well as the flow of income and expenditure (van Tongeren, van Meijl and Surry, 2000). Since equilibrium in each market is determined by situations in other markets the establishment of one general equilibrium solution is analysed through a simultaneous determination of equilibria in all other markets (University of Melbourne Department of Economics 2000). The theory of general equilibrium was first established by Lèon Walras who, through Walras' Law, explained that if one market is in equilibrium, the other markets must consequently be in equilibrium as well (Gandolfo, 1998). He also argued that a market cannot be in disequilibrium by itself without being matched by a disequilibrium in another market (University of Melbourne Department of Economics, 2000).

Simple GE theory is necessarily based on some restrictive assumptions in order to simplify and facilitate the analysis. The theory assumes that factors of production are mobile between industries, but not between countries. It further assumes that players on the market are competitive and that technology is available and constant in all countries with production functions illustrating constant returns to scale and diminishing marginal products[8]. To explain factor endowment and demand similarity, factor endowments vary across industries and consumption is maximised under identical utility functions (Leamer, 1987).

[8] Although GE models have now been built that relax some of these assumptions including many that incorporate imperfect competition (Francois, van Meijl et al. 2003).

4.2. Partial equilibrium theory

Because the economy as a whole constitutes of so many different actors, factors and commodities a partial equilibrium approach is therefore also commonly and widely applied. In a PE analysis, attention is directed at a smaller number of variables directly affecting a market, or a group of related markets, while influences of other factors are generally ignored. An analysis based on a partial equilibrium approach can therefore be seen as a technique that simplifies an economy in general equilibrium (Simpson, 1975) and allows for the examination of commercial policy issues to be sectoral specific, relatively rapid and transparent (Francois and Hall, 1997). The theory of partial equilibrium also generally assumes a competitive world market, homogenous commodities and that technology is held constant (van Tongeren, van Meijl and Surry, 2000).

Homogeneity and perfect competition simplify the practicality of trade modelling. The assumption of homogeneity implies that products are homogenous across markets and only one world price exists on the world market. When perfect competition is assumed the world market is divided into either importers or exporters for practical reasons. This enables tracing trade patterns at country and commodity level and hence facilitates an easier interpretation of the results (Cagatay and Saunders, 2003). By excluding intra-industry trade however, and limiting the analysis to net trade, partial models do not perfectly illustrate how countries interact (van Tongeren, van Meijl and Surry, 2000).

In the economic literature, many different partial equilibrium models, specific to different purposes, can be found. Examples are the FAPRI model with a focus on the United States, the AGLINK model used by governments of OECD member countries, SWOPSIM developed by the USDA specifically for the Uruguay Round, GAPSI emphasising the EU, VOMM developed by the World Bank and WFM developed by the FAO (van Tongeren, van Meijl and Surry, 2000).

There are several reasons for why a PE approach is considered the best option for the purpose of this research. A PE approach allows for much more product detail (such as different kiwifruit varieties) and a more specific trade policy analysis. The fact that there has been marginal research carried out in the kiwifruit industry concentrating on similar issues contributes to the aggregation problems of relevant data. Limited research time is also an issue and the collection of enough data for a GE approach would not be within the timeframe of the thesis. The unavailability of relevant data therefore means that a GE specification would be relatively unrealistic. However, the aim of this research is to address the sectoral effects of policy and market changes to a specific product, rather than economy wide impacts.

4.3. Conclusion of chapter

This chapter presented the analytical framework of this research. It investigated the main characteristics as well as the advantages and disadvantages of a general equilibrium and a partial equilibrium approach respectively. The area of application of this research is a detailed trade policy and market change analysis to specific countries for a specific product. For this reason, a partial equilibrium model has proven most relevant and useful. Next chapter will provide a summary of research focusing on the kiwifruit industry and similar trade-related issues. It concludes by determining how this particular research contributes to current literature.

5. Literature review

Since trade related issues in the kiwifruit industry have been rarely modelled so far, studies carried out in related industries will be reviewed together with the trade modelling literature in order to establish a relevant framework for future examination and analysis in this study. Parallels from trade in kiwifruit can be drawn to other valuable sources of horticultural export revenue for New Zealand and other countries, since other horticultural industries are concerned with similar trends and strategic challenges both currently and ahead.

A few criteria for article selection were established before selecting relevant literature. First of all, articles focusing on the kiwifruit industry were of primary interest to this research. Only when this literature had been identified, the potential gap where this research may provide value could be established. It was therefore investigated what had been done so far in the area in terms of modelling (preferably trade modelling) or investigation of trade-related issues.

Secondly, the trade modelling literature was reviewed and evaluated. The search for relevantarticles was kept as close to the kiwifruit sector as possible. The essence of this thesis constitutes the different hypotheses and therefore literature of PE modelling of similar issues on similar products was examined. Trade-related issues such as non-tariff trade barriers, trade liberalisation and the impact of a supply increase on other horticultural or agricultural markets, and/or how they are modelled, were taken into account in this chapter.

Protective trade restrictions such as SPS measures are increasingly affecting the current trade in kiwifruit (Voss, 2005). A global expansion of kiwifruit production constitutes another issue that is likely to have a significant impact on future trade patterns. This section will further explain the effects of these trade related issues based on previous studies carried out in the kiwifruit industry and studies using relevant trade modelling methodology in related industries.

5.1. Kiwifruit literature

Saunders and Cagatay (2003) investigate the short to medium term impact of commercially releasing Genetically Modified (GM) food and food production in New Zealand. The impact of different levels of GM food on producers, consumers and trade in New Zealand is simulated through scenarios using the GEMO, a trade model developed based on the Lincoln Trade and Environment Model (LTEM) framework. The results of the analysis illustrate the impact of GM introduction on New Zealand producer returns. A 20 percent change in preferences for GM food, for example, simulates an increase in producer returns by 20 percent for kiwifruit.

Peterson and Willett (2000) analysed the U.S. kiwifruit industry and its determinants of supply, demand and the price received by growers, through the use of a dynamic industry model. The study provides a quantitative description of the U.S. kiwifruit industry and a framework for decision making in production and marketing of fresh horticultural products. The study was the first economic analysis of the U.S. kiwifruit industry and is divided into a production sector component and a demand sector.

The model framework in Peterson and Willett (2000) is based on an annual component representing the production process and a monthly component expressing the marketing process. Profitability between sectors is compared and the model simulates relevant information for growers of whether to stay in production of kiwifruit, alter to another crop (peach) or convert to

non-farm uses. The study shows that early plantings of kiwifruit are quite speculative and as the orchard matures expected profitability and potential performance are increasingly significant parameters in the decision-making of future production and aim for increased returns (Peterson and Willett, 2000) .

The above model is not a model of trade. However, it mentions imports as one of the main factors affecting the production of US kiwifruit, which emphasises the significance of international trade on domestic markets.

An article by **Fournier and Hassan (2003)** investigates the pricing factors throughout the French kiwifruit channel and stresses that the type of margin (constant or proportional) at one stage strongly influences demand price elasticity and hence upstream turnover. Demand price elasticity is calculated for each of the three stages of the supply chain (production, shipping and retail). The demand function $Q=Cp^{\varepsilon}$ is calculated, where ε is the demand price elasticity at the level considered. The results of the estimations illustrate the highest elasticity on retail level (1.71), a positive elasticity at shipping level (1.26) and a steady elasticity at production level (0.81).

Again, the research in Fournier and Hassan (2003) is focused on production and does not include other countries or varieties.

5.2. Trade modelling literature

A study by **Bakshi (2003)** examines the impacts on demand, supply, imports and prices when Mexican avocados are allowed into the U.S. through the alleviation of U.S. SPS barriers. Results, through the use of a partial equilibrium trade model, show that Mexican imports increase significantly (as expected) when the U.S. market opens up. Imports from New Zealand and Chile as well as domestic U.S. supply fall when Mexican avocados enter the market. Consumption and total supply increase. The price of Mexican avocados increases whereas the prices of Californian, Chilean and New Zealand avocados decrease. As a result when the price on Mexican avocados increases, U.S. consumption subsequently falls. From the areas where Mexican access is granted, avocados from the U.S., New Zealand and Chile are generally redistributed. The supply of avocados with domestic or non-Mexican origin rises in the areas where Mexican avocados have no access, since the price of avocados falls across the entire country and the total supply, foreign and domestic, is displaced from approved Mexican access regions to other parts of the country. The result of this study demonstrates an increase of total supplies of avocado in the U.S. by 12 percent when Mexican avocados are imported. This consequently causes the price of domestic avocados to fall by 12.5 percent.

A report by **Calvin and Krissoff (2005)** explains the trade relationship between the world's largest apple exporters and the Japanese market. New Zealand used to export apples to Japan during five years (1993-1998) under a phytosanitary protocol, but found that the costs exceeded the benefits with the protocol. The report recognises a phytosanitary technical barrier as a measure that alters the relative price between the domestic market and the rest of the world and hence creates a price wedge between potential traders. The analysis concludes that exporters will enjoy increased opportunities due to the adjustment of the Japanese phytosanitary protocol, with domestic production decreasing by approximately 11 percent. Japanese consumers, on the other hand, would gain from lower prices and greater availability of varieties (Calvin and Krissoff 2005).

Research by **Arthur (2006)** examines the Australian SPS measure which restricts apple imports from New Zealand, and consider the economic impact that liberalisation would have on Australian welfare. The import ban was introduced in the 1920s in order to prevent the disease fireblight to enter the Australian production system via imports from New Zealand. The import barrier restricts market supply and competition and thereby raises the domestic price of the commodity, affecting consumers negatively yet benefiting domestic producers. The potential liberalisation of the Australian-New Zealand apple market was assessed through a Markov Chain Analysis. The paper's conclusion was that if the Australian apple market is liberalised through a relaxation of its SPS measures, regardless of the severity and the impact of a disease entry, social welfare increases relative to the current situation.

Research carried out by the **Economic Research Service of the USDA (n.d.)** investigates three different ways of analysing the effect of a technical barrier to trade through trade modelling. One of them constitutes a demand-shift element, which should be used if a trade regulation has been introduced to improve information to the consumer. Such information can be related to factors such as country of origin and quality and allows for the regulation to have a beneficial impact on producers or consumers. The demand-shift model implies a shift of the demand curve from an initial assumption of limited information to a situation where information targeted at consumers increases. Consumers, being better informed, are better off and demand for imported products either increases or decreases (shifts the demand curve outwards or inwards).

A research report on liberalisation in global dairy trade carried out by **Saunders, Cagatay and Moxey (2004)**, utilises a partial equilibrium modelling approach to investigate three different scenarios in dairy trade, an industry where New Zealand is a significant global actor. The scenarios include: no liberalisation, EU liberalisation and OECD liberalisation. The simulated results through the Lincoln Trade and Environment Model (LTEM) suggest that EU liberalisation leads to a rise in producer prices of raw milk in the main countries, except for the EU itself, suffering a price drop of 20 percent. EU production falls as well. The same scenario causes raw milk prices to rise by 11 percent in New Zealand and Australia. Under OECD liberalisation, production drops by three percent in the EU, eight percent in Japan and 2.5 percent in the United States. Australian and New Zealand outputs, however, rise by four and three percent, due to their comparative advantage in dairy production. This research suggests that New Zealand and Australia appear to gain most from full OECD liberalisation in global dairy trade.

According to current literature the introduction of an SPS measure results in domestic producers benefiting from the introduction of the restriction and exporters are worse off when facing the trade restriction. If supply increases on the domestic market consumers are subsequently better off due to lower prices and greater availability. It is also concluded that complete trade liberalisation would benefit New Zealand producers.

There are very few quantitative models in the international literature that consider kiwifruit, let alone different varieties of kiwifruit, and those that do exist do not adequately incorporate trade aspects. There has been no specific analytical framework available to examine changes in the dynamics of the kiwifruit industry in New Zealand.

5.3. Conclusion of chapter

This section examined some of the present literature relevant to this research and how similar studies have been carried out in the past. It explains how they contribute to this study and also provides an understanding of the gaps in the literature where this research will be of significant value.

In order to investigate and answer the research questions of this thesis, a modified and industry-specific version of a partial equilibrium framework will be developed and used. The approach taken is novel in two ways. Firstly, a model specific to the kiwifruit sector is developed to simulate various trade conditions. Secondly, the study considers key aspects of the kiwifruit industry and links these to international trade in the sector.

6. Methodology

Having outlined in chapter five why PE modelling is the best option, it is in this chapter possible to present the specifics of the model chosen, developed and calibrated for this research.

The empirical model, KIWI, is based on the framework for the Lincoln Trade and Environment Model (LTEM) (Saunders and Cagatay, 2003). The KIWI model is a multi-country, three-commodity partial equilibrium model focusing on the kiwifruit industry ignoring linkages with the rest of the economy. The framework is used to analyse the impacts of various domestic and border policies on the country and commodity-based price, demand, supply and net trade levels. KIWI is a price equilibrium, *non-spatial* model, which implies that focus is put on net trade of commodities between countries rather than trade flows based on country size, borders and geographical proximity. It is only observable what actors (countries) bring to the market and what each actor takes form the market. The non-spatial approach is therefore also referred to as the *pooled market* approach. The opposite approach is the one of *bilateral specification*, where representation of the complete set of interactions between each buyer and seller and for each commodity is defined (van Tongeren, van Meijl and Surry, 2000). The model framework also assumes that the structure of markets is competitive (Saunders and Cagatay, 2003).

KIWI is a synthetic model with parameters adopted from the literature. There are mainly two methods for estimating parameters in an applied trade model. The *economic estimation* approach, where parameters are derived through simultaneous equation estimation provides the most accurate result. However, this method is in some cases unfeasible, due to size of the model, identification problems and data unavailability. Instead, the *calibration* method, or the *synthetic* approach, is more widely used. For this purpose, data for the model is collected from existing literature and adjusted for the relevant model. (Saunders and Cagatay, 2003).

The model is used to quantify price, supply, demand and net trade effects of various policy changes. The model is calibrated to year 2003 and simulations are carried out up to 2013. This implies that policy impacts are derived in a *comparative static* fashion, based on the year 2003 (Saunders and Cagatay, 2003). A *dynamic* approach, on the other hand, would provide results based on the process over time (Francois and Hall, 1997).

The commodities included in KIWI are green kiwifruit, gold kiwifruit, and organic green kiwifruit. Commodities in the model are treated as homogenous with respect to country of origin and destination and to the physical characteristics of each product. Therefore, commodities are considered as substitutes in consumption on international markets[9] (Saunders and Cagatay, 2003).

The coverage of the KIWI model includes the major kiwifruit producers and consumers, specified by 13 countries: Australia (AU), Belgium (BE), China (CI), Chile (CL), France (FR), Germany (GM), Greece (GR), Italy (IT), Japan (JP), New Zealand (NZ), Spain (SP), United Kingdom (UK) and the United States (US). It further considers three additional trading regions: the old European Union (EO), including the first 15 member states, the new European Union (EN), including the subsequent member states acceded through 2004, and rest of the world (RW). Some of the actual EO members are accounted for separately in the model (significant

[9] As previously mentioned, New Zealand can command a premium in global markets due to various long standing industry factors, which would suggest that all kiwifruit are *not* the same. However, for simplicity and modelling purposes all green kiwifruit will be considered as homogenous and further differentiation between IPM kiwifruit and other kiwifruit will instead be suggested for future research.

independent producers or consumers) and therefore not included in the EO variable as to avoid accounting for the same value twice. Therefore, the countries included in the EO are Austria, Denmark, Finland, Ireland, Luxembourg, the Netherlands, Portugal and Sweden. The EN variable includes Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia. The rest of the world (RW) conclusively encompasses all countries not elsewhere included in the model.

Table 4: General characteristics of the KIWI model

Model	**KIWI**
Modelling approach	Partial equilibrium
Solution type	Non-spatial, net trade
Parameters	Synthetic
Commodity coverage	3
Country coverage	16
Behavioural equations	Domestic supply
(per commodity and country)	Domestic demand
	Stocks
	Producer price
	Consumer price
	Trade price
Economic identity	Net trade

Source: Saunders and Cagatay, 2003

The framework of the KIWI model allows the application of various domestic and border policies explicitly such as production quotas, set-aside policies, input and/or output related producer subsidies/taxes, consumer subsides/taxes, minimum prices, import tariffs and quotas, export subsidies and taxes (Saunders and Cagatay, 2003). However, only some of the policies are currently of interest in kiwifruit trade.

6.1. Equations

The general equation structure of each commodity at country level (see appendix A4 for country specific equations) in KIWI is represented by six behavioural equations and one economic identity as defined in the equations 1 to 7 (Saunders and Cagatay, 2003).

$$pt_{ij} = f(WDpt_i, ex_j) \quad (1)$$

$$pp_{ij} = g(pt_{ij}, sm_j) \quad (2)$$

$$pc_{ij} = h(pt_{ij}, cm_j) \quad (3)$$

$$qp_{ij} = l(fp_{ij}, pp_{ikj}) \quad (4)$$

$$qc_{ij} = m(fc_{ij}, pc_{ij}) \quad (5)$$

$$qe_{ij} = n(fe_{ij,}, qp_{ij}) \quad (6)$$

$$qt_{ij} = qp_{ij} - qc_{ij} - qe_{ij} \quad (7)$$

The trade price (*pt*) of a commodity (*i*) in a country (*j*) is determined as a function of world market price ($WDpt_i$) of that commodity and the exchange rate (ex_j). The domestic producer and consumer prices are determined by the trade prices of the related commodity and the country's domestic and border policies. The trade price therefore constitutes the producer price excluding

trade restrictions. The total effect of a change in world market price on the trade price of the country is determined by the price transmission elasticity.

The domestic producer (pp_{ij}) and consumer prices (pc_{ij}) are defined as functions of the commodity's trade price and specific production and consumption related domestic support/subsidy policies, (sm_{ij}) and (cm_{ij}). The domestic production and consumption equations are specified as constant elasticity functions that incorporate both the own and cross-price effects. Domestic production (qp_{ij}) is specified as a function of producer price (pp_{ij}) and a productivity (fp_{ij}) shifter, which represents the economic factors and policies that result in production shifts. Domestic consumption (qc_{ij}) is specified as a function of consumer price (pc_{ij}) and a consumption function (fc_{ij}) shifter, representing the economic factors and policies that result in consumption shifts. The ending stocks (qe_{ij}) are determined as a function of the stock shifter (fe_{ij}) and quantity produced (qp_{ij}). The shift variables in these equations allow exogenous shocks to produce pivotal shifts of the related functions. The equations also include cross-price effects from the kiwifruits in the model. Finally, net trade (qt_{ij}) of the country (j) in commodity (i) is determined as the difference between domestic production and the sum of domestic consumption and stock changes in the related year (Saunders and Cagatay, 2003).

6.2. Supply

In the KIWI framework, a uniform aggregate domestic supply function is used for each variety and country, specified as a function of own- and cross prices. Interdependencies between substitutes are reflected by cross-price elasticities (Saunders and Cagatay, 2003).

6.3. Demand

The behavioural relationship is assumed to be derived from the consumers maximising utility, acting under perfect competition. Therefore, demand is specified as a function of own- and substitute prices, per capita income and population growth rate (Saunders and Cagatay, 2003).

6.4. Economic identity

The economic identity is the net trade equation, which equals trade through excess supply or excess demand in the domestic economy, identifying the country as either a net-exporter or a net-importer (Saunders and Cagatay, 2003). Countries therefore make up the difference between domestic supply and domestic demand through trade.

Markets are linked to each other through net trade. A basic assumption of the model states that world imports have to equal world exports in all regions involved so that net trade equals zero in equilibrium. If a market is distorted from equilibrium (net trade $\neq 0$), a new equilibrium is calculated so that all markets are cleared. The new world equilibrium subsequently affects all relevant and connected market structures, through the adjustment of domestic price structures (Francois and Hall, 1997).

Trade policies affect the international market and hence adjust the price linkage between domestic and trade prices. Domestic policies, on the other hand, primarily affect supply and demand structures, which in turn have a consequent effect across regions and on international

trade (Francois and Hall, 1997). The market clearing equations close world markets for the relevant commodities and provide a mechanism to find a new world equilibrium if any (or all) markets are out of balance. Each world trade equation (for each commodity or region) defines/calculates net world trade as a sum of net trade from all regions (Francois and Hall, 1997).

The model basically operates by simulating the commodity based world market clearing price on the domestic quantities, prices and trade in each country. The different equations in the model are parameterised to reproduce the 2003 base data for each country's supply, demand, prices and trade (Saunders and Cagatay, 2003). The method for establishing world equilibrium and calculating market prices after a shock follows a certain structure. First of all, the model recalculates the domestic equations for supply, demand and trade, after the market has been exposed to an exogenous change/modification. The model consequently recalculates world net trade, which in turn leads to the estimation of a new world price and the establishment of a new world equilibrium. The impact of the new equilibrium on domestic prices in relevant markets is then determined, which in turn has an effect on domestic supply and demand schedules. When all these changes have been calculated world trade markets have found their new equilibria and a new solution in the model has been established (Francois and Hall, 1997). KIWI can capture the disequilibrium situations in the economy that may result from temporary shortages or excess supply situations by allowing the determination of stock levels endogenously. The pattern of prices and quantities observed in the base year is then compared to the pattern that emerges when the model is being exposed to changes.

6.5. Data required

The LTEM framework facilitates the selection and implementation of a preferred model structure. The framework hence makes it possible to construct a specific model in terms of product and country coverage and through the specification and adaptation of equations and policies.

In order to construct the KIWI model, the following data was required to develop a suitable framework for industry-specific scenarios:

Prices: producer, consumer and trade prices for selected countries and varieties.

Quantities: production, consumption, exports and imports for selected countries and varieties.

Elasticities: Demand, supply, cross-price and income elasticities were required.

Policies: Trade restricting policies such as import tariffs were collected for each country. Non-tariff trade barriers are not included per se, but can be modelled through shifts in either supply or demand (shift-parameters).

Macroeconomic data in terms of GDP, population and their growth rates.

6.5.1. Data sources

Much of the data for green kiwifruit has been sourced from the statistical database of the Food and Agriculture Organisation (FAO) of the United Nations. The year 2003 was set as the base year for the model, since the LTEM was already calibrated to this year. Data available beyond 2003 were also included. In order to maintain consistency data would ideally have been sourced from one single source. This was however unfeasible, since no one single database provides all required data for all varieties and countries involved. Therefore, a series of databases were used for different purposes and the most commonly utilised include: the Food and Agriculture Organisation (FAO) of the United Nations, World Kiwifruit Reviews (Belrose, 2004-2007), ZESPRI, European Commission Agricultural database, United States Department of Agriculture (USDA), the New Zealand Ministries of Agriculture and Forestry (MAF) and Foreign Affairs and Trade (MFAT).

Data on kiwifruit trade have been relatively difficult to obtain and some primary data could not be obtained. Data on gold and green organic kiwifruit were particularly difficult to obtain. The FAO data on green kiwifruit therefore provided a basis for several assumptions about the other two varieties. In all cases, the most current data have been projected up until 2013.

It should be mentioned that the FAO database does not distinguish between green, gold or green organic in its data on prices, production, consumption and trade. It has therefore been assumed that the data reflect total world quantity of all kiwifruit varieties. Given the proportion of green kiwifruit on the world market, the price data has been treated as representative of the green kiwifruit sector only.

6.5.2. Prices

The domestic producer (pp_{ij}) and consumer prices (pc_{ij}) are, as earlier mentioned, defined as functions of the commodity's trade price and specific production and consumption related domestic support/subsidy policies, (sm_{ij}) and (cm_{ij}). No producer subsidies[10] or consumer support were estimated or considered in this research. The FAO statistics for producer price was uniformly used for all countries.

[10] Due to unavailability of data this parameter was not considered in this research, even if producer subsidies may be implemented by some kiwifruit producing countries.

Green Kiwifruit

Kiwifruit producer prices were sourced from FAOSTAT. Where available, producer price (US$/tonne) was used. The availability of data, however, necessitated the substitution of average import unit value (US$/tonne) for the importing countries Belgium, France, Germany, Japan, Spain and the United Kingdom.

For New Zealand, total fruit and service payment including premium ($ per tray equivalent) was used as a proxy for producer/consumer price data (Zespri International Limited, 2005) and converted into US$/tonne, using an exchange rate of 0.70 US$/NZ$.

Among major kiwifruit producers, China is the only country in the FAO database that does not have a representative producer price. This exclusion creates a unique problem for China. Among non-producing countries, average import unit values are sufficient because they do not affect domestic production. Because China is a major producer, using import prices has the potential to overstate returns to domestic producers. Therefore, a base year 2003 average ratio of producer price/import price was calculated for three major kiwifruit producing countries that record both statistics – New Zealand, Italy and the United States. The average producer price in these three countries was 74 percent of the import price. The 74 percent value was then multiplied by the FAO 2003 average import unit value (US$/tonne) to find the producer price for China.

Gold Kiwifruit

Gold kiwifruit is mainly produced in New Zealand and China (Huang and Ferguson, 2003; Zespri International Limited, 2005). Pricing data for China was unobtainable. Prices for New Zealand were available in the ZESPRI Annual Report (2005) and converted to US$/tonne using the exchange rate of 0.70 US$/NZ$. To establish gold producer and consumer prices for each country, ZESPRI gold orchard gate returns were averaged over growing seasons 2002 to 2006, resulting in a gold premium of 29 percent over green kiwifruit. This premium was subsequently multiplied by the FAO green producer and consumer prices for each country (Zespri International Limited, 2005; FAO, 2007).

Green organic

Green organic price data is very difficult to obtain. Numbers are usually restricted to prices quoted within one place and time and are not representative of yearly average producer price. Additionally, price premiums for organic kiwifruit vary considerably from country to country.

ZESPRI is the single largest world marketer of kiwifruit (ZESPRI, nd). Since approximately four percent of the total kiwifruit marketed by ZESPRI is organic (Dryden et al. 2002), ZESPRI orchard gate returns are again observed as a reliable proxy for determining a consistent worldwide market premium for organic kiwifruit (Zespri International Limited, 2005). The resulting price average of four growing seasons (2002-2006) yields a premium of 41 percent for green organic over green kiwifruit which sits well within the range of organic premiums recorded in the literature (The Foreign Agricultural Service, 1999; Boto, Liu, Kortbech-Olesen, Vrolijk and Pilauskas 2001; Dimitri, Oberholtzer and Greene, 2005). The premium is multiplied by the green producer and consumer prices to yield the organic green producer and consumer prices for each country.

Table 5: ZESPRI premiums for gold and organic

Season	Gold/Green	Organic/Green
2002-2003	17%	34%
2003-2004	14%	37%
2004-2005	27%	40%
2005-2006	58%	54%
Average 2002-2006	29%	41%

Source: ZESPRI Annual Report 2005-2006

Trade price

FAO data for producer price includes the value of country-specific tariffs. In order to obtain the trade price, the value of each country's tariff was removed (New Zealand Fruitgrowers Federation, 2003; Skilton, 2005). Table 3 provides a sample calculation of trade price for Belgium where: producer price * (100% - tariff rate) = trade price.

Table 6: Belgium producer/consumer/trade price

Commodity	Producer/Consumer price	Tariff rate	Trade price
Green	$1,400.86	8%	$1,288.79
Gold	$1,807.11	8%	$1,662.54
Organic	$1,975.21	8%	$1,817.19

Source: FAOSTAT

6.5.3. Quantities

Green kiwifruit

FAOSTAT provides worldwide trade data for kiwifruit including production, consumption and import and export statistics. As previously mentioned, net traded quantities for each country is defined by the difference between domestic production and consumption. Net trade is also defined as the difference between exports and imports.

FAO consumption data do not consider fruit loss/waste or processed kiwifruit (Belrose Inc., 2006). For modelling purposes, FAO production, import and export data are therefore used to derive consumption figures as to balance the net trade equation. Where quantities were given in the unit trays, the value was converted into the generic unit of metric tonnes based on the assumption that one tray weighs 3.6 kg (Ministry of Agriculture and Forestry, 2004), (Zespri, 2004-2005), (Oppenheimer Group, 2003).

Gold kiwifruit

New Zealand and China are considered to be the sole world producers of gold kiwifruit in 2003 (Huang and Ferguson, 2001). Production data for New Zealand are provided in ZESPRI's Annual Report. China's production has been based on a comprehensive survey conducted in 2002, providing detailed acreages and a list of varieties, three of which have been identified as golden - Jinkui, Jinfeng and Lushanxiang (Huang and Ferguson, 2003). This review also provides data on overall average yield per hectare which, when multiplied by total gold hectares planted, resulted in the estimate used for Chinese gold production.

Both New Zealand and China are developing overseas relationships in order to be able to supply gold kiwifruit all year round (12 month supply programmes). New Zealand has licensed nearly 840 hectares of Hort16A in several countries around the world, beginning in the early part of this decade (Zespri International Limited, 2005). ZESPRI reports some data on country-specific acreages planted, but production and yield data are not available. Actual yields are believed to be small in base year 2003 and have been projected forward through 2013 at zero due to lack of reliable data. In 2000, China licensed the worldwide propagation rights to a gold variety known as Jin Tao to an Italian company, the Kiwigold Consortium (Chinese Academy of Sciences, 2003). Evidence suggests that significant quantities of Jin Tao were produced in Italy by 2005 and that production has also been licensed to France, Uruguay and Chile (China News, 2005; Belrose Inc., 2006; Kiwigold Consortium, 2007).

ZESPRI's production and export distribution is published in annual reports, although it does not break out country-specific statistics (with the exception of Japan). To calculate country-specific consumption for European countries, total EU gold exports were allocated to importing countries in direct proportion to their consumption of green kiwifruit according to the following example (where BE = Belgium):

> BE green consumption / total EU green consumption = BE % of EU green consumption
>
> Total EU gold consumption (ZESPRI EU exports) x BE % of EU green consumption = BE gold consumption

The following table illustrates consumption (production less net trade) of kiwifruit in different EU countries. The first column shows total consumption of green kiwifruit and the second column shows the different countries' share of total EU consumption of green kiwifruit. Finally, the third column illustrates quantities of Gold consumption for each EU country in the model, derived from each country's consumption of green kiwifruit (as explained above).

Table 7: EU green/gold kiwifruit consumption in metric tonnes

	2002			2003			2004		
Country	Green	**% EU**	Gold	Green	**% EU**	Gold	Green	**% EU**	Gold
BE	92.04	**12.8%**	1.20	97.73	**14.7%**	1.4	110.42	**13.4%**	2.13
EO	53.67	**7.5%**	0.70	61.19	**9.2%**	0.9	62.67	**7.6%**	1.21
EN	42.03	**5.8%**	0.55	47.48	**7.2%**	0.7	77.38	**9.4%**	1.49
FR	82.04	**11.4%**	1.07	83.64	**12.6%**	1.2	93.44	**11.4%**	1.80
GE	102.41	**14.2%**	1.33	84.74	**12.8%**	1.2	87.33	**10.6%**	1.68
GR	44.00	**6.1%**	0.57	44.63	**6.7%**	0.6	34.71	**4.2%**	0.67
IT	181.37	**25.2%**	2.36	115.01	**17.3%**	1.6	222.64	**27.1%**	4.29
SP	91.96	**12.8%**	1.20	97.82	**14.7%**	1.4	100.9	**12.3%**	1.94
UK	29.69	**4.1%**	0.39	31.94	**4.8%**	0.5	33.32	**4.1%**	0.64
Total	719.21	**100.0%**	9.36	664.18	**100.0%**	9.4	822.81	**100.0%**	15.84

Source: FAOSTAT

Green organic

Country-specific data on organic kiwifruit is very limited. A literature review of the general organic agricultural markets in individual countries proved useful in guiding production and consumption data assumptions for these markets. Countries that are significant producers of kiwifruit tend to also be significant producers of organic kiwifruit (Boto, Liu, Kortbech-Olesen, Vrolijk and Pilauskas. 2001; Zespri International Limited, 2005). Organic kiwifruit production figures in the model are based on two basic assumptions. First of all, conventional and organic green kiwifruit realise the same yield. Conflicting data suggest the occurrence of both higher yields and lower repack losses for organic kiwifruit (Hugh, Hasey, Johnson, Meyer and Klonsky, n.d.), while other sources suggest organic kiwifruit yields are less than conventional kiwifruit (Hugh, Hasey, Johnson, Meyer and Klonsky, n.d.). Secondly, organic kiwifruit production is five percent of conventional green kiwifruit production. This assumption likely overstates production for some countries in the model but is supported in the literature for the major world producers of kiwifruit (Boto, Liu, Kortbech-Olesen, Vrolijk and Pilauskas. 2001; Klonsky and Carmen, 2004; Zespri International Limited, 2005; California Kiwifruit Commission, n.d.). Table 5 demonstrates the level of organic production for two major kiwifruit producers.

Table 8: Production ratio: green organic to conventional (total yield)

Country	1998	1999	2000	2001	2002	2003	2004	Average
United States	4.3%	5.8%	4.6%	5.4%				5.1%
New Zealand					4.9%	4.6%	4.6%	4.7%

Source: California Kiwifruit Commission & ZESPRI Annual Report 2005-2006

Organic consumption has been observed to be growing at double-digit rates annually for much of the developed world (Boto, Liu, Kortbech-Olesen, Vrolijk and Pilauskas, 2001; Organic Trade Association, 2007) and organic kiwifruit consumption as a percentage of green kiwifruit consumption averages between one and five percent of green kiwifruit consumption (Boto, Liu, Kortbech-Olesen, Vrolijk and Pilauskas, 2001; Zespri International Limited, 2005; van der Wiel, 2006). Where available, consumption statistics of fresh organic fruits and vegetables are observed to be even higher (van der Wiel, 2006). It was therefore assumed that organic kiwifruit consumption is five percent of conventional green kiwifruit consumption.

New Zealand quantities were mainly sourced from ZESPRI, both annual reports and other documents. For other countries, data on production, consumption and trade were mostly extracted from the FAO Statistic Database. USDA database also provided some country-specific information on quantities.

6.4.4. Elasticities

The elasticity parameters are key variables in the model since they determine the responsiveness of domestic supply and demand to changing prices and policy measures. The framework assumes that price sensitivity varies by country and across the three varieties. Assumptions and calculations of elasticities (own-price, supply, income and cross-price) had to be made (see appendix A7). Each country in the model has an individual demand and supply (possibly zero) for each kiwifruit variety.

Elasticities for the KIWI model are synthesised from the literature. *Demand elasticities* were mainly sourced from the World Kiwifruit Review (2004) and the articles by Fournier and Hassan (2003) and Hanawa Peterson and Willett (2000). In the case of insufficient data on elasticities for specific countries, basic assumptions such as classifying a country as producing or non-producing or as developed or developing were made and elasticities of similar countries were applied. When two elasticities were found for the same country (kiwifruit specific), they were averaged. Demand elasticity for organic fruit is assumed to be twice the value of conventional fruit, according to a study of the U.K. organic market by ADAS (2003). Since gold and green organic kiwifruit are both charged with significantly higher premiums than green, the demand elasticities for both varieties were, for simplicity, considered to be twice the value of the country-specific conventional demand elasticity. The elasticities in the original LTEM for producing countries appear to lie between 0.3 and 0.5. The assumption was therefore made to set *supply elasticity* for these countries to 0.4 in the KIWI model. For non-producing countries supply elasticity was assumed to be 0.1 (for modelling purposes). It was further assumed that supply elasticities would equal across varieties. The value of *income elasticity* in the original LTEM is represented by the value of 0.18 in all countries. Based on income elasticities allocated in the World Kiwifruit Review of 2004 (Belrose Inc, 2004) and the LTEM number, new elasticities were calculated by setting the lowest number equal to 0.18 and allowing the following numbers to increase proportionally. Income elasticities were further assumed to equal across varieties. The value for *cross-price elasticity* was assumed to be 0.5 across all varieties, directly extracted from the original LTEM, assuming that the different kiwifruit varieties are substitutes.

Where data on elasticities for specific countries were unobtainable, basic assumptions such as classifying a country as producing or non-producing or as developed or developing were made and elasticities of most similar countries were applied. Greece is an example of such a country where the closest applicable economy was assumed to be the EU region. Belgium, a non-producing yet large kiwifruit consuming country was assumed to be most similar to Germany, another European non-producing country with a similarly developed economy. Chile was assumed to be most comparable to China, due to its significant kiwifruit producing and developing economy characteristics. The model incorporates the "rest of world" as a separate country variable, which was assumed to be mostly related to China, since it includes India, another significant developing country.

Sensitivity analyses were carried out to test the robustness of the estimated elasticities. Results illustrate that alterations in prices change the quantity demanded as expected and according to theory. The estimated elasticities therefore appear legitimate.

6.4.5. Policies

Import tariffs for relevant countries were obtained from different sources, ranging from a high of 20 percent imposed by China, to eight percent introduced by the EU. The policies are represented by the parameters sm (producer market subsidies, fees, levies, direct payments, etc.) and cm (consumer market subsidies). See appendix and table A5 for details on import tariffs. Subsidies are not included in the model due to insufficient information. When there are no policies affecting domestic prices for a certain commodity, then the variables sm and cm take the value 0. Alternatively, if a complete free market policy is introduced, then sm and cm equal 1.

6.4.6. Macroeconomic data

Macroeconomic data for each country on population, Gross Domestic Product and productivity levels and their respective growth rates were sourced from the OECD statistical database.

6.5. Conclusion of chapter

This chapter gave a brief description of the theoretical considerations underlying the new KIWI model. The new kiwifruit model was constructed so as to include the different industry-specific countries and varieties, allowing for consumers to be able to substitute between the different varieties of kiwifruit for each other. The section further identified data requirements and sources of the data obtained to facilitate the construction and further analysis of the KIWI model. Additional necessary assumptions and estimations, where lack of data was an issue, were also presented. Following is a description of the scenarios developed for this research. The purpose of these scenarios is to provide an understanding of potential trade-related issues facing the New Zealand kiwifruit industry, and their impacts.

7. Description of the scenarios

The LTEM was adapted to develop a three-commodity world kiwifruit trade model. The model will be used to investigate potential impacts of trade-related issues on production, consumption and trade for various scenarios. The potential changes, outlined in chapter two, are reproduced through the development of relevant scenarios. The final impact on producer returns will reflect the results of the different scenarios.

Scenarios have been selected and simulated according to potential future scenarios facing the global trade in general and the domestic New Zealand industry in particular. These scenarios constitute the most central and probable situations potentially influencing New Zealand trade in kiwifruit. This section initially describes the scenarios, their relevance and expected results. The results of the different scenarios are then evaluated and compared to the results of the reference scenario. The KIWI model was hence initially run with existing conditions for the base year 2003 with iterations to the year 2013. Three scenarios were developed; an EU introduction of an SPS policy, an expansion of Chinese production and finally a full trade liberalisation scenario. The objective of this research is to quantify and analyse the possible effects that these changes might have on the kiwifruit industry especially in New Zealand. The effects of the different scenarios will therefore be measured in changes in New Zealand producer returns[11].

7.1. Reference Scenario

The reference scenario, to which all other scenarios are compared, is set according to actual conditions in 2003. The reference scenario represents the situation with factual production, consumption and traded quantities at trading conditions (tariffs and prices) in 2003 (see Appendix A5). The results of the scenarios are presented for the year 2013 and compared to the reference scenario's results in 2013 (see Appendix A6).

7.2. EU consumption drop, reducing New Zealand imports through an SPS policy.

The European Union, if taken as a whole, is the largest consumer of kiwifruit in the world. According to FAO consumption data for 2004, the European Union alone accounts for 64 percent of world kiwifruit consumption (Food and Agriculture Organisation of the United Nations, 2006; FAOSTAT, 2006).

[11] Given the specific focus on the New Zealand kiwifruit industry, no macroeconomic results (changes in national welfare, GDP growth, etc) are reported.

This scenario will illustrate a large drop in EU consumption, as a result of a stricter SPS policy. The scenario targets New Zealand imports and is modelled through a shift in EU consumption[12], assuming that all EU countries are affected by the import restriction, but still accepting trade within the EU and with other countries. Since New Zealand's share of EU imports constitute approximately 60 percent of green kiwifruit and this is the number by which the consumption shift parameter (*fcKW=0.4*) will be reduced in this scenario.

The expected result of this scenario, according to theory, would suggest that the import restriction to the European market, due to an introduction of an SPS measure, reduces the imported quantity. Producers in the importing country are better off, since the SPS policy restricts imports and thereby protects domestic producers from international competition. Consumers in the importing country are worse off, due to fewer products at a higher price. Producers in the exporting country suffer from reduced exports and hence lower returns. New Zealand producers are hence negatively affected by a potential EU introduction of an SPS policy[13].

7.3. Chinese production doubles by 2013.

Huang & Ferguson (2003) estimate that one fifth to one third of production is processed domestically. As previously discussed, this could be due to the lack of infrastructure necessary to support the grading, storage and distribution of fresh fruit, but also because of the relatively low quality of the country's fruit. Commercial orchards continue to grow, making wild harvests less important and recent growth in kiwifruit exports may indicate that infrastructure is being improved (Food and Agriculture Organisation of the United Nations, 2007). Since the country previously managed to solve the quality problems facing the apple and pear industries, it is likely to perform similarly in the kiwifruit industry (Belrose Inc, 2006). In 1999, the total production of kiwifruit from China reached 165,000 metric tonnes. In 2003, production totalled 300,000 metric tonnes (Food and Agriculture Organisation of the United Nations, 2007) and was estimated to have reached 400,000 metric tonnes per year by 2006. If productivity approaches the level of other countries, Chinese annual production could potentially reach 700 000 metric tonnes per year (Huang and Ferguson, 2001). China is currently the largest volume producer of kiwifruit, yet productivity was still very low at around 8.5 metric tonnes/hectare according to the last comprehensive survey conducted in 2003 (Huang and Ferguson, 2003). No productivity improvements will be incorporated in the scenario modelled, which probably understates the output expansion that might be possible.

If China, being considered as a major producing and exporting country, contributes to an increased supply of kiwifruit on the world market, theory suggests that world prices of kiwifruit will be reduced due to a significant increase in global supply. This scenario is modelled through increasing Chinese production (and hence output) twofold from 2003 to 2013, based on historical development of the industry and estimations by Huang and Ferguson (2001). If New Zealand kiwifruit is considered homogenous with Chinese kiwifruit, and thus competes for the same market share, a Chinese expansion will have a negative impact on New Zealand producers in terms of lower returns.

[12] Since SPS measures are not included under the trade restriction parameter (*sm*) in the model, this scenario is modelled through a consumption shift.

[13] The effect on EU consumers depends on how easily other kiwifruit exporters might fill the gap in the EU market created by the stricter SPS regime on New Zealand exports.

7.4. Trade liberalisation through the elimination of all import tariffs.

This scenario will be examined through changing all the trade restricting variables in all countries in the model from current import tariffs to zero, demonstrating complete trade liberalisation within the industry. With all import barriers eliminated worldwide, an increase in import demand will occur. Theoretically, exporters will respond to the change by offering exports at a higher price. World prices in kiwifruit consequently increase and, as a result, New Zealand producers are better off through higher returns. The outcome of trade liberalisation on producers depends upon the tariff levels of the different countries. In countries with relatively high tariffs, complete trade liberalistaion would result in kiwifruit being imported on the expense of domestic production.

Table 9: Research scenarios

0. Reference scenario	• Actual conditions in 2003
1. EU import ban	• Tighter SPS policy on New Zealand exports • Consumption drop of 60%
2. Chinese expansion	• Chinese production doubles by 2013
3. Trade liberalisation	• All tariffs eliminated by 2013

Source: own illustration

7.5. Conclusion of chapter

This section introduced the four main scenarios investigated in this research. The scenarios are run through the KIWI model as suggested and subsequently presented are the modelling results followed by specific discussions for each scenario.

8. Results and discussion

This research is based on a methodology utilising three different versions of the same commodity included in a new trade model with kiwifruit industry-specific countries, statistics and assumptions. The results, focusing mainly on New Zealand producer returns, of the three different scenarios are given below. Other key results are also presented. All scenario outcomes are compared to the baseline scenario predictions in 2013.

8.1. EU consumption drop, reducing New Zealand imports through an SPS policy

This scenario illustrates a large reduction in EU demand for New Zealand kiwifruit, through the introduction of an SPS policy. This import restricting measure is a form of a non-tariff trade barrier, and is introduced to protect the domestic market from imports that could potentially be a threat to human, animal or plant health. The implementation of such a measure occurred in 1992, when Italian authorities threatened to take the New Zealand kiwifruit industry to court, claiming that the chemical residue levels of the imported shippings from New Zealand were significantly above Italy's allowed standards. As a result, imports were completely cut off and New Zealand producers suffered greatly in terms of reduced producer returns. The SPS measure is in this case targeting New Zealand exports to the EU, which represent 60 percent of total New Zealand kiwifruit exports in 2003.

By 2013, the effects of this dramatic reduction in European Union consumption of New Zealand kiwifruit result in a 28 percent reduction (compared to baseline scenario in 2013) in producer returns for green kiwifruit and 11 and 21 percent reductions in producer returns for gold and organic green kiwifruit respectively. New Zealand kiwifruit exports in 2013 will have fallen by 13 percent, three percent, and 17 percent respectively for green, gold and organic green kiwifruit.

The EU constitutes a significant player on the international kiwifruit market. It is the main kiwifruit consuming region and any potential import ban it introduces would have a significant negative impact on the New Zealand industry. The green and green organic sectors are especially affected, since a substantial share of total New Zealand exports of these varieties are shipped to Europe. An EU introduction of an SPS policy does not affect the New Zealand gold kiwifruit industry as significantly as the other two varieties. Changes in exports and producer returns are projected to be significantly smaller for gold than for green and green organic. This could possibly be explained by the fact that New Zealand is the world's sole exporter of this variety and there would be other potential destinations for New Zealand gold kiwifruit, should the EU completely ban imports of all varieties.

Other kiwifruit consuming and producing countries appear to be significantly affected by this policy shock as well. Consumption logically falls in the EU countries, whereas in countries such as the U.S., Japan and Australia consumption of green kiwifruit rises. This could possibly be due to a redistribution of New Zealand exports to other consuming markets, when access is denied to the EU.

Table 10: Scenario 1 – EU consumption drop through an SPS policy

	2013											
	Producer Price			Producer Returns			Quantity Produced			Quantity Consumed		
Country	Green	Gold	Organic	Green	Gold	Organic	Green	Gold	Organic	Green	Gold	Organic
AU	21%	8%	16%	-26%		-20%	7%		5%	31%	8%	53%
BE	21%	8%	16%							-48%	-89%	-39%
CI	21%	8%	16%	-28%	-11%	-21%	-9%	-3%	-7%	31%	8%	53%
CL	21%	8%	16%	-28%		-21%	-9%		-7%	31%		14%
EO	21%	8%	16%	-28%		-21%	-9%		-7%	-48%	-89%	-39%
EN	21%	8%	16%	-28%		-21%	-9%		-7%	-48%	-89%	-39%
FR	21%	8%	16%	-28%		-21%	-9%		-7%	-48%	-89%	-36%
GM	21%	8%	16%							-48%	-89%	-39%
GR	21%	8%	16%	-28%		-21%	-9%		-7%	-48%	-89%	-39%
IT	21%	8%	16%	-28%		-21%	-9%		-7%	-38%	-88%	-22%
JP	21%	8%	16%	-28%		-21%	-9%		-7%	31%	8%	53%
NZ	21%	8%	16%	-28%	-11%	-21%	-9%	-3%	-7%	31%	8%	53%
SP	21%	8%	16%	-28%		-21%	-9%		-7%	-68%	-89%	-36%
UK	21%	8%	16%							-45%	-89%	-34%
US	21%	8%	16%	-28%		-21%	-9%		-7%	70%	8%	136%
RW	21%	8%	16%	-28%		-21%	-9%		-7%	50%	8%	-7%

Source: own illustration, 2007

8.2. Chinese production doubles by 2013.

This scenario illustrates the effects of a Chinese production expansion, doubling the country's kiwifruit output by 2013, compared to the 2003 base year. This is modelled through increasing Chinese production (*qp*) twofold gradually from base year 2003 to 2013. No productivity improvements are incorporated in the scenario modelled, which probably understates the output expansion that might be possible.

The production increase causes world producer and consumer prices to fall and world kiwifruit consumption to increase, resulting in a new equilibrium. Chinese producer returns increase dramatically at the expense of the world kiwifruit industry. China consequently moves from being a net importer to a net exporter. The effects of increased availability of Chinese kiwifruit are simulated to reduce both New Zealand producer returns and exported quantities, as theory would predict. New Zealand grower returns for green, gold and green organic kiwifruit are consequently reduced by 16 percent, 19 percent and nine percent respectively. New Zealand kiwifruit export quantities in 2013 will have fallen by seven percent, six percent, and five percent respectively for green, gold and organic green kiwifruit.

The primary variety currently being expanded in China is conventional green kiwifruit, which could potentially constitute the country's strongest chance of success on the international market. Therefore, New Zealand market access and future exports of green conventional kiwifruit could be the variety that is threatened the most by China's potential expansion. This can be confirmed through the result of this scenario, where New Zealand exports for green kiwifruit are reduced by the most (compared to the other varieties).

China is the only other country, apart from New Zealand, that presently produces gold kiwifruit. New Zealand is currently the only exporter of this variety. However, the above scenario shifts China to being a net exporter of gold kiwifruit. This constitutes a challenge for the New Zealand

kiwifruit industry, suddenly facing a direct competitor on the world market in this variety. The scenarios result in reduced New Zealand gold kiwifruit exports and the largest fall in New Zealand producer returns out of the three varieties considered.

The organic sector is the least affected variety in New Zealand. The model projects a reduction in New Zealand producer returns of around half the magnitude of the falls seen in the other two varieties (20 percent compared to 36 and 37 percent). This could potentially be due to the fact that the organic kiwifruit industry is not particularly developed in China and does not pose a significant threat to the New Zealand organic industry. The scenario still affects the organic sector negatively, but not nearly as significantly. The quality issues mentioned earlier would be a reason why the organic sector is not as developed in China as in other major producing countries.

Kiwifruit producers worldwide are similarly negatively affected in this scenario. This shows, yet again, the significant impact China could have on the world market. Due to increased availability of kiwifruit, consumption increases worldwide. The expansion of the gold variety changes China to a net exporter thereof and subsequently provides the world market with the first competitor to New Zealand in terms of exports of golden kiwifruit. This increases consumption dramatically worldwide, but consequently also affects New Zealand producer returns of golden kiwifruit more negatively than the other two scenarios.

Table 11: Scenario 2 – Chinese production doubles by 2013.

	2013											
	Producer Price			Producer Returns			Quantity Produced			Quantity Consumed		
Country	Green	Gold	Organic	Green	Gold	Organic	Green	Gold	Organic	Green	Gold	Organic
AU	-12%	-14%	-6%	-15%		-8%	-4%		-2%	12%	49%	9%
BE	-12%	-14%	-6%							11%	48%	8%
CI	-12%	-14%	-6%	67%	63%	83%	90%	89%	95%	12%	49%	9%
CL	-12%	-14%	-6%	-16%		-9%	-5%		-3%	12%		-3%
EO	-12%	-14%	-6%	-16%		-9%	-5%		-3%	12%	49%	9%
EN	-12%	-14%	-6%	-16%		-9%	-5%		-3%	12%	49%	9%
FR	-12%	-14%	-6%	-16%		-9%	-5%		-3%	14%	55%	10%
GM	-12%	-14%	-6%	-16%		-9%	-5%		-3%	11%	48%	8%
GR	-12%	-14%	-6%	-16%		-9%	-5%		-3%	12%	49%	9%
IT	-12%	-14%	-6%	-16%		-9%	-5%		-3%	22%	83%	19%
JP	-12%	-14%	-6%	-16%		-9%	-5%		-3%	12%	49%	9%
NZ	-12%	-14%	-6%	-16%	-19%	-9%	-5%		-3%	12%	49%	9%
SP	-12%	-14%	-6%	-16%		-9%	-5%		-3%	15%	57%	11%
UK	-12%	-14%	-6%				-5%		-3%	15%	59%	12%
US	-12%	-14%	-6%	-16%		-9%	-5%		-3%	12%	49%	9%
RW	-12%	-14%	-6%	-16%		-9%	-5%		-3%	12%	49%	9%

Source: own illustration, 2007

8.3. Trade liberalisation through the elimination of all import tariffs

By removing all tariffs in all countries by 2013, a trade liberalisation scenario was modelled. This was expected to increase world prices due to an increase in import demand and consequently increase producer returns for exporting countries with low tariffs. Due to the multi-lateral removal of trade barriers, New Zealand grower returns increase for green, gold and green organic kiwifruit by 14 percent, 19 percent and 14 percent respectively. World market prices rise significantly for green, gold and green organic by ten percent, 13 percent and 10 percent respectively. This gives New Zealand an incentive to increase production by four percent for green, five percent for gold and four percent for green organic. New Zealand export quantities for green, gold, and green organic kiwifruit increase similarly by five percent, five percent and eight percent respectively.

In China, where the relatively high tariff (20 percent) is removed, the domestic price falls and consumption increases by eight percent for green, 11 percent for gold and 26 percent for green organic. China stays a net importer and increases imports as well. China is the largest consumer of gold kiwifruit, which is illustrated by the increase in quantity consumed were trade to be liberalised. Since New Zealand is the only current exporter of gold kiwifruit, the increase in Chinese demand is largely met by increased New Zealand exports.

Europe drops its relatively low tariff (eight percent) and as a result of complete trade liberalisation domestic EU price rises for both consumers and producers. Producer returns actually increase by two percent, which indicates that EU producers are better off if the world kiwifruit market were to be completely liberalised.

The implication of trade liberalisation relative to countries' different import tariff levels are clearly illustrated in this scenario. The following table demonstrates how producers in countries with no current trade restrictions on kiwifruit; New Zealand, Australia and Chile; are similarly better off from trade liberalisation. Japan, with its relatively low tariff of seven percent, will enjoy a four percent increase on green kiwifruit producer returns. Grower returns for EU green kiwifruit producers (current import tariff of eight percent) will increase by two percent. The United States will experience the lowest positive effect on green kiwifruit returns, only one percent, due to their import tariff level of nine percent.

Table 12: Scenario 3 – Trade liberalisation

	2013											
	Producer Price			Producer Returns			Quantity Produced			Quantity Consumed		
Country	Green	Gold	Organic	Green	Gold	Organic	Green	Gold	Organic	Green	Gold	Organic
AU	10%	13%	10%	13%		13%	3%		3%	-5%	-28%	-19%
BE	2%	5%	2%							0%	-13%	-2%
CI	-9%	-6%	-9%	-12%	-8%	-12%	-4%	-2%	-4%	8%	11%	26%
CL	10%	13%	10%	14%		14%	4%		4%	-5%		-5%
EO	2%	5%	2%	2%		2%	1%		1%	0%	-14%	-2%
EN	2%	5%	2%	2%		2%	1%		1%	0%	-14%	-2%
FR	2%	5%	2%	2%		2%	1%		1%	0%	-15%	-2%
GM	2%	5%	2%							0%	-13%	-2%
GR	2%	5%	2%	2%		2%	1%		1%	0%	-14%	-2%
IT	2%	5%	2%	2%		2%	1%		1%	-1%	-19%	-4%
JP	3%	6%	2%	4%		4%	1%		1%	0%	-16%	-4%
NZ	10%	13%	10%	14%	19%	14%	4%	5%	4%	-5%	-28%	-19%
SP	2%	5%	2%	2%		2%	1%		1%	0%	-15%	-3%
UK	2%	5%	2%							0%	-15%	-3%
US	1%	4%	1%	1%		1%	0%		0%	1%	-12%	0%
RW	10%	13%	10%	14%		14%	4%		4%	-5%	-28%	

Source: own illustration, 2007

The rise in EU prices can be explained through the increase in Chinese imports. The consumption drop in the EU compared to the consumption increase in China reflects that most increase in production worldwide is consumed by China. The model calculates the difference in population between the EU and China to be as much as 70 million by 2013, indicating that it is not unlikely that Chinese demand for kiwifruit will increase to the extreme of affecting EU prices. With China being such a significant and influential player it is theoretically defendable that the model predicts a consumption drop in countries where tariffs are relatively low and a significant boost in consumption levels where the eliminated import tariff was initially relatively high.

The following table summarises the effects on New Zealand producer returns for the different scenarios. It illustrates that the scenario with the most harmful impact on the New Zealand kiwifruit industry proved to be the EU introduction of an SPS policy. In this case the green kiwifruit sector experiences the most significant negative impact on grower returns (-28 percent). Out of the three scenarios the one on trade liberalisation proves to have the most positive impact on the New Zealand kiwifruit industry in terms of higher producer returns of golden kiwifruit (+19 percent).

Table 13: Summarised effects on New Zealand producer returns

Variety	1. EU SPS policy	2. China production x 2	3.Trade liberalisation
Green	**-28%**	-16%	+14%
Gold	-11%	-19%	**+19%**
Organic	-21%	-9%	+14%

Source: own illustration, 2007

8.4. Conclusion of chapter

This section introduced the model scenarios developed for this research. The objective of this thesis has been to study trade related issues concerning the global kiwifruit industry and their

impact on New Zealand producers. Relevant scenarios were developed in order to investigate the most likely potential future challenges facing the industry. They were consequently run through the KIWI trade model and impacts on New Zealand producer returns were finally quantified in order to evaluate the scope of these particular changes.

9. Conclusion

New Zealand was the first country in the world to develop a commercial kiwifruit industry. The emergence and development of competitors in Italy, France, Japan and the USA during the 1980s put pressure on New Zealand to maintain market access. This became even more important as a significant threat appeared with the development of a Chilean kiwifruit industry, representing direct competition to New Zealand in the Southern hemisphere.

New Zealand has developed its kiwifruit industry over several decades and currently enjoys a competitive advantage in several areas. The KiwiGreen production management system, the development of the Gold variety and the twelve month supply plan are some of the main strategies and production programmes leading to these advantages that constitute the reason for the relatively high international price premiums that New Zealand kiwifruit benefits from today. ZESPRI is the country's worldwide kiwifruit distributor through a single desk seller system.

The global kiwifruit industry is currently undergoing changes on both the demand and supply sides. The most fundamental challenge the industry will be confronted by shortly is the increasing global supply of kiwifruit. China constitutes the country with the most potential to increase the supply of Green kiwifruit on the world market in the nearest future. The import tariff is still the most widely applied trade restriction within the kiwifruit industry. However, other non-tariff trade barriers such as the SPS measure are becoming more commonly used and therefore one of the focal points of this research.

The analysis of current trade-related issues in the kiwifruit market is well suited to a partial equilibrium model approach. However, there are very few quantitative models in the international literature that consider kiwifruit, let alone different varieties of kiwifruit, and those that do exist do not adequately incorporate trade aspects. There has been no specific analytical framework available to examine changes in the dynamics of the kiwifruit industry in New Zealand.

In order to investigate and answer the research questions of this thesis, a modified and industry-specific version of a partial equilibrium framework was developed and used. The KIWI model is a multi-country, three-commodity partial equilibrium model focusing on the kiwifruit industry. The model is used to quantify price, supply, demand and net trade effects of various policy changes and is calibrated to year 2003 and simulations are carried out up to 2013. The KIWI model includes the major kiwifruit producers and consumers, specified by 13 countries, and the commodities included are green kiwifruit, gold kiwifruit, and organic green kiwifruit.

Three cases, illustrating potential scenarios that may face the global kiwifruit industry in the near future, have been modelled and analysed in this thesis. The scenarios included a potential EU drop in demand due to a stricter SPS policy towards New Zealand kiwifruit, a scenario where Chinese production doubles by the year 2013 and finally a trade liberalisation scenario where all tariffs currently imposed on the global kiwifruit industry were removed. The results illustrate interesting effects on countries included in the new kiwifruit model and New Zealand in particular. The consequences of the potential scenarios on New Zealand producer returns were estimated in order to quantify changes executed by the model.

A considerable drop in EU demand for New Zealand kiwifruit, due to an introduction of an SPS measure, significantly reduces total exports to the world from New Zealand and lowers producer returns. New Zealand producers are hence negatively affected by a potential EU introduction of

an SPS policy. Italy has utilised this measure before, and with the increasing use of non-tariff trade barriers worldwide, it is therefore not unlikely that this scenario could take place in the near future.

China is currently expanding its kiwifruit production at a significant pace. A scenario was developed where total production doubles by 2013. This may potentially be an understatement of the likely expansion in Chinese kiwifruit production, as it does not include productivity changes. The effects of increased availability of Chinese kiwifruit have a significant negative impact on New Zealand producer returns and exported quantities, albeit not as dramatically as in the scenario that considers the EU's introduction of an SPS policy.

A trade liberalisation scenario was modelled through the removal of all tariffs in all countries by 2013. World market prices rise significantly for all varieties giving New Zealand an incentive to increase production and exports. New Zealand producer returns increase as a result. China increases its imports and consumption significantly, which could possibly explain the rise in EU prices. The scenario, interestingly enough, illustrates that EU producers are better off, through higher producer returns, if the world kiwifruit market were to be completely liberalised.

The result of this scenario also illustrates the importance of using a trade model, including several interacting actors and factors. A simple partial equilibrium supply and demand diagram of any of the European kiwifruit consuming countries would suggest an outcome of increased demand and higher imports if tariffs were to be removed completely. The calculations and simulations by the model clearly show the complex and important interlinkages between various producing and consuming countries. This highlights how an appropriately-calibrated trade model can more accurately simulate a result that is closer to a real world situation.

It is clearly observed, through both the Chinese expansion scenario and the trade liberalisation scenario, what a potential impact and future role China has as a world market player. It is projected that a significant expansion of the industry will change the country from being a net importer to a net exporter, establishing itself on the world market as a significant provider of especially green and gold kiwifruit. The organic sector is still under development and not as likely to affect the world market as significantly as the other two varieties.

Regular import tariffs are increasingly being substituted by non-tariff trade barriers such as SPS measures. The introduction of such a non-tariff trade barrier against kiwifruit imports could potentially restrict future trade of the commodity, especially if introduced by a significant consumer market such as the EU. Import restrictions, classified as SPS measures, have had a detrimental impact on the New Zealand industry in the past and could come to play a more significant role on the future world market of kiwifruit.

With several issues challenging world trade in kiwifruit it becomes important to highlight the advantages of the New Zealand industry. The varieties where New Zealand benefits from high premiums (green organic and gold) generally appear to be the least affected by various international production and policy shocks. In the scenario where production expands in the Chinese industry, the New Zealand organic industry is the least affected variety in terms of loss in producer returns. The EU import ban scenario causes the least significant effect on the New Zealand gold variety sector. These results illustrate and confirm the competitive advantage that New Zealand has built up over the past decades and emphasise the importance of constantly maintaining and improving these qualities.

Out of the three scenarios in this research, the second one illustrating an expansion of the Chinese kiwifruit industry may be considered as the most realistic. New Zealand, and other major producing countries, needs to be prepared for global expansion by differentiating themselves from China through continued investment in quality assurance and the development of new varieties and branding strategies.

New Zealand, and other countries, needs to take caution against possible introduction of non-tariff trade barriers such as SPS policies, especially if potentially imposed by main consuming economies like the EU.

One way of overcoming potential threats and challenges would be to keep pushing for trade liberalisation in the kiwifruit sector, which according to this research, has a significant positive impact on New Zealand producer returns (and those in most other regions).

9.1. Limitations

This study has some limitations. It is important to mention that the KIWI model is still under construction. Data has been difficult to obtain, especially for the green organic and gold sectors. Several assumptions and estimations had to be made (presented in chapter six), which limits the robustness of the model and hence the study. The production costs and quantities, consumption prices and quantities and price elasticities considered in this model would benefit from further empirical investigation. The thesis has tried to maintain consistency through the use of as few and as neutral databases as possible. This proved to be difficult, and data had to be obtained from many different and individual country-specific sources.

Data on kiwifruit policies were also difficult to obtain. There was assumed no producer and consumer support or taxes for kiwifruit worldwide. The import tariff constitutes the single trade policy included in this research and was obtained from a few different sources (presented in chapter five). No SPS or TBT measures are included at this stage.

In this research three different varieties of kiwifruit (green, gold and green organic) have been considered. Other varieties can be found on the world market as well, but are not as prominent. The objective of this research has also been to estimate impacts on New Zealand producer returns, and New Zealand specific varieties were hence selected.

There are also other countries influencing world trade in kiwifruit, such as Iran, Mexico, South Korea and Taiwan. Due to their relative insignificance in the global kiwifruit market, compared to other countries included in the model, they were excluded and accounted for under the "rest of world" grouping.

9.2. Implications for further research

Future research may include the development of an improved dataset with revised quantities, prices, policies and elasticities. This would add robustness and accuracy to modelling results.

As previously mentioned, New Zealand can command a premium in global markets due to various long standing industry factors, which would suggest that all kiwifruit are *not* the same. However, for simplicity and modelling purposes all green kiwifruit are considered as

homogenous in this study. Further differentiation between varieties and quality of kiwifruit is therefore suggested for future research.

One possible option for future research would be to include further policies such as non-tariff trade barriers and environmental policies such as carbon taxes.

Another approach to take in the future would include adding seasonality as a factor in the model. This does indeed play a significant role in how world trade in kiwifruit is composed today.

Another area for future research involves including monopolistic competition in the model. This would facilitate an investigation of the impacts of New Zealand potentially losing ZESPRI as a single desk seller.

9.3. Policy implications

The approach taken in this research is novel in two ways. Firstly, this represents the first use of an international trade model focused specifically on kiwifruit. Secondly, the study considers key aspects of the kiwifruit industry and links these to international trade in the sector. The realistic scenarios developed in this research provide an understanding of the potential threats and opportunities facing the industry. This study identifies the possible impacts on producer returns and thus may provide decision-makers with important insights for future investment and policy developments.

A potential expansion of the Chinese kiwifruit industry may be considered as the most realistic scenario in this research. New Zealand, and other major producing countries, needs to be prepared for global expansion and maintain market access through product differentiation and intense marketing.

Given the potentially significant impacts of non-tariff barriers such as punitive SPS measures, the New Zealand kiwifruit industry should continue to support the New Zealand government in its efforts to maintain an open, transparent and robust global trading system.

According to this research, multilateral trade liberalisation has a significant positive impact on not only New Zealand producer returns, but on those of other major producing countries as well. One way of balancing potential threats and challenges would therefore be to keep advocating further trade liberalisation of the kiwifruit sector in future trade negotiations.

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Appendix

Table A1: Countries included in the model

ID	***Country***	**ID**	***Country***
AU	Australia	GR	Greece
BE	Belgium	IT	Italy
CI	China	JP	Japan
CL	Chile	NZ	New Zealand
EO	EU Old (15)	SP	Spain
EN	EU New (10)	UK	United Kingdom
FR	France	US	United States
GM	Germany	RW	Rest of World

Table A2: Kiwifruit variety coverage of the model

ID	***Variety***
KW	Kiwifruit green
KG	Kiwifruit gold
KO	Kiwifruit green organic

Table A3: Model variables

Variable	**Description**
pp	Producer price ($/t)
pc	Consumer price ($/t)
pt	Trade price ($/t)
qp	Quantity production (000 mt)
qc	Quantity consumption (000 mt)
qt	Quantity net trade (000 mt)
qe	Quantity ending stocks (000 mt)
fp	Shift in production
fc	Shift in consumption
fe	Shift in ending stocks
sm	Producer market subsidy, fees, levies, direct payments, other ($/mt)
cm	Consumer market subsidy and other ($/mt)
lib	Liberalisation (0=lib, 1=continued full support)
gdp	Gross Domestic Producer index (1979=100)
pop	Population (000)
xrt	Exchange rate (local currency/$)

Table A4: Equations in model

Australia

AUptKW	1.506253*(MAX(WDptKW,1)/AUxrt)^1
AUptKG	1.506251*(MAX(WDptKG,1)/AUxrt)^1
AUptKO	1.506253*(MAX(WDptKO,1)/AUxrt)^1
AUppKW	1*0+MAX(AUptKW*(1-AUlib)*(1+AUsmKW),1)
AUppKG	1*0+MAX(AUptKG*(1-AUlib)*(1+AUsmKG),1)
AUppKO	1*0+MAX(AUptKO*(1-AUlib)*(1+AUsmKO),1)
AUpcKW	1*0+MAX(AUptKW*(1-AUlib)*(1+AUcmKW),1)
AUpcKG	1*0+MAX(AUptKG*(1-AUlib)*(1+AUcmKG),1)
AUpcKO	1*0+MAX(AUptKO*(1-AUlib)*(1+AUcmKO),1)
AUqpKW	0.3333874*AUfpKW*AUppKW^.3
AUqpKG	0*AUfpKG*AUppKG^.3
AUqpKO	0.01539598*AUfpKO*AUppKO^.3
AUqeKW	0.003412969*AUfeKW*AUqpKW
AUqeKG	2007*AUfeKG*AUqpKG
AUqeKO	0.06666667*AUfeKO*AUqpKO
AUqtKW	0+0+AUqpKW-AUqcKW-(AUqeKW-AUqe:1KW)
AUqtKG	0+0+AUqpKG-AUqcKG-(AUqeKG-AUqe:1KG)
AUqtKO	0+0+AUqpKO-AUqcKO-(AUqeKO-AUqe:1KO)
AUqcKW	0.2450798*AUfcKW*AUpcKW^- 1.7*AUpcKG^.5*AUpcKO^.5*(AUgdp/AUpop)^.18*AUpop
AUqcKG	1597.119*AUfcKG*AUpcKW^.5*AUpcKG^-3.4*AUpcKO^.5*(AUgdp/AUpop)^.18*AUpop
AUqcKO	4267.716*AUfcKO*AUpcKW^.5*AUpcKG^.5*AUpcKO^-3.4*(AUgdp/AUpop)^.18*AUpop

Belgium

BEptKW	1.381579*(MAX(WDptKW,1)/BExrt)^1
BEptKG	1.381574*(MAX(WDptKG,1)/BExrt)^1
BEptKO	1.381579*(MAX(WDptKO,1)/BExrt)^1
BEppKW	1.00644*0+MAX(BEptKW*(1-BElib)*(1+BEsmKW),1)
BEppKG	1.006445*0+MAX(BEptKG*(1-BElib)*(1+BEsmKG),1)
BEppKO	1.006441*0+MAX(BEptKO*(1-BElib)*(1+BEsmKO),1)
BEpcKW	1.00644*0+MAX(BEptKW*(1-BElib)*(1+BEcmKW),1)
BEpcKG	1.006445*0+MAX(BEptKG*(1-BElib)*(1+BEcmKG),1)
BEpcKO	1.006441*0+MAX(BEptKO*(1-BElib)*(1+BEcmKO),1)
BEqpKW	0*BEfpKW*BEppKW^.1
BEqpKG	0*BEfpKG*BEppKG^.1
BEqpKO	0*BEfpKO*BEppKO^.1
BEqeKW	2007*BEfeKW*BEqpKW
BEqeKG	2007*BEfeKG*BEqpKG
BEqeKO	2007*BEfeKO*BEqpKO
BEqtKW	0+0+BEqpKW-BEqcKW-(BEqeKW-BEqe:1KW)
BEqtKG	0+0+BEqpKG-BEqcKG-(BEqeKG-BEqe:1KG)
BEqtKO	0+0+BEqpKO-BEqcKO-(BEqeKO-BEqe:1KO)
BEqcKW	1.966542*BEfcKW*BEpcKW^- 1.67*BEpcKG^.5*BEpcKO^.5*(BEgdp/BEpop)^.18*BEpop
BEqcKG	13102.54*BEfcKG*BEpcKW^.5*BEpcKG^- 3.34*BEpcKO^.5*(BEgdp/BEpop)^.18*BEpop
BEqcKO	126366.3*BEfcKO*BEpcKW^.5*BEpcKG^.5*BEpcKO^- 3.34*(BEgdp/BEpop)^.18*BEpop

China

ClptKW	0.6759459*(MAX(WDptKW,1)/Clxrt)^1
ClptKG	0.6759381*(MAX(WDptKG,1)/Clxrt)^1
ClptKO	0.6759422*(MAX(WDptKO,1)/Clxrt)^1
ClppKW	1.041663*0+MAX(ClptKW*(1-Cllib)*(1+ClsmKW),1)
ClppKG	1.041669*0+MAX(ClptKG*(1-Cllib)*(1+ClsmKG),1)
ClppKO	1.041669*0+MAX(ClptKO*(1-Cllib)*(1+ClsmKO),1)
ClpcKW	1.041663*0+MAX(ClptKW*(1-Cllib)*(1+ClcmKW),1)
ClpcKG	1.041669*0+MAX(ClptKG*(1-Cllib)*(1+ClcmKG),1)
ClpcKO	1.041669*0+MAX(ClptKO*(1-Cllib)*(1+ClcmKO),1)
ClqpKW	16.96128*ClfpKW*ClppKW^.4
ClqpKG	2.891054*ClfpKG*ClppKG^.4
ClqpKO	0.7394373*ClfpKO*ClppKO^.4
ClqeKW	0.00004096514*ClfeKW*ClqpKW
ClqeKG	0.000217061*ClfeKG*ClqpKG
ClqeKO	0.0008190008*ClfeKO*ClqpKO
ClqtKW	0+0+ClqpKW-ClqcKW-(ClqeKW-Clqe:1KW)
ClqtKG	0+0+ClqpKG-ClqcKG-(ClqeKG-Clqe:1KG)
ClqtKO	0+0+ClqpKO-ClqcKO-(ClqeKO-Clqe:1KO)
ClqcKW	0.08509478*ClfcKW*ClpcKW^-1.7*ClpcKG^.5*ClpcKO^.5*(Clgdp/Clpop)^.18*Clpop
ClqcKG	3346.101*ClfcKG*ClpcKW^.5*ClpcKG^-3.4*ClpcKO^.5*(Clgdp/Clpop)^.18*Clpop
ClqcKO	1254.574*ClfcKO*ClpcKW^.5*ClpcKG^.5*ClpcKO^-3.4*(Clgdp/Clpop)^.18*Clpop

Chile

CLptKW	0.1374042*(MAX(WDptKW,1)/CLxrt)^1
CLptKG	0.1374048*(MAX(WDptKG,1)/CLxrt)^1
CLptKO	0.1374014*(MAX(WDptKO,1)/CLxrt)^1
CLppKW	1*0+MAX(CLptKW*(1-CLlib)*(1+CLsmKW),1)
CLppKG	1*0+MAX(CLptKG*(1-CLlib)*(1+CLsmKG),1)
CLppKO	1*0+MAX(CLptKO*(1-CLlib)*(1+CLsmKO),1)
CLpcKW	1*0+MAX(CLptKW*(1-CLlib)*(1+CLcmKW),1)
CLpcKG	1*0+MAX(CLptKG*(1-CLlib)*(1+CLcmKG),1)
CLpcKO	1*0+MAX(CLptKO*(1-CLlib)*(1+CLcmKO),1)
CLqpKW	17.9602*CLfpKW*CLppKW^.4
CLqpKG	0*CLfpKG*CLppKG^.4
CLqpKO	0.7827037*CLfpKO*CLppKO^.4
CLqeKW	0.00000552868*CLfeKW*CLqpKW*CLqcKW
CLqeKG	2007*CLfeKG*CLqpKG
CLqeKO	0.0016*CLfeKO*CLqpKO
CLqtKW	0+0+CLqpKW-CLqcKW-(CLqeKW-CLqe:1KW)
CLqtKG	0+0+CLqpKG-CLqcKG-(CLqeKG-CLqe:1KG)
CLqtKO	0+0+CLqpKO-CLqcKO-(CLqeKO-CLqe:1KO)
CLqcKW	0.05112034*CLfcKW*CLpcKW^-1.7*CLpcKG^.5*CLpcKO^.5*(CLgdp/CLpop)^.18*CLpop
CLqcKG	0*CLfcKG*CLpcKW^.5*CLpcKG^-3.4*CLpcKO^.5*(CLgdp/CLpop)^.18*CLpop
CLqcKO	8.226361*CLfcKO*CLpcKW^.5*CLpcKG^.5*CLpcKO^-3.4*(CLgdp/CLpop)^.18*CLpop

EU (Old)

EOptKW	1.5428*(MAX(WDptKW,1)/EOxrt)^1
EOptKG	1.542801*(MAX(WDptKG,1)/EOxrt)^1
EOptKO	1.542804*(MAX(WDptKO,1)/EOxrt)^1
EOppKW	1.006441*0+MAX(EOptKW*(1-EOlib)*(1+EOsmKW),1)
EOppKG	1.00644*0+MAX(EOptKG*(1-EOlib)*(1+EOsmKG),1)
EOppKO	1.006443*0+MAX(EOptKO*(1-EOlib)*(1+EOsmKO),1)
EOpcKW	1.006441*0+MAX(EOptKW*(1-EOlib)*(1+EOcmKW),1)
EOpcKG	1.00644*0+MAX(EOptKG*(1-EOlib)*(1+EOcmKG),1)
EOpcKO	1.006443*0+MAX(EOptKO*(1-EOlib)*(1+EOcmKO),1)
EOqpKW	0.5572434*EOfpKW*EOppKW^.4
EOqpKG	0*EOfpKG*EOppKG^.4
EOqpKO	0.02428437*EOfpKO*EOppKO^.4
EOqeKW	0.0009478673*EOfeKW*EOqpKW
EOqeKG	2007*EOfeKG*EOqpKG
EOqeKO	0.01895735*EOfeKO*EOqpKO
EOqtKW	0+0+EOqpKW-EOqcKW-(EOqeKW-EOqe:1KW)
EOqtKG	0+0+EOqpKG-EOqcKG-(EOqeKG-EOqe:1KG)
EOqtKO	0.0025+0+EOqpKO-EOqcKO-(EOqeKO-EOqe:1KO)
EOqcKW	0.0667418*EOfcKW*EOpcKW^-1.7*EOpcKG^.5*EOpcKO^.5*(EOgdp/EOpop)^.18*EOpop
EOqcKG	678.6533*EOfcKG*EOpcKW^.5*EOpcKG^-3.4*EOpcKO^.5*(EOgdp/EOpop)^.18*EOpop
EOqcKO	4108.244*EOfcKO*EOpcKW^.5*EOpcKG^.5*EOpcKO^-3.4*(EOgdp/EOpop)^.18*EOpop

EU (New)

ENptKW	0.8987237*(MAX(WDptKW,1)/ENxrt)^1
ENptKG	0.8987281*(MAX(WDptKG,1)/ENxrt)^1
ENptKO	0.8987296*(MAX(WDptKO,1)/ENxrt)^1
ENppKW	1.006439*0+MAX(ENptKW*(1-ENlib)*(1+ENsmKW),1)
ENppKG	1.006441*0+MAX(ENptKG*(1-ENlib)*(1+ENsmKG),1)
ENppKO	1.00644*0+MAX(ENptKO*(1-ENlib)*(1+ENsmKO),1)
ENpcKW	1.006439*0+MAX(ENptKW*(1-ENlib)*(1+ENcmKW),1)
ENpcKG	1.006441*0+MAX(ENptKG*(1-ENlib)*(1+ENcmKG),1)
ENpcKO	1.00644*0+MAX(ENptKO*(1-ENlib)*(1+ENcmKO),1)
ENqpKW	0.005245129*ENfpKW*ENppKW^.4
ENqpKG	0*ENfpKG*ENppKG^.4
ENqpKO	0.0002285797*ENfpKO*ENppKO^.4
ENqeKW	0.125*ENfeKW*ENqpKW
ENqeKG	2007*ENfeKG*ENqpKG
ENqeKO	2.5*ENfeKO*ENqpKO
ENqtKW	0+0+ENqpKW-ENqcKW-(ENqeKW-ENqe:1KW)
ENqtKG	0+0+ENqpKG-ENqcKG-(ENqeKG-ENqe:1KG)
ENqtKO	0.006+0+ENqpKO-ENqcKO-(ENqeKO-ENqe:1KO)
ENqcKW	0.01708097*ENfcKW*ENpcKW^-1.7*ENpcKG^.5*ENpcKO^.5*(ENgdp/ENpop)^.18*ENpop
ENqcKG	69.59186*ENfcKG*ENpcKW^.5*ENpcKG^-3.4*ENpcKO^.5*(ENgdp/ENpop)^.18*ENpop
ENqcKO	326.2023*ENfcKO*ENpcKW^.5*ENpcKG^.5*ENpcKO^-3.4*(ENgdp/ENpop)^.18*ENpop

France

FRptKW	1.735224*(MAX(WDptKW,1)/FRxrt)^1
FRptKG	1.735218*(MAX(WDptKG,1)/FRxrt)^1
FRptKO	1.735225*(MAX(WDptKO,1)/FRxrt)^1
FRppKW	1.006441*0+MAX(FRptKW*(1-FRlib)*(1+FRsmKW),1)
FRppKG	1.006443*0+MAX(FRptKG*(1-FRlib)*(1+FRsmKG),1)
FRppKO	1.006442*0+MAX(FRptKO*(1-FRlib)*(1+FRsmKO),1)
FRpcKW	1.006441*0+MAX(FRptKW*(1-FRlib)*(1+FRcmKW),1)
FRpcKG	1.006443*0+MAX(FRptKG*(1-FRlib)*(1+FRcmKG),1)
FRpcKO	1.006442*0+MAX(FRptKO*(1-FRlib)*(1+FRcmKO),1)
FRqpKW	3.736172*FRfpKW*FRppKW^.4
FRqpKG	0*FRfpKG*FRppKG^.4
FRqpKO	0.1629523*FRfpKO*FRppKO^.4
FRqeKW	0.00013488*FRfeKW*FRqpKW
FRqeKG	2007*FRfeKG*FRqpKG
FRqeKO	0.002695418*FRfeKO*FRqpKO
FRqtKW	0+0+FRqpKW-FRqcKW-(FRqeKW-FRqe:1KW)
FRqtKG	0+0+FRqpKG-FRqcKG-(FRqeKG-FRqe:1KG)
FRqtKO	0+0+FRqpKO-FRqcKO-(FRqeKO-FRqe:1KO)
FRqcKW	1.525046*FRfcKW*FRpcKW^-1.83*FRpcKG^.5*FRpcKO^.5*(FRgdp/FRpop)^.18*FRpop
FRqcKG	39970.21*FRfcKG*FRpcKW^.5*FRpcKG^-3.65*FRpcKO^.5*(FRgdp/FRpop)^.18*FRpop
FRqcKO	272649.8*FRfcKO*FRpcKW^.5*FRpcKG^.5*FRpcKO^-3.65*(FRgdp/FRpop)^.18*FRpop

Germany

GMptKW	1.529789*(MAX(WDptKW,1)/GMxrt)^1
GMptKG	1.52979*(MAX(WDptKG,1)/GMxrt)^1
GMptKO	1.529794*(MAX(WDptKO,1)/GMxrt)^1
GMppKW	1.006443*0+MAX(GMptKW*(1-GMlib)*(1+GMsmKW),1)
GMppKG	1.006443*0+MAX(GMptKG*(1-GMlib)*(1+GMsmKG),1)
GMppKO	1.00644*0+MAX(GMptKO*(1-GMlib)*(1+GMsmKO),1)
GMpcKW	1.006443*0+MAX(GMptKW*(1-GMlib)*(1+GMcmKW),1)
GMpcKG	1.006443*0+MAX(GMptKG*(1-GMlib)*(1+GMcmKG),1)
GMpcKO	1.00644*0+MAX(GMptKO*(1-GMlib)*(1+GMcmKO),1)
GMqpKW	0*GMfpKW*GMppKW^.1
GMqpKG	0*GMfpKG*GMppKG^.1
GMqpKO	0*GMfpKO*GMppKO^.1
GMqeKW	2007*GMfeKW*GMqpKW
GMqeKG	2007*GMfeKG*GMqpKG
GMqeKO	2007*GMfeKO*GMqpKO
GMqtKW	0+0+GMqpKW-GMqcKW-(GMqeKW-GMqe:1KW)
GMqtKG	0+0+GMqpKG-GMqcKG-(GMqeKG-GMqe:1KG)
GMqtKO	0+0+GMqpKO-GMqcKO-(GMqeKO-GMqe:1KO)
GMqcKW	0.4332858*GMfcKW*GMpcKW^-1.67*GMpcKG^.5*GMpcKO^.5*(GMgdp/GMpop)^.22*GMpop
GMqcKG	3428.474*GMfcKG*GMpcKW^.5*GMpcKG^-3.34*GMpcKO^.5*(GMgdp/GMpop)^.22*GMpop
GMqcKO	28621.36*GMfcKO*GMpcKW^.5*GMpcKG^.5*GMpcKO^-3.34*(GMgdp/GMpop)^.22*GMpop

Greece

GRptKW	0.6698709*(MAX(WDptKW,1)/GRxrt)^1
GRptKG	0.6698701*(MAX(WDptKG,1)/GRxrt)^1
GRptKO	0.6698644*(MAX(WDptKO,1)/GRxrt)^1
GRppKW	1.006435*0+MAX(GRptKW*(1-GRlib)*(1+GRsmKW),1)
GRppKG	1.006436*0+MAX(GRptKG*(1-GRlib)*(1+GRsmKG),1)
GRppKO	1.006447*0+MAX(GRptKO*(1-GRlib)*(1+GRsmKO),1)
GRpcKW	1.006435*0+MAX(GRptKW*(1-GRlib)*(1+GRcmKW),1)
GRpcKG	1.006436*0+MAX(GRptKG*(1-GRlib)*(1+GRcmKG),1)
GRpcKO	1.006447*0+MAX(GRptKO*(1-GRlib)*(1+GRcmKO),1)
GRqpKW	4.399508*GRfpKW*GRppKW^.4
GRqpKG	0*GRfpKG*GRppKG^.4
GRqpKO	0.1915356*GRfpKO*GRppKO^.4
GRqeKW	0.0001676165*GRfeKW*GRqpKW
GRqeKG	2007*GRfeKG*GRqpKG
GRqeKO	0.003355705*GRfeKO*GRqpKO
GRqtKW	0+0+GRqpKW-GRqcKW-(GRqeKW-GRqe:1KW)
GRqtKG	0+0+GRqpKG-GRqcKG-(GRqeKG-GRqe:1KG)
GRqtKO	0.01+0+GRqpKO-GRqcKO-(GRqeKO-GRqe:1KO)
GRqcKW	0.6391731*GRfcKW*GRpcKW^-1.7*GRpcKG^.5*GRpcKO^.5*(GRgdp/GRpop)^.18*GRpop
GRqcKG	1128.994*GRfcKG*GRpcKW^.5*GRpcKG^-3.4*GRpcKO^.5*(GRgdp/GRpop)^.18*GRpop
GRqcKO	3655.695*GRfcKO*GRpcKW^.5*GRpcKG^.5*GRpcKO^-3.4*(GRgdp/GRpop)^.18*GRpop

Italy

ITptKW	1.10305*(MAX(WDptKW,1)/ITxrt)^1
ITptKG	1.103056*(MAX(WDptKG,1)/ITxrt)^1
ITptKO	1.103055*(MAX(WDptKO,1)/ITxrt)^1
ITppKW	1.006445*0+MAX(ITptKW*(1-ITlib)*(1+ITsmKW),1)
ITppKG	1.006437*0+MAX(ITptKG*(1-ITlib)*(1+ITsmKG),1)
ITppKO	1.006441*0+MAX(ITptKO*(1-ITlib)*(1+ITsmKO),1)
ITpcKW	1.006445*0+MAX(ITptKW*(1-ITlib)*(1+ITcmKW),1)
ITpcKG	1.006437*0+MAX(ITptKG*(1-ITlib)*(1+ITcmKG),1)
ITpcKO	1.006441*0+MAX(ITptKO*(1-ITlib)*(1+ITcmKO),1)
ITqpKW	19.49895*ITfpKW*ITppKW^.4
ITqpKG	0*ITfpKG*ITppKG^.4
ITqpKO	0.8497551*ITfpKO*ITppKO^.4
ITqeKW	0.00003097894*ITfeKW*ITqpKW
ITqeKG	2007*ITfeKG*ITqpKG
ITqeKO	0.0006195787*ITfeKO*ITqpKO
ITqtKW	0+0+ITqpKW-ITqcKW-(ITqeKW-ITqe:1KW)
ITqtKG	0+0+ITqpKG-ITqcKG-(ITqeKG-ITqe:1KG)
ITqtKO	0+0+ITqpKO-ITqcKO-(ITqeKO-ITqe:1KO)
ITqcKW	270.7224*ITfcKW*ITpcKW^-2.4*ITpcKG^.5*ITpcKO^.5*(ITgdp/ITpop)^.38*ITpop
ITqcKG	396076600*ITfcKG*ITpcKW^.5*ITpcKG^-4.8*ITpcKO^.5*(ITgdp/ITpop)^.38*ITpop
ITqcKO	6705455000*ITfcKO*ITpcKW^.5*ITpcKG^.5*ITpcKO^-4.8*(ITgdp/ITpop)^.38*ITpop

Japan

JPptKW	1.816769*(MAX(WDptKW,1)/JPxrt)^1
JPptKG	1.816769*(MAX(WDptKG,1)/JPxrt)^1
JPptKO	1.816775*(MAX(WDptKO,1)/JPxrt)^1
JPppKW	1.004925*0+MAX(JPptKW*(1-JPlib)*(1+JPsmKW),1)
JPppKG	1.004924*0+MAX(JPptKG*(1-JPlib)*(1+JPsmKG),1)
JPppKO	1.004924*0+MAX(JPptKO*(1-JPlib)*(1+JPsmKO),1)
JPpcKW	1.004925*0+MAX(JPptKW*(1-JPlib)*(1+JPcmKW),1)
JPpcKG	1.004924*0+MAX(JPptKG*(1-JPlib)*(1+JPcmKG),1)
JPpcKO	1.004924*0+MAX(JPptKO*(1-JPlib)*(1+JPcmKO),1)
JPqpKW	1.858429*JPfpKW*JPppKW^.4
JPqpKG	0*JPfpKG*JPppKG^.4
JPqpKO	0.08098941*JPfpKO*JPppKO^.4
JPqeKW	0.0002673797*JPfeKW*JPqpKW
JPqeKG	2007*JPfeKG*JPqpKG
JPqeKO	0.005347594*JPfeKO*JPqpKO
JPqtKW	0+0+JPqpKW-JPqcKW-(JPqeKW-JPqe:1KW)
JPqtKG	0+0+JPqpKG-JPqcKG-(JPqeKG-JPqe:1KG)
JPqtKO	0+0+JPqpKO-JPqcKO-(JPqeKO-JPqe:1KO)
JPqcKW	0.3576792*JPfcKW*JPpcKW^-1.7*JPpcKG^.5*JPpcKO^.5*(JPgdp/JPpop)^.18*JPpop
JPqcKG	55452.59*JPfcKG*JPpcKW^.5*JPpcKG^-3.4*JPpcKO^.5*(JPgdp/JPpop)^.18*JPpop
JPqcKO	43854.09*JPfcKO*JPpcKW^.5*JPpcKG^.5*JPpcKO^-3.4*(JPgdp/JPpop)^.18*JPpop

New Zealand

NZptKW	1.844027*(MAX(WDptKW,1)/NZxrt)^1
NZptKG	1.76705*(MAX(WDptKG,1)/NZxrt)^1
NZptKO	1.632681*(MAX(WDptKO,1)/NZxrt)^1
NZppKW	1*0+MAX(NZptKW*(1-NZlib)*(1+NZsmKW),1)
NZppKG	1*0+MAX(NZptKG*(1-NZlib)*(1+NZsmKG),1)
NZppKO	1*0+MAX(NZptKO*(1-NZlib)*(1+NZsmKO),1)
NZpcKW	1*0+MAX(NZptKW*(1-NZlib)*(1+NZcmKW),1)
NZpcKG	1*0+MAX(NZptKG*(1-NZlib)*(1+NZcmKG),1)
NZpcKO	1*0+MAX(NZptKO*(1-NZlib)*(1+NZcmKO),1)
NZqpKW	13.25873*NZfpKW*NZppKW^.4
NZqpKG	1.446327*NZfpKG*NZppKG^.4
NZqpKO	0.3852864*NZfpKO*NZppKO^.4
NZqeKW	0.00003835238*NZfeKW*NZqpKW
NZqeKG	0.0003229974*NZfeKG*NZqpKG
NZqeKO	0.001207729*NZfeKO*NZqpKO
NZqtKW	0+0+NZqpKW-NZqcKW-(NZqeKW-NZqe:1KW)
NZqtKG	0+0+NZqpKG-NZqcKG-(NZqeKG-NZqe:1KG)
NZqtKO	0+0+NZqpKO-NZqcKO-(NZqeKO-NZqe:1KO)
NZqcKW	1.596514*NZfcKW*NZpcKW^-1.7*NZpcKG^.5*NZpcKO^.5*(NZgdp/NZpop)^.18*NZpop
NZqcKG	8763.511*NZfcKG*NZpcKW^.5*NZpcKG^-3.4*NZpcKO^.5*(NZgdp/NZpop)^.18*NZpop
NZqcKO	62736.81*NZfcKO*NZpcKW^.5*NZpcKG^.5*NZpcKO^-3.4*(NZgdp/NZpop)^.18*NZpop

Spain

SPptKW	1.354032*(MAX(WDptKW,1)/SPxrt)^1
SPptKG	1.354027*(MAX(WDptKG,1)/SPxrt)^1
SPptKO	1.354027*(MAX(WDptKO,1)/SPxrt)^1
SPppKW	1.006439*0+MAX(SPptKW*(1-SPlib)*(1+SPsmKW),1)
SPppKG	1.006442*0+MAX(SPptKG*(1-SPlib)*(1+SPsmKG),1)
SPppKO	1.006442*0+MAX(SPptKO*(1-SPlib)*(1+SPsmKO),1)
SPpcKW	1.006439*0+MAX(SPptKW*(1-SPlib)*(1+SPcmKW),1)
SPpcKG	1.006442*0+MAX(SPptKG*(1-SPlib)*(1+SPcmKG),1)
SPpcKO	1.006442*0+MAX(SPptKO*(1-SPlib)*(1+SPcmKO),1)
SPqpKW	0.5565001*SPfpKW*SPppKW^.4
SPqpKG	0*SPfpKG*SPppKG^.4
SPqpKO	0.02425202*SPfpKO*SPppKO^.4
SPqeKW	0.001*SPfeKW*SPqpKW
SPqeKG	2007*SPfeKG*SPqpKG
SPqeKO	0.02*SPfeKO*SPqpKO
SPqtKW	38.11+0+SPqpKW-SPqcKW-(SPqeKW-SPqe:1KW)
SPqtKG	0+0+SPqpKG-SPqcKG-(SPqeKG-SPqe:1KG)
SPqtKO	0+0+SPqpKO-SPqcKO-(SPqeKO-SPqe:1KO)
SPqcKW	200.2682*SPfcKW*SPpcKW^-1.88*SPpcKG^.5*SPpcKO^.5*(SPgdp/SPpop)^.94*SPpop
SPqcKG	6154608*SPfcKG*SPpcKW^.5*SPpcKG^-3.76*SPpcKO^.5*(SPgdp/SPpop)^.94*SPpop
SPqcKO	57563520*SPfcKO*SPpcKW^.5*SPpcKG^.5*SPpcKO^-3.76*(SPgdp/SPpop)^.94*SPpop

United Kingdom

UKptKW	1.434212*(MAX(WDptKW,1)/UKxrt)^1
UKptKG	1.434211*(MAX(WDptKG,1)/UKxrt)^1
UKptKO	1.43422*(MAX(WDptKO,1)/UKxrt)^1
UKppKW	1.006443*0+MAX(UKptKW*(1-UKlib)*(1+UKsmKW),1)
UKppKG	1.006444*0+MAX(UKptKG*(1-UKlib)*(1+UKsmKG),1)
UKppKO	1.00644*0+MAX(UKptKO*(1-UKlib)*(1+UKsmKO),1)
UKpcKW	1.006443*0+MAX(UKptKW*(1-UKlib)*(1+UKcmKW),1)
UKpcKG	1.006444*0+MAX(UKptKG*(1-UKlib)*(1+UKcmKG),1)
UKpcKO	1.00644*0+MAX(UKptKO*(1-UKlib)*(1+UKcmKO),1)
UKqpKW	0*UKfpKW*UKppKW^.1
UKqpKG	0*UKfpKG*UKppKG^.1
UKqpKO	0*UKfpKO*UKppKO^.1
UKqeKW	2007*UKfeKW*UKqpKW
UKqeKG	2007*UKfeKG*UKqpKG
UKqeKO	2007*UKfeKO*UKqpKO
UKqtKW	0+0+UKqpKW-UKqcKW-(UKqeKW-UKqe:1KW)
UKqtKG	0+0+UKqpKG-UKqcKG-(UKqeKG-UKqe:1KG)
UKqtKO	0+0+UKqpKO-UKqcKO-(UKqeKO-UKqe:1KO)
UKqcKW	64.00703*UKfcKW*UKpcKW^-1.91*UKpcKG^.5*UKpcKO^.5*(UKgdp/UKpop)^.87*UKpop
UKqcKG	3189353*UKfcKG*UKpcKW^.5*UKpcKG^-3.83*UKpcKO^.5*(UKgdp/UKpop)^.87*UKpop
UKqcKO	10417250*UKfcKO*UKpcKW^.5*UKpcKG^.5*UKpcKO^-3.83*(UKgdp/UKpop)^.87*UKpop

United States

USptKW	0.834629*(MAX(WDptKW,1)/USxrt)^1
USptKG	0.8346308*(MAX(WDptKG,1)/USxrt)^1
USptKO	0.8346272*(MAX(WDptKO,1)/USxrt)^1
USppKW	1.008166*0+MAX(USptKW*(1-USlib)*(1+USsmKW),1)
USppKG	1.008163*0+MAX(USptKG*(1-USlib)*(1+USsmKG),1)
USppKO	1.00817*0+MAX(USptKO*(1-USlib)*(1+USsmKO),1)
USpcKW	1.008166*0+MAX(USptKW*(1-USlib)*(1+UScmKW),1)
USpcKG	1.008163*0+MAX(USptKG*(1-USlib)*(1+UScmKG),1)
USpcKO	1.00817*0+MAX(USptKO*(1-USlib)*(1+UScmKO),1)
USqpKW	1.46379*USfpKW*USppKW^.4
USqpKG	0*USfpKG*USppKG^.4
USqpKO	0.08380478*USfpKO*USppKO^.4
USqeKW	0.0004593477*USfeKW*USqpKW
USqeKG	2007*USfeKG*USqpKG
USqeKO	0.006993007*USfeKO*USqpKO
USqtKW	0+0+USqpKW-USqcKW-(USqeKW-USqe:1KW)
USqtKG	0+0+USqpKG-USqcKG-(USqeKG-USqe:1KG)
USqtKO	0+0+USqpKO-USqcKO-(USqeKO-USqe:1KO)
USqcKW	0.05507465*USfcKW*USpcKW^-1.7*USpcKG^.5*USpcKO^.5*(USgdp/USpop)^.18*USpop
USqcKG	442.549*USfcKG*USpcKW^.5*USpcKG^-3.4*USpcKO^.5*(USgdp/USpop)^.18*USpop
USqcKO	1095.605*USfcKO*USpcKW^.5*USpcKG^.5*USpcKO^-3.4*(USgdp/USpop)^.18*USpop

Rest of World

RWptKW	0.8007376*(MAX(WDptKW,1)/RWxrt)^1
RWptKG	0.8007402*(MAX(WDptKG,1)/RWxrt)^1
RWptKO	0.8007458*(MAX(WDptKO,1)/RWxrt)^1
RWppKW	1*0+MAX(RWptKW*(1-RWlib)*(1+RWsmKW),1)
RWppKG	1*0+MAX(RWptKG*(1-RWlib)*(1+RWsmKG),1)
RWppKO	1*0+MAX(RWptKO*(1-RWlib)*(1+RWsmKO),1)
RWpcKW	1*0+MAX(RWptKW*(1-RWlib)*(1+RWcmKW),1)
RWpcKG	1*0+MAX(RWptKG*(1-RWlib)*(1+RWcmKG),1)
RWpcKO	1*0+MAX(RWptKO*(1-RWlib)*(1+RWcmKO),1)
RWqpKW	6.565275*RWfpKW*RWppKW^.4
RWqpKG	0*RWfpKG*RWppKG^.4
RWqpKO	1.854397*RWfpKO*RWppKO^.4
RWqeKW	0.0001081315*RWfeKW*RWqpKW
RWqeKG	2007*RWfeKG*RWqpKG
RWqeKO	0.000333667*RWfeKO*RWqpKO
RWqtKW	-53.1+0+RWqpKW-RWqcKW-(RWqeKW-RWqe:1KW)
RWqtKG	0+0+RWqpKG-RWqcKG-(RWqeKG-RWqe:1KG)
RWqtKO	0+0+RWqpKO-RWqcKO-(RWqeKO-RWqe:1KO)
RWqcKW	0.026887*RWfcKW*RWpcKW^-1.7*RWpcKG^.5*RWpcKO^.5*(RWgdp/RWpop)^.18*RWpop
RWqcKG	206.3968*RWfcKG*RWpcKW^.5*RWpcKG^-3.4*RWpcKO^.5*(RWgdp/RWpop)^.18*RWpop
RWqcKO	0*RWfcKO*RWpcKW^.5*RWpcKG^.5*RWpcKO^-3.4*(RWgdp/RWpop)^.18*RWpop

World

WDqtKW	14.99+AUqtKW+BEqtKW+CIqtKW+CLqtKW+EOqtKW+ENqtKW+FRqtKW+GMqtKW+GRqtKW+ITqtKW+JPqtKW+NZqtKW+SPqtKW+UKqtKW+USqtKW+RWqtKW
WDqtKG	-0.01+AUqtKG+BEqtKG+CIqtKG+CLqtKG+EOqtKG+ENqtKG+FRqtKG+GMqtKG+GRqtKG+ITqtKG+JPqtKG+NZqtKG+SPqtKG+UKqtKG+USqtKG+RWqtKG
WDqtKO	0+AUqtKO+BEqtKO+CIqtKO+CLqtKO+EOqtKO+ENqtKO+FRqtKO+GMqtKO+GRqtKO+ITqtKO+JPqtKO+NZqtKO+SPqtKO+UKqtKO+USqtKO+RWqtKO

Table A5: Basedata for KIWI model (year 2003)

KIWI	AU	BE	CI	CL	EO	EN	FR	GM	GR	IT	JP	NZ	SP	UK	US	RW	WD
ppKW	1400.86	1396.64	785.81	127.79	1559.62	908.52	1754.14	1546.47	677.17	1115.08	1816.83	1715	1368.79	1449.85	853	744.71	930.03
ppKG	1807.11	1801.67	1013.69	164.85	2011.91	1172	2262.84	1994.95	873.55	1438.45	2343.71	2120	1765.74	1870.31	1100.37	960.68	1199.74
ppKO	1975.21	1969.26	1107.99	180.18	2199.07	1281.02	2473.34	2180.52	954.81	1572.26	2561.73	2141	1929.99	2044.29	1202.73	1050.05	1311.34
pcKW	1400.86	1396.64	785.81	127.79	1559.62	908.52	1754.14	1546.47	677.17	1115.08	1816.83	1715	1368.79	1449.85	853	744.71	930.03
pcKG	1807.11	1801.67	1013.69	164.85	2011.91	1172	2262.84	1994.95	873.55	1438.45	2343.71	2120	1765.74	1870.31	1100.37	960.68	1199.74
pcKO	1975.21	1969.26	1107.99	180.18	2199.07	1281.02	2473.34	2180.52	954.81	1572.26	2561.73	2141	1929.99	2044.29	1202.73	1050.05	1311.34
ptKW	1400.86	1284.91	628.65	127.79	1434.85	835.84	1613.81	1422.75	623	1025.87	1689.65	1715	1259.29	1333.86	776.23	744.71	930.03
ptKG	1807.11	1657.53	810.95	164.85	1850.96	1078.24	2081.81	1835.35	803.67	1323.38	2179.65	2120	1624.48	1720.68	1001.34	960.68	1199.74
ptKO	1975.21	1811.72	886.39	180.18	2023.14	1178.54	2275.47	2006.08	878.42	1446.48	2382.41	2141	1775.59	1880.75	1094.48	1050.05	1311.34
qpKW	2.93	0.00	244.11	125.00	10.55	0.080	74.14	0.00	59.66	322.80	37.40	260.74	10.00	0.00	21.77	92.48	1261.66
qpKG	0.00	0.00	46.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.96	0.00	0.00	0.00	0.00	77.03
qpKO	0.15	0.00	12.21	6.25	0.53	0.0040	3.71	0.00	2.98	16.14	1.87	8.28	0.50	0.00	1.43	29.97	84.01
qcKW	16.65	97.73	264.31	14.47	61.19	47.48	83.64	84.74	44.63	115.01	87.11	23.61	97.82	31.94	46.48	144.85	1261.66
qcKG	0.18	1.37	46.07	0.00	0.86	0.67	0.95	1.19	0.45	2.12	14.40	0.18	1.29	0.45	1.44	5.40	77.03
qcKO	0.34	9.39	12.21	0.16	3.68	2.22	4.48	7.06	1.03	22.40	8.05	1.24	8.26	1.00	2.52	0.00	84.01
qmKW	15.36	105.94	23.83		76.92	48.03	39.90	89.89	1.47	51.22	49.71	1.08	95.99	33.71	34.87	129.53	
qxKW	1.64	8.21	3.63	110.53	26.28	0.63	30.40	5.15	16.50	259.01	0.00	238.21	8.17	1.77	10.16	24.06	
qtKW	-13.72	-97.73	-20.20	110.53	-50.64	-47.40	-9.50	-84.74	15.03	207.79	-49.71	237.13	-49.71	-31.94	-24.71	-105.47	0.00
qtKG	-0.18	-1.37	0.00	0.00	-0.86	-0.67	-0.95	-1.19	-0.45	-2.12	-14.40	30.78	-1.29	-0.45	-1.44	-5.40	0.00
qtKO	-0.19	-9.39	0.00	6.09	-3.15	-2.21	-0.77	-7.06	1.96	-6.26	-6.18	7.04	-7.76	-1.00	-1.09	29.97	0.00
qeKW	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
qeKG	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
qeKO	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
fpKW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
fpKG	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
fpKO	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
fcKW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
fcKG	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
fcKO	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
feKW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
feKG	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

feKO	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
smKW	0.00	0.080	0.20	0.00	0.080	0.080	0.080	0.080	0.080	0.080	0.070	0.00	0.080	0.080	0.090	0.00	
smKG	0.00	0.080	0.20	0.00	0.080	0.080	0.080	0.080	0.080	0.080	0.070	0.00	0.080	0.080	0.090	0.00	
smKO	0.00	0.080	0.20	0.00	0.080	0.080	0.080	0.080	0.080	0.080	0.070	0.00	0.080	0.080	0.090	0.00	
cmKW	0.00	0.080	0.20	0.00	0.080	0.080	0.080	0.080	0.080	0.080	0.070	0.00	0.080	0.080	0.090	0.00	
cmKG	0.00	0.080	0.20	0.00	0.080	0.080	0.080	0.080	0.080	0.080	0.070	0.00	0.080	0.080	0.090	0.00	
cmKO	0.00	0.080	0.20	0.00	0.080	0.080	0.080	0.080	0.080	0.080	0.070	0.00	0.080	0.080	0.090	0.00	
lib	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
gdp	133.59	132.55	125.79	95.90	135.46	143.41	133.60	128.36	154.42	136.39	90.82	147.53	148.94	124.82	111.47	112.72	115.17
pop	19732	10331	1291496	15663	515122	1240469	60181.00	82398	10626	57998	127214	3951	40217	60095	290343	2473392	6299228
xrt	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table A6: Basedata scenario for KIWI model (year 2013)

KIWI	AU	BE	CI	CL	EO	EN	FR	GM	GR	IT	JP	NZ	SP	UK	US	RW	WD
ppKW	1616,42	1601,24	870,46	147,45	1788,09	1041,61	2011,11	1773,02	776,38	1278,43	2086,13	1978,90	1569,31	1662,24	976,29	859,31	930,03
ppKG	1995,74	1976,99	1074,72	182,06	2207,70	1286,05	2483,04	2189,08	958,56	1578,44	2575,66	2341,29	1937,57	2052,31	1205,39	1060,96	1199,74
ppKO	2144,59	2124,45	1154,88	195,63	2372,37	1381,97	2668,25	2352,36	1030,05	1696,17	2767,78	2324,60	2082,08	2205,40	1295,29	1140,10	1311,34
pcKW	1616,42	1601,24	870,46	147,45	1788,09	1041,61	2011,11	1773,02	776,38	1278,43	2086,13	1978,90	1569,31	1662,24	976,29	859,31	930,03
pcKG	1995,74	1976,99	1074,72	182,06	2207,70	1286,05	2483,04	2189,08	958,56	1578,44	2575,66	2341,29	1937,57	2052,31	1205,39	1060,96	1199,74
pcKO	2144,59	2124,45	1154,88	195,63	2372,37	1381,97	2668,25	2352,36	1030,05	1696,17	2767,78	2324,60	2082,08	2205,40	1295,29	1140,10	1311,34
ptKW	1616,42	1482,63	725,39	147,45	1655,64	964,46	1862,14	1641,68	718,87	1183,73	1949,65	1978,90	1453,07	1539,11	895,68	859,31	1073,14
ptKG	1995,74	1830,54	895,60	182,06	2044,16	1190,79	2299,11	2026,92	887,56	1461,51	2407,16	2341,29	1794,04	1900,28	1105,86	1060,96	1324,97
ptKO	2144,59	1967,08	962,40	195,63	2196,64	1279,61	2470,60	2178,11	953,75	1570,52	2586,71	2324,60	1927,86	2042,03	1188,34	1140,10	1423,79
qpKW	3,06	0,00	254,31	132,37	11,14	0,08	78,31	0,00	63,01	340,94	39,53	276,10	10,56	0,00	22,98	97,93	1453,10
qpKG	0,00	0,00	47,16	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	32,21	0,00	0,00	0,00	0,00	99,46
qpKO	0,15	0,00	12,41	6,46	0,54	0,00	3,82	0,00	3,07	16,64	1,93	8,56	0,52	0,00	1,47	30,97	87,51
qcKW	16,91	92,37	293,49	15,36	61,13	48,21	78,31	79,58	42,36	105,77	76,89	24,70	143,31	40,79	46,58	164,56	1453,10
qcKG	0,17	1,22	51,01	0,00	0,81	0,64	0,83	1,05	0,40	1,77	11,92	0,18	1,76	0,53	1,36	5,71	99,46
qcKO	0,34	8,92	14,45	0,19	3,69	2,27	4,21	6,67	0,98	20,49	7,12	1,29	12,13	1,28	2,55	0,00	87,51
qmKW	19,71	117,31	35,65		89,69	96,48	50,52	114,81	3,37	50,18	59,44	0,78	114,39	37,93	41,10	186,54	
qxKW	1,19	6,89	7,52	129,07	32,20	10,54	24,41	10,08	37,99	291,78	0,00	313,68	9,45	1,67	12,10	31,09	
qtKW	-13,85	-92,37	-39,18	117,00	-49,99	-48,12	0,00	-79,58	20,65	235,17	-37,36	251,40	-94,64	-40,79	-23,60	-119,73	0,00

qtKG	-0,17	-1,22	-3,85	0,00	-0,81	-0,64	-0,83	-1,05	-0,40	-1,77	-11,92	32,04	-1,76	-0,53	-1,36	-5,71	0,00
qtKO	-0,19	-8,92	-2,03	6,26	-3,15	-2,26	-0,39	-6,67	2,10	-3,85	-5,19	7,27	-11,61	-1,28	-1,07	30,97	0,00
qeKW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
qeKG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
qeKO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
fpKW	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
fpKG	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
fpKO	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
fcKW	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
fcKG	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
fcKO	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
feKW	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
feKG	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
feKO	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
smKW	0,00	0,08	0,20	0,00	0,08	0,08	0,08	0,08	0,08	0,08	0,07	0,00	0,08	0,08	0,09	0,00	
smKG	0,00	0,08	0,20	0,00	0,08	0,08	0,08	0,08	0,08	0,08	0,07	0,00	0,08	0,08	0,09	0,00	
smKO	0,00	0,08	0,20	0,00	0,08	0,08	0,08	0,08	0,08	0,08	0,07	0,00	0,08	0,08	0,09	0,00	
cmKW	0,00	0,08	0,20	0,00	0,08	0,08	0,08	0,08	0,08	0,08	0,07	0,00	0,08	0,08	0,09	0,00	
cmKG	0,00	0,08	0,20	0,00	0,08	0,08	0,08	0,08	0,08	0,08	0,07	0,00	0,08	0,08	0,09	0,00	
cmKO	0,00	0,08	0,20	0,00	0,08	0,08	0,08	0,08	0,08	0,08	0,07	0,00	0,08	0,08	0,09	0,00	
lib	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
gdp	235,19	204,42	337,35	199,64	211,45	299,20	206,07	184,66	246,43	206,32	106,75	291,22	268,47	201,88	170,38	214,66	188,66
pop	21395	10452	1374558	17280	558927	1288071	61811	82514	10780	58254	126471	4331	40663	61457	317209	3021681	7055854
xrt	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000

Table A7: Elasticities used in the model

Country/Region	Elasticity	KW	KG	KO
AU	demand	-1.70	-3.40	-3.40
	income	0.18	0.18	0.18
	supply	0.30	0.30	0.30
BE, GM	demand	-1.67	-3.34	-3.34
	income	0.22	0.22	0.22
	supply	0.10	0.10	0.10
CI, RW	demand	-1.70	-3.40	-3.40
	income	0.49	0.49	0.49
	supply	0.40	0.40	0.40
CL	demand	-1.70	-3.40	-3.40
	income	0.49	0.49	0.49
	supply	0.40	0.40	0.40
EN,EN,GR	demand	-1.70	-3.40	-3.40
	income	0.30	0.30	0.30
	supply	0.40	0.40	0.40
FR	demand	-1.83	-3.66	-3.66
	income	0.18	0.18	0.18
	supply	0.40	0.40	0.40
IT	demand	-2.40	-4.80	-4.80
	income	0.38	0.38	0.38
	supply	0.40	0.40	0.40
JP	demand	-1.70	-3.40	-3.40
	income	0.37	0.37	0.37
	supply	0.40	0.40	0.40
NZ	demand	-1.70	-3.40	-3.40
	income	0.18	0.18	0.18
	supply	0.40	0.40	0.40
SP	demand	-1.88	-3.76	-3.76
	income	0.94	0.94	0.94
	supply	0.40	0.40	0.40
UK	demand	-1.91	-3.83	-3.83
	income	0.87	0.87	0.87
	supply	0.10	0.10	0.10
US	demand	-1.70	-3.40	-3.40
	income	0.29	0.29	0.29
	supply	0.40	0.40	0.40