PELLERVON TALOUDELLISEN TUTKIMUSLAITOKSEN
RAPORTTEJA NRO 201

PELLERVO ECONOMIC RESEARCH INSTITUTE
REPORTS No. 201

IMPLICATIONS OF EXPORT SUBSIDY REMOVAL FOR THE FINNISH AND EU DAIRY SECTORS

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Helsinki 2006

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ISBN 978-952-5594-34-3 (NID)
ISBN 978-952-5594-35-1 (PDF)

ISSN 1456-3215 (NID)
ISSN 1796-4776 (PDF)

Helsinki 2006

FOREWORD

During recent years, agricultural sector has worked towards more liberalised trade. The dairy industry remains one of the most heavily protected industries in the agro-food sector worldwide, but WTO commitments will bring pressure for further reforms of dairy policy. The issue of dairy product exports is nowadays of great economic importance to both dairy processors and milk producers in Finland. Finland's agricultural sector is highly dependent on dairy production; about 30% of Finnish agricultural income is derived from dairy production. As a result of EU membership, imports of dairy products to Finland have increased each year, and thus, approximately 30% of domestic milk production is now exported.

However, very few studies about Finland's position in this new market context exist. This research analyses implications of export subsidy removal for the Finnish and EU dairy sectors. This research continues Pellervo Economic Research Institute (PTT) projects in the field of Finnish food production. Previous studies have examined impacts of EU enlargement and international trade on the Finnish food industry.

This research is an outcome of the efforts of three people. The original idea of this study came from former research director Doctor Panu Kallio from PTT. He together with Professor Philip Abbott from Purdue University developed the model introduced in chapter 4. Otherwise the study (dairy sector description, data collection, parameter estimation procedures, analysis of the model, the empirical testing of the model, the model results and conclusions etc.) have been independently done by Meri Virolainen, an economist at PTT.

The research was also accepted as a licentiate thesis of Agriculture and Forestry in Helsinki University in October 2006. Thus, the author would like to express gratitude to Professor Jukka Kola, to adjunct Professor Heikki Lehtonen, and to Doctor Juha Marttila for their contributions to this study. Finally, Pellervo Economic Research Institute would like to thank the Ministry of Agriculture and Forestry in Finland for financing the study.

Helsinki, December 2006

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MERI VIROLAINEN - PANU KALLIO – PHILIP ABBOTT. 2006. IMPLICATIONS OF EXPORT SUBSIDY REMOVAL FOR THE FINNISH AND EU DAIRY SECTORS. Pellervo Economic Research Institute Reports No. 201. 111 p. ISBN 978-952-5594-34-3 (NID), ISBN 978-952-5594-35-1 (PDF), ISSN 1456-3215 (NID), ISSN 1796-4776 (PDF).
Abstract: This research sought to answer, how EU and the Finnish dairy sectors would be affected by the removal of export subsidies. The research questions were addressed by applying an Armington-based partial equilibrium optimisation model. An Armington partial equilibrium trade flow model was applied instead of a general equilibrium model in order to bring more detailed sectoral information into the analysis, and to more realistically capture the policy instruments of the CAP. The study results can be summarised as follows. First, global dairy trade is likely to decline by 13% as a result of export subsidy removal. This is due to significant rise in import prices in rest of the world group and in Russia. Second, export subsidy removal would especially stimulate net exporting countries (Australia, Canada, New Zealand) and the new EU-countries dairy export. Third, the old EU member countries, Finland and the US, in this rank order, would be the main losers in terms of export volume changes. Finland's dairy exports would decline by fifth both in value and volume terms. Fourth, production and the producer price of raw milk would decline by approximately 4% in Finland, which would result from reduced dairy export. In this respect, export subsidy removal would most significantly affect Finland. Raw milk production and producer prices would decrease by approximately 2% in rest of the EU. The study results suggest that export subsidy removal would have relatively small affect on milk producer prices, but implications on agricultural trade are quite significant compared to other studies.
Key words: *Dairy sector, export subsidies, Finland, EU.*

MERI VIROLAINEN - PANU KALLIO – PHILIP ABBOTT. 2006. VIENTITUKIEN POISTON VAIKUTUKSET SUOMEN JA EU:N MAITOSEKTORILLE. Pellervon taloudellisen tutkimus-laitoksen raportteja nro 201. 111 s.
Tiivistelmä: Tutkimuksen tarkoituksena oli selvittää vientitukien poistamisen vaikutuksia EU:n ja Suomen maitosektorille. Tätä tarkoitusta varten rakennettiin Armington –tyyppinen kaupan osittaistasapainomalli. Armington kauppamallia käytettiin yleistasapainomallin sijaan, jotta maitosektoria pystyttiin mallittamaan yksityiskohtaisemmin, ja että EU:n maatalouspolitiikan instrumentit saadaan mallitettua melko realistisesti. Tutkimuksessa käytetyn mallin tulokset voidaan tiivistää seuraavasti. Maitotuotteiden maailmankauppa vähentyisi vientituen poiston myötä noin 13 %. Eniten alentuisi etenkin voin kauppa. Mallin kahden tärkeimmän tuojan (Venäjä ja muu maailma) tuonti alentuisi noin 13 %. Tämä johtui tuontihintojen kohoamisesta. Toinen merkittävä tulos oli, että vientitukien poistamisen seurauksena nettovientimaat (Uusi Seelanti, Australia ja Kanada) ja EU:n uudet jäsenmaat hyötyisivät selvästi, lisäten markkinaosuuksiaan maitotuotteiden maailmanmarkkinoilla. Vientitukien poistaminen alentaisi eniten vanhojen EU-maiden, Suomen ja USA:n maitotuotteiden vientiä. Näin ollen nämä maat myös menettäisivät eniten maitotuotteiden kaupan maailmanmarkkina-osuuksia. Suomen maitotuotteiden viennin määrä sekä arvo alentuisivat noin viidenneksellä. Tämä oli tutkimuksen kolmas keskeinen tulos. Neljäs merkittävin tulos oli, että vientitukien poiston vaikutukset olisivat selvästi suurimmat Suomen maitosektorille, jossa sekä tilityshinta että maidontuotanto alentuisivat noin 4 %. Myös muissa vanhoissa EU-maissa tilityshinta ja maidontuotanto vähentyisivät hieman, noin pari prosenttia. Tutkimuksen mukaan vientitukien poistolla olisi suhteellisen vähän vaikutusta maidon tuottajahintoihin, mutta implikaatiot maitotuotteiden kauppaan olisivat melko suuria muihin tutkimuksiin verrattuna.
Avainsanat: *Maitosektori, vientituet, Suomi, EU.*

CONTENTS

YHTEENVETO

Maailman kauppajärjestön WTO:n jäsenet ovat periaatteessa sopineet vientitukien poistamisesta maatalouskaupassa. Vaikka päätökseen liittyykin vielä täyttymättömiä ehtoja ja vientituen poistolle asetetaan luultavasti pitkähkö siirtymäkausi, on se silti merkittävä. Maitosektorilla vientitukien ja kauppaa hankaloittavien korkeiden tullien käyttö on yleistä. Näin ollen maitosektori onkin yksi kaikkein suojelluimmista maatalousssektoreista. Vientituet ovat muodostaneet noin 10-15 % EU:n maitotaloustuotteiden kokonaisviennin arvosta viime vuosina. Suomen maitotuotteiden vientituet ovat alentuneet viime vuosina selvästi. Kun vielä vuonna 2003 niiden arvo oli 70 miljoonaa euroa, niin vuonna 2005 tuet olivat kutistuneet 33 miljoonaan euroon. Toisin sanoen, kun vielä vuonna 2003 tuki muodosti neljänneksen viennistä, niin nyt tuki on reilut 10 % viennistä.

Tutkimuksen tarkoituksena oli selvittää vientituen poistamisen vaikutuksia Suomen ja EU:n maitosektorille. Tätä varten kehitettiin simulointimalli, jossa vientituen poisto kanavoituu mm. maidontuotantoon ja tilityshintaan sekä maitotuotteiden tuotantoon, vientiin ja tuontiin. Mallissa on 7 maata/maaryhmää: Suomi, EU-14 (EU-15 maat pl. Suomi), KIE–8 (EU:n uudet jäsenmaat pois lukien Malta ja Kypros) ja Yhdysvallat, nettoviejät eli NEC (Kanada, Uusi- Seelanti ja Australia), nettotuojat Venäjä ja muu maailma. Mallissa on viisi eri maitotuoteryhmää: voi, juusto, rasvaton maitojauhe, täysmaitojauhe ja muut maitotuotteet. Mallia varten kerättiin huomattava määrä aineistoa. Maitotuotteiden maailmanmarkkinat ovat olleet epävakaita viime vuosina, jonka vuoksi mallin simulointia varten aineistoa kerättiin vuosilta 1999-2001. Tuolloin Suomen maitotuotteiden EU:n maksamat vientituet olivat keskimäärin noin 60 miljoonaa euroa ja koko EU:ssa noin 1 220 miljoonaa euroa.

Vientituen poisto alentaa tilityshintaa ja tuotantoa Suomessa 4 % - kuluttajien tilanne lähes ennallaan

Tutkimuksen mallin mukaan vientitukien poistaminen maailmankaupassa alentaisi maidon tilityshintaa Suomessa ja EU:ssa, mutta vähemmän kuin edellisissä tutkimuksissa on arvioitu. Koska myös tuotannon määrä, ja siten vienti vähentyisi, jäisivät vaikutukset tilityshintoihin vähäisemmiksi. Selvästi suurimmat muutokset kohdentuisivat Suomen maitosektorille, jossa sekä tilityshinta että maidontuotanto alentuisivat noin 4 %. Kun lasketaan yhteen tilityshinnan ja maidontuotannon määrän muutoksen yhteisvaikutus, suomalaisten viljelijöiden maidosta saamat myyntitulot alenisivat noin 8 %, eli lähes 66 miljoonaa euroa. Myös EU:ssa tilityshinta ja maidontuotanto vähentyisivät hieman, noin pari prosenttia.

Kuluttajille vientituen poistamisella olisi melko vähän merkitystä. Maitotuotteiden kysyntä jäisi likimain ennalleen, vaikka muutoksia kuluttajahintoihin tulisikin. Voin kuluttajahinta alentuisi lähes 14 %, mutta muiden tuotteiden hinnat pysyisivät ennallaan tai nousisivat. Hintamuutokset eivät kuitenkaan juurikaan vaikuttaisi kuluttajien ostokäyttäytymiseen. Kokonaisuudessaan maitotuotteiden kulutuksen arvo pysyisi jokseenkin ennallaan.

Maitotuotteiden vientitulot alentuisivat Suomessa ja EU:ssa reilusti

Toinen merkittävä tulos oli, että vientitukien poistaminen alentaisi eniten EU-14 –maiden, Suomen ja USA:n maitotuotteiden vientiä. Näin ollen nämä maat menettäisivät eniten myös maitotuotteiden kaupan maailmanmarkkinaosuuksia. Suomen maitotuotteiden viennin määrä sekä viennin arvo alentuisivat noin viidenneksellä (noin 69 milj. euroa). Eniten maitotuotteiden vientitukien poisto vähentäisi rasvattoman maitojauheen ja muiden maitotuotteiden vientiä, joiden viennin volyymi alenisi noin kolmanneksen nykyisestä. Muilla tuotteilla viennin alentuminen jäi noin kymmenen prosentin tienoille.

EU-14:n ja USA:n maitotuotteiden viennin volyymi putoaisi yli viidenneksen, joka merkitsisi EU:lle reilun 1 200 miljoonan euron lovea vientituloissa. Yhdysvalloille maitotuotteiden viennillä on sen sijaan huomattavasti vähemmän merkitystä, jonka vuoksi menetykset USA:n maitosektorin viennille jäisivät noin 250 miljoonan dollarin tienoille. EU-14:n voin vienti romahtaisi lähes kaksi kolmannesta nykyisestä ja myös muiden maitotuotteiden vienti alenisi reilun kolmanneksen nykyisestä. Näiden tuotteiden viennin alentuminen johtuu pitkälti siitä, että näissä tuotteissa vientituen osuus on suhteessa suurin tuotteen hintaan. Myös Yhdysvaltojen viennissä muiden maitotuotteiden vienti romahtaisi yli kaksi kolmannesta, koska myös siellä tämän tuoteryhmän tuen osuus on suhteessa suurin tuotteen hintaan nähden.

EU:n uudet jäsenmaat ja suuret nettovientimaat hyötyisivät vientituen poistosta

Vientitukien poistamisen seurauksena suuret nettovientimaat (Uusi Seelanti, Australia ja Kanada) ja EU:n uudet jäsenmaat hyötyisivät selvästi lisäten markkinaosuuksiaan maitotuotteiden maailmanmarkkinoilla. Tämä on tutkimuksen kolmas keskeinen tulos. Nettovientimaiden maitotuotteiden viennin volyymi lisääntyisi lähes 7 %, mutta viennin arvo kasvaisi lähes 15 %. Viennin arvon nousu perustuu siihen, että vientitukien poistaminen nostaa vientituotteiden maailmanmarkkinahintaa, josta nettovientimaat eniten hyötyisivät. Näin ollen nettovientimaiden vientitulot kasvaisivat yli 400 miljoonaa dollaria. Myös EU:n uusien jäsenmaiden viennin volyymi kasvaisi vientitukien poistamisen seurauksena noin 12 %. Uudet jäsenmaat hyötyisivät siten edullisemmasta kustannustasostaan ja kohentaisivat myös viennistä saamiaan tuloja.

Suomen maatalous- ja elintarvikesektori häviäjä - samoin kuin maitotuotteiden nettotuojat, joiden tuonti kallistuu vientituen poistuessa

Tutkimuksen neljäs keskeinen tulos oli, että maitotuotteiden maailmankauppa vähentyisi vientituen poistuessa noin 13 %. Maitotuotteiden maailmankaupan volyymin alentumisesta huolimatta tuonnin arvo kasvaisi noin 5 %. Tämä johtuu ennen muuta siitä, että vientituen poisto nostaisi tuontihintoja. Mallin kahden tärkeimmän tuojaryhmän Venäjän ja muun maailman tuonnin volyymi alentuisi selvästi vientihintojen noustessa. Eniten alentuisi etenkin voin ja muiden maitotuotteiden kauppa. Venäjän tuonti alenisi lähes viidenneksen ja muun maailman lähes 15 %.

Tutkimuksessa käytetyn mallin perusteella voidaan sanoa, että vientitukien poistolla olisi selvästi kustannuksia nostava vaikutus etenkin merkittäville maitotuotteiden tuojamaille, mm. joillekin kehitysmaille. Tuontihintojen nousu vähentäisi näiden maiden tuontia, mutta kasvattaisi silti niiden tuonnista aiheutuvia kustannuksia. Voittajia olisivat sen sijaan nettovientimaat ja EU:n uudet jäsenmaat, jotka todennäköisesti lisäisivät vientiään kaikissa tuoteryhmissä. Vanhat EU-maat Suomi mukaan lukien sen sijaan olisivat suurimpia häviäjiä, mitä tulee vientimarkkinaosuuksiin ja maidon tilityshintoihin.

Suomen maatalous- ja elintarvikesektorille vientitukien poisto ja sitä kautta viennin aleneminen on suhteessa kaikkein haasteellisinta, sillä Suomi vie joka kolmannen tuotetun maitolitran. Vaikka muiden EU-maiden vienti alenee suhteessa enemmän kuin Suomen, niin muille EU-maille vienti ei ole yhtä tärkeää kuin Suomelle. Vientituen alentuminen heijastuu eniten maidon tilityshintoihin Suomessa. Näin ollen Suomen maitosektorin tilanne, joka näyttää jo EU:n maatalouspolitiikka uudistuksessa kärsineen melko tavalla, näyttää vientitukien poiston myötä muuttuvan yhä tukalammaksi.

1. INTRODUCTION

1.1 Background

The food and agricultural sector is working towards more liberal world trade. The process began during the previous GATT round in 1986, which ended in 1994 when the historical Uruguay Round Agreement on Agriculture (URAA) was signed and the World Trade Organisation (WTO) was established. The URAA set limits on agricultural support payments, and the first steps were taken towards more liberal agricultural trade. The URAA, however, achieved only limited access in increasing market access and reducing export subsidies. The WTO is now in charge of the ongoing Doha negotiation round for the ninth multilateral trade agreement. The aim of the negotiations is to continue in the liberalisation of world trade and to pay special attention to the position of developing countries.

Trade liberalisation is a very sensitive issue for the dairy sector. The global dairy markets are rather thin; in fact, only approximately 7 per cent of produced dairy products are traded across borders. However, it is worth noting that almost all agricultural markets are thin because almost every industrial western country pursues the production of its own food. Furthermore, few countries produce food for export purposes; most agricultural trade is surplus trading.

One reason behind the small scale of dairy trade is the easily perishable characteristics of dairy goods, but it is not the only reason. Globally, the dairy sector remains among the most protected and subsidised agricultural sectors. Trade barriers prohibit free market access and export subsidies are widely criticised due to their trade-distorting nature. Export subsidies have traditionally been one of the main targets of criticism aimed at dairy trade because they are assumed to significantly depress world market prices.

The EU is the biggest milk producer in the world. The dairy sector has traditionally formed the core of EU agricultural production, comprising nearly

20 percent of the EU's total agricultural production.[1] Dairy export by the EU represents only a relatively small share of the total production (under 5%), but it still plays a major role in world dairy trade, having a one-third market share in world dairy export markets. Certain significant efforts have been made to maintain this position in the world market – namely by using export subsidies. In 2003 the EU spent approximately € 860 million on dairy export subsidies. The EU has been the major user of export subsidies in the world, although not the only one. The US also subsidies dairy exports, but not to the same extent in volume terms.

The dairy sector has a great deal of importance for the European Union, but the significance of the dairy sector is an even more crucial issue for a country like Finland. In fact, dairy farms account for nearly 30% of real agricultural income. One fifth of Finnish food exports consist of dairy commodities, and as many as every third milk litre produced in Finland is exported abroad. Furthermore, export subsidies represent one-fourth of total Finnish dairy export revenues.

At this stage of the Doha negotiation round, following the Hong Kong ministerial meeting in December 2005, it has basically been agreed that all direct export subsidies (including export credits, insurance programmes, etc.) will be abolished by the end of 2013 and food aid and state trading enterprises will also be disciplined. Substantial improvements in market access have also been agreed, and deeper cuts will especially be applied for higher tariffs. After the Hong Kong ministerial meeting the negotiations have come to a deadlock for now, but still it seems very likely that export subsidies will be abolished in the future.

It is assumed that the removal of export subsidies will have a deep impact on EU dairy exports, because the competitiveness of EU dairy goods would become weaker on the world market. Comprehensive studies of this subject are quite few (ABARE 2001, OECD 2000, Bouamra-Mechemache et al. 2002, Zhu, Cox & Chavas 1999, Binfield et al. 2001, Gohin & Gautier 2003, Jensen & Yu 2005), and hardly any studies have been conducted on Finland's position in this new market context (Kerkelä et al. 2005, 2006). The

[1] Here the EU should be understood as the EU-15, consisting of the 15 "old" member states.

Finnish dairy sector does not represent an average case in the EU, and study results obtained for the whole EU cannot therefore be directly applied to Finland.

For the EU and the Finnish dairy sector the forthcoming WTO agricultural agreement will probably be of very great importance. The heavily subsidised production structure and highly protected domestic markets suggest that trade liberalising negotiations might turn out to be difficult. When all forms of export subsidies are phased out, major changes in dairy markets will result.

1.2 Objectives of the study

This study examines how dairy sectors in the EU and in Finland would be affected by the removal of export subsidies. The study attempts to answer the following research questions: 1) If the EU gave up its export subsidies under the WTO agreement, what would be the consequences for the EU dairy sector? 2) How would the Finnish dairy sector and dairy trade be affected by these policy changes? The research methodology in this study is to develop an Armington-based partial equilibrium optimisation model that is applied to generate results for the research questions. This framework is used to analyse the effects that elimination of export subsidies would have on the dairy sector in the EU and particularly in Finland. The aim of the study is to develop a modelling framework for international dairy product trade based on observed real world institutions. Instead of a general equilibrium model, an Armington partial equilibrium trade flow model of the dairy sector will be used in order to bring more detailed sector information to the analysis, and to capture more realistically the policy instruments of the CAP.

The study is divided into 7 chapters. Chapter 2 provides some background information on the EU-15 dairy sector. It provides an overview of the EU dairy policy and it also illustrates the main dairy policy instruments. The development in dairy trade volumes and prices through time is also presented. In Chapter 3, the theoretical background of study is introduced, while an Armington-based trade theory is presented more closely. Chapter 4 is concerned with the literature on dairy trade modelling, presenting a review of economic dairy models applied to EU dairy policy modelling and to dairy trade modelling in general. Chapter 5 concentrates on the Armington-based global dairy model applied in this study, discussing both data collection and parameter estimation challenges. The model results are presented in Chapter 6, and the main conclusions of the study are summarised in Chapter 7.

2. The dairy sector in the EU-15 and in Finland[2]

2.1 Importance of Export Subsidies for the EU Dairy sector

Milk production is the most important agricultural sector in almost all EU countries. It accounts for almost 20 per cent of the real agricultural income in the EU. Milk production is still based on family farming, but the farm structure is relatively small compared to the main competitors (the United States, Canada, New Zealand and Australia). The number of milk producers has declined in the past 30 years in the EU, but deliveries to dairies have remained more or less unchanged, because farm size and productivity have increased. Another reason for the relatively stable milk deliveries to dairies is the milk quota system. The quota system was successfully introduced in 1984 to stabilise milk production as a result of chronic oversupply in the late 1970s. The EU dairy sector is self-sufficient; in fact, it is characterised by a substantial surplus. The net surplus is estimated to be about 9 million tons as a whole milk equivalent, and must be exported or stored (European Commission 2000).

Dairy goods have an important role in the diet of consumers in the EU. The dairy manufacturing industry has a long history in Europe, providing traditionally-produced special dairy products, such as various types of European cheese. The supply of various European dairy products is impressive. Butter manufacture absorbs about one third of the total milk produced in the EU, but its share is constantly declining. The slowdown of butter production has been replaced by cheese and cream, whose share of production is increasing in relative and absolute terms. Skimmed milk powder (SMP) absorbs the majority of produced skim milk, but skimmed milk

[2] This chapter describes the EU-15 dairy sector, not the enlarged EU dairy sector. This is because the model introduced later in this study divides these countries into two separate regions: the “old” and the “new” EU countries. There are several reasons for this separation: first, the model covers the years 1999-2001, when the timetable for the enlargement was barely decided and the idea of common dairy markets hardly existed. Second, when comparing dairy sectors in the old and new EU countries in this time period, several differences were recognised in producer prices, wholesale prices, milk composition, milk quality and so on. In summary, the distinction between these regions seemed a reasonable choice and a virtual “common dairy market” was not created.

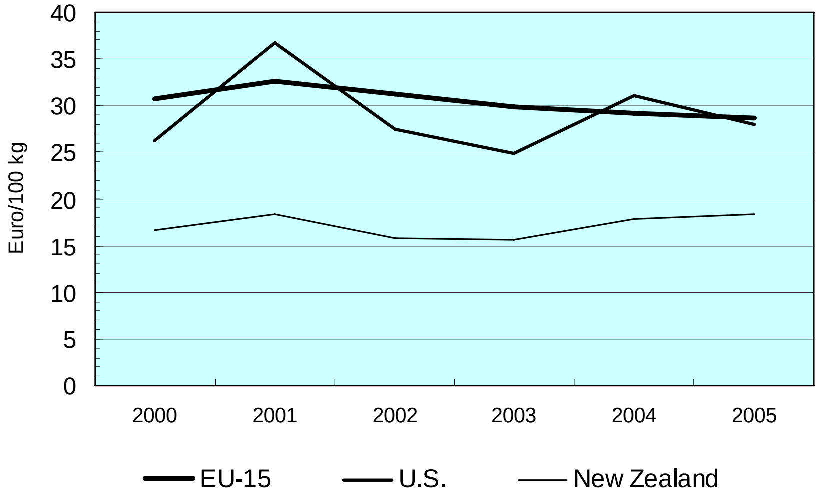
is also increasingly used in cheese, fresh products, whole milk powder (WMP), and casein production (EU Commission 2000).

The production costs of EU dairy farms are higher than in other relevant milk production regions, mostly due to climatic and farm structural reasons (IFCN 2005). In Finland, climatic circumstances are even less favourable than in the rest of the EU. Furthermore, Finnish agriculture is based on family farms and the average size of farms is well below the EU average, which increases production costs (Patjas 2003). Finland’s agricultural sector is highly dependent on dairy production. About 30% of Finnish agricultural income is derived from dairy production, which is more than the EU average. Moreover, the issue of dairy product exports is nowadays of great economic importance to Finnish dairy processors. As a result of EU membership, the imports of dairy products to Finland have increased each year. This means that more markets need to be found for Finnish dairy products outside of Finland. In fact, approximately 30% of domestic milk production is now exported.

The importance of the dairy sector is not solely based on production values. The dairy sector has an important multifunctional role in European agriculture by maintaining the vitality of European rural areas. The agricultural sector (including the dairy sector) provides various employment opportunities for Finnish rural areas, including the transportation and processing industries (Knuuttila 2004).

Producer prices paid for raw milk vary strongly among separate regions (Figure 1). Traditionally, producer prices paid in the EU and the US have been among highest, but US milk prices fluctuate more than in Europe (dollar/euro exchange rate changes do not solely explain the variation). When comparing producer prices during past few years, a price peak was experienced in 2001, when there was a strong positive boost to dairy product prices. The milk price in New Zealand is about half of the European milk prices. Over 90% of milk production in New Zealand is exported, and therefore the milk prices in New Zealand provide a good indication of the prices on the world market (LTO 2005).

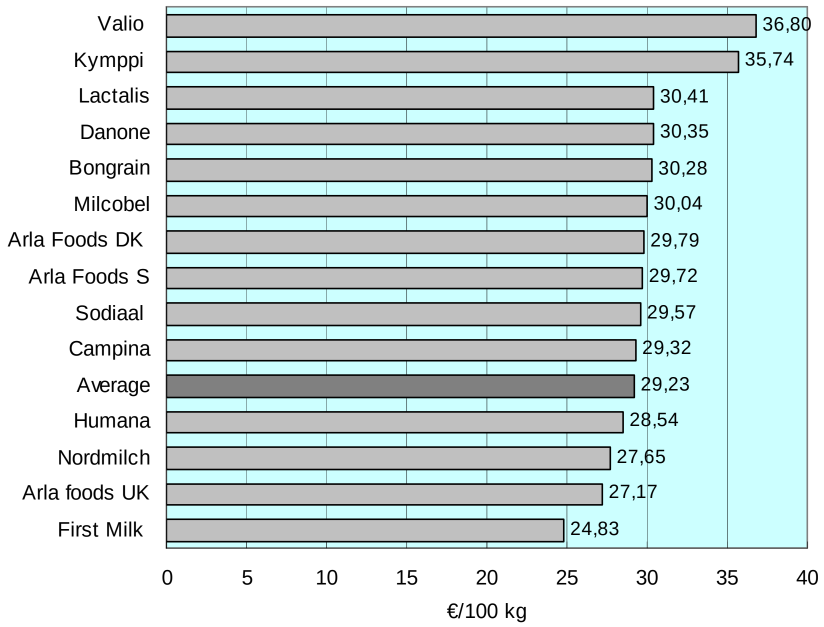
***Figure 1**. Variation in producer prices across the EU-15, the U.S. and New Zealand.*



Source: LTO.

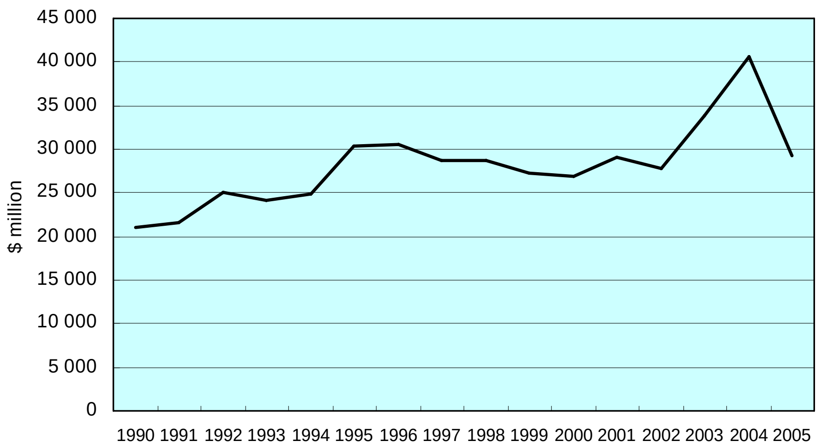
In the LTO's (2005, 2006) milk price comparisons (Figure 2), Finnish dairy companies paid the best price for 100 kg of standard milk in both in 2004 and in 2005 (the Finnish Kymppi group paid 35.74 euros/100 kg and Finnish Valio paid 36.80 euros/100 kg in 2004). However, it is worth noting that the majority of Finnish dairy farmers faced a milk price fall in 2004. Finnish Valio, which processes approximately 80% of Finnish milk, lowered their milk price by 1 euro per 100 kg. Despite the milk price decline, Finnish dairy companies remained in the top position in this milk price comparison. In fact, the difference in the milk price compared to other dairy companies has increased. By comparison, the EU-15 average producer price was slightly under 29 euros/100 kg in 2005. The reason behind the higher producer prices paid by Finnish dairy companies probably lies in efficient production chain. Value added final products have also enabled Finnish dairy companies to reach the current top position in the milk price comparison. For example, Valio is a world-class pioneer as a developer of functional products. Valio aims to protect inventions through patenting and commercialize them by selling licences outside the company. It is also worth noting that Finnish dairy companies are mainly co-operative and owned by dairy farmers, whose main goal is the highest possible producer price.

Figure 2. *Milk prices in some European dairy companies.*



Source: LTO.

Figure 3. *Total value of world dairy exports (US $).*



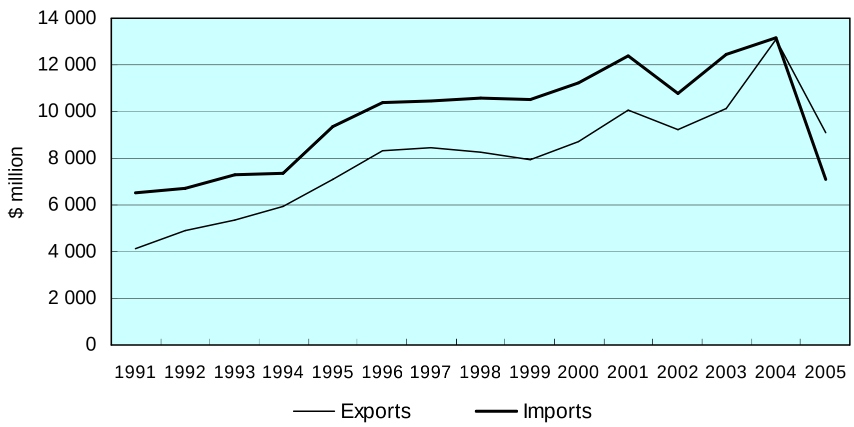
Source: Comtrade.

The development of world dairy exports is described in Figure 3. The value of world exports has increased since the early 1990s, but it experienced a rapid growth starting in 2003. This was probably due to the depreciating value of the US dollar. By contrast, the slowdown in 2005 is probably explained by the enlargement of the EU in May 2005. EU intra-trade is excluded from total exports, which has led to a declining trend in the global dairy trade.

Around seven per cent of the world's dairy production is exported. For decades the world dairy trade was dominated by the EU. The EU is the biggest milk producer in the world, but it exports only approximately 5% of its total production. The EU market share of the world export market is approximately 35%, but it is declining. Both New Zealand and Australia have increased their market share at the expense of the EU. Australia's market share of world dairy exports is over 10%, while New Zealand has a market share of over 35%, and it is constantly rising. US dairy exports represent under 5% of the total world dairy exports (Dairy 2005). As can be seen from Figure 4, the dairy trade value of the EU-15 has more than doubled over the past decade. The slowdown in 2005 probably originated from EU enlargement, which considerably increased intra-trade.

Dairy product exports play an important role for the Finnish dairy sector. Cheese is the main export product, representing approximately 45% of the total export revenues. The share of butter is less than one third, and

Figure 4. *Total value of the EU-15 dairy trade (excluding intra-trade).*

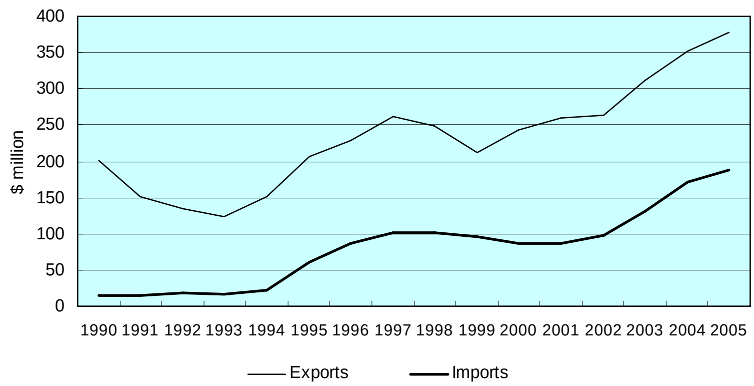


Source: Comtrade.

powder exports represent around 10% of the total value of dairy exports (Tullihallitus 2004). Since EU membership in 1995, imports of dairy goods have grown rapidly, and more dairy products therefore need to be exported outside of Finland. Russia is the main destination country, representing around one-third of the total export. As a result of the Russian economic crisis in 1998, Finland's dairy exports to Russia dropped dramatically in 1999, and since then the Russian exports have remained below the pre-crisis level. It should be borne in mind that the dairy exports of Finnish food companies are not in every respect profitable or intentional. In fact, the self-sufficiency rate of the Finnish dairy sector is approximately 130%, which naturally forces Finnish dairy companies to export a substantial part of their total milk volume. Dairy exports are, with some exceptions, commonly less profitable than domestic business. However, dairy companies cannot fix the raw milk supplied to a certain optimal level due to the co-operational nature of the dairy industry.

The EU dairy sector is still heavily dependent on export subsidies. In 2003 the value of EU extra-dairy exports was approximately 10 220 million euros (value of intra + extra exports was around 24 million euros), while export refunds for dairy exports were worth approximately 860 million euros, which is nearly 9% of the total export revenues (Comtrade, USDA/ERS 2004). During the same time period export refunds in Finland totalled approximately 70 million euros. Finland exported dairy products worth 267 million euros in 2003. In other words, about one fourth of the total exports

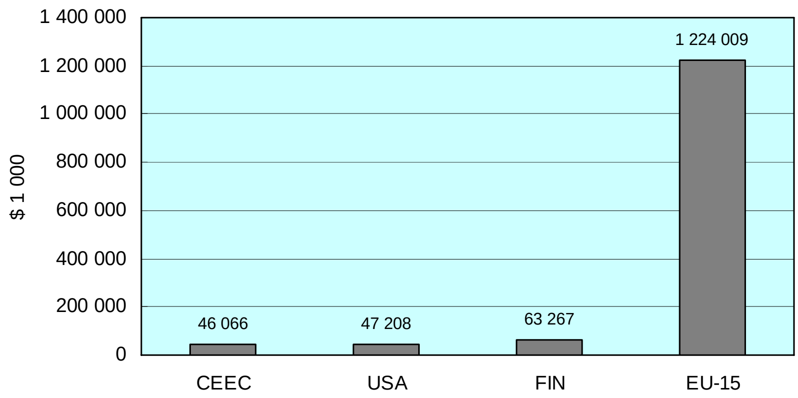
Figure 5. *Total value of Finnish dairy trade.*



Source: Comtrade.

were fully subsidised (Tullihallitus 2004). In Figure 6 the average dairy export refunds from 1999-2001 are presented. The EU-15 spent on average over 1.2 billion US dollars on dairy export subsidies, while the US and the new EU member countries (the CEEC) used under 50 million US dollars to promote dairy exports. It is worth noting that Finland's export subsidies exceeded that sum.

Figure 6. *Average annual dairy export subsidy expenditures in 1999-2001 (Finland is also part of the EU-15 group)*



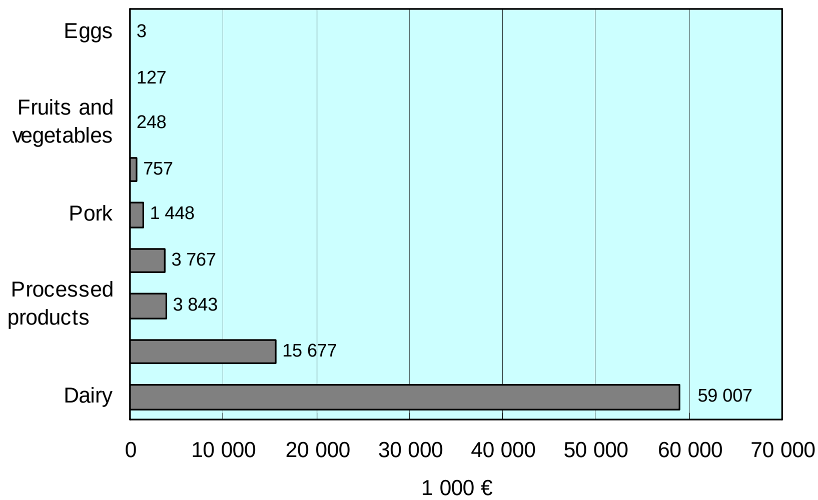
Source: USDA, ERS 2004.

According to Figure 6, export subsidy expenditures in the CEEC and the US were well below the EU-15 level. In fact, the value of the US and CEEC export subsidies was under 4% of the EU-15 total expenditures. However, some factors need to be taken into consideration before jumping to conclusions. First, the EU-15 simply exports more dairy products than, for example, the US or the CEEC; the EU-15 represents approximately 35% of the global dairy exports, while the US market share is less than 5%. Second, export credits, insurance programmes, state trading firms, food aid and so on are also applied in world dairy trade, indirectly supporting dairy exports. However, it is not easy to evaluate the effects of these other instruments due to lack of sufficient data.

A more detailed picture of export subsidies is obtained by comparing unit export subsidies according to products. Unit export subsidies are obtained by dividing the actual export subsidy expenditures by the total export volume (consisting of both subsidised and non-subsidised exports). A brief comparison shows that unit export subsidies are highest in the EU and are heavily channelled into butter exports, while unit export subsidies are on average lower in the US, and they are directed to exports of rest of the milk products and whole milk powder. The relative significance of export subsidies is determined by comparing the industry's unit export price with the unit export subsidy. This comparison reveals that butter and other milk products are relatively the most dependent on export subsidies in Finland and in the EU-15, while in the US the dependence on exports subsidies is highest with whole milk powder and other milk products. In summary, these are likely to be the most vulnerable products if export subsidies are abolished.

The total value of Finnish export subsidies was 84 million euros in 2004. The majority of Finnish export subsidies go to dairy exports (70%), while sugar, processed products and grains form a considerably smaller share of total subsidised exports. It should, however, be borne in mind that dairy exports subsidies have been cut by 50% during the past couple of years: export subsidies were worth of 72 million euros in 2003, while their total value was only 36 million euros in 2005. Approximately half of the total Finnish export subsidies are applied to Russian exports. The vast majority of the subsidies go to the dairy sector, which accounted for over 85% of the total supported exports to Russia.

Figure 7. *Division of Finnish export subsidies in 2004.*

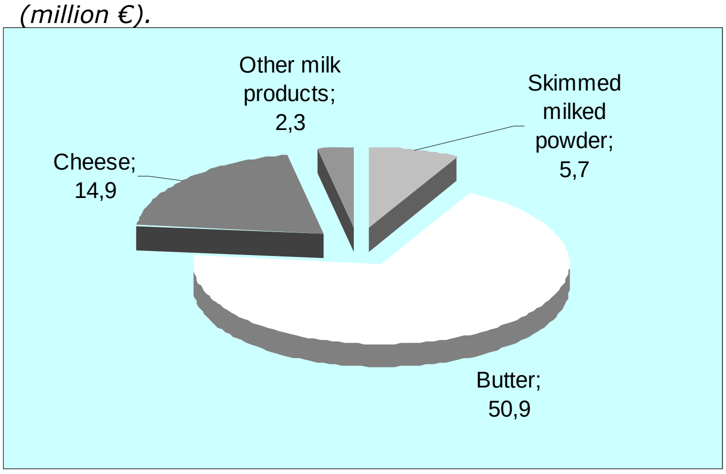


Source: Ministry of Agriculture and Forestry for Finland.

The majority of Finland's export subsidy refunds go to butter. The reason behind this is that the domestic market price in the EU clearly exceeds the world market price (OECD-FAO 2005). In fact, the butter price on the world market is about half of the EU price level. This indicates a substantial need for export refunds, because butter's unit subsidies are clearly above the average dairy product unit subsidies. This is a problematic issue, especially for Finland, due to the increasing demand for low-fat dairy products, and thus there is a significant over-supply of butter. It seems that butter is the most problematic product for the Finnish dairy sector, when export subsidies will be abolished.

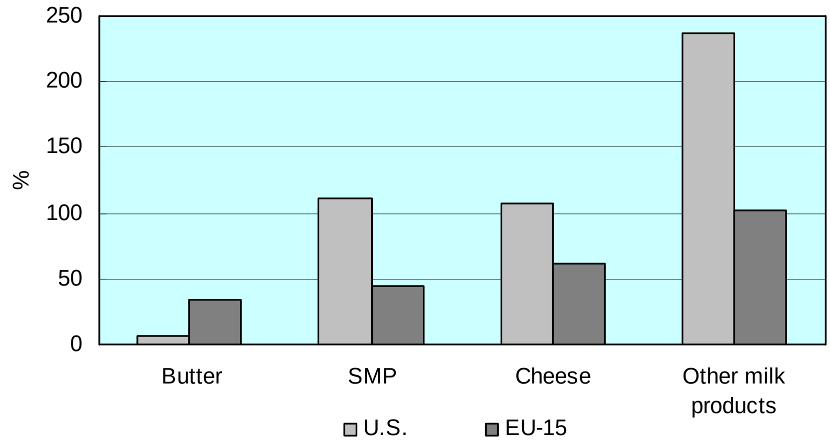
The URAA requires WTO members to cut both the budgetary costs and subsidised quantities of export subsidies. Developed countries agreed to lower the value of export subsidies by 36 per cent over a six-year period starting in 1995. The maximum level of subsidised export was lowered by 21 per cent over the same time period. Export subsidy commitments set maximum allowed volumes and values, but the maximum subsidy may not necessarily be needed. The percentage use of the maximum allowed subsidy varies between countries and commodities. Figure 8 presents the average subsidies as a proportion of the maximum allowed in the EU-15 and the US from 1999-2001. The commitments have been more binding for the US than for the EU. In fact, the US has exceeded the maximum budgetary limits in all categories excluding butter.

Figure 8. *Finland's export subsidy expenditures on milk products in 2003 (million €).*



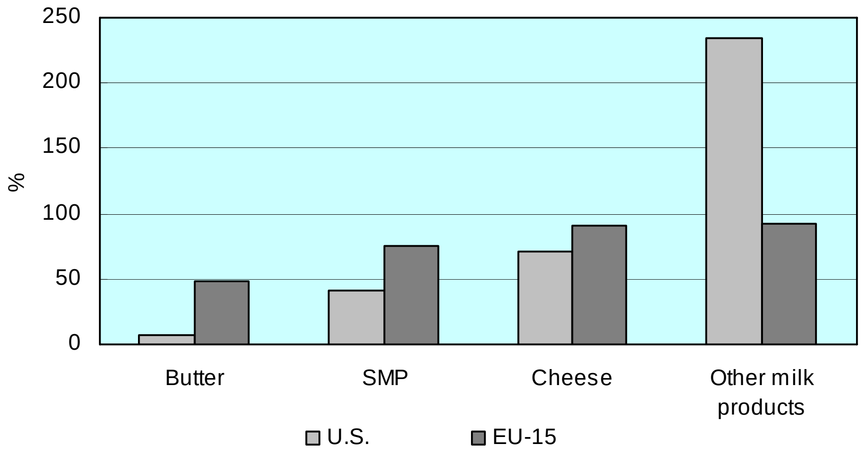
Source: Ministry of Agriculture and Forestry for Finland.

Figure 9. *Average export subsidies (value) as a percentage of the maximum allowed in the EU-15 and the US from 1999-2001.*



Source: USDA/ERS.

Figure 10. *Average export subsidies (volume) as a percentage of the maximum allowed in the EU-15 and in the US from 1999-2001.*



Source: USDA/ERS.

As we can see from Figure 10, volume-based commitments have been more binding for the EU-15 than for the US, if other milk products are excluded. The situation has slightly changed since the period 1999-2001. For example, in the marketing year 2003/2004 the EU-15 used over 95% of cheese export commitments. In fact, it is assumed that volume-based restrictions will be more problematic in the future than budgetary commitments. For the US, differences between goods are considerable. The maximum limit of export subsidies was clearly exceeded in the case of other milk products, but subsidised exports of butter were extremely modest.

To summarise, export subsidies are of considerable importance to the EU and the Finnish dairy sectors. Export refunds have not only boosted dairy exports but they have also had a positive influence on producer prices.

2.2 Dairy policy in the EU

The EU dairy policy is rather complicated. Not only production but also processing and the dairy trade are regulated through various policy instruments. Policy tools are created to implement the Treaty of the European Economic Community. According to the EEC Treaty, objectives of the common agricultural policy are to ensure a fair standard of living for agricultural producers, to stabilise markets, and to ensure that supplies reach consumers at reasonable prices.

This chapter presents the main dairy policy instruments applied in the EU. Major changes took place in EU agricultural policy in 2003 when the Common Agricultural Policy was reformed. The reform included some changes to the dairy sector, but the majority of the older policy instruments have remained valid after the policy reform. The global dairy model applied in this study covers the years 1999-2001, when older policy instruments were applied, and thus some minor changes in the intervention system introduced by the policy reform are ignored in the global dairy model. Policy instruments are here divided into three categories. Common support measures are first shortly presented, followed by national support measures for Finnish dairies, and finally measures for dairy market operations are discussed.

2.2.1 Common support measures of the EU

The European Commission orchestrates European agricultural policy by functioning as a “think tank” for policy strategies. It not only plans the directions of the Common Agricultural Policy (CAP), but also implements the policy. CAP payments make up the majority of agricultural subsidy payments in most of the EU countries and they are financed in full through the EU budget. The EU also contributes about one third of compensatory payments for the less favoured areas (LFA support), and more than half of the environmental support. The remaining support measures consist of national support and are fully financed by national budgets. LFA and environmental support play a minor role in EU agricultural policy, but in Finland the LFA payments represent one fourth of the total support payments (Finnish Agricultural and Rural Industries 2002).

The milk quota system is one of the most significant CAP policy tools applied to the dairy sector. The EU suffered from a chronic over-supply of raw milk production by the late 1970s. As a consequence, the milk quota system was successfully introduced in the mid 1980s to reduce the excess supply. Quotas are allocated separately for each member country. In the EU agricultural policy reform it was decided that milk quotas would be raised by 0.5% each year from 2006/07 to 2007/08. The quota regime will remain in force at least until 2014/2015.

The milk quota system efficiently restricts raw milk production. In fact, according to studies concerning the abolition of the milk quota system (e.g. INRA 2002, European Commission 2002), milk production would clearly increase as a result of quota removal compared to the current situation. Moreover, production would concentrate on efficient areas (Jansson 2002) at the expense of less favoured areas, including Finland. Thus, the milk quota system has specific importance for a country like Finland suffering from an unfavourable climate.

2.2.2 National support measures

Due to the unfavourable natural conditions, agricultural support plays a greater role in the income formation of agriculture in Finland than in other parts of the EU. The criteria for payment of national support in Finland were decided during the negotiations on EU membership. National support consists of northern aid, national aid for Southern Finland and a national supplement to the environmental support and certain other measures. National support may not exceed the total level of support before EU membership and it is not allowed to increase the level of production. National aid is mainly directed to milk and beef production (Finnish Agricultural and Rural Industries 2004).

Finland is allowed to pay national northern aid for 55% (1.4 million ha) of the arable area. Northern aid includes price support for milk, aid based on the number of animals, and aid based on the cultivated area. The total value of northern aid was € 389.1 million in 2004. Northern aid has gradually increased since EU membership by compensating income losses caused by the reduction in transitional aid. The majority of northern aid is directed to milk production, accounting for over 50% of the total support (Finnish Agricultural and Rural Industries 2002, 2004).

Northern aid is not paid for the whole country, which created a need for another support instrument for the rest of Finland. Finland is allowed to pay national aid for Southern Finland (article 141 of the Accession Treaty) to relieve serious difficulties resulting the full application of the Common Agricultural Policy. National aid for Southern Finland will gradually decrease during the years 2004 to 2007, but farmers receive investments aid in the full amount allowed under EU State aid rules. Finland may also pay additional LFA payments to farmers who fulfil the support commitments. National aid for Southern Finland comprises quite similar payments in the livestock sector to northern aid. National price support for milk production varies in different support regions depending on whether the region lies in northern or southern Finland (Finnish Agricultural and Rural Industries 2002, 2004).

The national milk support price has a great deal of importance to the Finnish dairy sector. The milk support price makes up approximately 20% of the producer price of milk in Finland, and therefore it forms a significant proportion of total revenues. National price support should not be paid elsewhere in the EU according to the Agreement of the European Economic Area. However, Finland, Sweden and Norway obtained an opportunity to pay a national milk support price as a result of negotiations on EU membership.

2.2.3 Market Operations for milk and milk products

The EU dairy policy measures are applied to the EU dairy markets and have a significant effect on them. Common organisations of the market (COM) set a target price for cow's milk that is fixed by the Council. The target price is a type of reference price that should be close to market price for milk. However, it is important to stress that the target price is only a reference level, and the dairy industry is not entitled to follow that price. As a result of the agricultural policy reform in 2003, the target price was abolished.

The intervention buying mechanism is one of the most relevant dairy policy tools in the EU. When market prices of dairy products decline under a certain level (e.g. the price of butter or skimmed milk powder is 92% of the intervention price or lower), the system triggers intervention buying (European Commission 2002). In the Council regulation No 1255/1999 concerning dairy markets the intervention mechanism is described as follows "..implementation of an intervention system should maintain the competitive position of butter on the market and provide for the most efficient possible storage.. ...buying into intervention should take place in so far as it is necessary to maintain the stability of the market by reference to the market price of butter in the Member States, and should be carried out under a tendering procedure". The goods must meet some requirements concerning quality (maximum water, protein and fat content) and age, and the goods must be produced in the EU (Council Regulation 1999). Aid is also granted for private storage of skimmed milk powder and cheese, if there are temporarily imbalances. The sum of aid is based on storage costs (European Commission 2002).

The agricultural reform decided in 2003 slightly changed the intervention system. It resulted in the reform of dairy policy starting in 2004/05, including intervention price cuts. The butter intervention price will be gradually cut by 25% over three marketing years, and skimmed milk powder by 15% over four marketing years. Furthermore, the degressive annual ceiling for butter intervention purchases is set to be 70 000 t in 2005, and 30 000 t from 2008 onwards. This income loss will be partially compensated by direct dairy payments in 2004-2006. The aid will be decoupled from production, but it will not be fully implemented until the cuts have been fully phased in. The national application of the phasing out dairy payments differs considerably between countries.

The intervention mechanism has at least two implications for dairy markets. Firstly, it stabilises changes in domestic market prices. Secondly, intervention buying increases the stock ratio. When market prices are low, intervention stocks normally grow, and conversely, stocks are sold when market prices rise. The EU butter production is around 1 670 000 tons per year. If intervention purchases are fully booked (70 000 tons), this represents approximately 4% of the total butter production. In other words, the intervention stock constitutes a significant part of the butter markets.
SMP and cheese may also be granted private storage aid if trends in prices and stocks indicate a serious imbalance on the market. The total aid depends on the total costs of private storage. If market conditions develop favourably, the Commission may decide that stored products must be re-marketed (Council Regulation 1999).

The EU also indirectly supports the dairy industry by means of product-based aids. Aid for industrially-used butter is granted for butter, butter oil and cream intended for use as ice cream and pastry products. Support is paid according to a tendering process and national intervention units govern the payments. A similar type of aid is also paid for skimmed milk and skimmed-milk powder intended for use as feedstuffs, provided these products meet certain standards. Skimmed milk is also entitled to receive aid when it is directed to casein and caseinate production. Again, certain quality standards must be fulfilled and national intervention units govern the support payments. Furthermore, when surpluses of milk products occur, the Commission may support the purchasing of butter, cream and concentrated butter. The supported milk products are sold to non-profit-making institutions, such as the military forces (Council Regulation 1999). In addition, the European Commission supports efforts to stimulate the consumption of milk and milk products in educational establishments. Butter was subject to 900 €/t aid in 2002 and SMP is granted 700 €/t in aid to stimulate the consumption of dairy products in the EU. SMP support represents a half of the total SMP production, while aided consumption of butter is around 25% of the total butter consumption (European Commission 2002).

The European Commission is the authority that is responsible for implementing trade policy regulations. Export subsidies have been commonly applied to stimulate export efforts. The significance and magnitude of export subsidies in the EU and in Finland was already discussed in chapter 2.1. The main purpose of export refunds in the Council regulation 1255/1999 is as follows: "to the extent necessary to enable the products listed in Article 1 to be exported... ..difference between those prices (world prices) and prices in the Community may be covered by export refunds". Products must naturally originate from the Community and they are to be exported from the Community to third markets. Export refunds have commonly played an important role in dairy export policy due to the wide gap between the world market price and the EU domestic price. However, prices of dairy products may strongly fluctuate, which sometimes enables dairy products to be exported completely without subsidies.

The European Commission also governs imports of dairy products. A significant share of dairy product imports are under tariff rate quotas (TRQs) or some other bilateral preference agreement, because "normal" import duties on dairy products are simply too high. In fact, import quotas are a key to the EU market access system. Import quotas can be divided into several subgroups, which makes the market access system for dairy goods rather complicated. Tariff rate quotas were introduced as a result of the URAA. The aim of introducing the tariff rate quotas was to raise the consumption of foreign commodities to five per cent of total consumption. Current rate quotas were also introduced to ensure that the existing share of import commodities in domestic consumption would not decrease.

The EU also applies various preference duties to imported goods depending on the country or region of origin. There are special GSP preferences[3] for developing countries. The Cotonou Agreement is directed to ACP[4] countries and a bilateral double-zero agreement was in force with Eastern European countries before these countries became members of the EU. The EU also attempts to open duty-free market access to products originating from the least developed countries (Everything but Arms agreement). For butter and cheese originating from New Zealand, Australia, South Africa, Switzerland, Canada, Turkey and Norway the EU also applies special import quotas (with lower duties). These quotas officially fall into the tariff rate quota and current access quota categories. All the agreements in force offer substantially lower duties for exporting countries than MFN duties.[5]

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[3] GSP = Generalised System of Preferences.
[4] ACP = African, Caribbean and Pacific Ocean countries.
[5] MFN = Most Favoured Nation duties are applied with all trading partners.

It is important to stress that bound tariffs agreed in the URAA do not describe well the market access system in the EU. Applied tariffs are normally considerably lower and, moreover, a major part of total dairy imports is under separate import quotas.

3. Theory and modelling

The aim of this chapter is two-fold. First, it presents the general theoretical framework of the study. Theoretical motives for international trade are shortly presented, and the theory of trade policy is considered from the perspective of export subsidies. Emphasis is also placed on the Armington-type trade theory that is later applied in our global dairy model. Therefore, the main ideas and assumption of the Armington approach are introduced. Second, this chapter aims to illustrate basic trade modelling alternatives that are applied to demonstrate these economic theories in practise. The main ideas and differences between general and partial equilibrium models are shortly presented. Basic classifications of international agricultural trade models are also presented to make it easier to understand the literature review regarding the EU dairy policy and dairy trade modelling in chapter four.

3.1 Theory of trade policy

The motive for international trade is commonly explained by two main concepts: the theory of absolute advantage and the theory of comparative advantage. Both of the concepts simply claim that a country benefits from international trade. A country has an absolute advantage in the production of a good when its production costs are lower than in other countries, given the prices and exchange rates. In other words, a country exports whatever it can produce more cheaply than others, and it imports those items others can produce more cheaply. However, a country benefits from international trade, even if a nation has an absolute advantage in all its products. According to the theory of comparative advantage, the cost of producing additional units of any single product leads to a reduction in the output of other goods. This theory is known as the Ricardian model. To produce additional units of any good, a nation would have to rearrange its resources, for example land and labour, but simultaneously it might lose an opportunity to produce some units of other goods. The theory suggests that one should compare "opportunity" costs with comparable international prices. A nation should import goods for which the domestic opportunity cost of producing an additional unit at home exceeds the international price (Houck 1992).

The Ricardian model suggests that international trade benefits both sides of the transaction, as trade would otherwise not occur. However, the Ricardian model includes some assumptions that may lead to misleading conclusions about international trade. First, the model suggests an extreme degree of specialisation, which is not the case in the real world. Second, differences in resources are not taken into account as a cause of trade in the Ricardian model, even though this is an important aspect of the trading system. Third, the Ricardian model does not consider the role of economies of scale as a cause of trade, which leaves large trade flows between similar nations unexplained. Finally, the Ricardian model does not take into account the distribution of income within countries, but international trade commonly has strong effects on income distribution (Krugman & Obstfeldt 2003).

The Ricardian model is based on the theory of comparative advantage in terms of a one-factor model. Heckscher and Ohlin later developed a two-factor model, where two factors are both mobile between sectors. This Heckscher-Ohlin model is a theory of long-term general equilibrium, where the cause of trade is the difference between countries in relative factor endowments. The theory claims that a country relatively abundant in factor j (labour or capital) exports the relatively j-insensitive good. The theorem comprises several assumptions, which are skipped here (Borkakoti 1998, Sörensten & Reed 1994).

Despite the gains from international trade, it causes inconvenience to some lines of industry and sectors. Those groups affected often support protective actions against fully-liberalised trade. These actions include tariffs, import quotas, labelling requirements, sanitary restrictions, export controls, exports and subsidies (Houck 1992). The agricultural sector in the EU has commonly opposed actions towards more liberalised trade, because it might impose serious difficulties for agricultural producers. More specifically, the dairy sector provides a good example, and is thought to lose out if imports of dairy products are liberalised. The political influence of rural producers and their representatives has still remained strong, even though farm and rural populations are relatively small compared to other economic sectors.

Tariffs are commonly considered as the simplest trade policy tool, but export trade policy also offers an opportunity to protect domestic producers. Export subsidies are commonly understood to occur when a government provides an exporter a direct pre-unit payment on the volume of goods for foreign destinations. In practice, the exporter can purchase the product internally at a higher price and can sell it externally at a lower price. Export subsidies can also be provided indirectly, for example to marketing agencies that buy on the domestic market and have monopoly rights to sell on the international markets. If the internal price exceeds the international level the agency has received an export subsidy (Houck 1992). The European Union provides a good example of the motives behind the export subsidy system. Originally, the EU pursued stable income flows to European farmers by developing specific support levels. The system guaranteed high prices to European farmers, because the EU bought agricultural products whenever the prices fell below the so-called intervention level. In addition, tariffs were also raised to prevent large quantities of imports, which led to a difference between the European internal price and world agricultural price. However, in the 1970s the supply of food considerably exceeded the demand quantity, leading to growing stocks of food, because the EU was obliged to buy the "extra" food into intervention storage. To avoid rapid growth of stocks, the EU began to subsidise exports of surplus production (Krugman & Obstfeld 2003).

Export subsidy in a partial equilibrium framework

Next we will examine the impact of export subsidy imposition on international trade in a partial equilibrium framework. First, we will consider an export subsidy, whose per-unit value is a specified amount. A fixed export subsidy occurs when export costs are lowered by a specific per-unit amount, such as 50 cents per kilogram. In other words, this intervention enables the domestic price to exceed the world price by 50 cents per kilogram. A fixed export subsidy for a small exporter nation is described in Figure 11. The excess supply curve function is ES for the nation, while the horizontal excess demand curve for the rest of the trading world is ED(R)*. ES* is a new excess supply curve, where the supply price of exports is lowered by the value of s per unit. The per-unit export subsidy is described by s, which is the vertical distance between ES and ES*. The new intersection of ES* and ER indicates the export expansion, which is an amount equal to ab. When considering a small nation, the international price remains unchanged at p_1, while the internal price exceeds this, being p_2. As a result of the increase in

Figure 11. *Fixed export subsidy*

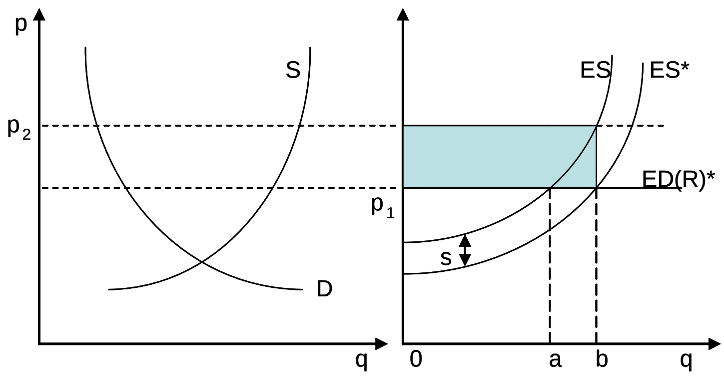
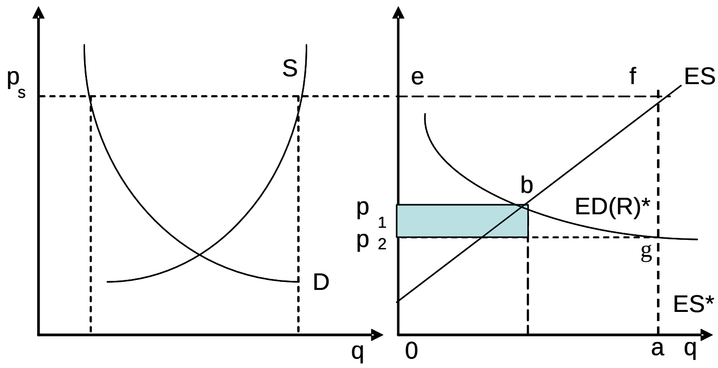


Figure 12. *Variable export subsidy.*

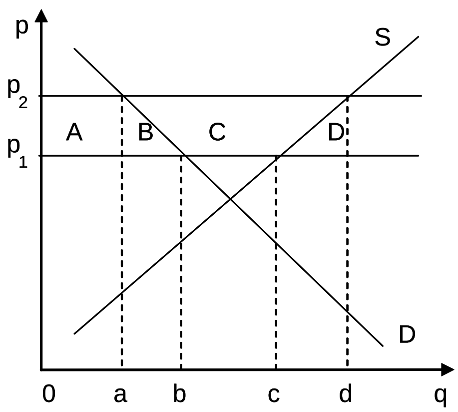


the domestic price, internal consumption naturally declines, and exports are thus likely to increase, which is financed by the government (Houck 1992).

In the case of a variable and open-ended export subsidy, domestic prices and world prices are fully disconnected. In this large-nation case the guaranteed domestic price (like the intervention price in the EU) for the commodity q is p_s, which is considerably higher than the free-market equilibrium price p_1. The domestic consumption is naturally lower compared to situation at p_1. Now an export subsidy is introduced in order to move this excess supply to the world market at the lower international price p_2. This is an intersection of ED(R) and ES*. The amount needed to be exported is described here by 0a in Figure 12. Compared to the previous case, the large exporter country depresses the world market price below p_1. The total subsidy expenditure is efg p_2. The larger the exporter nation is, the more sizable is the effect on the world price, and the open-ended export subsidy may turn out extremely expensive for the government. Moreover, both importing and exporting nations suffer from subsidised exports that drive international prices downwards and replace non-subsidised production and sales (Houck 1992).

Next we will analyse economic gains and losses, and the concepts of producer and consumer surpluses caused by an export subsidy. The basic idea of welfare changes is shown in Figure 13, where the world price is depicted by p_1 and the protected internal price p_2 exceeds the world price. The difference between these prices is covered by an export subsidy. In the case of pure competition (without intervention), amount 0c is produced, amount 0b is domestically consumed and bc is the remaining amount that needs to be exported. However, if the export subsidy is introduced, amount 0d is produced and amount 0a is consumed, while ad is exported with the subsidy. As a result of export subsidy imposition, the producer surplus increases by the area A+B+C, and the output also expands by the amount cd. A subsidy is paid on all exports generated at p_2, and the value of the export subsidy is the area B+C+D. The gain of producers is the area A+B+C, while consumers lose A+B, and taxpayers face a drop in their welfare, which equals B+C+D. The social net losses are areas B and D. Consumer losses equal the area B, as the amount ab is internally priced at p_2 and exported rather than consumed at p_1. D represents an efficiency loss to the society (Houck 1992).

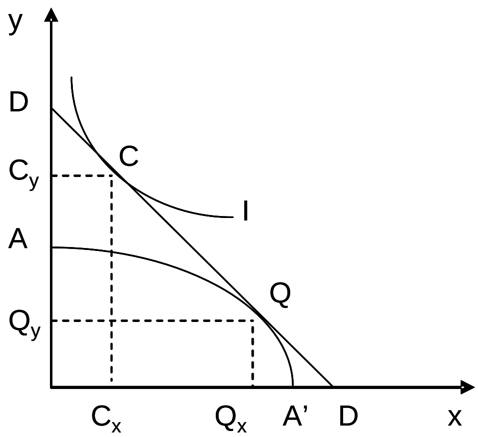
Figure 13. *Welfare gains and losses from an export subsidy.*



Export subsidy in a general equilibrium framework

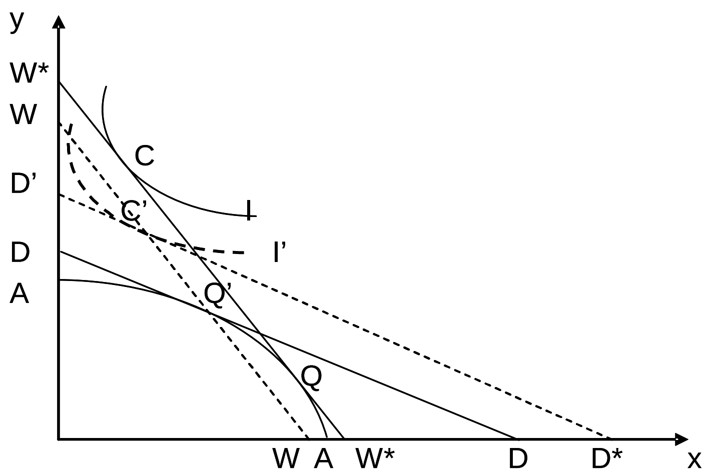
Next we will concentrate on export subsidies (and tariffs) in a general equilibrium framework. We will first consider the free trade case and then examine the effects on a small country of imposing an import tariff or export subsidy. We assume that the small country exports good x and imports good y. Curve AA´ describes the transformation curve, where points A and A' represent the maximum quantities of good x (or y) that the economy could produce. With free trade at the world price ratio shown by the slope of the line DD, the production mix is shown at point Q. In other words, the slope of the tangent gives the marginal rate of transformation at Q. Next, the demand side is introduced by homothetic indifferences curves. One of these curves tangentially touches the price line DD at point C. Under free trade, C is a unique general equilibrium point, where the small country consumes C_x and C_y quantities of goods x and y at the equilibrium price p. Q_y and Q_x correspondingly shows the quantities of production of goods x and y. The trade of the goods is illustrated as follows: $C_y - Q_y$ shows the imports of good y and while $Q_x - C_x$ defines the exported quantity of good x.

Figure 14. *The general equilibria of a small country under free trade.*



We will now suppose that the government imposes a tariff on imports of good x, or the government introduces an export subsidy, which will be financed by representative consumers as a lump-sum transfer payment. This implies that domestic prices differ from world market prices. Producers in the domestic country will adapt to these changes in relative prices such that more of the importable good and less of the exportable good is produced. Therefore, domestic production point Q will move to Q´ (Figure 15). The relative price of x within the importing country will increase by the amount of the export subsidy financed by consumers (or by the amount of the tariff), and the line will move to a new position DD'. Trade must still be at the same price ratio as before, so consumption needs to be at some point along the new trade line WW*, which is parallel to the original trade line WW. The consumption point must therefore be where the line WW cuts the indifference curve, and the indifference curve needs to tangentially touch the new domestic price ratio line DD´. Thus, the consumption point will move from point C to C'. This is the effect of a fall in real income due to substitution, provided that x and y are both normal goods. The fall in demand does not affect the world price, but the domestic price of the importable good is

Figure 15. *The general equilibria when a tariff or export subsidy is imposed.*



relatively higher. This, in turn, will lead to substitution in consumption. In summary, after having imposed an export subsidy (or tariff), the country is worse off once it moves from welfare level I to welfare level I´ (Borkakoti 1998, Sörensten & Reed 1994).

The imposition of a tariff (or export subsidy) has certain interesting consequences. First, it increases domestic production and decreases the consumption of imported goods, and decreases both production and exports of other goods. Second, the tariff (or export subsidy) leads to the violation of one of the Pareto optimality conditions that are satisfied under free trade. In the case of a small country, the marginal rate at which x can be transformed into y by shifting resources between two production sectors (along the production-possibility curve) is no longer equal to the marginal rate of substitution on the world markets. It is also worth noting that the welfare of the rest of the world will remain unchanged, because the world price is not affected by the tariff (or export subsidy). The burden of this policy change is carried by the country on which the tariff is imposed (Sörensten & Reed 1994).

3.2 Modelling

The previous descriptions of the implications of export subsidies had some interesting features. In the first case, examples of changes were examined from the point of view of certain business sectors, even if consumers, producers and tax-payers were taken in consideration when evaluating the effects of export subsidies in the final case. It is worth noting that other business lines and changes for the whole economy were ignored. This is because exports subsidies were evaluated in a partial equilibrium framework, contrary to the general equilibrium framework. In the second case the export subsidy system was examined in a general equilibrium framework, where the implications for other business lines were taken into consideration. Next we will concentrate more closely on trade modelling alternatives that are applied to examine the implications of trade policy instruments.

General equilibrium (GE) models have been widely applied in modelling international trade and also widely employed in analysing multisectoral agricultural models. GE models take into account the main macro-economic factors, such as employment, investments and savings, and they therefore analyse the implications for the entire economy. The use of general equilibrium models in agricultural trade models is based on the significant contribution of the agricultural sector in government spending or GDP. When calculating agriculture's share of the government budget or of total exports, the agricultural sector clearly matters. For instance, the developing countries are usually heavily dependent on agricultural raw material production, i.e. the agro food sector's share of total GDP is high (Brown 1993, Lehtonen 2001, Brockmeier et al. 1996).

However, in western economies agricultural production's share of GDP is modest, and employment by the sector is declining. Agricultural policy instruments are also more complicated, and the processing industry more diversified. GE models are not necessarily a proper modelling framework for these types of problems. In fact, in GE models agricultural products need to be aggregated and lumped together due to the manageability of the model, and identification of the effect of separate policy changes on single production lines is difficult. Results yielded by GE models may be ambiguous or otherwise difficult to interpret, especially if only a single product is examined (Törmä & Rutherford 1993). Partial equilibrium (PE) models are recommended if agriculture constitutes only a small part of the national economy. The structure of PE models is usually less complex compared to GE models, and the results are easier to interpret (Brown 1993, Lehtonen 2001, Salvatici et al. 2000).

In PE models, other sectors in the economy are simply neglected; the model does not take into consideration effects or feedback from other markets. This is a restrictive assumption, but the agricultural sector's influence on other economic sectors in western countries is limited. PE model are useful in empirical modelling when broader effects of policy tools on particular products or product groups are analysed. This is the case with the dairy sector, which requires a more disaggregated and detailed model framework. When modelling only one part of the agricultural sector, models are termed partial market models. This modelling type enables rather detailed modelling, but it also has some disadvantages. Agricultural markets are usually closely related to each other, and only limited conclusions should be drawn when applying partial market models (Hubbart 1995, Lehtonen 2001).

3.2.1 International trade models

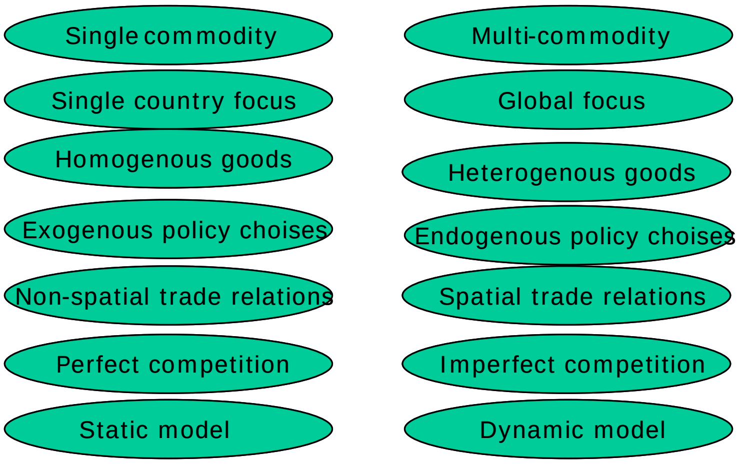
Agricultural trade models are typically applied to observe the impacts of trade or agricultural policy changes on agricultural trade flows. The models are typically static GE or PE models (Lehtonen 2001). Literature concerning trade liberalisation implications for the agricultural sector has significantly increased in recent years and models have become more sophisticated. Enthusiasm in agricultural trade modelling grew during the 1980s as a result of increased agricultural trade liberalisation pressures in multilateral trade negotiations. The highly protected and complex agricultural policy system required a detailed modelling framework to facilitate quantitative analysis (Brown 1993).

Agricultural trade models can be divided to several groups that are not easily classified. Figure 10 presents a simple dichotomy of the various options when constructing a partial equilibrium trade model. In the 1970s the focus of trade modelling was mainly on single commodity and national models. Since the 1980s interest in multi-commodity and multi-country models has grown (Brown 1993). The basic assumptions of agricultural trade models are presented next, and their applicability to the dairy sector is also briefly discussed.

The supply of various dairy products nowadays is wide. It is perhaps easily concluded that the single commodity framework is an unsatisfactory option to analyse the entire dairy sector. The majority of dairy models developed in the past few years have been multi-commodity models. Multi-commodity dairy modelling requires a good understanding of dairy processing in order for the model to accurately reflect reality. For instance, cheese production cannot be increased if milk fat and milk protein production remain unchanged (Westhoff et al. 2004). A single country focus does not meet the reality of global dairy markets well due to increased international trade. It seems that a purely national focus in dairy modelling is no longer widely applied.

The growing supply of dairy products have also has other implications for modelling. Consumers do not necessarily consider, for example, two similar Gouda cheese packages made in different countries as perfect substitutes. This suggests that dairy products should be considered as *heterogeneous* commodities. Tongeren et al. (2000) identified some typical

Figure 16. *Some basic assumptions of agricultural trade modelling.*



Source: modified from Brown's model.

features of PE and GE models in reviewing 18 separate agricultural trade models. In PE models, products were typically treated as being homogeneous, i.e. as perfect substitutes. In GE models, in contrast, products were differentiated by origin.

Policy instruments, like any other variables, can be incorporated into trade models basically in two separate ways. In endogenous policy modelling, policy instruments are not directly incorporated into the model, but they are derived as a result of other variables. Intervention stocks can be used as an example of this modelling procedure. Domestic policy makers have instruments to control the intervention stock level, but stock accumulation normally depends on world market prices. In endogenous modelling, the world market price is taken into consideration in determining the stock ratio. In exogenous policy modelling, variables are simply directly put into a model by fixing stocks on a certain level so that they remain unchanged in response to price fluctuations. It is intuitively perhaps evident that a model capturing many endogenous variables normally describes reality better than exogenous policy choices. Moreover, in the endogenous modelling framework a comparison of the implications of separate policy instruments is more straightforward.

Increased intra-industry trade in the dairy sector suggests that the trade dimension needs to be carefully incorporated into dairy trade models.

Basically, we have at least two options to do this. Trade can be taken into account by summing the import and export flows; in other words, trade is an aggregated variable. If this is the case, the model is termed a non-spatial model. If import and export flows are separately modelled according to the sources, the model is termed a spatial model.

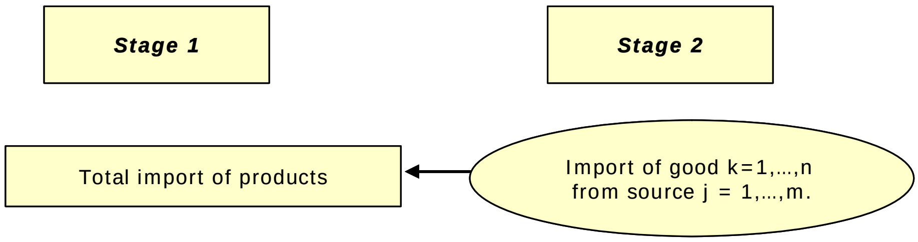
Spatial modelling has become an important research tool in trade modelling. Spatial models have several advantages; they generate trade flows and market shares, policy instruments can be easily introduced into them, and the spatial pattern of prices is consistent with transportation costs. The weakness of spatial modelling is specialised trade flows, which will minimise transportation costs. However, this is not consistent with trade patterns. Another weakness in spatial modelling is the assumption of homogeneous commodities (Patterson 1987).

Agricultural trade models can also be divided into static and dynamic models. Static models enable a comparison of the equilibrium resulting from different assumptions on exogenous data or policy variables ignoring time paths. Dynamic models allow the consideration of processes over time, and they are useful in tracing, for instance, stock accumulation. Dynamic features can be incorporated into the models in several ways. The most common way is to specify a recursive sequence of temporary equilibria (Tongeren et al. 2000).

3.2.2 Armington trade model

When examining international trade flows the country of origin is commonly of interest. In spatial modelling, trade flows are separated according to sources, but it considers commodities as perfect substitutes. This problematic assumption can be relaxed by applying the Armington (1969) trade theory model. Armington developed a system that allows imperfect substitution between domestic and foreign products, i.e. products originating from different countries can be considered as heterogeneous. The Armington-type partial equilibrium modelling framework is applied in this study. To make this model more familiar, the basic assumption of the model is presented here.

Figure 17. *Armington-type import system.*



The basic idea behind the Armington model is that importers maximise utility subject to national income. After solving the maximisation problem, product demand functions are yielded. The Armington model is based on the theory of separability. The model is solved in two stages; in the first stage an importer determines the total import of goods. In the second stage, an importer decides on the import sources. Imported goods are differentiated by the source of production. The main advantages of the Armington model are: 1) it predicts trade flows in a more diversified way than the spatial equilibrium model, 2) prices are not fixed to one value and differentiated goods can thus be examined, 3) the Armington model can be statistically estimated, and the number of parameters is relatively low (Figueroa 1986, Patterson 1987).

The derivation of trade flows from separate origins begins with the utility maximisation problem (Armington 1969, Patterson 1987). Importers are assumed to maximise utility U = U(X), where X is a product vector that incorporates n products and m sources. A vector product can also be presented in the following vector formats: $X = (X_1^1, X_2^1 ..., X_m^1)$, where m describes supplying countries, and $X = (X_1^1, X_1^2 ..., X_1^n)$, where n represents the goods. For each good n there are m different sources. Utility maximisation is restricted by national income function $\hat{Y}$.

$$\text{Max } U = U(X_1^1, X_2^1, .., X_m^1, X_1^2, ... X_m^n) \qquad (3.1)$$

$$\text{s.t. } \hat{Y} = \sum_{k=1}^{n} \sum_{j=1}^{m} p_j^k X_j^k \qquad (3.2)$$

X_j^k = the quantity of good k from source j

p_j^k = import price of the product.

$\hat{Y}$ = National income function.

The product demand function is yielded by solving the problem

$$X_j^k = X_j^k(p_1^1, p_{2,}^1 ..., p_m^1, p_1^2 ..., p_m^n, \hat{Y}) \tag{3.3}$$

for goods k =1,2,...,n and for import sources j = 1,2,...,m. The demand function above does not reflect the close association between products of the same type. Thus, U needs to be specified in such a way that the demand for any good X^k can be measured. This is achieved by “collapsing” U into the following form:

$$U = U'(X^1, X^2, ..., X^n) \quad \text{and} \tag{3.4}$$

$$X^k = \phi^k(X_1^k, X_2^k, ..., X_m^k) \tag{3.5}$$

ϕ^k = index function

Now X^k is classified as a good, while X_j^k is a product. In other words, the product includes the import source element, and therefore associates more information than a pure good. To make this specification possible, it is necessary to assume that the marginal rate of substitution between any two products is the same, i.e. U(X) is strongly separable. This means that importers’ purchases are independent of their purchases of other goods, i.e., buyers’ relative evaluation of different products is independent of their purchases in other markets. After this specification the maximisation problem can be presented as follows:

$$\text{Max } U = U'(X^1, X^2, ..., X^n) \tag{3.6}$$

$$\text{s.t. } \hat{Y} = \sum_{k=1}^{n} p^k X^k \tag{3.7}$$

The demand function is yielded for goods

$$X^k = X^k(p^k, p^k, ..., p^k, \hat{Y}) \tag{3.8}$$

Now, the optimal level of imported *goods* is determined (p^k presents an index price for good k). In the following stage, the optimal level for imported *products* from separate sources needs to be determined. This is described in a dual form by minimising costs:

$$\text{Min } \sum_{j=1}^{m} p_j^k X_j^k \tag{3.9}$$

$$\text{s.t. } X^k = \phi^k (X_1^k, X_2^k, ..., X_m^k) \tag{3.10}$$

The demand function yielded is

$$X_j^k = (X^k, \frac{p_j^k}{p_1^k}, \frac{p_j^k}{p_2^k}, ..., \frac{p_j^k}{p_m^k}) \tag{3.11}$$

This demand function is restricted by an assumption that the index function ϕ^k is linear and homogeneous of degree one. This means market shares are independent of the size of the market; in other words, market shares are determined by the relative prices of the products in the market.

Before we can determine import flows of different products, elasticities of demand function need to be estimated. The estimation form can be derived from the demand function after some manipulations. However, we need to assume constant elasticity of substitution, because direct estimation would fail. First, if several countries and commodities are included the function form is not exactly simple. Second, prices of a good from different sources tend to move together, causing multicollinearity problems. By assuming that ϕ^k follows a constant elasticity of substitution function form, the function can be expressed as follows:

$$X^k = \phi^k (X_1^k, X_2^k, ..., X_m^k) = (b_1^k X_1^{k^{-\rho k}} + b_1^k X_2^{k^{-\rho k}} + ... + b_m^k X_m^{k^{-\rho k}})^{-1/\rho_k} \tag{3.12}$$

ρ^k = constant and greater than –1.

$\sum_{j=1}^{m} b_j^k = 1$.

Now the products demand function can be expressed as

$$X_j^k = b_j^{k^{\sigma_k}} X^k (P_j^k / P^k)^{-\sigma_k} \qquad (3.13)$$

In this formula, σ^k is the elasticity of substitution for good k from different sources. b_j^k is constant, because the sum of exporters' market shares should equal one. The function is still modified by assuming that there are several importers in the model,

$$X_{ij}^k = b_{ij}^{k^{\sigma ik}} X_i^k (P_{ij}^k / P_i^k)^{-\sigma_{ik}} . \qquad (3.14)$$

In this formula, i presents an importer and j is considered as an exporter.

X_{ij}^k = quantity of good k imported from region j to region i.

X_i^k = total imports of good k to region i.

P_i^k = an index price of all the imports of good k

P_{ij}^k = price of good k imported from source j to region i.

σ_{ik} = the elasticity of substitution when importing good k from various sources to market i.

To estimate the elasticities of substitution the following formula is derived:

$$\frac{X_{ij}^k}{X_i^k} = b_{ij}^{k^{\sigma ik}} \ (P_{ij}^k / P_i^k)^{-\sigma_{ik}} \qquad (3.15)$$

By taking logs from both sides the elasticities can be estimated directly from the following form:

$$\ln(\frac{X_{ij}^k}{X_i^k}) = \sigma_i^k \ln b_{ij}^k - \sigma_i^k \ln(P_{ij}^k / P_i^k) . \qquad (3.16)$$

The Armington model has several advantages that make it a useful modelling technique. Figuero (1986) lists following reasons. First, the Armington model can be used to specify and forecast trade flow patterns adequately and to determine highly diverse trade flows, which is an advantage compared to spatial equilibrium models. Second, the model assumes heterogeneous goods, indicating that the law of one price does not hold. Third, the model parameters can be econometrically estimated. Fourth, only few parameters need to be estimated.

However, the Armington model includes some restrictive assumptions. Three main assumptions of the model have been criticised and some improvements to the original model have been made. First, the utility maximisation problem includes an assumption of independence of demands. This means, for example, that importer's purchases are independent of their purchases of other goods. In other words, if Finland intends to increase cheese imports from the European Union, Finland is not supposed to change the import of whole milk powder from the EU. This specification has been improved by not assuming constant elasticity of substitution (Figuero 1986, Hanuch 1971, Artus and Rhomberg 1983).

The second restrictive assumption relates to homotheticity. According to the Armington model, market shares are independent of the size of the market, but market shares are determined by the relative prices of the products on the market. For example, Russia would not make any distinction between Finland and New Zealand when importing butter to Russia if the relative import prices were the same. However, according to empirical research, homotheticity is too restrictive an assumption. For example, Yang and Koo (1993) found that if a good is differentiated such that each product gives different utility, changes in buyers' budgets may not be allocated in the same proportion to all products. Relatively more would be allocated to a high-quality product, even if the relative prices were the same.

The third restriction in the Armington model is the form of elasticity. An assumption of constant elasticity of substitution is problematic, because all the same types of commodities are substituted at the same rate. This is probably an unrealistic assumption and it is inconsistent with the model, which assumes differentiation of goods by sources.

Anania (2001) discusses some problems concerning the Armington approach. According to Anania, the Armington approach of imperfect substitution according to the county of origin gives rise to various questions. First, if goods produced in different countries are not perfect substitutes, this implicitly introduces a protection element for domestically produced goods. This is not a problem if substitution is not perfect between domestic and imported products. This probably reflects reality, i.e. existing implicit protection of the domestic market. However, if imperfect substitution between domestic and foreign goods does not occur, then a distortion is being introduced. In other words, market protection exists that derives from differences in quality between domestic and foreign products. Secondly, can dishomogeneity among agricultural products be entirely explained on the basis of the country where the goods are produced? For example, is it reasonable to assume that butter from Greece and Denmark are perfect substitutes, if the EU is considered as a single country? According to Anania (2001), the Armington approach serves to take into account existing product differentiation that can be explained by the country of origin, but it should not be used instrumentally as a means of finding a solution to the problem of how to model dishomogeneous products. Finally, if products from different countries are imperfect substitutes, it increases the possibility that countries may exercise market power to their own advantage.

Despite these restrictions of the Armington-type trade model, it has some advantages compared to spatial models. Armington models produce much smoother changes in trade shares than spatial equilibrium models, and account more adequately for observed trade flows than traditional spatial models. This can be tested empirically in chapter 7, where the results of the global dairy model are presented.

4. REVIEW OF EU DAIRY POLICY MODELLING AND DAIRY TRADE MODELLING

The previous chapter presented the theoretical framework of this study. Now we move closer to the theme of this study by more specifically examining dairy trade modelling. The aim of this chapter is to provide an overview of dairy trade modelling, where theories are applied in specific models. The chapter presents some modelling options and problems considering dairy trade modelling. The focus of this chapter is in EU dairy policy instruments modelling, because dairy policy tools have a great deal of importance for the whole dairy sector in the EU. Secondly, modelling problems originating from the WTO commitments are described with some solution concepts. Finally, some general remarks are made about dairy trade modelling. The modelling concepts presented are mostly derived from partial equilibrium dairy trade models.

4.1 Modelling the EU dairy sector

The European Common Agricultural Policy (CAP) is a complicated system including separate subsidies and market regulations, which also makes the modelling of the CAP a challenging task. Next we concentrate on typical challenges in modelling the EU dairy policy instruments.

Intervention mechanism

Dairy products (butter and skimmed milk powder) are subject to an intervention mechanism that guarantees for the product a certain minimum price. When the market price of a dairy product is below the intervention price level (i.e. the price of butter or skimmed milk powder is 92% of the intervention price or lower), it triggers intervention buying (European Commission 2002). The general significance of the intervention system for the whole EU dairy sector was already discussed in chapter 2.2, and thus we skip it here and concentrate on the modelling side.

Guaranteed minimum prices and the domestic market price can be easily intermixed, causing some problems in modelling. Institutional prices and market price are not always connected through price transmission equations, or the purpose and effect of different prices are mixed. As a result, models may assume that not only are guaranteed minimum prices set by domestic policy makers but that domestic market prices are also implicitly governed by domestic decision makers (Conforti 2001).

If the model neglects the existence of a transmission mechanism between institutional and market prices, it may cause problems in the following type of case. In partial equilibrium models, domestic prices are commonly related to international prices by price transmission or the price linkage equation. However, this can be a problematic choice if there are constraints on the use of border policies and the domestic price formulation does not take into account guaranteed price schemes. For example, if the WTO export subsidy commitments become binding, this will lead to a decrease in the domestic price. If the minimum guaranteed price is not taken into account, the simulated domestic price may fall unrealistically low, below the intervention price (Salvatici et al. 2000).

Salvatici et al. (2000) find it essential to model transmission from the institutional price to the market price, since institutional prices have an impact on market prices. Furthermore, explicit modelling of price support requires exogenous fixed institutional prices and the model determines endogenously the actual market price. Evaluation of the elasticity of transmission between intervention and market prices is a good modelling tool when assessing the extent of compensation for farmers if the minimum guaranteed prices are reduced.

Behaviour equations for stock demand are sometimes represented incompletely in partial equilibrium models, or in some cases stocks are completely ignored. If stocks are taken into consideration, they are commonly treated as an exogenous variable. If stocks are exogenously fixed to a certain level, they do not respond to market changes. However, the EU intervention stocks play an important role as a market “stabiliser”. Moreover, exogenous modelling does not take into account the public cost of either stock holding or the release of stock. Finally, the absence of modelling public stock decisions implies an overestimation of subsidised exports, and it also overestimates the effect of the CAP on world prices (Salvatici et al. 2000). Thus, endogenous modelling of intervention stocks is a more realistic modelling choice. An example of endogenously derived demand for intervention stocks is introduced below (Conforti et al. 2001):

$$S_t = cS_{POLt} + a\max[0,(1 - p_{MEU} / p_{InEU})] \quad (4.1)$$

$S_t =$ Amount of stock
S_{POLt} = (Exogenous) minimum stocks
p_{MEU} = Market price in the EU
p_{InEU} = Intervention price in the EU
a, c = calibrated coefficients

The intuition behind the equation is that the stock accumulation depends on the price difference between the domestic market price and the intervention price. If the market price exceeds the intervention price ($p_{MEU} > p_{InEU}$), demand for stocks depends on supply in the EU and on the minimum amount of stocks. By contrast, if the market price falls below the intervention price $p_{MEU} < p_{InEU}$, the stock accumulation continues until the market price exceeds the intervention price again. The speed of stock accumulation depends on a coefficient *a.* A similar approach is used in WATSIM, except that intervention buying starts when the quantitative limit on subsidised exports is met (Conforti et al. 2001).

The model approach presented above is based on the calibration of the stock reaction with respect to market price. However, this method does not produce an optimum public stock level, but only an empirical notion that stocks increase at given price level. In fact, this method should not be considered as endogenous stock determination. This approach requires a behavioural equation for stock demand, which is frequently absent from models (Conforti et al. 2001).

Modelling of intervention buying mechanisms varies across separate models. FAPRI-CARD is a multi-commodity and a multi-region partial equilibrium model that includes 24 products and 29 regions. The model includes meat, dairy, sugar and grain sectors. The model endogenously determines stocks by comparing domestic prices and intervention prices that determine the elasticity of intervention, which produces intervention stocks. AGLINK is another multi-commodity and multi-region partial equilibrium model. In AGLINK, dairy stocks are exogenously modelled, although intervention stocks of some other food products are endogenously determined (Conforti 2001).

In Bouamra et al. (2002), an intervention system is modelled by introducing an “additional region” that represents sales for commodities to EU intervention agencies. The demand for goods in that region is perfectly elastic at the intervention price up to the ceiling quantity level. When the upper bound constraint of government purchases (ceiling) is met, the demand is perfectly inelastic.

The intervention system is one of the most significant policy tools of the CAP. The absence of a behavioural relationship for public stock is an important limitation in models that aim to evaluate the implications of direct price support within the CAP. Other direct price support tools are less important, and they are in principle also more easily modelled (Conforti et al. 2001).

Milk quota

Supply management measures for output markets are particularly applied to milk and sugar production. Milk quotas were introduced in the mid-1980s to stabilise milk overproduction; since the quota system was applied, EU milk production has settled at about 121 million tons. As a result of the latest EU agricultural reform, the quota regime will remain in force until 2014/2015.

Basically, there are two options for modelling milk production quotas. Explicit milk quota modelling provides the first example. Quantitative supply restriction means that the model output becomes price-insensitive as the (maximum) quota level is reached. This type of explicit modelling of the production quota is used, for example, in the SPEL/EU model. However, this method does not take into account rent associated with the quotas, when the quota is binding (Conforti et al. 2001).

In some models raw milk production is treated as an exogenous variable. For example, in AGLINK the EU milk production is set to equal the milk quota (Conforti 2001). In other words, the quota is always binding, since the production capacity is not assumed to exceed the quota (Salvatici et al. 2000). The model by Boumra et al. (2002) restricts milk production by means of a milk quota. The model also includes quota rents. In the model presented by Mechemache and Rèquillart (1999), fluid milk production is constrained by production quotas, but over-quota production is allowed when paying over-quota taxes. In FAPRI-CARD and WATSIM, the milk output is also fixed exogenously at the maximum quota level, whatever the price level. This is probably a realistic assumption, but this exogenous output approach prevents the observation of quota rents and assessments of reform scenarios would also impossible if production quotas were to be abolished (Conforti 2001).

The most common technique for modelling the production quota is to use an indirect approach based on taxes. There are several examples of this modelling method. The quota can be represented through a producer "shadow price" (ESIM). In some models a production tax is introduced to ensure that the quota is not exceeded, like in some GTAP applications. The level of the quota rent can also be fixed exogenously (MISS). Price reduction does not affect the output unless it is above a certain percentage, which is assumed to correspond to the quota rent. In other words, milk production is not dependent on price changes, provided that the price changes are below a certain threshold (Salvatici et al. 2000, INEA 2001a).

There are also models that ignore altogether the existence of a production quota. In some modelling cases the EU domestic policy is not under specific interest (like FAO/WFM), or the quota is part of larger aggregates, making product specific analyses difficult (Salvatici et al. 2000).

According to studies on the EU milk quota system (INEA 2002, European Commission 2002), the quota significantly restricts EU milk production. This suggests that quota modelling has to be carefully taken into account in EU dairy policy modelling.

4.2 Modelling the WTO commitments

The Uruguay Round Agreement on Agriculture (URAA) has restricted the use of export subsidies and changed market access mechanisms. Trade policy regulations introduced by the URAA can be divided to three groups. First, maximum domestic support is to be reduced by 36% in the six following market years. This is calculated according to average production, not on a product basis, and therefore discussion of domestic support modelling is ignored here. Second, export subsidies are to be restricted by a 36% reduction in export subsidy expenditures and a 21% reduction of the volume of subsidised exports. Third, tariffs are to be lowered on average by 36%

over a six-marketing-year period, and the minimum tariff reduction per product was set at 15%. Market access of foreign products was improved by introducing a tariff quota system, which is divided into current access quotas and minimum access quotas. A product subject to tariff rate quotas or minimum access quotas is imported at a lower rate of duty, but only to a specific quantity limit.

In the following are presented the typical problems when modelling international dairy trade, and more particularly the commitments originating from the WTO.

Tariff modelling

Prices of exported and imported goods (c.i.f and f.o.b) differ due to trade policy. This is a reason behind the fact that trade policies are in most cases represented through a price linkage. Ad valorem tariff equivalents are normally modelled by means of a price linkage equation that describes the impact of trade policies as a wedge between the domestic and the external price. This is assumed to represent the "net tariff equation" of all trade policies. An example of a price linkage equation is presented below, which not only links the domestic price to the world price, but also takes into consideration transportation costs and specific tariffs:

$$p_{MEU} = t_s + (1+b)\,p_w + \delta \qquad (4.2)$$

$p_{MEU} =$ Market price in the EU
$p_w =$ International price
$t_s =$ Specific tariff
$b =$ Ad valorem tariff equivalent
δ = qualitative differences and transport costs

Most PE models follow a similar approach to the price wedge equations described above (like FAO-WMP, SWOPSIM, WATSIM) (Conforti et al. 2001). Necessary information for the equation can be obtained from different sources; price components of the PSE and the CSE can be applied, but nominal protection rates are also employed. Producer Subsidy Equivalents (PSE) and Consumer Subsidy Equivalents (CSE) are commonly employed in calculating the price wedges, even if they do not correspond well to the effects of direct price support due to the aggregate nature of the wedges. Problems in using the PSE arise when a single policy change is interpreted through the PSE, because the PSE cannot separate different policy actions. The PSE takes into account all the support received, and therefore it overestimates the wedges caused by a single policy change. The PSE is not a very stable parameter, either; on the contrary, it varies a lot from year to year because the unit PSE is calculated by dividing the overall support transfers by overall production. Therefore, changes in yield alter the PSE unit, even if the domestic policy remains unchanged (Anania 2001).

Moreover, the PSE may change although domestic policy and domestic production would remain stable if world market prices or exchange rates varied (Anania 2001). For example, the PSE value for milk substantially fluctuated in the 1980s, creating a cyclical pattern in the EU, in Japan and in the US. In fact, it seems that the PSE value reflects world price changes better than changes in domestic policy (Brown 1993). To sum up, the PSE is a good tool in assessing complete liberalisation of agricultural policy, including domestic actions and trade policy measures. However, this is not usually the case when implications of a single trade policy tool or separate domestic policy measure are compared (Anania 2001).

Because the PSE and the CSE are problematic, the nominal protection rates can be applied as well. Nominal tariff modelling may seem quite a straightforward task, but it may also turn out to be a complicated exercise (Salvatici et al. 2000).

Firstly, there are also some purely technical problems in tariff modelling. For example, an exact representation of tariff commitments in the dairy sector cannot be conducted without some modifications, because the EU has over 100 tariff commitments for dairy products. Products have to be classified and grouped into aggregate products, which necessarily creates distortions in the model. If tariffs are simply counted on an average basis, the market protection level is usually underestimated, because low tariff commodities have a rather limited influence on domestic markets. By contrast, tariffs for sensitive products are usually substantially higher. The principle of weighting tariffs as a basis of imported value does not, however, solve the distortion problem either. This is because the number of low tariff products imported may turn out to be very low, and at the extreme, their weight in the tariff calculation may be close to zero. To summarise, if more commodities belong to the same group, the scale of tariffs normally grows, and the likelihood of distorted tariff estimates grows (Anania 2001).

Secondly, tariff reduction commitments are commonly calculated from the maximum binding level, rather than current tariff rates. Maximum binding values normally overestimate the degree of trade barriers, because countries frequently apply lower tariffs than agreed in the URAA. Furthermore, countries normally apply lower tariff lines for non-sensitive products. In summary, the impact of the URAA can be significantly overestimated when reduction commitments are compared to the maximum binding level (Salvatici et al. 2000).

Thirdly, tariffs are basically divided into two main categories: ad valorem tariffs and per unit fixed tariffs. The charging basis for the ad valorem tariffs is a certain percentage of import prices. In contrast, fixed tariffs depend on the quantity imported. Both duty collection methods are frequently applied, but trade modelling normally only concentrates on ad valorem tariffs. If per unit fixed tariffs are included in the model, they are usually transformed into ad valorem tariffs by using a reference border price. If this is the case, changes in border prices do not directly transmit to tariff equations, and thus they do not correspond to changes in border protection (Anania 2001).

Fourthly, the absence of trade preferences in the model overestimates the effects on tariff reductions (Anania 2001). For example, the majority of dairy product trade is under some specific quota. Finally, non-tariff barriers (NTB) are not normally incorporated into agricultural models. This is because they cannot be properly represented through a tariff “equivalent”, because it simply does not exist. However, the importance of NTBs is probably growing as the use of conventional tariff barriers declines. NTBs include a wide range of separate measures including price controls, quantitative controls, state trading enterprises, technical trade barriers, subsidies and intellectual property rights (Westhoff et al. 2004, Salvatici et al. 2000).

Tariff rate quotas and preferential quotas

Tariff rate quotas (TRQ) were introduced as a result of the URAA with the aim of enhancing the consumption of foreign commodities to meet the minimum 5% of domestic consumption. A significant share of total dairy imports are already carried out by TRQs or some other bilateral quotas, because over-quota tariffs are normally too high. The quota system has great deal of importance when importing dairy products into the EU, because over-quota duties can be two or three times higher than in quota tariffs. The EU applies various preference duties and border measures for imported products depending on the country or region of origin. For example, GSP preferences are intended for developing countries, the Cotonou Agreement is for ACP countries and bilateral double-zero agreements provided lower duties for Eastern European Countries before their EU membership.

Quotas can be incorporated into a model in two separate ways (Tongeren et al. 2000). The first way is by tariff equivalent modelling, and the second is by a direct quantity restriction. The latter way works usually better. If a quota is not binding in the benchmark, the tariff equivalent will be set to zero. However, as a result of policy simulations quotas may become binding, but tariff equivalent modelling cannot take into account this effect.

In several PE models (Salvatici et al. 2000, Anania 2001) TRQs are completely ignored, or the TRQ modelling is inadequately performed. Problems in TRQ modelling originate from the possibility of switching from a lower to a higher tariff once the TRQ has been filled (over-quota duty). If a significant quantity of products is import above the TRQ, the relevance of TRQ modelling naturally increases. When modelling TRQs one should also stress that the model takes into account the possibility for each country to export and import at the same time, even if they have access to a TRQ. In some models the imports of net exporters are assumed to be equal to the TRQ. For example, AGLINK and FAPRI apply this method. However, this creates some problems, because according to the latest research the actual quantity imported via TRQs has been well below the maximum volume of the quota. Unfilled import quotas may refer to unrecognised trade barriers or to an inefficient allocation of quotas (Meilke et al. 1999).

In the Zhu, Cox & Chavas (1999) model, the market access mechanism is divided into two parts: an in-quota (lower) tariff rate and an over-quota (higher) tariff rate. In the model presented by Mechemache and Rèquillart (1999), model tariff rate quotas are also presented by introducing a two-tiered tariff system. The model simply divides imports into lower level in-quota tariffs and higher-level over-quota tariffs. The imported goods are then either consumed or used as an input for further processing.

It is perhaps easily concluded that careful modelling of preference agreements is a cumbersome task. Spatial (or Armington) models are the only proper way to model discriminatory import policy where bilateral trade flows are separately modelled. (However, it is worth noting that the spatial model assumes homogeneous products.) This is perhaps a time-consuming task, but this method guarantees that bilateral import quotas and tariffs are properly included in the model (Anania 2001, Salvatici et al. 2000).

Export subsidies

The URAA restricted the employment of the maximum amount of export subsidies by imposing a 21% reduction in volume-based subsidies and a 36% reduction in budgetary-based expenditures over a six-marketing-year period. In most cases, such undertakings are commonly modelled by assuming a 36% reduction in the per unit export subsidy. However, this method does not guarantee a 21% reduction in volume-based subsidies. According to the latest studies, the volume-based restrictions have been quite binding while value-based constraints have been slack. This finding also concerns dairy products. This implies that a 36% reduction in per unit subsidies may easily lead to underestimation of the expected slowdown of subsidised exports. Unsubsidised exports are commonly introduced such that non-subsidised exports cannot take place until the subsidised exports limit is binding (Salvatici et al. 2000).

Anania (2001) remarks that in several models the determination of the market equilibrium is not perfectly clear once the export subsidy commitments have become binding. In some cases, it is simply assumed that unsubsidised export is not allowed after the commitments have been filled. If this is the case, the importance of stocks naturally grows, and more specifically the endogenous determination of intervention stocks.

Quantitative constraints are commonly implemented in export subsidy modelling. For example, the FAPRI-CARD model employs this method. Exports are determined by comparing the position of domestic prices relative to world prices (Conforti 2001):

$$Q_{\exp} = \min[(L_{GATT,}(Q_s + S_{\varepsilon}Q_d)(p_{EEU} / p_w)] + s\{\max(0,(1-(p_{EEU} / p_w))\} \quad (4.3)$$

$Q_{\exp}$ = Exports

L_{GATT} = GATT quantitative restriction of subsidised exports

S_{ε} = EU domestic stock

Q_s = EU domestic supply

Q_d = EU domestic consumption

p_{EEU} = EU export price (including subsidy)

p_W = World price

S = Calibrated coefficient

The intuition behind the model is that if the EU export price exceeds the world market price, the second term in the equation is zero, and then the exports are equal to the minimum between the GATT restrictions quantitative limit and excess supply. However, if the EU export price falls below the world market price, the export is obtained by applying the whole formula, allowing both subsidised (the first term) and non-subsidised exports (the second term). In the WATSIM model the EU domestic price is assumed to be an endogenous variable. Quantitative restrictions for export are modelled by means of intervention stocks; the intervention buying starts when the export exceeds the subsidised export. Even if the structure of the model is different from FAPRI's above, there are some similarities in the mechanism (Conforti 2001).

In AGLINK the level of subsidised export of dairy products depends on the price wedge between the EU price and world price, i.e. on the relative competitiveness of EU dairy products. Exports of dairy products are divided into two separate groups: subsidised and non-subsidised exports. If the EU export price is lower than world market price the EU exports goods without subsidies. Conversely, if the EU market price exceeds the world market price, exports are subsidised until the maximum subsidy limit is reached (Conforti et al. 2001). In Zhu, Cox & Chavas (1999), WTO commitments are also taken into account by assuming that subsidised exports cannot exceed the WTO subsidisation limits. In Boumra-Mechemache et al. (2002), subsidised export is also subject to maximum quantity and budgetary restrictions that follow the GATT agreement. FAPRI-GOLD, WATSIM and SPEL-TRADE models assume that unsubsidised exports cannot take place once the volume-based export subsidy commitments have become binding.

Salvatici et al. (2000) stress that models would allow unsubsidised export once the commitments on export subsidisation are binding. This is important for the EU, where non-subsidised dairy exports have significantly increased as the commitments have become binding. Moreover, endogenous determination of EU intervention stocks guarantees that once the URAA commitments have become binding, intervention stocks may increase.

4.3 Some general remarks about dairy trade modelling

The EU domestic dairy policy instruments or the WTO commitments are not the only relevant issues that need to be taken into account when modelling dairy trade. In fact, the large range of dairy products, complicated processing methods, consolidated market structure, and separate technical problems make dairy trade modelling a challenging task.

Raw milk is used as an input in dairy product processing. Raw milk composition, i.e. the fat and non-fat components, has an important impact on the processing side. In fact, raw milk may vary considerably across different producers/regions. How should this be taken into consideration when modelling the dairy sector? Zhu, Cox and Chavas (1999) examine the effects of the Uruguay round agreement and full dairy trade liberalisation on the world dairy sector in their study. The model is constructed by assuming that alternative compositions of five milk components are inputs for eight final dairy products. Boumra-Mechemache et al. (2002) used a similar method. They developed a static spatial partial equilibrium model that assumes that the relative composition of two raw milk components (fat and non-fat) is used as an input for ten processed milk commodities.

In both models, each milk component used in final good production cannot exceed the amount of that milk component supplied in raw milk, and thus raw milk production and dairy products must match. This concept is good in the sense that it guarantees that milk composition has an effect on the production side. For example, a high fat percentage in raw milk produces more fat in final goods. Secondly, all raw milk is used and no extra dairy goods are produced. However, fat contents and processing methods vary between countries and sufficient information on milk components and processing methods is usually available only from developed countries.

The supply of separate dairy products is very wide. This suggests that dairy products cannot be lumped into one product if more specific product-based examination is pursed. On the other hand, some kind of aggregation is needed due to the large number of products. The problem is how to realistically describe such a wide range of products. For example, cheese is commonly presented as one category in dairy models, but variation across this group is enormous. Moreover, if dairy products are disaggregated, should they be treated as perfect or imperfect substitutes. In other words, should we treat cheese originating from Poland or Denmark as homogeneous products?

Dairy products are commonly divided into several groups in partial equilibrium models. For example, in AGLINK dairy products are divided into as many as 10 subgroups (Anania 2001). In Zhu, Coz and Chavas (1999), dairy products are divided into eight groups, and in Boumra-Mechemache et al. (2002) the model produces 10 final products including three groups for various cheese types. The dividing of cheese types into three different categories is definitely an advantage of this model. However, dairy good aggregation into one group is also applied. In the MISS partial equilibrium model, dairy products are lumped together into one group (Conforti et al. 2001).

In chapter three, the basic idea in Armington models that products originating from different countries are not considered as perfect substitutes was already presented. Tongeren et al. (2000) noted that the volume of processed food trade is increasing relative to trade volumes in primary commodities, and they are probably more differentiated nature than primary products. Food trade modelling should also reflect this change towards more differentiated processed food, but in PE models the products are commonly perfect substitutes. For example, AGLINK, FAPRI, SPEL-TRADE, SWOPSIM, WATSIM and other programs include an assumption on perfect homogeneity of goods (Conforti 2001). Dairy goods are also considered as homogeneous products in the dairy model of Zhu, Coz and Chavas (1999), and in the model of Boumra-Mechemache et al. (2002).

Anania (2001) remarks that international markets are characterized by the existence of firms large enough to exercise significant market power, but models typically assume a perfectly competitive market structure both in domestic and international markets. This problem also concerns the dairy sector. Dairy trade is highly concentrated on a country basis; the EU's market share of world exports market is approximately 35%, Australia's over 10%, while New Zealand has a market share of over 35%, and it is constantly rising (Dairy 2005). The size of dairy firms has also substantially grown in the past few years as a result of industrial consolidations. Therefore, some of the largest dairy firms exercise a significant market power in the world market.

The central role of the EU in the world dairy trade also has some implications for modelling. The majority of the EU agricultural models assume that the EU is a "large" country. In other words, world prices are influenced by the changes in domestic market price equilibria. However, some models consider world prices as an exogenous variable, and they remain unchanged after policy changes. However, changes in EU domestic policy have implications for exports and on a broader scale for production, consumption, net trade, and so on. A model based on the assumption that the EU is a "small" country will most likely yield distorted estimates when policy changes are analysed (Anania 2001).

According to a review of agricultural trade models by Tongeren et al. (2000), standard PE models have some typical characteristics: global coverage, homogeneous goods, a static model approach, ad valorem price wedges (trade), and the parameter estimation relies on the calibration method. PE dairy trade models mentioned in this chapter had similar characteristics. Tongeren et al. (2000) also remark that input sectors (fertilisers, herbicides, agricultural machinery etc.), the primary sector and processing sector are closely linked to the agricultural sector. However, most PE modes do not utilise this potential, because the main emphasis is placed on primary agricultural commodities.

Dynamic specifications were few in agricultural trade models. Dynamics is frequently added to trade models by using a recursive sequence of temporary equilibrium, but it causes some problems, because time-consistent behaviour cannot be guaranteed. Many restrictive assumptions (like the development of exogenous variables) need to be made when dynamic elements are added into a PE model (Tongeren et al. 2000). When interpreting the results of such a model, one needs to remember that outcomes are not necessarily yielded from the model itself, but from assumptions and exogenous variables (Lehtonen 2001).

Documentation of trade models is incomplete in some cases. The model itself is not always thoroughly described in papers, but poor documentation of the model estimation is a more common feature in trade models. According to Tongeren et al. (2000), this raises doubts when examining the validity of the results.

When assessing the results of agricultural trade models there are some purely technical issues that need to be taken into consideration. For example elasticities may have a significant effect on model results. Changes in domestic prices transmit to trade volumes, which depends both on export demand elasticity and import demand elasticity. However, price changes in the domestic market do not necessarily adjust instantly to export/import behaviour. There are some factors that may have an influence on incomplete transmission of elasticity, including narrowness of the product, stock holdings, and restrictions on domestic production. In other words, single trade elasticity does not necessarily present well the changes in trade behaviour in all circumstances. In fact, elasticities more closely resemble a variable than a parameter. The chosen time period may also be a crucial factor when calculating elasticities. Estimates of supply and demand elasticities may also depend on the extent of cross commodity relationships (Brown 1993).

There are basically two main approaches to estimate parameters for trade models (Tongeren et al. 2000, Lehtonen 2001). Parameter estimation should be done by a simultaneous equation estimation method that takes into account the overall model structure. However, the large size of the model, identification problems, or data problems frequently prevents direct estimation. Therefore, other options need to be considered. The second choice is normally a calibration method also called the synthetic approach. The main idea behind this method is to obtain parameter values in accordance with both the benchmark data and the theory chosen in the study. Initial estimates are taken from outside sources, but certain parameters are adjusted to same functional forms as in the initial data set. Calibration exploits theoretical restrictions, equilibrium assumptions, and assumptions on functional forms. Tongeren et al. (2000) find it somewhat surprising that the majority of agricultural trade models rely on calibration methods, especially when parameter estimate sources could be more up-to-date.

The selection of a base year has a great deal of importance in agricultural trade modelling when assessing the final results of the model. In the past Uruguay Round the base year decided for subsidy cutting was 1986.

During this selected base year the markets experienced a deep recession leading to a substantial enhancement in the import protection level. As a consequence, implementation of the URAA tariff reduction schemes did not turn out to be precisely tight, because the protection level in the base year was abnormally high (Brown 1993). Base year selection may also matter when a model is specified. Sometimes the model itself is well-specified and relevant causal links are taken into consideration, but the base year does not correspond to an economic equilibrium, and the model cannot replicate the base scenario (Lehtonen 2001).

Meilke et al. (1999) present in their study some common problems in dairy trade modelling. Here are listed some difficulties that have not already been previously mentioned. It is not perhaps surprising that data collection is problematic in several cases. The variation between time series is rather limited, which implies difficulties in estimating behavioural equations. Dairy production, stocks and trade flows were previously partly regulated, and hence market changes have not directly transmitted to production decisions, and so on. This, in turn, makes predictions based on historical data not necessarily reliable.

Representative price information on internal and world prices is needed in determining the “water” in over-quota tariffs (Meilke et al. 1999). The measured tariff equivalents will include the following items related to protection: market access commitments, consumer subsidies, consumer taxes and market price support. The developing countries are a major dairy importing area, but behaviour equations for dairy import demand are an underdeveloped area in dairy trade modelling. A demand component for developing countries would definitely improve dairy models, but the quality of data is often questionable (Meilke et al. 1999).

Meilke et al. (1999) also raise some problems regarding standardisation issues. Comparability of dairy products may involve some problems when building up a database. Consumption, prices and production are usually represented by different unit measures that make direct comparison impossible. This is not perhaps an insuperable obstacle, but in handling a large data set this may turn out to be a time-consuming task. Finally, Meilke et al. (1999) also place emphasis on determining supply curves. The existence of supply management makes the estimation of a supply curve complex, perhaps impossible task. This implies, in turn, that the marginal cost of production cannot be directly calculated and it needs to be taken from other cost of production data.

To summarise, dairy trade modelling has many challenging elements: processing methods are rather complicated, the number of final commodities is large compared to other agricultural sectors, and the scale of policy instruments is wide. Thus, modelling is less straightforward than in other agricultural sectors.

Several theoretical and practical issues need to be taken into account when constructing a dairy trade model. However, it should be borne in mind that the purpose of the study naturally drives the selection of the model type and subsequent decisions concerning the modelling. The Finnish dairy sector has strongly faced an inflow of foreign dairy products during the past 10 years. As a result of growing imports, Finnish dairy firms were compelled to identify more markets outside Finland. Here we are interested in examining the implications of export subsidy removal for the Finnish and the EU dairy sectors. In other words, general welfare analysis is not pursued, but an analytical examination of the possible changes directed to the dairy sectors. The dairy sectors are also highly influenced by the separate policy instruments applied. Chapter 2 already discussed the magnitude and significance of the European agricultural policy for the EU dairy sector. Endogenous policy modelling commonly produces more reliable results than exogenously-fixed policy modelling. All the issues mentioned above suggest that the PE model is preferable compared to the GE model, because it is simply more applicable in this case.

It is a global trend that consumers consider domestic food products differently from foreign food products. Furthermore, the supply of dairy products is currently growing, with imports of dairy products increasing as a result of trade liberalisation. This supports the idea of treating products as heterogeneous products, and the Armington approach especially provides a good tool here.

Differences between the dairy sectors of Finland and other EU countries were discussed in Chapters 2 and 3. However, an empirical model is not reliable and it cannot replicate and support general findings if the data collected for the model are inappropriate and inconsistent. In other words, the importance of high-quality data cannot be overestimated, especially in this case, where the unique Finnish dairy sector is modelled.

5. GLOBAL DAIRY MODEL

The global dairy model applied in this study is introduced in this chapter.[6] The model is partly based on the French model and the Wisconsin model (Boumra-Mechemache et al. 2002, Zhu, Cox & Chavas 1999). The French model is a compact description of the EU dairy sector that includes a good interaction between farm milk production and the dairy industry. The French model assumes that farm milk is transformed into final dairy products by using different amounts of milk components (fat and non-fat) as an input to produce the final dairy goods. This allows us to analyse both commodity prices and the shadow price of the implicit milk component. As we can see later, milk component prices are driving forces in changes in dairy product prices, and thus shadow prices provide a better understanding of policy change implications. The French model incorporates relevant policy mechanisms, such as the intervention system, quota restriction and trade policy instruments. The model solves prices for raw milk and dairy products, the production and consumption of dairy products, and trade for every region. The EU countries are divided into smaller sub-groups and dairy products are disaggregated as well.

The global dairy model was modified from the previous model to better meet the purposes of this study. The most significant changes were made to the trade dimension, which is more diversified than in the French study. The global dairy model is a multi-country and multi-commodity Armington-type nonlinear partial equilibrium model. In other words, import goods are differentiated according to sources. Secondly, the EU dairy sector description is not as disaggregated as in the French model due to the lack of data.

In this global dairy model it is assumed that fluid milk is a primary good that is transformed into five processed goods by using different amounts of two (fat and non-fat) raw milk components. The five processed final products are butter, cheese, skimmed milk powder (SMP), whole milk powder (WMP) and the other milk products (OMP). The model combines 7 regions: Finland, the EU-14 (EU-15 minus Finland), the CEEC-8 (New EU member countries excluding Malta and Cyprus) and the US are described in more detail, while one region (Australia, New Zealand, Canada) is described as an exporting

[6] The model was developed by Panu Kallio and Philip Abbott. However, analysis of the model, empirical testing of the model, data collection, estimation procedures, the model results and conclusions have been independently written up by Meri Virolainen.

region, and two regions (Russia and the rest of the world) as importing countries. EU countries are divided into three separate country regions. Finland creates one region, because one of the main tasks of this study is to examine the implications of export subsidy removal in more detail especially for the Finnish dairy sector. The other EU member countries are divided into "old" (EU-14) and "new" (CEEC-8) member countries. There are several reasons for this separation: first, the model covers the years 1999-2001, when the enlargement was barely decided on and the idea of the common dairy markets simply did not exist. Second, several differences (producer prices, wholesale prices, milk composition, milk quality etc.) were recognised when dairy sectors in the old and the new EU-countries were compared for that time period. In summary, the distinction between these regions seemed a reasonable choice and a virtual "common dairy market" was not created for this model.

The global dairy model consists of eight parts, which are introduced next in more detail.

5.1 Global dairy model in detail

Production of raw milk by dairy farmers

Raw milk production depends on the milk price and on the milk support price. The milk support price concerns only Finland, because it is not used in the rest of the EU, excluding Sweden. The support price has great deal of importance in Finland, because it accounts for approximately one-fifth of the producers' total milk-selling revenues. Milk production in the EU is also influenced by a milk quota that has stabilised the EU milk production ever since it was introduced. For four of the regions (FIN, EU-14, CEEC-8, US) the production and consumption of dairy products are explicitly modelled. To look at the production side in these regions we start by deriving the raw milk production q. Determination of raw milk production is solved by the profit maximisation function. Raw milk production depends on the average producer price, price support and the production quota.

$$q_i^{RM} = \min\{\alpha_i + \beta_i(p_i^{RM} + s_i^{RM}), \quad \bar{q}_i^{RM}\} \ , \quad [\, q_i^{RM} \leq \bar{q}_i^{RM} \,] \tag{5.1}$$

Where, q_i^{RM} = Annual raw milk production in region i.

p_i^{RM} = Annual average producer (farmgate) prices for region i.

s_i^{RM} = Price support for farmers €/kg (exist at least in Finland and Sweden)

$\overline{q}_i^{RM}$ = Production quota for raw milk production in region i.

α_i, β_i = parameters

Processing of final dairy products by dairy companies

Final commodities are produced from the received raw milk. The processing of final dairy products is described from the firm's perspective. Dairy companies are assumed to maximise their profits subject to two constraints which state that the amount of each milk component used in final good production cannot exceed the amount of that milk component supplied in raw milk. The model includes five final commodities, which are butter, cheese, skim milk powder, whole milk powder and other milk products. The model yields shadow prices for milk components that provide important information when analysing changes in final product prices.

$$\underset{y_r^k\, q_r^{RM}, \lambda_{rs}}{Max} L = \sum_{k=1}^{8} p_i^k y_i^k - p_i^{RM} q_i^{RM} - \sum_{k=1}^{8} (c_{i1} y_i^k + c_{i1}^k (y_i^k)^2) - c_F + \sum_{s=1}^{2} \lambda_{is} [q_i^{RM} a_{is}^{RM} - \sum_{K=1}^{8} y_i^k B_{is}^k] \quad (5.2)$$

Where, i = FIN, EU-14, U.S., CEEC-8

s = milk components; milk fat, protein

k = cheese, butter, whole milk powder, skimmed milk powder, and other milk products.

c_F = Fixed costs

c_{1i}^k = Unit processing cost

λ_{is} = implicit prices of components (shadow price of the s th component in region i.)

p_i^k = price received by processors (industry price) on final good k in region i.

y_i^k = Quantity of production for final good k in region i.

a_{is}^{RM} = Quantity of the sth component per unit of raw milk.

B_{is}^{k} = Quantity of the sth component per unit of the kth processed good.

By taking Kuhn-Tucker conditions the Lagrange function can be solved. The aim of Kuhn-Tucker conditions is to generalise first order conditions to a set of boundary conditions for finding equilibrium. Kuhn-Tucker conditions associated with the above maximisation problem are:

$$\frac{\partial L_i}{\partial y_i^k} = p_i^k - c_{1i}^k - 2c_{2i}^k y_i^k - \sum_{s=1}^{2} \lambda_{is} B_{is}^k \leq 0 \text{, for } y_i^k = 0 \quad (5.3)$$

$$= 0 \text{, for } y_i^k > 0$$

$$\frac{\partial L_i}{\partial q_i^{RM}} = -p_i^k + \sum_{s=1}^{2} \lambda_{is} a_{is}^{RM} \leq 0 \text{, for } q_i^{RM} = 0 \quad (5.4)$$

$$= 0 \text{, for } q_i^{RM} > 0$$

$$\frac{\partial L_i}{\partial \lambda_{is}} = q_i^{RM} a_{is}^{RM} - \sum_{k=1}^{8} y_i^k B_{is}^k \geq 0 \text{, for } \lambda_{is} = 0 \quad (5.5)$$

$$= 0 \text{, for } \lambda_{is} \geq 0$$

The expressions $q_i^{RM} > 0$ and $y_i^k > 0$ are so-called non-negativity conditions for the two "primal" variables, i.e. these variables (quantity of final products and raw milk) cannot be negative in order for the problem to make sense. The last expression, $\frac{\partial L_i}{\partial \lambda_{is}} \geq 0$, reiterates the constraints. The expressions $y_i^k \frac{\partial L_i}{\partial y_i^k} = 0$ and $q_i^{RM} \frac{\partial L_i}{\partial q_i^{RM}} = 0$ are known as complementary slackness conditions, i.e. the product of the expression needs to be zero. Thus, the complementary slackness condition must hold for each variable and for each partial derivative of the Lagrangian function L. In other words, the marginal condition holds with a strict equality, or the choice variable considered has a zero value. An optimal solution is found for λ_{is} such that the associated marginal condition holds, i.e. $\frac{\partial L_i}{\partial \lambda_i^k} = 0$, or the Lagrange multiple vanishes ($\lambda_{is} = 0$), or both.

Perhaps the most interesting interpretation of the Kuhn-Tucker conditions is that complementary slackness conditions enable the corner of boundary solutions to be found. Second, Lagrange multipliers can be regarded as shadow prices. When the optimal solution is found, a constraint holds with a strict inequality, and the associated shadow price must be zero.

Determination of demand; Consumer-demand system derived LES

The domestic consumption of final dairy products in each of four regions is derived here. The consumption is yielded using the so-called Linear Expenditure System (LES function). The linear expenditure system (LES) is a complete set of consumer-demand equations linear in total expenditure. The advantage of this model is that it determines a consumer choice solution for the general equilibrium system without computational iterations. The main idea of the LES function is that it produces the minimum level of consumption, and the excess of income over the total cost of the minimum consumption basket is spread across the various consumer goods. Marginal budget shares determine how consumers allocate their income above the minimum level of consumption (Taylor 1979).

Deriving of the total demand for final goods is started by maximising utility subject to a budget constraint. LES “characteristics” are seen in the function

$$V_i = \sum_{k=1}^{8} m_i^k \log(z_i^k - \theta_i^k) - \mu_i (D_i - \sum_{k=1}^{8} p_{iz}^k z_i^k) \qquad (5.6)$$

in which z_i^k is the consumption of the k[th] commodities, p_{iz}^k is the consumer price of k in region i, and m_i^k and θ_i^k are parameters of the utility function. μ_i is a Lagrange multiplier. θ_i^k can be interpreted with the following formula

$$\theta_i^k = (\frac{D_i^k}{p_{iz}^k})[\phi_i^k - m_i^k \sigma_i^z] \qquad (5.7)$$

Where: $\phi_i^k =$ The budget share of good k in region i. $= \frac{p_i^k z_i^k}{D_i}$.

For the residual sector $\theta_i^9 = 1 - \sum_{k=1}^{F} \frac{p_i^k z_i^k}{D_i}$. Assume that the price of the residual good is 1. => The residual sector's expenditure = quantity, and is $p^9 z^9 = D - \sum_{k=1}^{8} p^k z.$

$\sigma_i^z =$ Inverse of the Firch parameter. This value is about ½ for most commodity groups.

$m_i^k = \eta_i^k \phi_i^z$. η_i^k income density of demand is required from the literature.

The derivation of formula 7 and the final LES-set demand function are presented in more detail in Appendix 1.

The LES-set of demand equations is:

$$z_i^{CHE} = \theta_i^{CHE} + \frac{m_i (D_i - F_i)}{p_{iz}^{CHE}} \quad (5.8)$$

$$z_i^{BUT} = \theta_i^{BUT} + \frac{m_i^{BUT} (D_i - F_i)}{p_{iz}^{BUT}} \quad (5.9)$$

$$z_i^{SMP} = \theta_i^{SMP} + \frac{m_i^{SMP} (D_i - F_i)}{p_{iz}^{SMP}} \quad (5.10)$$

$$z_i^{WMP} = \theta_i^{WMP} + \frac{m_i^{WMP} (D_i - F_i)}{p_{iz}^{WMP}} \quad (5.11)$$

$$z_i^{RES} = \theta_i^{RES} + \frac{m_i^{RES} (D_i - F_i)}{p_{iz}^{RES}} \quad (5.12)$$

Where: $p_{iz}^k =$ Consumer price of k in region i.

$z_i^k =$ Consumption of good k in region i.

$D_i =$ Total expenditure, GDP or better disposable income

$F_i =$ Total cost of the minimum consumption basket

Dairy trade model is based on the Armington approach. This modelling system enables import products to be incomplete substitutes. Industry prices were already determined in the second part of the model, and here this result is utilised when export prices for dairy products are set. Export prices of dairy products are yielded by adding (or actually reducing) export subsidies to industry prices. Import prices were obtained by adding tariffs and transportation costs to export prices.

Trade flows to each region i will be determined in this section in two stages by using the Armington model. In the first phase, the total demand for foreign commodities is determined, and then sources for imported goods are determined. The basic idea of the Armington trade model has already been explained previously in this study, and it will be still discussed later in chapter 6, when import substitution elasticities σ_{iz}^{k} are derived. The derivation of import quantities begins with the determination of total import.

- Stage 1: $z_{ij}^{k} = (b_{ijz}^{k})^{\sigma_{iz}^{k}} z_{i}^{k} (\frac{P_{ijz}^{k}}{p_{iz}^{k}})^{-\sigma_{iz}^{k}}$, j = home, foreign (5.13)

i = FIN, EU-14, CEEC-8, U.S

Where: $z_{ij}^{k} =$ Consumption of good k in i from source j.

$z_{i}^{k} =$ Total consumption of good k in region i.

$p_{ijz}^{k} =$ Price of good k paid by importer i from source j.

$p_{iz}^{k} =$ Average consumer importer price of good k in region i.

$\sigma_{iz}^{k} =$ Elasticity of substitution between home and foreign product k in region i.

In the second stage, import is determined by sources.

- Stage 2: $M_{in}^{k} = (b_{inm}^{k})^{\sigma_{im}^{k}} M_{i}^{k} (\frac{P_{inm}^{k} - S_{ij}^{k} + t_{in,in-quota}^{k}}{p_{in}^{k}})^{-\sigma_{ii}^{k}}$, (5.14)

n = exporter (FIN, EU-14, CEEC-8, NEC)

Where: $M_{in}^{k} =$ Import quantity of good k from region j to region i.

$M_{i}^{k} =$ Total imports of good k to region i.

$P_{inm}^{k} =$ Price of imported good k paid by consumers from source j in region i (Prices after transportation costs but before tariffs).

$P_{im}^{k} =$ Average price of imported good k from all sources (Price for foreign good includes transportation costs and tariffs)

$\sigma_{im}^{k} =$Elasticity of substitution of good k from different sources

$S_{in}^{k} =$ Export subsidies for good k from source j to region i

$t_{in,in-quota}^{k} =$ In-quota tariff.

In this section it is assumed that dairy import tariffs are in-quota tariffs, but this is explained more thoroughly in the next chapter.

Stocks

Public stocks (intervention stocks) are now introduced in this model. In chapter two, the intervention mechanism and its significance to the EU dairy sector was presented more thoroughly, and we pass over it here. Private stocks are ignored in this modelling, because they play a minor role in a long period model. The endogenous stock demand function (intervention stocks) is determined as follows:

$$\text{Stocks}^{k}(p_i^k) = \begin{cases} 0, \text{ if } p_i^k > p_{\text{int}u}^k \\ \gamma_i^k - \delta_i^k p_i^k, \text{ if } p_{\text{int}l}^k \le p_i^k \le p_{\text{int}u}^k \\ \text{Ceiling, if } p_i^k < p_{\text{int}l}^k \end{cases} \tag{5.15}$$

Where: Stocks_i^k = Carry-out stocks for good k in region i.

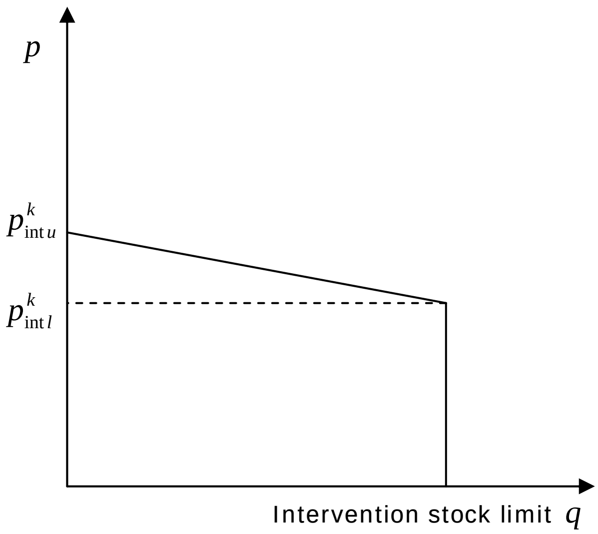
p_i^k = Price received by processor

$p_{\text{int}u}^k$ = Intervention price (intervention buying starts)

$p_{\text{int}l}^k$ = Intervention price (intervention buying stops)

In actual intervention, buying starts as the market price drops below the intervention price level, and it continues until the intervention quantity limit is met. When the market price (butter and skimmed milk powder) exceeds the intervention level, intervention stock accumulation stops. In this model the buying mechanism is not as simple for mathematical reasons.

Figure 18. *Intervention mechanism in this study.*



Intervention buying is divided into a small range, and price $p^k_{\text{int}\,u}$ triggers intervention buying, while the intervention limit is met when the price approaches $p^k_{\text{int}\,l}$ (shown in Figure 18). The small range is constructed to avoid discontinuity problems in the stock modelling. The demand for stocks δ^k_i is assumed to be very elastic.

Market equilibrium conditions

In the sixth part of the model, market equilibrium conditions are determined. The sum of total demand and total supply for each dairy good k and for each region i yields the market equilibrium. The model endogenously determines production, domestic demand, imports, exports and ending stocks, while beginning stocks are exogenous variables. Beginning stocks are also used to equalise the demand and the supply. The market equilibrium condition states that all production is consumed, traded or stored into intervention stocks. When the market equilibrium holds, total imports and exports also match.

Carry-in stocks (beginning stocks, exogenous) + y^k_i (production) + M^k_i (imports) = Stocks^k_i (carry-out stocks = ending stocks) + z^k_i (final demand) + $\sum_{n=1}^{N} M^k_{ni}$ (exports) (5.16)

Trade for "pure" exporting countries

In the seventh part of the model it is assumed that there are net exporting countries whose behaviour is captured by the linear net export supply function. The functional form is very simple, assuming that the total export is linearly dependent on exports prices. This net exporting country group is termed NEC (Net exporting countries) and consists of Australia, Canada and New Zealand.

$$E_{NEC}^{k} = w_{NEC}^{k} + v_{NEC}^{k} p_{NEC}^{k} \tag{5.17}$$

Where: $E_{NEC}^{k} =$ Total exports of good k from NEC.

$p_{NEC}^{k} =$ Export price (fob) of good k from NEC + transportation cost.

Trade for "pure" importing countries

In part eight it is assumed that the net importing countries are comprised of two country groups, namely Russia and the rest of the world (ROW), whose import behaviour is captured by the net import demand function. Trade flows to each group will be determined in two stages. The Armington-type import function is applied in the second stage to determine how net importing countries substitute imports between different sources. However, in the first stage the total import is determined by using a simple linear import function rather than the Armington import function. The use of the same functional form would have probably been a more consistent choice, but there are no representative data on consumer prices from Russia or from rest of the world group.

In first stage, a linear net import equation for region x is determined by

$$M_{x}^{k} = g_{x} + hp_{x}^{k} \tag{5.18}$$

x = importer (Russia, ROW)

Where: $M_{x}^{k} =$ Total imports of good k into region x.

$p_{x}^{k} =$ Weighted average price of all the imports of good k after transportation cost, tariffs and export subsidies.

In the second stage, imports are determined by sources.

- Stage 2: $$M_{xn}^{k} = (b_{xn}^{k})^{\sigma_x^k} M_n^k (\frac{P_{xn}^k - S_{xn}^k + t_{xn}^k}{p_x^k})^{-\sigma_x^k} \quad (5.19)$$

n = exporter (FIN, EU-14, CEEC-8, US, CAINRS)

Where: $M_{xn}^{k} =$ Imports from source n to x of good k.

$M_x^k =$ Total imports of good k into region x.

$p_{xn}^k =$ Price of imported good k from source n to region x.

(Price after transportation but excluding tariffs and subsidies.)

$S_{xn}^k =$ Export subsidy from n to x for good k.

$t_{xn}^k =$ tariffs.

$\sigma_x^k =$ Elasticity of substitution between different sources.

The global dairy model presented above describes dairy sectors in Finland, the EU and the US. One of the main advantages of the model is that it endogenously determines raw milk production, dairy good production, domestic demand, public stocks, export demand, and import demand. The model includes the most important EU dairy policy instruments, and the trade dimension is carefully modelled, including export subsidies, tariffs and transportation costs.

As with any model, this model has its limitations and restrictive assumptions. The classification of dairy regions is rather simple, assuming that three NEC countries are net exporters, while Russia and the rest of the world are net importers. This is not necessarily true in all cases; for instance, Russia is not a net importer for a few commodities with respect to dairy trade with the new EU countries (the CEEC). With the rest of the world group, some countries are probably not net importers either. Furthermore, this group consists of very heterogeneous countries such as extremely poor Sub-Saharan countries and very wealthy countries like Switzerland and Japan. It is quite obvious that food demand elasticities vary considerably across these countries. However, the enlarged EU, the US and the NEC dominate the world dairy export markets, and other regions have no significant influence on either world dairy trade flows or on world market prices. In summary, this rather simplified model covers rather well the dominant players in the global dairy markets. The weakness of the study relates to the basic character of the simulation model; there are no standardised methods to test it in the same way that econometric models can be tested.

The global dairy model includes a consistent and detailed description of the Finnish and the EU dairy sector. Some dairy models do include a more detailed description of global dairy markets (ABARE 2001, Zhu, Cox & Chavas 1999 etc.), and in some models dairy products and countries are more disaggregated on the EU level (Boumra-Mechemache et al. 2002). The main difference between the global dairy model and previous models is that products are differentiated by sources. This Armington approach suggests that the global dairy model would produce a smoother change in trade shares than spatial equilibrium models. The empirical results of this model are presented in chapter 7.

5.2 Some remarks on the data

The purpose of this chapter is to illustrate the database and estimated parameters that are later used in the global dairy model to analyse the implications of export subsidy removal. Dairy markets are rather unstable, and year-to-year price fluctuations can be substantial. When deciding the base year for this kind of model, the instability of dairy markets creates a problem. Because choosing only one representative base year was such a complex task, it was decided to use an average value of three years as a base year. The selected years were 1999, 2000 and 2001, from which the average base year was calculated. During that period world market prices fluctuated, indicating fairly well the instability of dairy markets.

Due to the large number of variables in this model, the data were collected from various sources. This normally causes some problems relating to the comparability of data and technical problems in converting between different units. However, even very simple issues like the consistency of a commodity may vary across countries, and thus goods are not necessarily the same in Finland or in the New Zealand. Special attention was paid to data consistency. This subject is discussed in more detail later in this chapter. Here are listed the database sources used in this study:

Production: ZMP, Gallup Suomen Elintarviketieto

Fat/protein content in milk: Zhu, Cox & Chavas (1998), INRA

Consumption: ZMP, Gallup Suomen Elintarviketieto, IAMO
Industry price: ZMP, USDA (ERS)
Consumer price: ZMP, Fapri, Gallup Suomen Elintarviketieto
Intervention price: ZMP, OECD
Stocks: ZMP, USDA (ERS)
Trade: Comtrade, Finnish Customs
Export subsidies: USDA, ZMP
Market access: AMAD, EU Market Access Database, IAMO, GATT, ABARE

The majority of production, consumption and price data were obtained from the ZMP dairy database, with some addition from various other sources. Finnish Customs and Gallup Suomen Elintarviketieto (2002) were the main sources for Finland's database. Data for the US dairy sector were obtained from the USDA's data sources (2003, 2004), while IAMO (2004) was the main data source for the CEEC's dairy sector. The majority of the trade distortions (export subsidies, import tariffs, quotas) database was obtained from AMAD (2004), with some addition from IAMO (2004), ABARE (2001) and GATT (1994). The database for Russia and for the rest of the world was obtained from the EU Market Access database and ABARE (2001).

Data collection on trade policy instruments was not without difficulties, for many reasons. The first problem related to the applicability of trade agreements. Basically, maximum export subsidies and duty levels were set in the Uruguayan Round Agricultural Agreement, and can thus be calculated for every single region. However, countries seem to apply lower tariffs and sometimes use less export subsidies, depending on world market prices, than decided in the URAA. Bilateral trade agreements are also widely applied and, for example, the majority of cheese trade takes place under some type of preferential quota. In percentage terms the within-tariff quota (TRQ) imports represent a large share of total dairy imports in the world: 80-90% of total dairy imports in the EU, and 50-70% in the US. Due to the high relative share of in-quota imports, in-quota tariffs are mainly applied in this study. (As we later see in this study, in-quotas did not turn out "binding" in volume terms when simulations were run.) However, for example, normal tariffs were applied for Russia and for the rest of the world because data on preferential duties were not available. Calculation of the average tariff for other milk products became too complicated, and therefore tariffs are omitted for this group. This is a rather strong assumption.

Transportation costs were obtained by multiplying transportation distances by unit transportation costs. Transportation distances were calculated by using “Distances between ports” obtained from the Defence Mapping Agency. Transportation and unit transportation costs were obtained from Zhu, Cox & Chavas al. (1998).

The second challenge relates the commodity classification of the model. Export subsidies are classified in the URAA for only four main commodities: butter, SMP, cheese and other milk products. However, the commodity classification in this study includes 5 final commodities (cheese, butter, SMP, WMP, other milk products), and thus export subsidies should be calculated for all commodities. Export subsidies were calculated based on actual budgetary expenses (not commitments). Unit export subsidies were reached by dividing actual export expenses by total export volume (consisting of both subsidised and non-subsidised export). For other milk products export subsidies were provided by dividing actual budgetary expenses (other milk products) by the total export of other milk products. For whole milk powder, actual budget expenses were divided by total WMP export. Export and import prices were formulated by using price linkages. Transportation costs, tariffs and export subsidies were added to the export price to obtain the import price.

The third problem relates to country/region classification. When calculating simple average values for aggregated country groups (=regions) the chosen value is not necessarily representative. For instance, tariff rates in Central and Eastern European Countries (CEEC-8) vary considerably, and thus a “true” average value for import tariff is difficult to set. For example, market access regulations for Poland are fairly strict, but Estonia has barely any duties. In this study, tariffs were calculated by taking weighted average of tariffs based on the share of dairy imports out of the total CEEC-8 dairy import, and thus the weight for Poland is greater than, for example, Estonia’s.

Collection of representative price data is a complicated task, because price data is neither well available nor easily compared to other data sources. For example, separate data sources produced slightly different values for industry prices and consumer prices in separate regions. The values have been chosen in such way that industry and consumer prices are consistent between products and between countries. However, some simplifications were made to create a sufficient dairy price data. Due to the lack of sufficient and representative data from all countries in certain regions, data were sometimes gathered only from one/some of the countries in the region. In some cases, either industry price data or retail price data were unavailable, and the lacking price value was calculated by multiplying the given data by a particular coefficient. Coefficients were obtained by comparing study results from the Ministry of Agriculture and Forestry (New Zealand, MAF 2003), the Milk Development Council (MDC 2004) and, discussions with dairy industry experts. Dairy goods classification might have been even more disaggregated in this study if lacking price data had not caused problems. After careful evaluation of the data, the goods were divided into five groups in order to obtain relatively representative price data for each dairy good.

Representative consumption data was also difficult to find. If the data were not available, the consumption was calculated by using production, export and import data. In a few cases, trade flows were modest and consumption was calculated by using production data.

The global dairy model is based on the idea of constructing final commodities from various combinations of raw milk components (fat and protein). Data for raw milk components is available from the ZMP database, and data for final product components was gathered from INRA and Zhu, Cox & Chavas (1998). Sometimes, the representative combination of fat and protein components in the final product was hard to set. Cheese offers a typical example, where variation in the fat and protein content is large and an average combination was difficult to decide. The problem was resolved by calculating weighted averages for fat and protein contents based on shares of the total production.

5.3 Parameter estimation

The parameter estimation method is of specific interest when assessing the validity of the model results. Parameters can be estimated by using the same theoretical framework as in the model, or the calibration method can also be used. Here, the Armington-type import demand function was applied to obtain import demand elasticities.

Basically, there are two types of elasticities in this study: elasticity of substitution between domestic and foreign products and elasticity of substitution of goods from different sources. The previous is the rate at which domestic and foreign commodities are substituted, and the latter substitutes import commodities from different regions. Due to the lack of sufficient consumption time series, the first-mentioned estimation between domestic and foreign products is omitted, but import demand elasticities were estimated according to source. Elasticities were calculated by using a CES (constant elasticity of substitution) function that differentiated goods according to the source. The formula is derived and explained in more detail in chapter 3.

$$\ln(M_{ij}^{k} / M_{i}^{k}) = \sigma_{i}^{k} \ln(b_{ij}^{k}) - \sigma_{i}^{k} \ln(\frac{p_{ij}^{k}}{p_{i}^{k}}) \qquad (5.20)$$

M_{ij}^{k} = import quantity of good k from region j to region i

M_{i}^{k} = total imports of good k to region i.

p_{i}^{k} = average price of all the imports of good k

p_{ij}^{k} = describes the price of good k imported from source j to region i.

b_{ij}^{k} = a constant variable and that should sum to one.

All prices include transportation costs tariffs and export subsidies. Elasticity of substitution is interpreted in this case as the percentage change in the market share of exporter j for a one per cent change in the ratio of the landed import price from exporter j to the price index for good k in importing country i. Elasticity is calculated for every commodity and every importer, but not for all exporters due to the *constant* nature of substitution elasticity. In other words, the same commodity (e.g. butter) from different sources is substituted at the same rate. For example, the elasticity of substitution is the rate at which Russia would alter the share of Finnish butter in response to a change in the landed price of Finnish butter relative to the price index of all imported butter in Russia. According to this theory, commodities are perfect substitutes when elasticity of substitution equal to infinity. When commodities are perfect complements, the elasticity is equal to zero (Patterson 1987).

The use of the Armington model presents some technical challenges. Data for import/export prices and quantities are needed, and transportation costs must also be taken into account. The technical problem is that should one use c.i.f. import prices or f.o.b. export prices? It is also worth considering whether unit import/export values or standard import/export prices are preferable.

In this study, c.i.f. import price data from the Comtrade database were chosen. Standard export prices were rejected, because variation in dairy products is large, and unit values probably describe better the value of the trade than standard export prices. C.i.f. import prices were preferred to f.o.b. export prices for easier data handling. Annual c.i.f. price and quantity data were collected to calculate unit values of imported commodities. Unit values were simply calculated by dividing the total value by the total quantity. Data were collected for the years 1990 to 2002, but in some cases such a long time series was not available. Time series may be too short for some regions in the statistical sense, and contemporary price fluctuations may have too important a weight in a short period. However, longer time series are not necessarily better, because trade was more restricted 15 or 20 years ago, which may cause distortion in the yielded estimates.

The Armington model works best if commodities are aggregated goods. In this study, dairy products are divided into five subgroups, which may seem a rather disaggregated choice. However, dairy products are highly processed and differentiated products, and thus, five dairy commodities create a rather aggregated group. Aggregation is stressed for both theoretical and empirical reasons. First, the CES function theoretically requires that expenditure elasticity is equal to unity, which means that the same types of commodities must be substitutes. If commodities are aggregated products these conditions are more likely to be fulfilled. Second, empirical problems relate to trade flows, if trade volumes are close to zero in some periods (Patterson 1987).

Elasticities were calculated from panel data by using the Statistica program. The panel was constructed by using trade data from 1990-2002 for 6 regions and for 5 products. Estimation was conducted by using a one-way fixed effect error model as a within-group estimation. There were some purely technical problems in calculating elasticities. In some cases the lack of importers made the panel formulation an impossible assignment. For example, as a net exporter, Finland imports practically no butter. Hence, panel data cannot be formed in such cases.

The resulting elasticities of substitutions are presented in Table 1. The missing values in columns mean that the pooled panel data were not created due to lack of data (lack of importers). Of the 26 dairy estimates, 20 had a proper positive sign. Eleven of 26 values were statistically significant at the 0.1 level, which is a satisfactory result. A small sample may explain why only under half of the estimates were statistically significant. Panel data formulation for Finland succeeded only for cheese, but it was not statistically significant, and the EU estimates were applied for Finland in the model.

Table 1. *Elasticities of substitution from pooled-time-series-cross-section data.*

	Butter	Cheece	SMP	WMP	Other milk products
FIN	No panel	0,91	No panel	No panel	No panel
EU-14	-5,37	0,17	0,26	-2,24	-1,41
CEEC	-1,17	-0,12	-1,68	-0,63	-0,28
US	-0,83	-1,40	-1,14	-0,13	0,11
ROW	-0,47	-0,33	2,31	1,30	-1,12
RUS	0,68	-0,24	-0,42	-0,25	-1,80

The preliminary analysis of the model (in chapter 5) using these estimated elasticities was problematic. In the first phase a base scenario was run, and export subsidies were then abolished to produce an export subsidy removal scenario (ESR scenario). The results provided in the ERS scenario were not completely consistent in every respect. In fact, the results indicated that global trade of dairy products would increase, while the original expectation was that trade would decrease due to the rise in export prices. Changes in world market prices were also inconsistent across goods and their implications for trade flows were illogical as well.

Panel data commonly produce more reliable results as the number of groups (importers) grows. This estimation produced mostly right signs and the scale of estimated elasticities was also good, but the number or importers was probably too small to produce consistent results. Due to limitations of the estimated elasticities, consensus elasticities of substitution were calculated from the study of Gallaway et al. (2002), which probably offers the most comprehensive, disaggregated and up-to-date set of

Armington elasticity estimates. When these elasticities were tested in the model, changes and magnitudes in trade flows were consistent.

Linear regional export and import elasticities are obtained from the USDA's (1989) Trade Liberalisation database. Income elasticities were taken from ABARE (2001). Elasticities applied in this study are presented in Appendix 2.

6. The model results

The purpose of this chapter is to demonstrate how the model developed in the preceding chapters can be applied to analyse export policy changes. In other words, the model is tested empirically by using the database described in the previous chapter. To accomplish this task, a base scenario was constructed by using the collected data, which corresponded to the global dairy market situation at the beginning of this decade. Then, an export subsidy removal scenario was run. Results of the export subsidy removal scenario were compared to a base solution to in order to analyse the implications of export subsidy elimination.

Simulations for separate scenarios were run in practice as follows. Determination of the simulation solution for our empirical international dairy trade model requires setting values of model parameters. In the first stage the model benchmarked the parameters of the empirical model. The model was constructed in Excel by using price linkage method, in other words, the model and the data was linked to each other in the same way as in the model. Then, the model was run to produce the necessary parameters to the model. As the model reproduced the base scenario, that is the actual data, and it also produced parameters. In other words, the produced parameters satisfy the equations with the given data. This means, in turn, that there is no difference between the base scenario and the data. This model running to set the parameter for the model with the given data is called here as the base scenario. After that the export subsidy removal scenario was run by abolishing export subsidies from the base scenario. Now, the changes of the export subsidy removal transferred to the endogenous variable by price linkages. Finally, the base scenario and the export subsidy removal scenario were compared.

Technically, the Excel solver function was used to run the base scenario. Prices of raw milk components (fat and non-fat) and NEC export prices were treated as “target” variables, while equation conditions for raw milk components and final good components as well as trade balance equations were used as constraints. Changes in target variables were transmitted to other endogenous variables by using price linkages. The only differences between the theoretical model described in Chapter 4 and the empirical model used in this chapter exist in the presentation of dairy processing costs. Due to data limitations, fixed marginal costs are used in the empirical model.

The simulation results of the export subsidy removal scenario were consistent and changes in directions and magnitudes of variables seemed logical as well. The model results are presented next in two stages. First, general results for all regions are briefly explained, and in the second stage, the model results for each product and region are analysed more thoroughly.

General results:

First, global dairy trade is likely to decline by nearly 13% as a result of export subsidy removal. However, the value of global dairy trade would decrease by only 5% due to the increase in import prices. Second, dairy imports to Russia and the ROW would decline by nearly 20% in volume terms. Third, the EU-14, Finland and the US would be the main losers in terms of changes in export volumes and values, while the CEEC and the NEC would be the main beneficiaries of the change. Export subsidy removal would especially stimulate their exports of butter and other milk products. Fourth, implications of export subsidy elimination for producer prices, raw milk production and domestic demand are rather modest, while changes in trade flows are quite significant.

Finland:

Exports of dairy products would decline on average by 20% in both volume and value terms, with SMP and other milk products facing the steepest drop. The decline in dairy exports would also reflect in the production side, where SMP production would decline by one fifth. In absolute terms, the greatest drop would occur in butter, SMP and other milk products. Both the production and producer price of raw milk would decline by approximately 4% because of the reduced competitiveness of Finnish dairy products on the world market. As far as this is concerned, export subsidy removal would hit Finland the hardest.

EU-14:

The EU-14 would be one of the main losers in the global dairy export markets. Changes in export volumes of dairy products would vary from a 13% decline in cheese exports to a drop of over 70%in butter exports. Dairy export revenues would drop by over 20%. The reduction in dairy exports would also transmit to production. However, changes in the production side are smaller than in Finland because dairy good exports play a less important role for the EU-14.

CEEC-8 (the new EU member countries):

The new EU member countries would be the winners in the global dairy trade if export subsidies were abolished. A slight rise in raw milk production would naturally increase dairy goods processing as well, with the largest growth occurring in WMP production. Exports of dairy products would be boosted in all categories, but exports of other milk products would experience the most significant growth both in absolute and value terms.[7]

USA:

Export subsidy elimination would have rather modest implications for raw milk production in the US and producer prices would both remain more or less unchanged. The most dramatic change would be that export of other milk products would face an almost 70% reduction as a result of an increase in the export price. However, dairy exports do not play a central role in the US dairy sector, and thus changes transmitted to the production of dairy processing goods would also be small.

NEC (Australia, New Zealand, Canada):

The NEC group would be the main beneficiary of export subsidy removal. Exports of dairy products would increase on average by 7%, notwithstanding the fact that NEC export prices would also increase. This is because export prices of other exporters would increase even more. Export revenues of the NEC group would increase by nearly 15% (over $ 400 million).

[7] When assessing the study results for the CEEC-8, some issues are worth noting. Major changes have taken place in the dairy sectors in the new EU countries since the years 1999-2001, which are covered in this study. The gap in price and quality between EU-15 and the new EU-countries has significantly reduced. Producer prices in the CEEC were approximately 30 per cent lower five or six years ago, but in the run up to EU enlargement significant price convergence had taken place. Despite the diminishing gap in producer prices, there are still quality differences. There has been substantial improvement on the technical side and quality has also been enhanced during a couple of years, but a substantial part of raw milk production still does not meet the EU's quality standards.

Russia:

A substantial grow in import prices would decrease import volumes by nearly 20% in Russia. Butter imports would decline by one fifth of the base level and imports of other milk products to the Russian market would be approximately one third less than in the base scenario.

Rest of the World:

Imports of dairy goods would drop in the rest of the world by approximately 13% due to a rise in import prices, but the value of imports would still grow by 7%. Butter imports would drop by nearly one-fifth compared to base level, while import demand of rest of milk products would decrease by one-fourth from the original level.

Model results in more detail

As we see from Table 2, the abolition of export subsidies has relatively modest implications for producer prices. Finland's producer price would decrease by approximately 4%, while changes in the EU-14 prices would be smaller (-2.1%). For the US, implications are neutral, and the CEEC would face a slight increase in producer prices. Compared to previous studies (e.g. ABARE 2001, OECD 2000, Bouamra-Mechemache et al. 2002, Gohin & Gautier 2003), changes in the EU-14 (EU-15) producer prices are small. The reasons for the relatively small changes in producer prices are discussed later when raw milk production changes are analysed.

As shown in Table 3, the removal of export subsidies would lead to a rise in the NEC group export prices for all products. This result fits original expectations well, i.e. export subsidy elimination would increase export prices for countries not using export subsidies. Price of other milk products would experience a rise of over 16%. Prices of butter and WMP would also rise by nearly 10%.

Table 2. *Changes in producer price*

$/1 000 kg	FIN	EU-14	CEEC	USA
Base	345,04	311,22	201,36	307,37
ESR Scenario	331,50	304,61	203,76	307,18
Change (%)	-3,9	-2,1	1,2	-0,1

Table 3. *Implications of export subsidy elimination for NEC export prices.*[8]

$ / 1 000 kg	**Butter**	**Cheese**	**SMP**	**WMP**	**OMP**
Base	1 498	2 158	1 567	1 727	1 465
ESR Scenario	1 623	2 195	1 647	1 871	1 707
Change (%)	8,4	1,8	5,1	8,3	16,5

Globally, export subsidy removal would not have a dramatic effect on raw milk production. Export subsidy removal would hit Finland the hardest, which would experience an approximately 4% decrease in total milk deliveries to dairies, while the EU-14 milk production would diminish by approximately 1.5%. The results suggest that Finland or the EU-14 would not have any problems in keeping milk production within the quota; in fact, the quota is far from binding. According to the results, the CEEC would slightly increase their milk production and the US would face hardly any changes in raw milk production. The share of foreign trade out of total production is rather modest in both the CEEC and the US, and thus implications for raw milk production are also small.

Compared to previous studies (e.g. Bouamra-Mechemache et al. 2002, ABARE 2001, Jensen & Yu 2005), changes in production volumes are not similar. Here, the abolition of export subsidies generates a decline in raw milk production in Finland and in the EU-14, while in other studies milk production increases or remains more or less unchanged. Changes in producer prices also differ compared to previous studies; the decline in producer prices is less dramatic here than in other studies. However, quota

Table 4. *Implications of export subsidy removal for milk production (deliveries to dairies).*

1 000 kg	**FIN**	**EU-14**	**CEEC**	**USA**
Base	2 357 844	112 622 027	14 223 086	74 346 333
ESR Scenario	2 260 730	110 837 586	14 341 640	74 293 314
Change (%)	-4,1	-1,6	0,8	-0,1

[8] OMP = Other milk products.

rents and supply elasticities of raw milk used in this study are similar to those in Boumra-Mechemache et al. (2002). In other words, it seems that the Armington model type here generates a decline in both milk production and producer prices.

The Table 5 shows that total dairy good production would experience a small reduction in the EU-14 based on a similar trend in raw milk production. However, production changes between separate dairy product groups are quite significant. In Finland, the production of processed dairy products would decline in all production categories; SMP production would drop by over 20%, WMP would decrease by 10%, while other goods would experience a smaller drop in production. In summary, the slowdown in dairy goods production would concentrate on powder production. The EU-14 would face smaller changes; WMP production would decrease by nearly 13%, but changes for other goods would be less dramatic. The drop in WMP production is due to a slowdown in WMP exports. The export subsidy removal would

Table 5. *Effects of export subsidy elimination on dairy goods production (tons).*

1 000 kg	Butter	Cheese	SMP	WMP	OMP
FIN					
Base	53 633	97 700	23 131	2 367	1 049 844
ESR Scenario	50 173	94 715	18 387	2 111	1 033 344
Change (%)	-6,5	-3,1	-20,5	-10,8	-1,6
EU-14					
Base	1 774 967	6 858 633	1 035 428	866 923	39 484 995
ESR Scenario	1 744 259	6 817 131	1 008 079	757 283	39 217 214
Change (%)	-1,7	-0,6	-2,6	-12,6	-0,7
CEEC					
Base	273 104	799 467	214 307	76 332	4 825 575
ESR Scenario	275 390	802 899	214 946	80 324	4 869 453
Change (%)	0,8	0,4	0,3	5,2	0,9
USA					
Base	570 000	3 691 167	641 233	40 940	27 130 966
ESR Scenario	571 246	3 706 860	655 877	38 783	26 958 708
Change (%)	0,2	0,4	2,3	-5,3	-0,6

increase dairy goods production in the CEEC, and the biggest growth would occur in WMP production (5%). Implications of export subsidy removal are rather neutral in the US dairy sector; the greatest relative changes would be direct at powder production. The decline in final goods production in Finland and in the EU-14 would directly originate from a slowdown in the export market, while growth in the dairy export market would stimulate dairy goods production in the CEEC.

Changes in milk component prices varied across country groups, which were reflected in the industry price of dairy goods. While changes in Finland's milk components would be rather dramatic, the EU-14, the CEEC and the US would face only minor changes in milk component prices. As a result of export subsidy removal, foreign demand for Finnish butter would drop, requiring adjustment in component prices. The industry price for fat would drop by one-fourth in Finland, which would naturally have the most dramatic impact on the butter industry price. This would also lead to a nearly 15% decline in the butter consumer price. By contrast, the industry price for protein would increase by around 13%, because non-fat milk components are relatively more profitable than fat production. The rise in the protein component price would naturally have the greatest effect on the SMP price. The increase in the industry price would also transmit to the consumer price, which would rise by nearly one-tenth from the base scenario.

It may seem odd that the EU-14 would not face a similar drop in the fat component to that in Finland, even though the EU-14 butter exports would collapse by nearly two-thirds. This is because butter exports play a more crucial role for the Finnish dairy sector than for the EU-14. Finland exports every third produced milk litre, and the growing demand for low-fat products simply forces the Finnish dairy industry to export butter relatively more than other products. Finland's share of the EU's total milk production is less than 2%, but Finland uses approximately 12% of subsidised butter export refunds. In other words, Finland constitutes a significant share of the EU's total butter exports to third markets. For other regions, changes in raw milk component prices are less dramatic, and thus implications transmitted to consumer prices are also smaller.

Table 6. *Effects of export subsidy removal on consumer prices ($/1 000 kg).*

$/1 000 kg	Butter	Cheese	SMP	WMP	OMP
FIN					
Base	4 960	6 943	2 774	3 253	825
ESR Scenario	4 283	6 921	3 003	3 201	826
Change (%)	-13,6	-0,3	8,2	-1,6	0,2
EU-14					
Base	3 923	6 890	2 774	3 253	1 397
ESR Scenario	3 913	6 850	2 708	3 201	1 388
Change (%)	-0,3	-0,6	-2,4	-1,6	-0,6
CEEC					
Base	3 760	3 593	2 285	2 380	700
ESR Scenario	3 782	3 609	2 300	2 398	702
Change (%)	0,6	0,4	0,6	0,7	0,3
USA					
Base	5 595	8 397	2 820	3 372	1 113
ESR Scenario	5 811	8 416	2 718	3 364	1 108
Change (%)	3,9	0,2	-3,6	-0,2	-0,5

Intervention stocks would slightly increase in the EU-14 as a result of export subsidy abolition, but the stock ratio would still be well below the maximum limit. Butter intervention stocks would face a nearly 10% growth and SMP stocks would increase by one-fourth to 75 000 from the original level. By contrast, in the US, CCC stocks (commodity credit stocks) for SMP would be 5 times higher than in the base scenario. However, the stocks constitute only a minor part of total production. Growing intervention stocks naturally stabilises domestic prices, because they defend intervention prices. However, modest changes in producer prices would not originate from a tremendous rise in the stock ratio.

Changes in domestic consumption were extremely modest in all four country regions. The demand for dairy goods is rather inelastic. In other words, minor changes in prices have very limited implications for consumption. In fact, relatively large changes in consumer prices have a rather modest influence on domestic consumption patterns. For instance, a

Table 7. *Effects of export subsidy elimination on domestic dairy consumption (tons).*

1 000 kg	Butter	Cheese	SMP	WMP	OMP
FIN					
Base	19 151	90 933	7 531	541	1 014 024
ESR Scenario	19 301	90 990	7 503	542	1 013 946
Change (%)	0,8	0,1	-0,4	0,2	0,0
EU-14					
Base	2 020 191	6 643 400	863 728	335 923	39 022 903
ESR Scenario	2 020 456	6 651 163	864 780	336 464	39 034 701
Change (%)	0,0	0,1	0,1	0,2	0,0
CEEC					
Base	254 581	708 993	95 880	49 263	4 766 585
ESR Scenario	254 509	708 385	95 851	49 228	4 765 807
Change (%)	0,0	-0,1	0,0	-0,1	0,0
USA					
Base	569 600	3 815 567	544 851	29 424	27 044 001
ESR Scenario	568 549	3 813 156	546 877	29 434	27 056 783
Change (%)	-0,2	-0,1	0,4	0,0	0,0

nearly 14% drop in the butter consumer price in Finland would increase butter consumption by less than one per cent.

Before analysing trade flows of the study more thoroughly, it is perhaps necessary to repeat the country grouping of the study. Finland, the EU-14, the CEEC and the US are assumed to have trade in both directions, while the NEC is a net exporting country, and Russia and the rest of the world are net importing countries.

As shown in Table 8, export subsidy removal would indicate some significant changes in market shares of export markets. The results show that Finland, the EU-14 and the US would be the main losers, which fits the preliminary expectations well. The reasons behind declining exports are very consistent. For example, Finland's SMP exports would decrease dramatically due to a rise in the non-fat milk component price, which would transmit first to the final product price and then to the export price. However, the majority of milk component prices in other regions remained more or less unchanged. If this is the case, export subsidy elimination would directly cause a rise in the export price, and thus market shares would partially be lost to other regions. The main beneficiaries of the policy change would be the NEC and the CEEC. The CEEC and the NEC would boost their dairy exports in all goods, the greatest growth being in other milk products. Finland, the EU-14 and the US would lose their market shares, especially in other milk products markets, due to a rise in export prices.

Export subsidy abolition would cause some interesting changes in export market shares. For example, Finland's butter exports to the EU-14 would rise by a half, while exports to Russia would collapse by 50% and to rest of the world by over 40%. Finland's SMP exports would decline by approximately 30% to Russia and the rest of the world, and for exports of other milk products the collapse would be even four-fifths from the original level in both regions. In summary, exports shares would mostly be lost in the Russia and in the rest of the world, where export subsidies can be paid. The EU-14 would lose market shares in Russia, in rest of the world and also in the US. The most significant reductions would occur in exports of butter and other milk product. A vast majority of US dairy exports are directed to the rest of the world, where the US would face the greatest market share losses.

The CEEC would increase its market share especially in the rest of the world, while gains in other regions would be less significant. The NEC countries would boost their market share in Russia, but in the rest of the world in particular. Interestingly, the NEC countries would lose market shares in the EU-14, in the CEEC and in the US.

The model results suggest that export subsidy abolition would reduce the total dairy export volumes in Finland, in the EU-14 and in the US, but these regions would also suffer losses in dairy export revenues. For example, the Finnish dairy industry's export revenues would drop by one-fifth, or over 65 million dollars. The EU-14 and the US would suffer the most from export subsidy elimination in absolute terms, but dairy exports play a considerably smaller role in these regions. The EU-14 would lose nearly $ 1 200 million, which is slightly below the average amount of export subsidies spent during the study period, while the US dairy sector would face a slowdown of over $

Table 8. *Implications of export subsidy removal for dairy goods export (tons).*

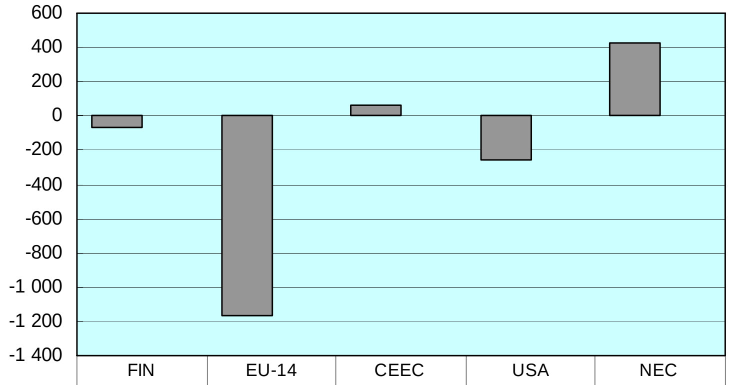
1 000 kg	Butter	Cheese	SMP	WMP	OMP	Total
FIN						
Base	33 484	32 285	16 365	2 238	56 100	140 472
ESR Scenario	29 860	29 397	11 728	1 982	39 752	112 721
Change (%)	-10,8	-8,9	-28,3	-11,4	-29,1	-19,8
EU-14	Butter	Cheese	SMP	WMP	OMP	Total
Base	54 844	416 332	289 671	539 427	856 097	2 156 372
ESR Scenario	21 406	364 820	240 053	428 820	562 258	1 617 356
Change (%)	-61,0	-12,4	-17,1	-20,5	-34,3	-25,0
CEEC	Butter	Cheese	SMP	WMP	OMP	Total
Base	30 378	86 999	114 178	29 794	191 425	452 775
ESR Scenario	32 855	91 101	114 934	33 894	237 010	509 794
Change (%)	8,2	4,7	0,7	13,8	23,8	12,6
USA	Butter	Cheese	SMP	WMP	OMP	Total
Base	7 828	148 377	119 985	12 366	312 861	601 418
ESR Scenario	7 601	148 824	112 083	9 879	84 586	362 974
Change (%)	-2,9	0,3	-6,6	-20,1	-73,0	-39,6
CAIRNS	Butter	Cheese	SMP	WMP	OMP	Total
Base	152 234	441 482	375 529	306 971	432 610	1 708 826
ESR Scenario	156 067	449 251	385 015	335 108	504 188	1 829 630
Change (%)	2,5	1,8	2,5	9,2	16,5	7,1

250 million in export revenues. The winners are, again, the CEEC and the NEC. Rising export prices and a greater market share would lead to a nearly 15% enhancement in the NEC export revenues, while the CEEC dairy exports would grow by nearly 10% in value terms. Export subsidy removal would boost NEC dairy export revenues by over 400 million dollars. The net benefit for the CEEC would be approximately 60 million dollars.

Finland has traditionally imported relatively small amounts of dairy goods, excluding the import of cheese and rest of milk products. Export subsidy abolition would not change this situation. The total dairy import value would remain unchanged in the Finnish dairy sector. Only minor changes would take place in the CEEC dairy sector. As a result of growing exports, the dairy imports would slightly increase to satisfy domestic consumption. The value of total imports would also face a small enhancement (1%). The study results suggest that dairy goods imports to the EU-14 and to the US would decrease, while the most dramatic drop would be in imports of other milk products. The reason behind the declining import volumes is two-fold. First, export subsidy removal would lower export demand in the EU-14 and in the US, leading to a slight reduction in the milk component prices. In other words, it would push domestic milk component prices down, and thus import products would simply be relatively more expensive. Second, export subsidy removal would raise import prices. Declining import volumes would suggest that the total value of imports would decline in both countries; dairy import would decline by $ 15 million (-2%) in the EU-14, while the US would face an almost $ 44 million (-5%) drop in the total dairy import value.

Export subsidy removal would clearly have a negative impact on dairy product import volumes both in Russia (RUS) and in the rest of the world (ROW). The slowdown in imports of butter and other milk products would be

Figure 19. *Changes in total dairy export revenues (million U.S. dollars).*



	FIN	EU-14	CEEC	USA	NEC
Change, $ Mio	-66	-1 162	61	-256	428
Change (%)	-20,0	-22,6	8,4	-21,6	14,6

significant both in percentage and in absolute terms. The reason originates simply in the rise in import prices – compared to unit industry prices for butter and other milk products, unit export subsidies are higher than in other dairy products. Interestingly, the total import value would grow in both regions. The total import cost would increase by 4% in Russia, while the ROW region would face a 7% grow in the total value of imports. In summary, notwithstanding the declining import volumes, import value would grow by $ 19 million in Russia and over $ 500 million in the rest of the world.

The global dairy model yielded some interesting results compared to previous studies (ABARE 2001, OECD 2000, Zhu, Cox and Chavas 1999, Jensen & Yu 2005, Gohin & Gautier 2003). It seems that changes in producer prices are smaller in this model, while dairy goods production would face a steeper drop compared to other studies. Moreover, slowdowns in total export volumes are not as dramatic as in other models. In other words, this model predicts smaller changes in trade flows for the EU-14 and Finnish dairy sector given the differentiated import goods. The studies of Kerkelä et al. (2005, 2006) produced similar type of results too. The Armington model approach commonly produces smoother trade flows than spatial models, as confirmed by this empirical model.

It seems that the significance of dairy exports compared to domestic production has a great deal of importance when analysing underlying factors that affect the results. If dairy exports play only a minor role compared to domestic dairy production, changes in trade volumes are large, but changes transmitted to domestic market are modest. In Finland, by contrast, dairy exports constitute a significant share of domestic production and the abolition of export subsidies would seriously hurt its dairy sector compared to other regions. Moreover, a substantial part of dairy surpluses are exported under subsidy.

It is also worth noting that in the new EU member states the producer prices of milk substantially increased during 2004. In fact, producer prices in the CEEC are converging with the EU-15 average price. This increase may have some interesting implications for the CEEC dairy sector. In other words, the model results for the CEEC dairy sector might be slightly different when using the latest data from the years 2004 and 2005.

Table 9. *Implications on export subsidy removal on dairy product import (tons).*

1 000 kg	Butter	Cheese	SMP	WMP	OMP
FIN					
Base	73	19 124	517	396	10 807
ESR Scenario	60	19 277	596	397	10 881
Change (%)	-18,7	0,8	15,4	0,2	0,7
EU-14					
Base	103 582	112 105	50 143	11 795	98 504
ESR Scenario	102 479	109 858	45 639	11 370	84 243
Change (%)	-1,1	-2,0	-9,0	-3,6	-14,5
CEEC					
Base	4 337	4 635	4 363	1 956	74 863
ESR Scenario	4 456	4 697	4 451	2 028	75 792
Change (%)	2,7	1,3	2,0	3,7	1,2
USA					
Base	12 221	172 840	9 157	3 774	139 257
ESR Scenario	9 696	155 183	8 204	3 454	96 022
Change (%)	-20,7	-10,2	-10,4	-8,5	-31,0
Venäjä					
Base	41 073	55 937	46 572	12 262	90 100
ESR Scenario	30 979	53 845	43 437	11 497	60 607
Change (%)	-24,6	-3,7	-6,7	-6,2	-32,7
ROW					
Base	117 484	760 834	804 976	860 614	1 435 562
ESR Scenario	95 736	739 456	761 087	780 536	1 090 779
Change (%)	-18,5	-2,8	-5,5	-9,3	-24,0

Sensitivity analysis

The modelling results presented in this chapter are premised on a number of assumptions. Some of the assumptions will probably make little difference to the results, but some of them will be more important. Elasticities are commonly under specific interest when assessing the validity of model results. Here, the model results are subjected to sensitivity analysis. In other words, the model results obtained by using applied elasticities are now compared to those obtained from other sources. Alternative elasticities chosen here are GTAP (Global Trade Analysis Project) substitution elasticities for milk products (Hertel 1997).[9] As we know, substitution elasticities indicate the degree of substitutability between domestic and imported products. GTAP elasticities have higher elasticity values than the original elasticities that might be expected with a greater ease of shifting between domestic and imported goods.

The model was re-run by using alternative elasticities. Some of the most important new model results are collected in Appendix 4 and compared to the original model results. As we see, only minor changes took place in the Finnish dairy sector when the GTAP elasticities were applied. Changes in the producer price, production volume, production of final products, imports, and exports were modest. However, higher values of the substitution elasticities indicate larger benefits for the new EU member countries. Both producer price and production volume would increase more in the new model compared to the original results. Higher values of substitution elasticity imply greater substitutability between imports and domestic products, and the new member countries seem to benefit from this by increasing their exports. The total volume of world dairy exports decreases less than in the original model results. In other words, the volume of dairy exports faces smaller changes, which fits well the original expectation of a greater ease of shifting between domestic and imported goods.

To summarise, it seems that alternative elasticities do not imply major changes for the model results. In fact, alternative elasticities produce very similar results for the Finnish dairy sector compared to the applied elasticities.

[9] The Global Trade Analysis Project (GTAP) was established to conduct quantitative analyses of international economic issues in an economy-wide framework. The project consists a standard modelling framework and a fully documented publicly available global data base (including GTAP behavioural parameters).

7. SUMMARY AND CONCLUSIONS

The dairy sector is the core of the Finnish and the European agricultural sectors. Milk production accounts for nearly one-fifth of the total agricultural production of the EU, being the largest single production sector. The Finnish agricultural sector is even more dependent on dairy production than the other EU countries. About 30% of Finnish agricultural income is derived from dairy production, which is clearly above the EU average.

The EU is one of the major dairy exporters, having an approximately 35% share in the world export markets. However, the majority of dairy production is consumed by domestic markets, with only approximately 7% of the total production being exported. International dairy markets are rather thin in the sense that only a fraction of produced dairy products are traded across borders. The reason lies partly in the easily perishable nature of dairy goods, but trade policy also matters. Dairy trade is protected by high tariff barriers, but dairy exports are also subsidised.

The WTO's ninth round of multilateral trade liberalisation negotiations is pursuing the liberalisation of world trade. In the ongoing Doha round the liberalisation of agricultural trade is - again - one of the central themes. At the present stage of the Doha negotiation round, when the framework text has been agreed, it seems very likely that all export subsidies (including export credits and insurance programmes) will be abolished during a transition period. According to the framework text, food aid and state trading enterprises will also be disciplined. When these changes are fully transmitted in practice, major changes can be expected in the Finnish and the EU dairy sectors.

Export subsidies are of considerable importance to EU dairy exports. EU domestic market prices are well above the world market prices. The EU domestic butter price provides an extreme example, where the domestic price is twice the world market price. In 2003, export subsidies comprised nearly 9% of the total EU dairy export revenues. The highest unit subsidies channelled to other milk products and butter exports in the EU. Export subsidies have even more crucial importance for Finland. Since EU membership in 1995, imports of dairy products to Finland have increased considerably each year. At the same time, raw milk production has remained unchanged, and therefore more Finnish dairy products need to be exported outside of Finland. Nowadays, approximately 30% of domestic milk production is exported. The majority of Finland's export subsidy refunds in the Finnish dairy exports are directed to butter.

The aim of this study was to analyse the implications of export subsidy removal for the Finnish and EU dairy sectors. An Armington-type partial equilibrium trade model was developed to analyse the effects of export subsidy abolition, especially for the Finnish dairy sector. Some studies have previously been conducted on the implications of export subsidy removal for the EU, but comprehensive investigations of this topic are few and no detailed analysis of Finland in particular exists. The Finnish dairy sector does not represent an average case in the EU, and study results obtained for the whole EU cannot therefore be directly applied to Finland. The aim of the model developed in this study was to describe the Finnish and EU dairy sectors and produce a consistent model framework from the farm level up to international trade flows. Previous partial-equilibrium dairy trade models can be basically divided into two groups. Some dairy trade models do include a very detailed description of the global dairy market, while in other models the EU-level dairy production sector is very carefully modelled with highly disaggregated product and country categories. Both of these elements were important in this study, and some modifications to previous models were therefore needed so that the model would better meet the purposes of this study.

Modelling of the EU dairy sector is a challenging task because the processing technology is complicated, the number of final products is high, and dairy policy instruments are numerous and also complicated. The global dairy model applied in this study was partly inspired by previous models, but it also includes some new elements. The model provides two major contributions to research into export subsidy removal. First, the model developed in this study considers the Finnish dairy sector individually and separate from other EU countries, and therefore the results provided by the model can be directly applied to Finland. Second, the dairy trade modelling framework assumes that imported dairy products are not perfect substitutes. Armington-type analysis considers each importer's products as differentiated goods. The Armington model approach frequently produces smoother changes in trade shares than spatial equilibrium models, and accounts more adequately for observed trade flows than traditional spatial models. Empirical results of the global dairy model confirmed this.

A large part of the work effort was channelled into data collection for the model. A relatively large database was compiled for the global dairy model. In order to eliminate odd base market year selection, the data is based on averages values from the years 1999, 2000 and 2001. Data collection was a challenging task for many reasons, which are described more thoroughly in chapter 5. The goal was to create as consistent a database as possible.

The results of the empirical model show that export subsidy removal would have some interesting implications for the dairy exports market, but reflections in producer prices were relatively modest. However, the elimination of export subsidies would hit the Finnish dairy sector the hardest; raw milk production and producer prices would decrease by approximately 4%. In the EU-14 and in the US, the estimated reductions in raw milk production and producer prices are less than 2%. These are slightly smaller changes than in previous studies (e.g. ABARE 2001, OECD 2000, Bouamra-Mechemache et al. 2002, Gohin & Gautier 2003, Jensen & Yu 2005).

Second, the EU (including Finland) and the US, which are major users of export subsidies, seem to be the greatest losers in the dairy exports market. For example, Finland's dairy export value would drop by one-fifth from the original level. The US and the EU-14 would both face a more than 20% collapse in their dairy export revenues. The butter exports of the EU-14 would drop by as much as 70% as a result of export subsidy abolition. In the US rest of the milk product exports would face a more than 70% collapse due to a weaker competitive ability in world markets. Changes in export volumes were smaller in other products.

Third, when examining changes in export market shares, the new EU countries and the NEC region will gain by increasing their share of global dairy markets. The study results suggest that the NEC would increase dairy exports by nearly 7% in volume terms, despite the fact that their export prices would also rise. Export prices in other regions would rise even more, and thus the NEC will benefit from the situation. In fact, its export revenues would increase by nearly 15%, which is over US$ 400 million. The CEEC would also experience an approximately 8% enhancement in total export revenues. The NEC and the CEEC would especially increase their exports of butter and the remaining milk products.

Fourth, export subsidy elimination would diminish global dairy import volumes by nearly 13% due to the rise in import prices. Trade in butter and the remaining milk products would suffer the greatest losses. The import volume in Russia would diminish by nearly 2 % and that in the rest of the world by 13%. However, the value of dairy imports would rise by 4% in Russia and by 7% in the rest of the world due to higher prices. The import value of dairy products would rise by nearly US$ 540 million in the rest of the world.

To sum up, the study results suggest changes in the position of food-importing countries as a result of export subsidy removal. The cost of dairy imports would grow over by 5% while the import volume would be cut by nearly 13%. Export-oriented dairy regions would be the winners, while the EU, including Finland, would be the major losers.

The study results suggest that export subsidy removal would have more severe implications for the Finnish dairy sector than for the rest of the EU. Dairy exports constitute a significant part of domestic production, and thus the abolition of export subsidies would hit the Finnish dairy sector the hardest. As a result of the EU agricultural policy change, the dairy sector will probably face the greatest losses in Finland. The study results indicate that pressures in the Finnish dairy sector will continue.

Further research is needed in order to describe the dairy sector more realistically. This global model is based on the assumption of perfect competition, which is a theoretical starting point. As a result of consolidation development, some dairy firms probably exercise market power. An oligopoly market structure modelling would definitely make an improvement to the current model. The model also assumes a static framework, while a dynamic model would probably provide interesting results when the behaviour in separate periods could be compared.

This global dairy model is purely focused on the dairy sector, but agricultural markets are usually closely related to each other. Dairy production is highly linked to beef production in Finland, and crop production also is also reflected in the dairy sector as feed input. The modelling framework could be extended to other agricultural sectors that would provide more profound understanding of the sector behaviour. Modelling of the dairy sector itself could be improved too. The future of the milk quota system in the EU is uncertain, and therefore quota rents are discussed lively again. Hence, the most interesting research topics in the Finnish and in EU dairy sectors are probably phasing out of milk quotas and removal of export subsidies in the near future.

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Appendix 1

The function (7) is maximised subject of the constraint (Taylor)

$$V_i = \sum_{k=1}^{8} m_i^k \log(z_i^k - \theta_i^k) - \lambda_i (D_i - \sum_{k=1}^{8} p_{iz}^k z_i^k) \qquad \text{(A1.1)}$$

First order conditions are taken by setting $\frac{V_i}{z_i^k} = 0$, which yields

$$m_i^k = \lambda_i P_{iz}^k (z_i^k - \theta_i^k) \,. \qquad \text{(A1.2)}$$

When the normalisation condition is taken into account, the formula can be written as

$$1 = \sum_{k=1}^{8} m_i^k = \lambda_r (\sum_{k=1}^{8} P_{iz}^k z_i^k - \sum_{k=1}^{8} P_{iz}^k \theta_i^k) = \lambda_i (D - F) \qquad \text{(A1.3)}$$

Now, the total expenditure can be defined as $F_i = \sum_{k=1}^{8} P_{iz}^k \theta_i^k$. When formula A1.3 is modified, we obtain $\lambda_i = 1/(D_i - F_i)$, and when added to formula (A1.2), we obtain

$$z_i^k = \theta_i^k + \frac{m_i^k (D_i - F_i)}{P_{iz}^k} \qquad \text{(A1.4)}$$

Formula (A1.4) can be interpreted as follows. The first variable θ_i^k is an absolute minimum level of consumption for commodity k, and F_i is the total cost of a minimum consumption basket. If $D_i - F_i$ exceeds zero, the extra income D_i will be spend on commodities k . Parameter m_i^k indicates how consumers allocate their income above the minimum level; in other words, it can be interpreted as marginal budget shares. By differentiating formula (A1.4) the following expression is reached

$$\eta_i^k = \frac{\partial z_i^k}{\partial D_i}\frac{D_i}{z_i^k} = \frac{m_i^k D_i}{P_{iz}^k z_i^k}, \; (m_i^k = \eta_i^k \phi_i^k), \tag{A1.5}$$

where $\phi_i^k = \frac{P_{iz}^k z_i^k}{D_i}$, and it is the budget share of commodity k. By substituting A1.4 with A1.5 a new expression is yielded

$$\eta_i^k = \frac{m_i^k D_i}{P_{iz}^k \theta_i^k + m_i^k (D_i - F_i)} \tag{A1.6}$$

When the equation above is further manipulated, the following expression is reached

$$\theta_i^k = \frac{D_i}{P_{iz}^k}[\phi_i^k - m_i^k(\frac{D_i - F_i}{D_i})] = \frac{D_i}{P_{iz}^k}[\phi_i^k - m_i^k \sigma_i^k]. \tag{A1.7}$$

Appendix 2

Below are presented the elasticities applied in the global dairy model.

	Butter	Cheese	SMP	WMP	ROP
Income elasticity of demand					
FIN	0,05	0,4	0,05	0,2	0,05
EU-14	0,05	0,4	0,05	0,2	0,05
CEEC	0,05	0,4	0,05	0,2	0,1
US	0,05	0,55	0,2	0,3	0,3
Export supply elasticity					
CAIRNS	0,3	1,0	0,5	1,1	1,0
Import elasticity (linear)					
Russia	-0,8	-0,5	-0,5	-0,5	-0,5
ROW	-0,8	-0,8	-0,8	-0,6	-0,5
Elasticity of substitution between different sources					
Russia	2	2	2	2	2
ROW	2	2	2	2	2
Elasticity of substitution between home and foreign goods					
FIN	1,5	1,5	1,5	1,5	1,5
EU-14	1,5	1,5	1,5	1,5	1,5
CEEC	1,5	1,5	1,5	1,5	1,5
US	1,5	1,5	1,5	1,5	1,5
Elasticity of substitution between different sources					
FIN	2,0	2,0	2,0	2,0	2,0
EU-14	2,0	2,0	2,0	2,0	2,0
CEEC	2,0	2,0	2,0	2,0	2,0
US	2,0	2,0	2,0	2,0	2,0

Appendix 3

Table A1. *The model results for producer prices and milk production under separate substitution elasticities*

	FIN	EU-14	CEEC	USA
Producer prices				
Base, $/1 000 kg	345	311	201	307
Change (%), Applied elasticities	-3,9	-2,1	1,2	-0,1
Change (%), GTAP elasticities	-3,7	-2,5	5,6	0,2
Milk production				
Base, 1 000 kg	2 357 844	112 622 027	14 223 086	74 346 333
Change (%), Applied elasticities	-4,1	-1,6	0,8	-0,1
Change (%), GTAP elasticities	-3,8	-1,9	3,9	0,3

Table A2. *The model results for the Finnish dairy sector under separate substitution elasticities*

Finland	Butter	Cheese	SMP	WMP	ROP
Production of final products					
Base, 1000 kg	53 633	97 700	23 131	2 367	1 049 844
Change (%), Applied elasticities	-6,5	-3,1	-20,5	-10,8	-1,6
Change (%), GTAP elasticities	-6,4	-3,1	-22,2	-8,7	-0,8
Exports of dairy products					
Base, 1000 kg	33 484	32 285	16 365	2 238	56 100
Change (%), Applied elasticities	-10,8	-8,9	-28,3	-11,4	-29,1
Change (%), GTAP elasticities	-10,5	-9,6	-31,0	-9,2	-15,0
Imports of final products					
Base, 1000 kg	73	19 124	517	396	10 807
Change (%), Applied elasticities	-18,7	0,8	15,4	0,2	0,7
Change (%), GTAP elasticities	-16,6	0,5	12,9	0,1	-0,8

Table A3. *The model results for the dairy product exports under separate substitution elasticities*

	Butter	Cheese	SMP	WMP	ROP	Total
Change in world dairy exports						
Base, volume (1000 kg)	278 769	1 125 475	915 728	890 797	1 849 093	5 059 862
Change (%), Applied elasticities	-11,1	-3,7	-5,7	-9,1	-22,8	-12,4
Change (%), GTAP elasticities	-5,1	-3,9	-5,6	-8,4	-10,0	-7,3

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