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Abstract. The study presents oligopoly models to investigate the welfare losses of imperfect competition so that the implications of different kind of restrictions to foreign trade are included in the models. The approach is based on the conjectural variations and the leadership position of the domestic firms against foreign firms on the Finnish market. The derived models are applied to the Finnish food manufacturing industries and the welfare losses due to oligopolistic market power are estimated. Furthermore, the effects of the EU membership on meat and cheese markets, assuming oligopolistic behaviour in the manufacturing sector, are evaluated using a calibrated partial equilibrium model.

The results suggest that the deadweight losses due to oligopolistic competion may be considerable even under Cournot equilibrium. Losses increase as the absolute value of the price elasticity of demand declines and as the conjectural variations elasticities increase. If firms are able to collude, monopoly power is a substantial problem in terms of allocative inefficiency. Welfare gains could be expected from public policies that are able to restrict collusive practices and, especially, to lower entry barriers. According to the results, the effects of the EU membership on the food economy depend heavily on the nature of strategic interactions between firms and the structural features of the specific market. Increased competition in the Finnish food manufacturing leads to a considerable redistribution of welfare between consumers and domestic food manufacturers. The overall net effect is welfare improving.

Index words: imperfect competition, oligopoly, welfare loss estimates, integration, food manufacturing

Contents

1. Introduction

The relative importance of the food processing industries in the Finnish food chain has increased in the past few decades. Food processing industries constitute a major market for the domestic farm sector and, hence, the effects of agricultural and trade policies on consumers and overall welfare spread throughout the food processing. Contrary to the atomistic structure of farming, food processing industries usually contain only a few main rivals. A market with a number of competitors, but not so many as each of them may be considered a price-taker, is *oligopolistic* in nature. Because oligopolistic markets are characterized by the interdependence among firms, the modern study of oligopolies is based on the *game theory*. The theory of oligopoly provides useful analytical framework for analyzing competition within the Finnish food manufacturing industries.

How much profit margin to add to the costs is one of the most important decisions for an oligopolistic firm. Two important factors influencing the decision are the strength of the total industry demand and the distribution of demand across the competing firms. Given the preference ordering of consumers, the first is mainly determined by the purchasing power of the buyers. The second will be determined mainly by the market structure of the industry, such as concentration, product differentiation, or the extent of imports. Different oligopoly models can be used to explain the relationship between market structure and profit margins. Eventually, the determination of the prices and margins of the industry depends on the form of competition, which can vary from tight price competition to collusive pricing. If price deviates from marginal cost due to market power, misallocation of resources will take place, and this will result in *welfare losses*. Because of the concentrated market structure of the Finnish food manufacturing and previously strict public regulation of food imports, it is possible that the impacts of imperfect competition on the economic efficiency of the food sector are considerable.

1.1. Background of the study

Models of oligopoly that permit empirical evaluation of welfare are usually based on Bain's (ref. MARTIN 1993) work on structure-performance relationships. The form of the relation is determined by the oligopolistic conduct. Since Bain's empirical work, the *structure-conduct-performance (S-C-P) paradigm* has provided the basic framework to study market performance in terms of market characteristics and firm behaviour.

The main outlines of the S-C-P paradigm are presented in Figure 1.1. The determinants of the market structure are influenced by various elements connected with supply and demand (basic conditions). The conduct of firms refers to their competitive strategies. Conduct is influenced by the market structure, for example, so that price coordination among sellers is easier the more concentrated the market or the higher the barriers to entry. The performance of an industry depends on its conduct. Furthermore, especially in the food sector, several public policies affect the S-C-P causation. For example, competition policy and the regulation of foreign trade may affect the market structure and conduct. An important feature of the post-Bain literature is that the backward pointing arrows indicate the interdependence of basic conditions, structure, and conduct. There are reverse causations from conduct to structure and basic conditions, as

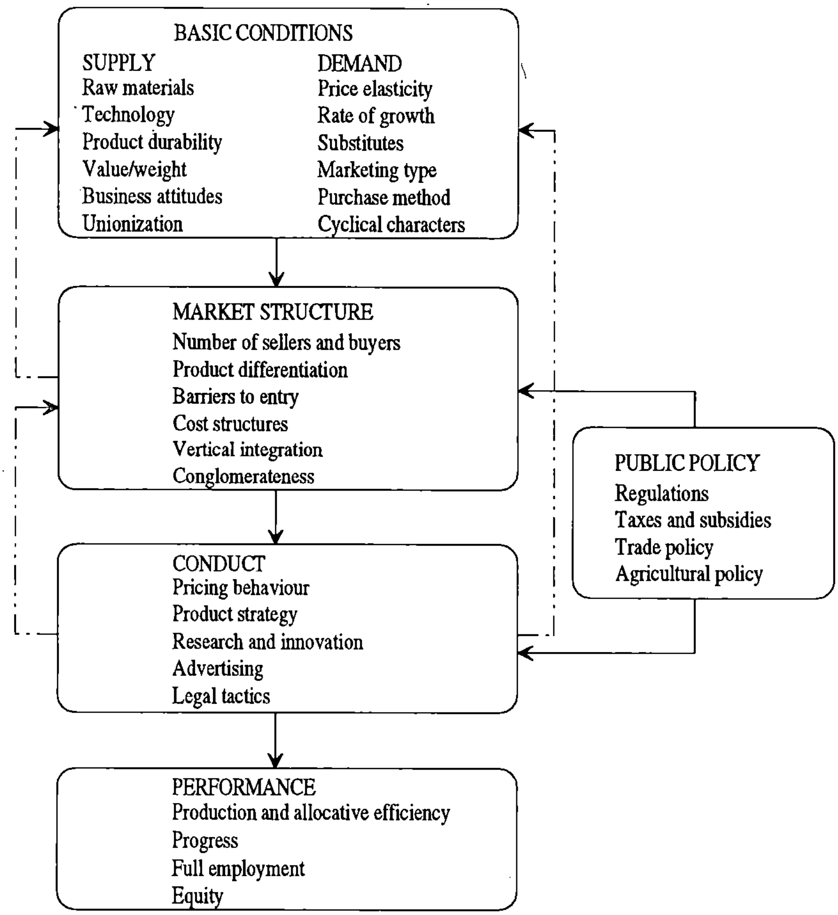

Figure 1.1. The structure-conduct-performance model. Source: based on S*CHERER* *(1980) and* S*CHERER* *and* R*OSS* *(1990).*

well as from structure to basic conditions. For example, the level of advertising expenditure influences the degree of product differention and the demand conditions.

Studies of *industrial organization* (I.O.) also employ different versions of the S-C-P framework than presented in Figure 1.1. For example, market structure can be treated as an exogenous element or the direction of causation can be reversed from performance to conduct and further to structure. SHEPHERD (1990) presents a review of the history and different schools of the field. The application of the game theory to oligopoly models in the 1970s provided a framework for the analysis of competition and determination of market performance. This *game theoretical I.O.* (new I.O.) has been mainly directed to purely theoretical aspects of economics, but recent work also involves empirical industry studies. A typical methodology of the new I.O. is to separate the analysis of short-run equilibrium when market structure is fixed from the analysis of long-run equilibrium when conduct has effects on the market structure. The main interest is directed to modelling conduct as the outcome of *individually rational* decisions. Many of the new theoretical models formalize these intuitive arguments which can be found in the traditional S-C-P literature.

Oligopoly is probably the most common form of competition. Firms in oligopolistic industries make their strategic decisions based on assumptions about the reactions of rival firms. Because individual Finnish food processing firms often hold considerable market shares, it can be assumed that the Finnish food markets are characterized by oligopoly. According to the common view of industrial organization, the conduct of firms is largely determined by the market structure. Therefore, the market equilibriums of concentrated markets will probably differ from those under perfect competition in which firms act as passive price-takers. Structure and conduct have impacts on the market performance, such as the firms' profits, consumer prices, production efficiency, and competitiveness.

From the point of view of consumer welfare, oligopoly prices that are above marginal costs cause loss in utility. At the same time, producers may obtain additional revenues compared to perfect competition. Markets are allocatively inefficient if oligopolistic pricing behaviour leads to a net welfare loss (*deadweight loss*). The most common approach to measuring the welfare effects of oligopolistic competition is the partial equilibrium analysis with the concepts of producer and consumer surplus. Producer surplus can be measured in terms of profits, and Marshallian consumer surplus is a common method to obtain a money measure of consumer welfare. However, it must be noted that Marshallian surplus is only an approximation of more exact measures of welfare changes, such as compensating and equivalent variation. Compensating variation is the change in income that a consumer requires after a change in prices to allow him to reattain his former level of welfare. Equivalent variation is the change in income needed at the original prices to allow a consumer to reach the welfare level he would have achieved after the change in prices. Their sign will be the same, but their magnitudes will generally differ because the marginal utility of money changes along the demand curve. Marshallian surplus is a precise measure of welfare change when compensating variation equals equivalent variation.

Controversy surrounding the level of welfare losses due to imperfect competition has persisted since HARBERGER (1954) first produced estimates of welfare loss in U.S. manufacturing. His monopoly model resulted in a very low loss estimate of 0.08 percent of the GNP and, for instance, GISSER's (1986) estimates derived from a price leadership model supported these results. However, a significant part of literature (e.g. COWLING and MUELLER 1978, OLSON and BUMPASS 1986) has reported larger losses in the range of 4 to 7 percent of the GNP. The magnitude of welfare losses varies between industries and depends on the firms' possibilities to use market power. The differences of estimates depend, for instance, on the procedure to model competition, the estimation of the price elasticity of demand, the length of the time period covered, and the determination of the competitive profit rate.

Most earlier studies on the effects of oligopolistic competition on the food sector have concerned the U.S. economy. The magnitude of estimated welfare losses for food manufacturing has ranged widely. PETERSON and CONNOR (1995) have analyzed eight different models to evaluate cross-industry deadweight losses for U.S. food manufacturing. They compare the rankings of industries according to the estimated welfare losses. They found out that, although the levels of the deadweight loss estimates differ substantially, from 0.1 to 5.15 percent as a value of shipments, the differences of model assumptions and measurement methods have relatively small effects on the industry rankings of the estimated deadweight losses. The welfare losses are usually the greatest in the case of high-value-added products.

In Finland a pioneer work in the area of S-C-P research is the study of WAHLROOS (1980). He noted that demand growth, advertising intensity, risk, and the degree of foreign competition explain the profitability differences within industries. VIRTANEN (1987) found out that concentration is also an essential determinant of profitability. The relationship is positive when profitability is measured as profit margins, but it turns to be negative when capital productivity is used as profitability measure. One reason for this is that the market power may lead to overinvestments and to inefficiency in the use of capital. Furthermore, an intra-industry study of WILLNER and STÅHL (1992) evaluates welfare losses of Finnish four-digit industries using concentration data from 1982. They found out that there is a number of industries in which high concentration may lead to substantial welfare losses.

Application of imperfect competition to food processing industries has been infrequent in Finland. VOLK (1993) applied Cournot behaviour to raw material supply when studying the interdependences between a cooperative and its members. In the study of ISOSAARI (1993), the welfare effects of sugar policy alternatives in the monopolistic markets are evaluated. Market imperfections can be observed to have influence on the choice of policy instruments. Furthermore, HOLM (1994) applied strategic trade theory when analyzing the effect of international agricultural policy harmonization and trade liberalization. He also evaluated the welfare impacts of the Nordic countries' EU membership on the agricultural sector by using a vertically integrated monopoly model.

The strength of foreign competition influences domestic structure-conduct-performance relationships. In Finland a high domestic price level of agricultural products has been maintained through the administrative foreign trade system consisting of both *import protection* and *subsidized exports* of surplus production. Imports have been regulated, for instance, by means of tariffs, imports levies, and quantitative import restrictions. In the Finnish food manufacturing, the effects of protection on efficiency may appear as oligopolistic coordination of the protected firms or too small plant scale within an industry.

The integration of previously segmented food markets is an essential part of Finland's accession to the European Union (EU) at the beginning of 1995. Joining the EU leads to lower trade costs and lower prices of agricultural products. This reduces the average production costs of food manufacturers. Removing institutional barriers to trade has effects on economic welfare through increased foreign competition within the food sector. A potentially important effect of the EU membership is that the integration may reduce the market power that firms have in their domestic markets. Thus, it can be assumed that the estimates of the economic effects of the EU membership on Finnish food economy, assuming perfect competition, would probably underestimate the welfare improvements resulting from integration.

1.2. Research objectives

Due to the high level of industrial concentration and the small market size, welfare losses associated with imperfect competition may be large in the Finnish food processing industries. The high degree of border protection before the accession to the EU may have increased the level of allocative inefficiency. However, research concerning imperfect competition in the Finnish food manufacturing and its quantitative effects on welfare has been quite limited in the field of agricultural economics. *What is the magnitude of the possible welfare losses of oligopolistic competition in the Finnish food manufacturing* has remained a question without quantitative answers.

A potential reason for the lack of research in this field is that the oligopoly models usually yield a large spectrum of possible market equilibriums. The general theory of oligopoly is lacking at present. The results depend on the context in which the theory is set and, thus, different oligopoly models describe what might happen in some particular situations. It is essential to know *how oligopolistic competition influences market performance according to different oligopoly models.*

Integration of the national markets to the larger European single markets reduces the market power that domestic firms have in the domestic markets and may generate welfare gains. This is a result of the abolition of trade barriers, which increases foreign competition, but may also lead to increasing competition between domestic firms. Furthermore, membership in the EU leads to lower production costs in food manufacturing. The degree of transmission from cost reduction to product prices and the effect on consumer welfare depend on the degree of market imperfection. A problem is *to what extent possible welfare changes are due to the different impacts of integration, and what the magnitude of changes is.*

The purpose of the present study is to provide answers to the problems presented above. The *objectives* of this study are the following:

1) to study the effects of market structure and conduct on performance by using the game theoretical model formulations;
2) to derive measures of welfare losses associated with oligopolistic market power for a number of equilibrium types;
3) to estimate welfare losses of oligopolies for the Finnish food manufacturing by employing alternative oligopoly models;
4) to predict how the membership in the EU affects the oligopoly equilibriums, consumer surplus, and firms' profits in the Finnish food manufacturing.

This study presents a way to link industry performance and structure in oligopoly. The empirical analysis is based on explicit models in which welfare losses associated with the oligopolistic equilibrium are computed directly instead of relying on a proxy like the price-cost margin. Because there are important variations in the strength of foreign competition, the aim is to develop a framework of high flexibility to permit the impact of trade on conduct and performance to vary across food processing industries.

When studying welfare losses due to oligopolistic competition, it can be assumed that the conduct of industries with regulated imports and those with free trade differ significantly from each other. In the first group, firms may have a high degree of market power due to the high protection measures, while in the second group foreign competition affects conduct and performance. As a result, the performance of protected industries is more significantly determined by the domestic market stucture variables.

Market integration is a considerable *policy change* that leads to increased foreign competition, a more fragmented market structure in terms of the increased number of potential competitors, and a decrease in the domestic firms' potential market power. The game firms play is altered. The purpose of this study is to develop a theoretical model that captures oligopolistic interactions of the food processing industries, to simulate the consequences of the integration, and to compute the relevant welfare effects. The purpose is to analyze the effects of integration that are induced by changes in the competitive environment.

1.3. Plan of the study

This study consists of a descriptive analysis of the Finnish food manufacturing (Chapter 2), a theoretical study of the structure-performance relationships (Chapters 3 and 4), an empirical investigation of the welfare effects of oligopolistic competition and market integration (Chapters 5 and 6), and sections that draw conclusions from the main findings (Chapter 7) and summarize the entire study (Chapter 8). The considerable emphasis on theoretical analysis is based on the fact that most equilibriums of imperfect competition are greatly dependent on the model selection, and the form of oligopolistic competition is decisive when effects on welfare are studied.

The S-C-P framework of the Finnish food manufacturing is described in Chapter 2 by reviewing previous studies and collecting statistical data. First, the role of food processing industries in Finnish economy is presented briefly. Different dimensions of the market structure and conduct provide the basis for the model selection in the following chapters. In this context, the linkages between the strategies of food manufacturing and public policies are described. A description of market performance concentrates on the profitability and financial performance of the Finnish food processing industries.

The main interest of Chapter 3 is to study the effects of market structure and conduct on performance. Firms' strategic behaviour is modelled as noncooperative games, and a conjectural variations model of an oligopoly is used to investigate the short-run relationship between structure and market power. The stability conditions of collusive behaviour are also analyzed by using the theory of repeated games. However, if there exists some kind of strategic asymmetry between firms, the relationship between structure and market power may be different than when compared with the simultaneous moves approach. Relevant concentration indices are derived both in the case of symmetric simultaneous moves oligopoly and in asymmetric oligopoly. A dominant firm model and a hierarchical Stackelberg model are presented as special cases. Because the integration theory is largely based on the modern trade theory, a short section is used to investigate how optimal trade policies change with the nature of oligopolistic competition. The basic idea is that the government's policy can influence firms' behaviour and, in some cases, interventionist policies may increase national welfare. However, results depend again heavily on the nature of oligopolistic competition, and some other, e.g. country-specific, factors.

Different trade policy arrangements of the Finnish food sector form the basis for the model selection in Chapter 4. The objective is to derive applicable models to estimate welfare losses due to the oligopolistic competition so that the implications of import quotas and import levies are included in the models. The intention is to derive models that allow for empirical findings without detailed firm-level information about sales, costs, and profits. Therefore the welfare loss estimates produced by these models can be described as potential welfare losses that are realized if firms operate optimally, i.e. they really utilize the market power due to the concentration, foreign trade arrangements, and demand characteristics. First, Chapter 4.1 presents a model in which quantitative import restrictions are adopted. Foreign firms are supposed to take prices as given in their individual export decisions within the permitted quota. In the second model (Chapter 4.2), quantitative import restrictions do not exist, but the government can impose an import levy or a subsidy per unit of home production. The Stackelberg model, in which domestic firms are assumed to be in the leadership position, is used in this context. Brief discussion on potential extensions of the models is also presented.

The models to evaluate welfare losses of oligopolies are applied to Finnish food, drink, and tobacco industries in Chapter 5. Welfare loss estimates are based on 1993 statistics on domestic production, foreign trade, and the level of concentration. Estimated welfare losses for an industry depend largely on the price elasticity of demand and the form of oligopolistic competition and, therefore, a sensitivity analysis is needed to evaluate the range of variation. Finally, this chapter contains a procedure to link the price elasticity of demand and the degree of competition by using the industry level profitability measures for some industries.

In Chapter 6 the effects of the EU integration of the Finnish food manufacturing on consumer welfare and domestic firms' profits are investigated. As in the earlier chapters, the modelling framework follows a general conjectural variations approach. However, domestic and foreign products are assumed to be imperfect substitutes. The empirical analyses concentrate on bovine meat and cheese markets. Integration reduces trade barriers, increases foreign competition and, thus, reduces domestic firms' market power within the previously protected industries.

Examination of the results and conclusions, based on the research results and the theory, are presented in Chapter 7. Chapter 8 contains a summary of the entire study as well as some suggestions for future research.

2. The Finnish food manufacturing industry

Food manufacturing industries produce mainly intermediate food materials and edible food for the use of households, restaurants, and other sectors. It comprises the production of foodstuffs, beverages, tobacco, and animal feeds in which processors use labour, capital, and energy to transform raw animal, vegetable, and marine commoditities into a processed form. An increasing share of production is used for non-food purposes e.g. in biotechnology. In this study the *definition* of food processing is based on the 1988 version of the Standard Industrial Classification (SIC) system. It distinguished 25 food processing industries at the four-digit level.

The aim of this chapter is to *identify* the characteristics of the Finnish food manufacturing industries. This descriptive analysis is carried out by collecting data on the economic and structural characteristics of food industries and reviewing previous studies. Later on, the information presented provides the foundations for the model derivations. The theoretical analysis and empirical research of imperfect competition in the following chapters are based on the evidence of *market concentration and oligopolistic competition*.

The first section describes the size and the role of food manufacturing industries in the Finnish economy. The food industry is of great importance, because among all industries it is ranked third according to sales and value added. The rest of this chapter is divided into three parts following the structure-conduct-performance (S-C-P) framework, which is a procedure to explain the degree to which industries approached the competitive ideal in terms of market characteristics and firm behaviour. In Chapter 2.2 the structure of food manufacturing is described. Traditionally, the three dimensions of market structure are the number and size distribution of companies, the degree of product differentiation, and the ease with which a new firm can enter an industry (CONNOR and WILLS 1988). The conduct of firms is usually explained to be largely determined by the structure of the markets. For example, higher concentration encourages a greater degree of collusion. The relationship between structure and conduct in Finnish food processing is discussed in Chapter 2.3. The basic determinants of markets, like demand and supply conditions, vertical integration, and public policies, also influence a firm's conduct. However, the reverse causation also occurs. A firm's conduct will affect the market structure, demand conditions, etc. Strategic behaviour can appear, for instance, in the investment of resources for the purpose of limiting rivals' choises or in cutting price, even if this means short-run losses, to force rivals out of the market (see e.g. GILBERT 1989, ORDOVER and SALONER 1989). Furthermore, advertising can be a source of product differentiation and thus shift a firm's demand curve. Finally, the issues of industry performance are treated in Chapter 2.4. Economic performance has many dimensions, such as efficiency in resource allocation, innovations, and fairness in distribution. Good performance is usually associated with a competitive structure and behaviour, but much of the controversy among economists is due to different measures of performance and their interpretation. However, a widely followed line of research has focused on profits as a key performance variable (SHEPHERD 1990). This section also concentrates on the analysis of profitability and financial performance in the Finnish food processing industries. A more formal presentation of the relationship between profitability and overall economic performance follows later on in the theoretical part of the study.

2.1. Food industry in the Finnish economy

According to the Census of Manufacturing, total shipments of food manufacturing plants totalled FIM 52.5 billion and value added FIM 13.4 billion in 1993. It ranked third after metal and forest industries. The value of food processing output as a percentage of all manufacturing was 18.1 percent. The share of value added remained lower, accounting for 13.4 percent of the value added in all manufacturing.

Within the food processing industry, dairy products manufacture clearly accounts for the largest share, if total shipments are used as a measure (see Table 2.1). Meat processing, slaughtering, and feed manufacture have the second largest scope of operations. Nevertheless, dairy products ranks only third in terms of value added, accounting for 12 percent in 1993. The other major product groups are meat processing (14.8%), fresh bakery products (13.3%), malt beverages and soft drinks (10.9%), and chocolate and confectionaries (6.2%). The highest value added per shipments ratio has been obtained in beverages and in the manufacture of fresh bread and pastries.

The relative weight of the food processing in all manufacturing, measured by total shipments, decreased slightly from 1983 to 1993 (Table 2.1). However, in terms of value added, the share of the food processing industry has increased. A well-known fact is that business cycless in the economy have smaller effects on the output of food processing as compared to the main part of other manufacturing industries. The industry groups that expanded the most rapidly during the 10-year period were starch manufacture, fruit and vegetable processing, chocolate and confectionary manufacture, meat processing, and manufacture of beverages. Furthermore, the group of other food products obtained a very high growth rate. The deflation procedure, however, aggregates different groups, and it is also unable to correct for product quality changes. In the case of industries with new product introductions and large quality changes, the growth rates overstate the rate of physical volume growth.

Table 2.1. Shipments and value added in the Finnish food processing industries in 1983 and 1993.

Industry		Shipments 1983[1]	Shipments 1993	Value added 1983[1]	Value added 1993
1111	Slaughtering	6.811	4.807	1.034	640
1112	Meat processing	6.707	9.368	1.330	1.982
1113	Fruit and vegetable processing	712	1.959	280	625
1114	Fish processing	313	353	118	99
1115-6	Manufacture of margarine,oils, and fats	1.464	1.785	346	314
1121	Dairy products manufacture	13.136	12.240	1.988	1.575
1122	Ice-cream manufacture	492	763	197	335
113	Grain mill products manufacture	1.836	1.357	436	244
1141	Fresh bread and pastries manufacture	3.821	3.659	2.087	1.782
1142	Crispbread manufacture	192	-	88	-
1143	Biscuits manufacture	388	613	193	222
1144	Macaroni manufacture	71	-	22	-
1151-2	Sugar manufacture and refining	1.784	1.567	452	419
1153	Chocolate and confectionary manufacture	1.028	2.030	398	837
1154	Coffee roasting	1.030	1.151	234	312
1159	Manufacture of other food products	395	1.518	130	478
1161-2	Manufacture of alcohol	-	1.294	-	647
1163	Malt manufacture	452	448	122	111
1164	Manufacture of malt beverages, soft drinks	1.953	2.599	1.346	1.460
117	Tobacco products manufacture	1.084	1.022	573	534
118	Starch manufacture	327	708	120	192
119	Feed manufacture	4.865	2.856	685	521
	TOTAL	48.606	52.523	12.178	13.420
	of all manufacturing	19.1 %	18.1 %	12.6 %	13.4 %

[1] Deflated to 1993 prices by the wholesale price index based on commodity groups.
(-) Data not available.

In the past three decades, the share of food manufacturing in the GDP has declined from four to three percent, indicating that its role in the national economy has declined roughly at the same rate as that of total manufacturing. However, the decrease has been small compared to the trend in the relative importance of agricultural production. This can be seen in Figure 2.1, which presents the share of agriculture and food processing industries in the GDP. At

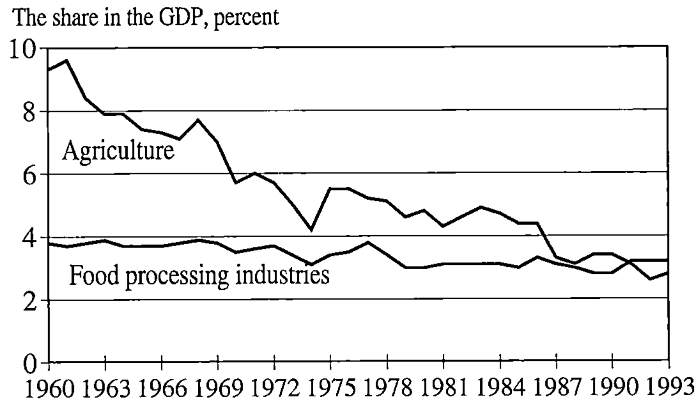

Figure 2.1. The share of agriculture and food processing industries in the GDP.

the beginning of the 1960s the share of agriculture in the GDP was almost 10 percent, but in 1993 it was less than three percent. Thus, the significance of food processing in the food chain has increased considerably. Because raw materials used in food manufacturing are largely of domestic origin (85% according to AALTONEN 1993), these figures indicate both the product quality change of processed food and the change in the input structure of agricultural production.

Food processing industries employed about 43.500 persons in 1993, accounting for 13 percent of the total employment in manufacturing and slightly over 2 percent in the whole economy. Both fresh bakery products and meat industries employ a fourth of the total personnel of food manufacturing. The total wages and social security expenses of the food processing industries were FIM 6.9 billion (about half of value added) in 1993. Although the average annual decrease in the number of employees has been above two percent in the last decade, MALIRANTA (1994) estimates that the productivity of labour in the Finnish food manufacturing is lower than that of foreign competitors.

Investments in the food manufacturing increased in the 1980s and even at the beginning of the 1990s despite the sharp decrease of investment in the national economy (see HERNESNIEMI et al. 1995). During the period from 1988 to1993, the share of the food processing industry in the investments of the whole manufacturing was about 12 percent. In 1992 the share was more than 19 percent, but in 1993 the share fell to 12 percent, accounting for 2.2 percent of the investments of the whole economy. Labour has been substituted by capital, and the capital intensity has increased in the food processing.

Finnish food processing industries are highly oriented to satisfy domestic demand. About 60 percent of the food processing industry was included in the

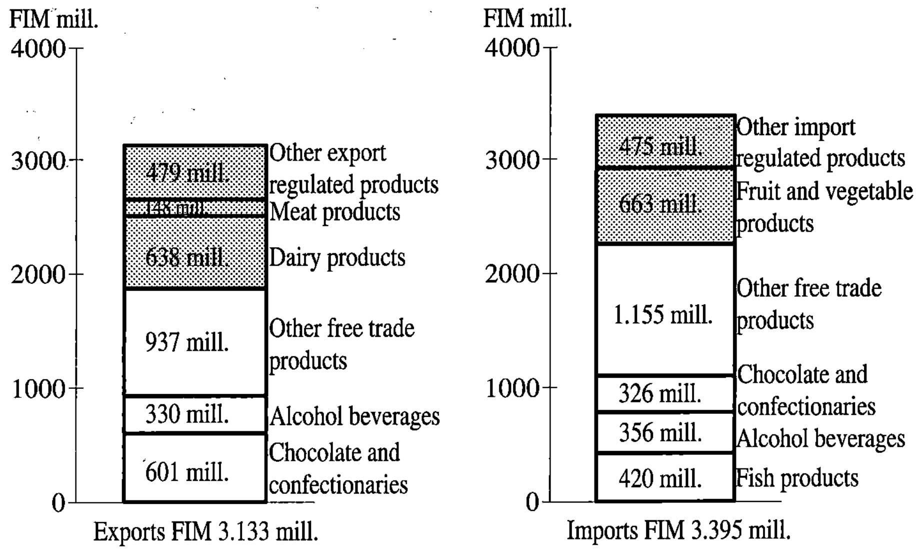

Figure 2.2. Exports and imports of processed food in 1993.

closed sector of the economy before the EU membership in 1995 (HYVÖNEN and VOLK 1995). Imports were limited by means of quantitative restrictions, tariffs, and import levies. Exports required export subsidies because of the high price level of agricultural raw materials. Generally, the main function of foreign trade has been to balance the variations in demand and supply, i.e. to export overproduction in order to keep the domestic prices at the set level (KETTUNEN 1995). Within the *regulated* sector, the exports of processed food consisted mainly of dairy products, meat products, as well as fruit and vegetable products (Figure 2.2). Fruit and vegetable products were the most important regulated import articles.

According to the free trade agreements, i.e. the EFTA and EC, a considerable share of food processing industries has produced *free trade* products from the beginning of 1970s. Chocolate and confectionaries, alcohol beverages, biscuits, baby foods, and sucrochemical products were the most important exported products in 1993. Of the free trade imports, fish products ranked first before alcohol beverages and chocolate and confectionary products. The proportion of *intra-industry trade*, i.e. foreign trade that consists of simultaneous imports and exports of products belonging to the same industry, was large, indicating the general phenomenon in the economy (see PARJANNE 1992). In 1993 the total value of Finnish food manufacturing imports amounted to FIM 3.4 billion, which is equivalent to 3.3 percent of the total imports. Exports were FIM 3.1 billion, accounting for 2.3 percent of the total value of exports.

Table 2.2. The volume of food processing industries by provinces in 1993. Source: Yearbook of Industrial Statistics. Volume 1.

Province	Personnel total	Gross value FIM mill.	Value added FIM mill.	% of all manufacturing
Uudenmaan	11,485	11,286	3,022	13.6
Turun- ja Porin	8,914	10,099	3,293	18.8
Ahvenanmaan	322	351	189	59.0
Hämeen	7,255	7,636	2,163	13.1
Kymen	2,501	2,944	767	7.5
Mikkelin	985	674	202	8.0
Pohjois-Karjalan	755	1,003	228	11.6
Kuopion	2,126	3,251	524	14.1
Keski-Suomen	1,429	1,619	327	5.7
Vaasan	4,306	6,587	1,433	17.5
Oulun	2,718	3,032	809	10.6
Lapin	723	994	462	12.4
Total	43,519	49,477	13,420	13.4

Food manufacturing industries have more important consequences for the rest of the economy than their GDP or employment shares show. According to the inverse matrix of the input-output table in 1992, one unit of production in the manufacture of food products and beverages requires 2.7 imput units, of which 1.2 units come from the other sectors of Finnish economy. The strongest dependency naturally exists between food manufacturing and agricultural production, but food manufacturing also has considerable indirect effects on the other sectors, like the manufacture of metal products and machinery.

The relative economic importance of food processing industry, as well as agriculture, varies at the regional level. While the role of agriculture is the highest in Central Finland, the food manufacturing industry is concentrated to Southern and Southwestern Finland, where the relative importance of food processing is also higher than on the average (Table 2.2). Thus, a large amount of agricultural primary products is exported from Central and Eastern Finland to be processed elsewhere.

The tables above show the significance of the food processing industry within the food economy, all manufacturing, and the whole economy. It is an essential part of the modern food chain. Thus, the questions concerning supply and pricing behaviour of the food industry, as well as the public policy interventions may have considerable impacts on the functioning and efficiency of the national economy.

2.2. The structure of the food manufacturing

According to SCHERER (1980), the *main elements* of the market structure are the number and concentration of sellers and buyers, the degree of product differentiation, barriers to the entry of new firms, the ratio of fixed to total costs, the degree of vertical integration, and the amount of diversification or conglomeration in a firm's product lines. Due to the different theoretical approaches and differences among industries, it is difficult to rank these characteristics in importance. CAVES (1982) argues that the important elements of structure are those that can and do make a major difference for market performance.

The structure of industry is often used as a proxy indicator of the presence of market power. However, there is no single measure of market structure that could perfectly indicate the ability of firms to set prices over marginal costs. For instance, the indicators of market concentration are relevant (not sufficient) measures of market power for industries producing homogenous products. Later in Chapter 3, the theoretical relationship between concentration and performance is derived. If products are strongly differentiated, market power can be assumed to be more a firm-specific phenomenon. The potential or actual power of firms to influence market performance is a mix of the elements of the market structure.

In empirical studies, the structure of an industry is often presented as the number of firms or, more specifically, as the size distribution of the competing firms. The central role of market concentration is based on its theoretical strength, because the degree of oligopoly is identifiable with the extent to which the individual market is dominated by its largest sellers. Furthermore, the degree of market concentration is easier to observe and measure than, for example, the degree of product differentiation. In the following, concentration will be treated as the main indicator of market structure, but some attention is also directed to the other elements of structure. The possible relationships between different elements of market structure are also considered.

Conceptually, two dimensions of concentration can be separated: the *number of firms* and *inequalities in the size*. In the formal oligopoly theory, the number of firms (n) often determines where an industry falls in the spectrum between monopoly ($n = 1$) and pure competition ($n = \infty$). However, real-world industries are never composed of identical firms, and thus statistical measures of dispersion are needed. The concentration of sales can also be described by the cumulative distribution of sales. This can be done, for example, by using the Lorenz curve, which plots the cumulative percentage of sales against the cumulative percentage of firms. It is, however, a pure inequality measure which does not measure the effect of the number of firms. Because the complete size distributions are often unavailable, some summary indices that collect both dimensions of concentration to a single number have been developed (see e.g. KWOKA

1981). The most widely used indices are the *seller concentration* ratio and the *Herfindahl index of concentration* (or the Herfindahl-Hirschman index).

The seller concentration ratio measures the degree of market domination by the largest firms. The m-firm concentration ratio (CRm) is the combined market share of the largest m firms. Table 2.3 presents the three-firm concentration ratios for the Finnish food processing industries in 1993 and 1986. Unfortunately, the period of comparison is quite short due to the restrictions of the industrial statistics. Total firm numbers are also shown.

Of the 20 industries for which data is available, the number of food processing firms has increased in 10 industries and decreased in 8 industries from 1986 to 1993. In slaughtering and tobacco products manufacture, the number of firms has remained the same. If a longer time period is taken into account, the total number of firms has decreased remarkably (see e.g. ALA-PEIJARI 1987). Differences in the number of firms across the industries are great. The production of bread and cakes consists of 870 firms, whereas only one firm manufactures sugar and crispbread.

Table 2.3. Total firm numbers and three-firm concentration ratios (CR3) of the Finnish food processing industries in 1986 and 1993.

Industry	Number of firms		CR3	
	1986	1993	1986	1993
Slaughtering	26	26	74.7	71.7
Meat processing	110	127	54.7	60.5
Fruit and vegetable processing	84	133	71.3	51.2
Fish processing	70	108	25.0	30.2
Manufacture of margarine, oils and fats	8	7	86.7	91.9
Dairy products manufacture	99	67	47.9	65.4
Ice-cream manufacture	5	4	99.5	99.4
Grain mill products manufacture	101	83	63.8	82.1
Fresh bread and pastries manufacture	786	870	38.1	29.9
Crispbread manufacture	4	1	94.7	100
Biscuits manufacture	12	16	90.1	90.0
Sugar manufacture and refining	2	1	100	100
Chocolate and confectionary manufacture	25	37	98.5	85.5
Coffee roasting	2	5	100	99.1
Manufacture of other food products	44	49	72.0	47.0
Malt manufacture	5	3	99.9	100
Manufacture of malt beverages and soft drinks	15	27	91.4	99.1
Tobacco products manufacture	3	3	100	100
Starch manufacture	3	5	100	85.0
Feed manufacture	65	60	81.4	68.6

The market share of the three largest firms has increased in eight cases, decreased in ten, and remained the same in two from 1986 to 1993. The value of the concentration ratio has usually fallen when the number of firms has increased, and vice versa. However, some notable exceptions exist. In meat processing, in the production of malt beverages and soft drinks, and in fish processing the number of firms has increased but, at the same time, the market position of leading firms has become stronger. Other industries that became noticeably more concentrated in terms of the concentration ratio are dairy products, manufacture of margarine and other vegetable and animal oils and fats, grain mill products manufacture, and crispbread manufacture. The largest declines in the three-firm ratio can be seen in the manufacture of fresh bread and pastries, chocolate and other confectionary products, feeds, and in the group of other food products. In 1993 the industry groups with increasing and declining three-firm concentration ratios both accounted for the value added of about FIM 5.9 billion. In the value of shipments, the share of industries with increasing concentration ratio was noticeably larger.

If the three-firm concentration ratios are weighted by the value added of each industry, the average ratio of the whole food manufacturing was 72.2 percent in 1993. The concentration ratio varies widely within industries. The highest ratios are in crispbread, sugar, malt, and tobacco products manufacture, followed by ice-cream, coffee roasting, and beverages. The concentration ratio is low in the production of bread and cakes as well as in fish processing.

The use of the three-firm concentration ratio involves at least two problems. First, it takes no account of the differences in size within the top three firms, but only compares the top three as a group with all others. Consider the sugar and tobacco products industries in 1993 as an example. In both cases CR3=100, but the sugar industry is clearly more monopolistic. Second, it does not provide any information about the structure of the smaller firms in an industry. As a result, the ranking of industries may vary depending on the value of m, which is arbitrarily chosen. Table 2.4 shows, however, that using the five- and ten-firm concentration ratios causes very small changes in the ranking of food industries. The share of the ten leading companies of industry shipments remains under 80 percent only in fish products as well as in the production of bread and cakes. In 15 of the 20 industries the ten-firm concentration ratio is at least 90 percent. The food processing industry can be *described as oligopolistic.*

In addition to the different concentration ratios, the Herfindahl index of concentration ($0<H\leq1$) is also computed for the Finnish food processing industries. The index is defined as the sum of the squares of market shares of firms in the industry, i.e. $H=\Sigma s_i^2$, where s_i is the market share of firm i. Althought the concentration ratio is often used as a proxy for the Herfindahl index, very different degrees of correlations between them can be found, depending heavily upon the samples of industries used in the analyses (SLEUWAEGEN and

Table 2.4. Five- and ten-firm concentration ratios and the Herfindahl indices of concentration for Finnish food processing industries in 1993.

Industry	CR5	CR10	H for the largest 5	H for the industry
Slaughtering	84.6	96.2	0.32	0.23
Meat processing	71.3	81.8	0.26	0.14
Fruit and vegetable processing	69.2	88.8	0.25	0.13
Fish processing	42.7	61.5	0.22	0.05
Manufacture of margarine and other oils and fats	99.9	100	0.33	0.33
Dairy products manufacture	73.6	83.8	0.43	0.24
Ice-cream manufacture	100	100	0.86	0.86
Grain mill products manufacture	92.1	96.3	0.43	0.37
Fresh bread and pastries manufacture	34.3	41.1	0.33	0.04
Crispbread manufacture	100	100	1.00	1.00
Biscuits manufacture	96.1	99.1	0.39	0.36
Sugar manufacture and refining	100	100	1.00	1.00
Chocolate and confectionary manufacture	96.3	98.7	0.30	0.28
Coffee roasting	100	100	0.37	0.37
Manufacture of other food products	66.8	90.6	0.23	0.11
Malt manufacture	100	100	0.64	0.64
Manufacture of malt beverages and soft drinks	99.6	99.8	0.40	0.40
Tobacco products manufacture	100	100	0.49	0.49
Starch manufacture	100	100	0.30	0.30
Feed manufacture	81.7	91.0	0.27	0.18

DEHANDSCHUTTER 1986). Especially in concentrated industries, like in the Finnish food manufacturing, the relationship cannot be linearly approximated.

A practical problem with the Herfindahl index is that a complete index requires information on the sizes of all firms in the industry. However, because the market shares of the largest firms are usually high in the Finnish food manufacturing, the effects of minor firms can be approximated without major losses of information. In Table 2.4 the Herfindahl index is first computed among the five largest firms of the industry. The index is then *approximated* for the whole industry by means of the formula:

$$H = H_5(CR5)^2+(1/5)(CR10-CR5)^2+(1/(n-10))(1-CR10)^2,$$

where H_5 is the Herfindahl index among the five largest firms, CRm is the concentration ratio of m firms, and n is the total number of firms in the industry.

This means that firms placed from 6 to 10 in the size ranking are assumed to be of the same size and, similarly, the smaller firms are assumed to be of an equal size.

The lowest Herfindahl index is in fresh bread and pastries manufacture, followed by fish processing (Table 2.4). The highest values are naturally in the monopoly industries. The value added weighted Herfindahl index for food processing is 0.27. If the indices are weighted by the value of shipments, the average index is 0.25.

The concentration data involves some problems in the classification of markets. In some cases the nationwide basis of the SIC does not take adequately into account the local nature of markets. Especially in the case of fresh bread, in which the national concentration measures show very low values, the geographic market size is often very small and, thus, local concentration may be high. The SIC four-digit industry category is also often too broad, including a variety of products that do not substitute for one another. For example, the SIC industry 'dairy products' covers many distinct markets, like liquid milk, cheese, and butter. It also includes a portion of ice-cream production. Furthermore, the data does not take into account that firms may have the same owner. These factors make the values of concentration indices too low compared to the actual markets. However, there are potential factors that influence the real concentration in the opposite direction. First, different industries may include products that are close substitutes in consumption. Second, imports are not included in the data. In many Finnish food industries, imports were strictly restrained in 1993, but for industries such as fish processing, biscuits manufacture, and chocolate and confectionary manufacture foreign imports are at least potentially important, causing true concentration of sales to be lower than the concentration of production.

Theories on the *determinants of concentration* cover a wide range from the technology and entry barriers arguments of the traditional S-C-P approach to the new I.O., in which concentration is jointly determined along with performance. DAVIES et al. (1992) argue that different approaches have developed largely independently of each other, and there is nothing that could be labelled an integrated theory of the determinants of concentration at present. However, the theories show that concentration mainly reflects other elements of the market structure, such as *barriers to entry* and *product differentiation.*

Entry barriers can be classified into exogenous (structural) barriers and those which have been manipulated by incumbents, i.e. strategic barriers to entry. In 1956 Bain (ref. MARTIN 1993) emphasized absolute cost advantages of incumbent firms compared with entrants, economies of scale, and product differentiation as the main determinants of entry conditions. Such entry barriers may be either structural or strategic.

Incumbents have an absolute cost advantage over entrants if, for instance, patents restrict access to the most efficient production techniques, if they control the most efficient sources of supply of factors of production, or if financial markets impose a higher cost of capital on entrants than incumbents. Furthermore, incumbents' vertical integration or dealing contracts with retailers reduce the size of potential entrant's market. As research suggests, the actual long-run average costs usually fall at first, i.e. economies of scale arise, and then remain constant over a very large range of outputs (CAVES 1982). Thus, entrants must come into the market in a large scale. Approaches explaining the relationship between entry and economies of scale are typically linked to strategic behaviour in which an incumbent firm expands its capacity in order to deter future entry (e.g. DIXIT 1980, SCHMALENSEE 1981). Analogously, product differentiation may also be a barrier to entry. LYONS (1991) determines product differentiation as a situation where two or more products are perceived by consumers to be close but imperfect substitutes. Incumbents with differentiated products can have several advantages over entrants. For instance, buyers might have strong preferences for established brands and entrants must spend more than incumbents to reach the final consumer. BAGWELL (1990) shows a situation in which uncertainty about product quality acts as a barrier to entry, and imperfect information precludes entry by a firm producing a high-quality product.

CONNOR and WILLS (1988) argue that product differentiation is the most forbidding barrier to entry in the manufacturers' brand channels of the U.S. food processing industries. Product differentiation is often divided in *horizontal and vertical differention*. In the food sector, horizontal differentiation may arise e.g. from new product development supported by R&D activity. The first-mover advantage of pioneering brands is an example of vertical differentiation. Within the Finnish meat, beverages, and ice-cream industries, HYVÖNEN (1992) identifies the superior experience and skills of incumbents as the most important entry barrier. Limited access to sales outlets, the restrictions on imports, more advanced production technology of incumbents, and product differentiation are also seen as important entry barriers. Only ten percent of firms estimated that economies of scale and limited financial resources of entrants constitute strong entry barriers. Economies of scale can, however, be substantial in many other food processing industries. If markets are local, economies of scale are likely to create entry barriers. Because the market size is very small in Finland, the cost-efficient plant size can account for a large share of the total markets.

The cost structure of the Finnish food processing industries (Table 2.5) reveals that *access to raw materials* is a key determinant of succesful entry. The share of raw materials in the food processing is considerably higher than in all manufacturing on the average. Within food manufacturing the shares are the highest in slaughtering, grain mill products, and feed manufacture, and the lowest in the manufacture of malt beverages and soft drinks, as well as in fresh bread and pastries manufacture.

Table 2.5. Acquisition costs of inputs in the Finnish food processing in 1993, percentage of shipments.

Industry	Cost item (see explanations below the table) 1.	2.	3.	4.	5.	6.	7.
Slaughtering	77.7	0.3	4.2	3.4	0.6	6.6	7.3
Meat processing	63.0	2.6	4.0	7.8	0.9	14.1	7.6
Fruit and vegetable processing	38.6	12.0	2.5	12.8	1.8	15.6	16.8
Fish processing	53.7	2.9	7.7	5.1	1.7	13.8	15.0
Manufacture of margarine,oils and fats	46.3	4.7	8.4	16.6	1.5	9.6	12.9
Dairy products manufacture	63.0	4.8	11.3	6.9	1.1	6.8	6.1
Ice-cream manufacture	34.2	10.4	1.3	12.4	1.0	11.6	29.1
Grain mill products manufacture	72.9	2.7	1.7	6.4	1.1	6.4	8.8
Fresh bread and pastries manufacture	27.5	2.7	6.1	12.6	2.5	31.4	17.2
Biscuits manufacture	34.7	7.8	4.7	16.9	1.2	20.5	14.2
Sugar manufacture and refining	63.3	1.7	5.4	5.3	2.4	9.0	12.9
Chocolate and confectionary manufacture	33.5	8.7	3.1	13.9	1.4	19.8	19.6
Coffee roasting	52.3	4.8	3.6	15.7	0.7	8.0	14.8
Manufacture of other food products	35.0	8.9	13.4	11.0	1.9	14.3	15.5
Malt manufacture	50.0	0.9	5.1	6.2	2.9	7.1	28.0
Manufacture of malt beverages and soft drinks	17.5	5.7	1.0	18.7	1.7	17.1	38.4
Tobacco products manufacture	29.0	5.8	2.8	10.6	0.8	16.0	34.9
Starch manufacture	55.5	0.2	3.2	9.6	3.2	12.5	15.8
Feed manufacture	67.8	1.4	2.7	6.6	1.8	6.4	13.3
Food manufacturing, total	53.9	4.3	5.9	9.1	1.4	12.5	12.9
All manufacturing	45.5	1.6	3.0	12.0	3.2	18.5	16.2

1. Raw materials 2. Packing 3. Other commoditities 4. Services (include payments for temporary repair work, rents, and other services) 5. Energy 6. Wages 7. Others (the value of shipments minus costs presented. Covers capital costs, profits, etc.)

Packing materials also play an important role in the food processing. In the production of fruit and vegetable products and ice-cream, they account for more than 10 percent of the value of total shipments. This provides one form of product differentiation. Labour costs vary a lot between industries, i.e. the share of these is more than 30 percent in fresh bread and pastries manufacture and only 6.4 percent in feed and grain mill products manufacture. The last column in Table 2.5 is value added minus labour costs, and this shoud be enough to cover at least capital costs. This residual is lower in food processing than in other forms manufacturing partly because, according to LIIKETALOUSTIETEELLINEN TUTKIMUSLAITOS (1992), food processing industries are, on the average, less capital intensive.

Although food markets are quite concentrated in most of the western countries (e.g. LINDA 1992), Finnish statistics show an *exceptionally* high degree of concentration in many cases. One obvious explanation is the often empirically observed negative relationship between market size and concentration. SUTTON (1991) shows, however, that this relationship does not hold across industries generally. It holds for homogenous products industries and usually for differentiated products, but it is not valid for industries in which endogenous sunk costs are present, i.e. in which fixed outlays in advertising or R&D can be used to enhance consumers' willingness-to-pay. In this latter case, increase in the market size does not lead to convergence to a fragmented structure. This approach follows the tradition of vertical product differentiation (SHAKED and SUTTON 1987), and combines price competition, scale economies, R&D, and advertising intensity as the determinants of the equilibrium pattern of industrial structure.

Other measures of market structure include the existence and market shares of *leading firms* and brands. RASIMUS et al. (1991) found out that a leading firm (brand) often holds 40-100 percent of a market in Finnish food manufacturing. This is significant because competition is likely to be more coordinated when there is a market leader ready to make the first move.

Advertising to consumers is the principal tool used to create a level of differentiation. CONNOR and WILLS (1988) deal with this as a structural dimension of markets, because intensity of advertising tends to be about the same between competing firms, and intensity is also quite stable for long periods. Thus, the level of advertising is useful (and often the only) indicator of the extent of product differentiation in an industry. However, advertising is one of the main factors of conduct, and it will be discussed in the next chapter.

2.3. Competition and strategies in the food manufacturing

Firms' conduct consist of their decisions, for instance, on pricing, output levels, selling expenses, and research expenditures. The market structure influences the behaviour of the firms as they decide how strongly to compete or collude with each other. For example, higher concentration encourages a greater degree of collusion. However, the causation does not flow only from structure to conduct (Figure 2.3). Strategic behaviour may appear like in the investments of resources or in predatory pricing for the purpose of limiting the entry of new firms. They are long-run strategic desicions of the firms. The situation can be thought of as a two-stage game. At stage one, technology determines the minimum efficient scale (setup costs) and a firm decides e.g. the level of R&D

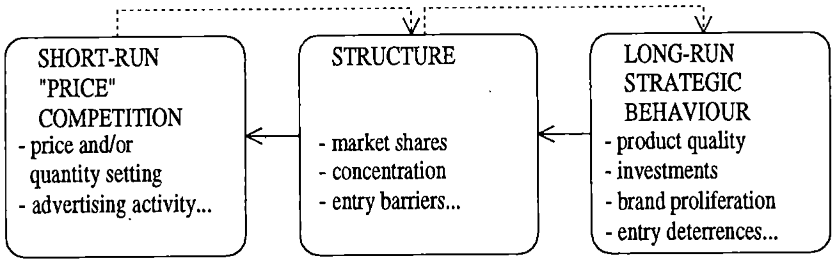

Figure 2.3. The relationships between long-run and short-run conduct and structure.

and the quality of products. At the second stage, these investments are treated as sunk costs when firms compete against each other. There also exists a reverse causation from short-run competition to the structure and further to long-run strategic desicions.

Futhermore, a fundamental problem in the nature of conduct is the conceptual difference between *strategies* and *actions*. E.g. SHEPHERD (1990) notes that behaviour covers a range of firms' actions. Nevertheless, action is only an equilibrium of a set of firms' strategies, and strategy is a rule which specifies an action as a function of determinants such as market structure and demand conditions. The analysis should concentrate on firms' strategies but, unfortunately, they are mostly unavailable or even unobservable. Thus, actions are usually used as indicators of strategies.

In the case of Finnish food manufacturing, where most industries are very concentrated, the actions of the largest firms are probably interdependent. Competition can be described as oligopolistic. Sometimes, market behaviour is linked to the concentration measures. For instance, SCHERER (1980) argues that if the four-firm concentration ratio is higher than 40 percent, markets can be classified to be oligopolistic. Within the Finnish food processing industries, only in fish processing and bread baking the three-firm concentration ratio was lower than 40 percent in 1993. Because these industries were also relatively close to this 'critical' value, all food processing industries, except monopolies, are oligopolistic. In making strategic decisions, firms take into account what kind of reactions the rival firms are likely to have.

Concentration is only one determinant behind the toughness of competition. Concentration measures understate the potential for imperfectly competitive behaviour when the market classification includes non-substitutes, when markets are local, when products are differentiated, and when institutional arrangements (e.g. import quotas and tariffs) limit competition (MAIER 1994). Furthermore, demand and cost conditions affect firms' behaviour. Because the demand for food is quite price inelastic in Finland (LAURILA 1994) and the four-digit industry classification includes a lot of non-substitutes, it is likely that the market power of firms is understated on the basis of concentration.

Pricing strategies and the choice of the output level can be determined in many ways in oligopoly. The most profitable way for firms can be *joint profit maximization.* In the extreme case, firms would have a formal agreement which includes common prices, quantities, and even territories for each seller or buyer. Most of these cartel agreements have been made illegal by competition laws. Finnish competition legislation was largely reformed in 1988. The legislation concentrates on removing cartels, preventing the abuse of determining the market position, and lowering entry barriers. Competition policy has, for instance, led to the structural reform within the cooperative field of milk processing industry. Similarly, in slaughtering and meat processing cooperation between the largest companies has changed towards tight price competition in the beginning of the 1990s.

Outside the explicit cartel, oligopolistic pricing and production decisions can be seen as a game with moves and countermoves. There are many models of oligopolistic behaviour, and 'right' models differ from one market to another. One special case arises in respect of *first-mover advantages*, i.e. to what extent strategic asymmetries between early entrants and firms that enter later affect competition. A possible result of asymmetries is a price leadership in which changes in actions are first decided by the leader and then the followers make the same change. The leader is normally an early entrant in the industry. Price leadership is probably a quite common form of competition in the Finnish food manufacturing. For example, it can be assumed that Valio has a price leadership position at least in the trade of fresh milk and cheeses. In the margarine market, Unilever enjoyed a strong first-mover advantage in many European markets (SUTTON 1990), where it still has a leadership position and from where it has captured a strong position in Finland, too. In chocolate and confectionary manufacture, Fazer had the first-mover advantage and it still has the market leader position (MIKKOLA and VOLK 1994).

The strategies of the Finnish food processing firms are largely home market oriented e.g. due to the regulation of foreign trade and distant location. Trade in basic food stuffs has mainly consisted of subsidized exports of overproduction. Firm strategies are affected by agricultural policy, and export subsidies have clearly benefitted both agricultural producers and the food industry (HYVÖNEN and KOLA 1995).

Some exceptions are, for instance, confectionaries, crackers, beer, and sucrochemical products, which are increasingly export oriented sectors. Internationally operating firms can have several strategies. Because the growth potential of the domestic market is low, they increase exports in order to meet growth objectives. Exports can be viewed as a low-risk means of entering new markets or as a way to serve foreign markets too small for profitable local production. Direct investments, licensing, or joint ventures are also possible strategies in entering new markets. At the same time as imports to Finland have also increased, foreign and multinational food firms use these strategies to an increasing degree e.g. in beverages and dairy products when they enter Finnish markets.

HYVÖNEN (1992) found five factors that characterize competitive strategies of Finnish meat processing, ice-cream, and beverages industries:

1) *Marketing differentiation strategy* includes a broad product range as well as intensive product development and brand advertising. Firms are relatively old and large, they also produce distributors' brands, marketing organization is strong, and plenty of new products are developed.
2) *Distributor oriented strategy* is characterized by strong marketing organization, accurate choice of market segments, emphasis on trade marketing, manufacturing of distributors' brands, and economies of scale.
3) *Strategy based on high quality and cost efficiency* attributes a great deal of importance to good corporate image and tight quality and cost control. Firms are usually small, and they adopt cautious strategies in sales expansion.
4) *Production oriented strategy* concentrates on cost efficiency based on economies of scale and new technology. Good availability of raw materials is the main strength. This large-scale manufacturing consists of some dominant firms. These firms also emphasize the coverage of distribution channels and good financial liquidity, but invest relatively little in product development.
5) *Price oriented strategy* group does not produce well-known brands, but concentrates on competitive pricing and low production costs.

Largest firms usually tend to follow differentiation strategy with a broad product range, price competitivenes due to economies of scale, and bargaining power in the food chain (HYVÖNEN and VOLK 1995). Because the retailing sector is highly concentrated, the four largest chains account for 95 percent of sales, and food manufacturers need continuous product development and high advertising expenditures for increasing their bargaining power. Figure 2.4 shows that the advertising intensity of food manufacturing is internationally very high in Finland. Empirical evidence (see MARTIN 1993) suggests that advertising intensity is greater at intermediate levels of market concentration than when

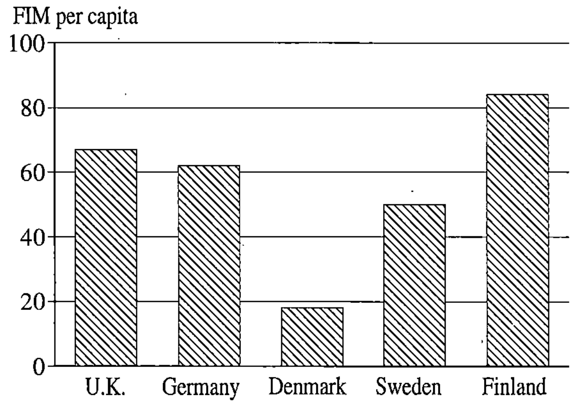

Figure 2.4. Advertising expenditures of manufacturers' brands in 1991. Source: RASIMUS *et al. (1991).*

concentration is either very low or very high. In addition to the aim of increasing bargaining power in the food chain, dominant firms can use advertising as a means of responding to the entry of new firms.

Firm behaviour, especially marketing strategy, differs greatly between different customer groups or marketing channels. According the input-output tables, more than 30 percent of the gross value of processed food is used as ingredients in other food processing industries, and about 7 percent goes as inputs to other domestic sectors. These are usually the least differentiated channels in food processing, characterized by hard price competition or vertical integration. Low differentiation is also characteristic to the sales of unbranded goods to distributors. Quality standards are set and advertising and other sales promotion of distributors' brands is done by retailers or wholesalers. Manufacturers must be price-competitive and reliable in this market channel. The share of distributors' brands has grown rapidly in many European markets (RASIMUS et al. 1991), but this development has been relatively slow in Finland. A possible strategy for the manufacturer is to introduce its own low-price brand that competes with distributors' brands. Correspondingly, the food-service marketing channels to restaurants and other establishments consist mainly of undifferentiated products. Thus, the sales of manufacturers' brands offer the greatest opportunities for advertising and product differentiation to food processors.

The competition strategies of some Finnish food processing industries have been analyzed in Pellervo Economic Research Institute by using the diamond model created by M.E. Porter as a framework for the analysis. For example, in confectionary industry large firms have strong brands and luxury products are often sold through their own channels, but competition is relatively tight due to the existence of close substitutes (MIKKOLA and VOLK 1994). In baby foods firms invest in strong brands and high quality products, because their international price competitiveness is poor (KETTULA 1994). In the study of ISOSAARI (1994), Finnish vegetable oil and margarine industry is found to be characterized by the aim of the largest company (Unilever) to receive a dominant position by means of economies of scale and international product development. The rival firm (Raisio) is entering new markets in the Baltic countries. On the Finnish cheese markets, the market leader (Valio) has a broad range of products, while its competitors have specialized in few market segments (LAMMINMÄKI 1995).

Cooperative firms owned by agricultural producers still have a dominant role in the acquisition of raw materials in milk (90%), meat (65%), and eggs (40%), although processing and marketing is usually organized as stock companies (AALTONEN 1995). Joint action of farmers in terms of cooperatives is based on the creation of members' market power, exploitation of size economies, risk pooling, and decrease in the uncertainty about sales and price fluctuations due to the larger size of the economic entity (SEXTON 1995, OLLILA 1989). Traditional principles of cooperatives may differ significantly from that of investor-owned firms, because cooperatives are dealing directly with their owners and profits are distributed according to patronages. Open membership and obligation to buy products offered by the members are characteristics of Finnish producer cooperatives. A thorough analysis on production, pricing, and investment behaviour of cooperatives is provided by VOLK (1993).

Finland's membership in the EU will have effects on the conduct of many Finnish food processing industries due to the elimination of border protection and more severe competition. For example, KOLA (1992) states that firms' new strategies are either growth and concentration or specialization on regional or local markets such that vertical and horizontal integration are utilized in order to improve efficiency and the competitive position of the firms. The consequences of integration appear both in the short-run price competition between firms and in the long-run strategic decisions that have feedback effects on industrial structure.

2.4. Market performance in the food manufacturing

Market performance has *several dimensions*, such as efficiency in resource allocation, technological progress, and equity in distribution. Efficiency refers to aspects of technological and allocative efficiency as well as avoiding resource waste like unemployment. More advanced technology creates economic growth and innovations bring new products. Equity is more an ethical matter, depending on the society's values and standards. Due to the different dimensions of performance, it is difficult to decide how to rank them in importance. At the industry level, CONNOR (1990) emphasizes profitability and prices as measures of allocative efficiency, and summarizes that food prices and profitability are usually found to be positively related to market concentration and product differentiation in the literature. In contrast to the negative relationship between concentration and efficiency of recource allocation, technological progress and concentration can be related positively. Innovative firms gain cost advantages and greater efficiency, which increase their market shares and industry concentration. For example, CARLSSON (1972) estimated that productive efficiency of Swedish manufacturing was the greatest in more concentrated industries and in industries with lower protection from tariffs.

Measures of *profitability* are commonly used in the empirical context when the implications of concentration and market power on performance are studied. However, high profits may also be due to efficiency differentials or demand conditions. Correspondingly, concentration and less competitive markets can lead to X-inefficiency or weak managerial behaviour. Profitability analysis is also sensitive to the choice of the profit measure. Therefore, different ratio measures are presented in this chapter to characterize the profitability of the Finnish food manufacturing. Furthermore, the *financial performance* of food, beverage, and tocacco industries are measured in terms of leverage, liquidity, and efficiency.

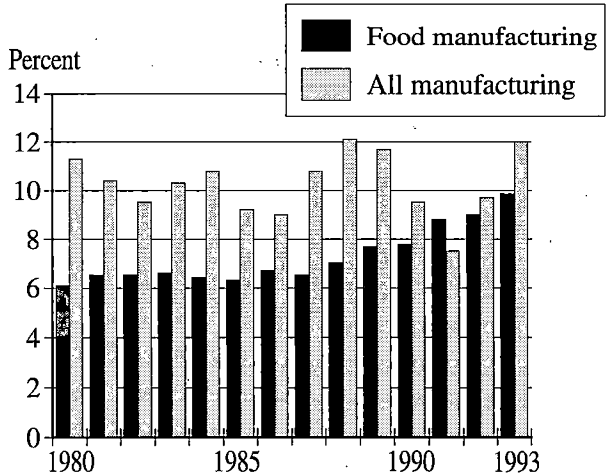

Figure 2.5. Operating margin as a percentage of turnover in the food manufacturing and all manufacturing in 1980-1993. Sources: LIIKETALOUSTIETEELLINEN TUTKIMUSLAITOS (1992) and STATISTICS FINLAND.

The operating margin as a percentage of turnover has steadily increased in the Finnish food manufacturing from the end of the 1980s (Figure 2.5). The need for operating margin differs significantly within different industries due to the differences in cost structures. Because food processing industry has been less capital intensive than manufacturing on the average, it is expected that the relative operating margin of food processing has remained at a lower level. An increasing trend in the relative operating margin of food processing correlates with the increasing capital intensity, as well as with the better net results during the last years (Figure 2.6). From 1990 to 1993 the years of economic depression affected dramatically the Finnish manufacturing, whereas in the food processing, especially beverages, record results were achieved. Over a longer time period, the net result percentage has usually remained lower in food processing compared to all manufacturing on the average. Annual changes have been smaller in the food manufacturing. According to the study of LIIKETALOUSTIETEELLINEN TUTKIMUSLAITOS (1992), good results of all manufacturing in 1988 are partly due to the changes of statistical principles. Furthermore, it must be noted that the balancing of accounts data from Statistics Finland is based on a sample in the case of small and medium sized enterprises.

Different profitability measures may rank industries in a different manner. In Table 2.6 some average profitability ratios are presented for seven food manufacturing industries that include an adequate number of firms for publishing the results. It can be seen that probitabily varies a great deal between food process-

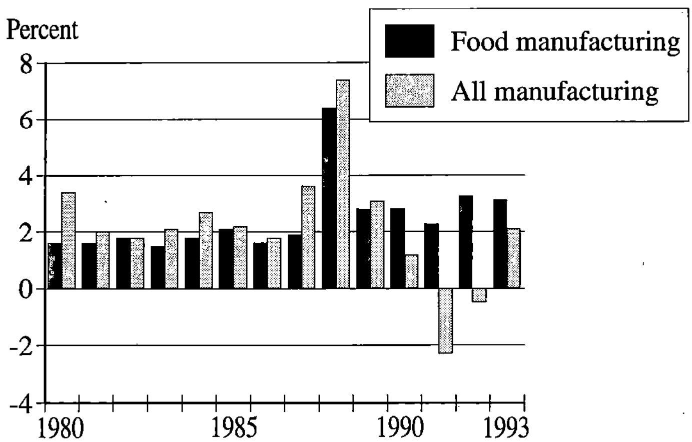

Figure 2.6. Net result as a percentage of turnover in the food manufacturing and all manufacturing in 1980-1993. Sources: LIIKETALOUSTIETEELLINEN TUTKIMUSLAITOS (1992) and STATISTICS FINLAND.

Table 2.6. Profitability measures of certain food manufacturing industries from 1990 to 1993 on the average.

Industry	Operating[1] margin %	Total[1] result %	Net[1] result %	Return on investment %
Slaughtering	4.19	0.26	-1.93	5.78
Meat processing	5.37	-0.23	-0.36	7.24
Fruit and vegetable processing[2]	10.61	4.44	1.72	8.34
Dairy products manufacture	4.22	0.32	0.20	8.85
Fresh bread and pastries manufacture	7.05	0.63	-1.28	5.91
Malt beverages and soft drinks	10.75	1.75	1.25	7.89
Feed manufacture	7.26	1.27	-0.87	7.84
Food processing	6.55	1.18	0.70	8.35
Beverages and tobacco	21.53	18.13	14.73	17.70
All manufacturing	9.68	0.25	0.13	7.30

[1] As a percentage of turnover [2] Only in 1990 [Total result = operating margin + financial income and expenses ./. adjusted taxes ./. depreciation + other extraordinary income and expenses. Net result = profit after financial items + adjusted taxes. Return on investment = profit after financial items + interest expenses + other expenses on liabilities / liabilities subject to interest + shareholders' equity + reserves + valuation items]

ing industries. Fruit and vegetable processing is not comparable with other industries because it only includes the results of one year. In 1990 the profitability of this industry was considerably better than in other food processing industries.

Operating margin percentage is the highest in malt beverages and soft drinks, in which the share of long-term expenses is also the highest. Slaughtering and dairy products industries account for the lowest margins of this short-run profitability measure. Similarly, total and net result percentages are high in malt beverages and soft drink industries, even if they are considerably lower compared to the average of beverages and tobacco industries, in which the state monopoly dominates in the production of alcoholic drinks. In terms of the total result, only meat processing shows weaker profitability than all Finnish manufacturing on the average, but when measured by net result, slaughtering, bakery products, feeds, and meat processing receive lower and even negative values. Total and net result ratios are more long-run measures than operating margin. They take depreciations, financial incomes and expenses, as well as taxes into account. Total result also covers other casual incomes and expenses. Especially in bread baking, the net result is negative every year, and, consequently, equity and solidity are weakened.

Table 2.7. Financial solidity and liquidity of certain food manufacturing industries from 1990 to 1993 on the average.

Industry	Total[1)] liabilities	Debt ratio	Equity ratio	Current ratio
Slaughtering	45.04	3.72	21.98	1.69
Meat processing	38.32	2.77	26.97	1.59
Fruit and vegetable processing[2)]	62.74	1.26	44.15	1.69
Dairy products manufacture	34.95	1.90	34.95	1.49
Fresh bread and pastries manufacture	54.32	1.89	34.79	1.46
Malt beverages and soft drinks	100.26	2.42	30.69	1.21
Feed manufacture	84.21	1.54	41.60	1.29
Food processing	51.38	1.62	38.10	1.55
Beverages and tobacco	102.18	1.67	36.40	1.50
All manufacturing	92.28	1.97	33.70	1.65

[1)] As a percentage of turnover [2)] Only in 1990 [Debt ratio = Liabilities ./. advance payments / shareholders' equity + reserves + valuation items. Equity ratio = shareholders' equity + reserves + valuation items / total liabilities and shareholders' equity ./. advance payments. Current ratio = Financial assets + inventories / current liabilities]

In the long-run, the most useful profitability measure is the return on investment ratio, because it takes into account the amount of capital invested. This ratio also varies significantly within the food processing industries so that dairy products rank first and slaughtering last. The average of food processing (excl. beverages and tobacco) is higher than that of all manufacturing. Beverages and tobacco industries show very high ratios. The return on investment ratio must be compared to the interest on liabilities. If the ratio seems to be high, but the net result is negative, operating profits are totally transferred to the financial sources of liabilities.

Financial analysis conveys information on certain facts about firms' financial structure, liquidity, as well as profitability from the investor's point of view. Table 2.7 presents some ratio measures of the financial performance of Finnish food manufacturing. Beer and soft drinks industries accounted for the highest profits, but they also have the heaviest burden of debt with respect to turnover. One measure of financial solidity is the debt ratio, which compares liabilities to equity. A firm's financial structure is usually considered good if the debt ratio falls below two, and weak if the ratio exceeds four (AHO and RANTANEN 1994). It can be seen that slaughtering is very close to this upper critical point, but usually food processing industries have a quite good financial structure. Equity ratio is practically an identical measure with debt ratio, but it is shown for illustrative purposes. Finally, current ratio measures liquidity and solvency, i.e. firm's possibilities to manage its payments in the near future. It measures the ratio between liquid assets and current liabilities. This ratio is lower in food manufacturing compared to all manufacturing. Values are relatively low in feed as well as malt beverage and soft drink manufacturing.

The performance of cooperatives is generally believed to differ from that of investor-owned firms due to differences in goals and strategies. However, empirical findings are ambiguous. Some studies show significant differences, but some studies find the performance of cooperatives, in terms of profitability, productivity, and financial situation, comparable to that of investor-owned firms (GENTZOGLANIS 1995). In Finland dairy products manufacture and slaughtering are dominated by cooperative firms to the greatest extent. The average profitability measures of these two industries are usually lower than in food processing on the average. An exception is the return on investment ratio in dairy processing. Indebtedness of dairy products manufacture and slaughtering is low when compared to turnover, but high in terms of debt or equity ratios. In dairy processing the degree of liquidity is lower, and in slaughtering it is higher than in food processing on the average.

Profitability measures show that food processing industries have succeeded more steadily than all manufacturing on the average over the business cycle from 1980 to 1993. Price stability can also be seen as one dimension of economic efficiency. According to the wholesale price index, the price of food has followed approximately the same rate with the total index during the period from 1980 to 1993. With the exception of coffee and cocoa products, annual price fluctuations of processed food and drinks have been relatively small, following the general price development. Prices can be also seen as indicators of operational efficiency, i.e. productivity and utilization of scale economies. In the study of KUPIAINEN (1994), Finnish price level of foodstuffs is found to be about the same with other Nordic countries, but higher compared to the EU countries. However, the direct price comparison provides very little information on the internal efficiency of food manufacturing due to the differences, for example, in taxation, prices of raw materials, state subsidies, and trade policy.

Operational efficiency of food processing in Finland and some other EU countries has been compared by RASIMUS and KORHONEN (1992). They found out that the efficiency and international competitiveness of the Finnish food manufacturing had improved during the past few years, but the average cost level of production was still very high when compared internationally. Agricultural policy and border protection caused higher costs of raw materials. From the viewpoint of efficiency and competitiveness, it is more important that in the Finnish food processing industries the capital, labour, and various other cost items, such as marketing costs, are higher. This is mainly due to weak efficiency in the utilization of capacity. This kind of X-inefficiency can be related to the market power of monopolies, dominant firms, and oligopolists.

Different oligopoly models relate performance to industry concentration and firm behaviour. A common theoretical measure of pricing efficiency is the *Lerner index*, which is the mark-up of price over marginal cost. Concentration and oligopolistic competition lead to a higher Lerner index and lower pricing efficiency, i.e. cause welfare losses in the economy because prices are above and production is below competitive levels. Oligopoly pricing is more likely when markets are very concentrated but, at the same time, increase in concentration may lead to cost reductions through the exploitation of economies of scale. However, weakening competition may also lead to X-inefficiency. This dynamics of competition is usually ignored when the implications of concentaration on industry performance are studied and, thus, this kind of analyses operate in the short-run. Furthermore, as the description of the food processing industry indicates, it can be assumed that the form of competition varies significantly within food industries. Markets are characterized by monopolistic, or more generally, oligopolistic behaviour, which makes the price-taking hypothesis inappropriate. However, the *degree of competition* is not known. The analysis of market performance and the realized or potential degree of market power requires a general framework to model oligopolistic competition.

3. Competition in concentrated markets - A review with applications of linear demand

A general proposition of the *structuralist* view in industrial organization research is that industry concentration is an essential determinant of the market power (DONSIMONI et al. (1984) provide a discussion of this view). This framework is widely used since it posits a systematic association between profitability and the combined effect of concentration and various exogenous structural characteristics of an industry.

However, the traditional structure-conduct-performance paradigm, in which exogenous market structure determines conduct and the two together determine performance, has been subjected to considerable criticism both by empirical researchers and by contributors to the game theoretical literature. For example, while it may be possible to estimate a positive relationship between industry concentration and profitability, it is not possible to say very much about long-run causation. The weakness of the traditional view is that it does not take into account the links between the determinants of concentration and profitability (SAWYER 1982). Thus, many studies (e.g. JACQUEMIN et al. 1980 and GEROSKI 1982) have argued that joint determination rather than a causal relation exists between concentration and profitability. Within game theoretical literature, the response has been the formulation of *multistage* games in which, for instance, a firm's decision is presented as taking place in two stages (see SUTTON 1990). At the first stage, potential entrants decide whether or not to enter. At the second stage, those firms that have entered set their respective prices. This structure of the model leads to endogeneity of structure. The greater the degree of price competition at the second stage, the fewer the number of firms choosing to enter. The solution method is based on the backwards induction, and most analyses begin with assumptions concerning behaviour or conduct at the second stage. The two stage game formulation offers a way of analyzing the two-way link between structure and conduct.

This chapter concentrates on the *subgame* of stage 2. It provides the theoretical basis for the model constructions and empirical analyses of the latter parts of this study. The analysis is one of partial equilibrium, operating at the level of a single industry and concentrating on the output market. The main interest is in the study of the effects of market structure and conduct on performance. It is shown that most results, for example between structure and profitability, are largely dependent on the model selection, i.e. the form of the game. In modelling a game, there usually is considerable scope for designing the structure of moves or the degree of price competition as well as the problem of multiple equilibria.

An oligopolistic market structure indicates that firms do not act as passive price-takers. At least one of the firms is large enough to operate at a downward sloping demand curve. Demand faced by this firm is determined through the actions of competitors. Correspondingly, the optimal decisions of actual or potential competitors follow assumed or realized behaviour of this individual firm. A decision-maker incorporates these mutual actions in the set of strategies. In Chapter 3.1 a *conjectural variations* model of an oligopoly is used to investigate the short-run relationship between structure (concentration) and market power (profitability). It is shown that this relationship is heavily dependent upon the value of the conjectural variations parameter. The notion of the toughness of price competition can be used to distinguish different forms of competition between Bertrand competition and joint profit maximization. At the industry level, market power is a notion which depends not only on the average extent of power exercised by all firms but also on the distribution of power within the industry. The first step in computing the appropriate concentration index is to take into account the distributional elements within the industry. As concentration is one of the structural features which determine profitability, this relationship can be seen as an estimate of the conduct of the industry.

In this study the strategic behaviour is modelled as *noncooperative games*. Someone might criticize the approach by appealing to the obvious collusive arrangements in certain markets. However, even collusion is consistent with noncooperative behaviour, because we can see it as an equilibrium which results from *individual rationalism*. Models of this kind are provided in Section 3.2. According to AUMANN (1987, p. 39), a cooperative game needs a mechanism that can enforce agreements, i.e. players can make binding commitments. For example, in some cases, cartels can be legal and registered. In such a situation the agreements are enforceable and stable if cheating parties can be sued. Similarly, collusive outcomes in noncooperative games are also supported by the threat of retaliation by other industry members. Players can cooperate, but this setting may collapse if an individual firm has an incentive to play different strategies and defect from an agreement. This is the type of collusion to be dealt with in Chapter 3.2, and the theory of repeated games (supergames) is used to model such situations.

It is sometimes argued that the different concentration indices provide the same information and it is unimportant which particular index is chosen. This claim has usually been based on the finding that concentration indices are highly correlated and tend to yield similar rankings of industries. However, BOYES and SMITH (1979) show empirically that different measures of concentration can yield significantly different implications. In Chapter 3.3 the presence of strategic asymmetry in the firms' relations to each other is allowed in various ways. First, a dominant firm model is investigated, and the conclusion is that different sets of concentration indices correspond to different solution concepts of optimizing firms. Second, it is shown that strategic asymmetry between firms can result in very different outcomes, compared to the simultaneous moves approach, when the relationship between structure and profitability is analyzed.

The background of the empirical part of this study is closely connected to the trade theory. Therefore, Chapter 3.4 reviews the applications of the strategic trade theory. The emphasis is on oligopolistic markets with governments and private firms as participants. Chapter 3.5 summarizes the main results, which form the theoretical framework of this study.

3.1. Conjectural variations approach of static games

The aim of this chapter is to derive a formal one-shot model which establishes a theoretical connection between concentration and market power. For this purpose, the market power or the degree of oligopoly is equated with the price-cost margins. Because this connection tends to depend on the precise form of the game or on the toughness of price competition, a framework which allows for non-competitive behaviour of the industry without imposing *a priori* market behaviour of a certain kind is used. To motivate the theoretical link between structure and performance, the standard conjectural variations model is applied, because it provides a framework for several forms of oligopolistic behaviour. Furthermore, this general model allows for both extreme cases: competitive market structure and monopoly pricing. This large spectrum of outcomes is an advantage since little of this spectrum can be ruled out by the formal dynamic game theory due to the folk theorem (QUIRMBACH 1988). The folk theorem holds that all outcomes from the collusive outcome to the competitive outcome are outcomes of a Nash equilibrium depending on the value of the discount factor (KREPS 1990, p. 525).

First, it is necessary to determine what is the firm's *strategy space*. Traditionally, the strategic variables used to model competition are prices or quantities, of which the latter can be interpreted as production capacity when quantities can only be adjusted slowly. Product differentiation and investments in research and development or advertising are, among other things, other aspects of strategic competition. Second, definition of simultaneous moves is needed. Presumably firms do not actually make decisions at exactly the same time. However, if each firm chooses a strategy given its *beliefs* about other firms' choises and without observing these, then the game can be viewed as simultaneous regardless of the actual timing of moves.

Consider non-cooperative competition in the output market with the firms producing a homogenous good and in which the strategies of each firm consist of quantity choices (on the role of strategy space see e.g. KREPS and

SCHEINKMAN 1983, BOYER and MOREAUX 1987, MCCORRISTON and SHELDON 1992). The number of firms in an industry is n and Q is industry output. The quantity produced by firm i (i=1,2,...n) is labelled q_i. Firm i faces the inverse demand function

$$P_i = P_i\left(\sum_{i=1}^{n} q_i\right) = P_i(Q), \tag{3.1}$$

in which a function P:(0,∞)→R+ is nonincreasing and concave on the interval where it has a positive value. Without determining any specific functional form, it is assumed that the form of the demand curve is a result of utility maximization of a representative consumer.

In addition to the oligopolistic industry, the economy contains a perfectly competitive sector producing inputs. Due to marginal cost pricing, the input price vector, w, is exogenously given to firm i. Thus, an oligopolistic firm has the following profit maximization problem:

$$\begin{aligned} &\text{Max } \pi_i = P_i(Q)q_i - c_i(q_i, w) \\ &\text{Subject to: } q_j = f(q_1,\ldots,q_i,\ldots,q_n)\forall j = 1,\ldots,n; j \neq i. \end{aligned} \tag{3.2}$$

The cost function is c_i (.) for all i = 1,...,n with marginal costs c_i' $(q_i) > 0$. The constraint represents the interdependence of oligopolistic firms. There are n-1 functions determining the response of other n-1 firms against the change in the output of firm i. n-1 functions represent the interdependence of firms, indicating that any change in the output level of firm i may induce a response of each of the other n-1 firms. These responses can be summed up, and the constraint is construed as the conjecture of firm i about the output of all rivals ($\alpha_i = d\{\Sigma_{j\neq i} q_j\} / dq_i$).

Let us assume that *quantity* is the strategic variable that is chosen simultaneously by firms. The problem of profit maximization specifies the profit to firm i as a function of the strategies chosen by it and by the other firms. The equilibrium concept employed is that of *Nash equilibrium.* Following the definition of GIBBONS (1992), a set of strategic actions (q_1*,...,q_i*,...,q_n*) is a Nash equilibrium if for each firm i and for every feasible strategy q_i, q_i* is firm's best response to the strategies specified for the n-1 other firms:

$$\pi_i(q_1^*,\ldots,q_i^*,\ldots,q_n^*) \geq \pi_i(q_1^*,\ldots,q_i,\ldots,q_n^*). \tag{3.3}$$

In a Nash equilibrium neither firm can change its strategy to increase its profits, π, given the actions of the other firms. Maximizing profits with respect to quantity and utilizing the definition of Nash equilibrium and α_i, the equilibrium values of q_i can be written by the n first-order conditions:

$$P(Q) + P'(Q)q_i(1+\alpha_i) = \frac{\partial c_i(q_1, w)}{\partial q_i} \forall i = 1,\ldots,n. \tag{3.4}$$

As a consequence of the first order conditions, it is possible to show some commonly used models as special cases (DIXIT 1984). *Cournot* outcome is the case $\alpha_i = 0$, i.e. an individual firm believes that its output change does not lead to output changes of other firms. In *Bertrand* competition, conjectures become $\alpha_i = -1$, when firms are price-takers. Finally, *market share collusion* is the case $\alpha_i = (\Sigma_{j\neq i}\ q_j\ /\ q_i)$, when all firms expand output by the same proportion and industry behaves as a cartel. If s_i is determined as a firm i's market share from industry output and $1/|\eta|$ is the inverse of the absolute value of the demand elasticity, the first order conditions can be rewritten:

$$P(Q)\left[1 - \frac{s_i}{|\eta|}(1+\alpha_i)\right] = \frac{\partial c_i(q_i, w)}{\partial q_i} \forall i = 1,\ldots,n. \tag{3.5}$$

In an empirical context (e.g. APPLEBAUM 1982, LOPEZ 1984, STÅLHAMMAR 1991) conjecture is often described as the elasticity of industry supply with respect to q_i. A conjectural variations term β is defined in the *elasticity form* developed by CLARKE and DAVIES (1982). β is defined as the elasticity of rivals' output changes with respect to firm i's output change. This means $\beta\ (dq_i/q_i) = dq_j/q_j$ for all $i\neq j$ and for all j or, alternatively, it implies that $d(\Sigma_{j\neq i}q_j)/dq_i = \beta\ ((Q/q_i) - 1)$. A constant β means that all firms expect the same proportional output response from other firms. Small firms expect smaller output response and smaller price change than large firms as a result of an increase in their output. Thus, as long as $\beta<1$, small firms will have higher marginal revenue and operate with higher marginal cost than large firms. This is consistent with STIGLER's (1964) model, which makes it possible for small firms to have a lower risk of punishment in the implicit collusion.

Henceforth in this study, the conjectures about firms' reactions will be presented in the elasticity form. When the elasticity representation of conjecture is used, the first order conditions of Nash equilibrium can be derived to the form (derivation is performed in detail in Appendix 3):

$$P(Q) + P'(Q)q_i\left(1 + \frac{\Sigma_{j\neq i}\, q_j}{q_i}\beta\right) = \frac{\partial c_i(q_i, w)}{\partial q_i} \forall i = 1,\ldots,n. \tag{3.6}$$

The conjecture term β can be interpreted as an index of industry collusion, with higher β representing greater collusion. The equation can be rewritten in terms of the price cost margin:

$$\frac{P(Q)-MC_i}{P(Q)}=\frac{1}{|\eta|}[\beta+s_i(1-\beta)]\ \forall\ i=1,\dots,n, \tag{3.7}$$

where MC_i is the marginal cost for firm i. The left term is the *Lerner index* of firm i's monopoly power (L_i). The problem is now to define an aggregate monopoly power in the whole industry from the distribution of Lerner indices of the firms composing this industry. A non-cooperative solution framework creates a theoretical basis for the specification of some concentration indices and for the relation of these into a measurement of monopoly power. Although the central role of concentration indices in the traditional industrial organization has been based on the S-C-P paradigm, the concentration indices are, however, still commonly used as the empirical counterpart of the degree of oligopoly in the models derived from the strategic competition (DAVIES et al. 1992). The derivation of indices is based on the axiomatic basis of ENCAOUA and JACQUEMIN (1980), which combines the theoretical links between the properties of measuring concentration and the degree of market power prevailing in an industry. Accordingly, the aggregate market power (the Lerner index) in an industry consisting of n firms, noted L, should possess three properties:

1) The value of L must be between the two extreme values of the distribution (L_1,...,L_n). If L_1=...=L_n, the optimal allocation of the market shares is such that the marginal costs of the different producers are equal.
2) The value of L must take into account the existence of producers that are price-takers so that their monopoly power is null.
3) In the case of a merger of two or more firms, the aggregate monopoly power would not decrease.

The model is consistent with these conditions. Conditions one and two are clearly fulfilled, because after multiplying throughout by (q_i/Q) and summing across the industry:

$$\frac{\Sigma_i Pq_i-\Sigma_i MC_i q_i}{PQ}=\frac{1}{|\eta|}\left[\frac{\Sigma_i q_i\beta}{Q}+\Sigma_i(s_i)^2(1-\beta)\right]. \tag{3.8}$$

The third condition is a consequence of the definition of β, since the conjecture is an increasing function of a firm's size. The aggregate Lerner index is obtained by rewriting Equation 3.8 as:

$$L = \frac{1}{|\eta|}[\beta + H(1-\beta)], \tag{3.9}$$

where $H = \Sigma_i (s_i)^2$ is the *Herfindahl index* of concentration. The range of variation of the index is [1/n,1] and the value of 1/H can be interpreted as the number of firms of an equal size, the distribution of which results in the same concentration index as that given by H.

In the Cournot competition each firm assumes that the rivals' output is held constant and $\beta = 0$. The aggregate Lerner index approaches zero when the Herfindahl index of concentration approaches infinity. With β equal to null, the industry is free of collusive practices. However, the aggregate Lerner index and concentration are positively related. One possible interpretation is that some industries become concentrated because one or more firms have a strong efficiency advantage over their competitors. This greater efficiency leads to the concentration of a large part of the market to the hands of the leading firms and also to greater profitability (CLARKE et al. 1984). This result can be linked to the contestable market theory of BAUMOL (1982).

With β=1, the model gives the monopoly result, i.e. that the price-marginal cost margin is equal to the reciprocal of the demand elasticity. If $0<\beta<1$, the higher Lerner index is due to partly collusive behaviour. The elasticity formulation of β makes it possible that smaller firms can expect a smaller price change as a result of, for instance, a 10 percent increase in their output than larger firms.

When competition is tougher than Cournot, we have $\beta<0$. In this case each firm expects that if it reduces output others will expand output. The lower limit for β gives the Lerner index of zero in Equation 3.9, from which it follows that the lower limit is $\beta = -H/(1-H)$. For instance in duopoly (n=2) with equal marginal costs, both firms must have the same market share in equilibrium (H=1/2) and the lower limit for β is -1. Both firms expect that if they reduce output the other will expand output by an equal percentage.

Even though the connection between concentration and the mark-up is generally accepted, the assumed nature of conduct as exogenous is inadequate. The central hypothesis of the STIGLER's (1964) oligopoly model suggests an inverse relation between the degree of concentration and the cost of controlling a collusion arrangement. Stigler's model is based on the likelihood that, where sellers are few, it is easier to detect and punish any firm that cheats by setting the price below the agreed level. The modelling of β leads to the causality $d\beta/dH > 0$, and higher concentration leads to higher industry profits because it facilitates collusion. This implies the endogeneity of conduct. Generally, the first order conditions are derived to the equilibrium relation between structure and performance, which can be assumed to yield indirect information about conduct. E.g. the papers by IWATA (1974), BRESNAHAN (1981a) and SUMNER (1981) attempt to estimate the nature of competition from intra-industry data of prices, profits, and output.

The Nash equilibrium, q_i* for all i, implicitly determines q_i in terms of the quantity produced by the other firms. The *reaction function* can be thought of as firm i's reaction to the rest of the industry. Let a subscript j note the rest of the industry or the other firm in the duopoly case. The reaction functions, R, determine how firms set quantities in the simultaneous move game:

$$q_i^* = R_i(q_j^*) \text{ and } q_j^* = R_j(q_i^*). \tag{3.10}$$

The derivation of reaction functions and stability conditions are shown e.g. by VARIAN (1992, pp. 286-288) for Cournot duopoly, DIXIT (1986) for conjectural variations oligopoly, and QUIRMBACH (1988) for conjectural elasticities oligopoly. Figure 3.1 illustrates the reaction functions in duopoly (R_i for firm i and R_j for firm j) with linear demand and identical marginal costs for the two firms. The set of possible equilibria is the range from competitive output (β = -1 and L = 0) to monopoly (β = 1 and L = 1/|η|).

In the Nash equilibrium, the reaction functions cross in quantity space. The intersecting point determines equilibrium outputs q_i* and q_j*. If β = -1, each firm maximizes its profits by producing half of the competitive output (Figure 3.1a). This case is possible in the long run only if there are no fixed costs. The existence of fixed costs results in the lower boundary for β to be

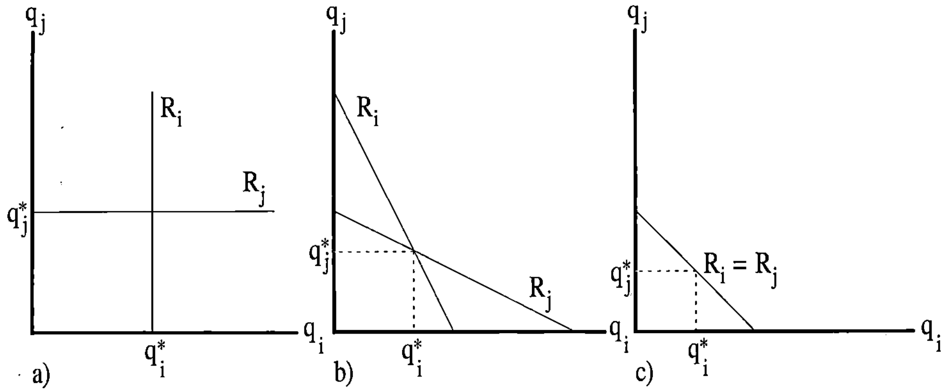

Figure 3.1. Duopoly reaction functions in the quantity space: a) β = -1; b) β = 0; c) β = 1. Source: MARTIN (1993).

higher than -1. If $\beta = 0$, the result is the Cournot equilibrium (Figure 3.1b). Total supply is lower than in the competitive equilibrium (3.a). If $\beta = 1$, total output is restricted to the monopoly level and reaction functions coincide. In Figure 3.1c it is assumed that the 'negotiation' powers of two firms are identical and both firms produce half of the monopoly output.

The dynamic interpretation of the model is a typical *cobweb* adjustment process. Consider, for example, the Cournot case. Beginning with an out-of-the-equilibrium situation, let firm i take the quantity produced by other firms as given and move to its profit-maximizing output determined by the reaction function. Then firm j will move to $q_j = R_j$, firm i will move to $q_i=R_i$, and so on. At every step, each firm has maximized its profit. If the reaction functions and actual behaviour of the firms equal the conjectures, these conjectures are said to be *consistent* (BRESNAHAN 1981b). Thus the solution will be unique even in the static one-shot aspect.

In contrast to the consistency, if the firms are assumed to hold conjectures which turn out to be different from the optimal reactions of the competitors, the conjectures are inconsistent. The concept of consistency is criticized, for example, by BOYER and MOREAUX (1983) in the sense that practically any situation can be understood as a locally consistent conjectural equilibrium. They derive an algorithm to compute, given any sustainable market situation of a duopoly, conjectural variations functions which make this market situation a locally consistent conjectural equilibrium. ULPH (1983) argues that the multiplicity of consistent equilibrium does not mean that the concept of consistent conjectures is inadequate, but that the definition of consistency is too weak to effectively limit the set of equilibrium. He found out that the fundamental problem is that the appropriate consistency tests are impossible to construct because they need additional rationality criteria requiring the correctness of conjectures about the consequences of output changes from points other than the equilibrium relative to the given beliefs.

It can be asked how obvious a solution the conjectural variations equilibrium really is, and whether it can only be by chance that the conjecture is consistent in the static framework. In spite of the weaknesses in the modelling of dynamic features of strategic competition in a static or ad hoc dynamic framework, TIROLE (1990) points out the usability of conjectural variations models in empirical estimations of the degree of competition in an industry. However, e.g. FRIEDMAN (1977, 1983) criticizes the conjectural variations analysis because the models are not actually dynamic, the firms are assumed to maximize one-period profits rather than the discounted stream of profits, and the firms have expectations about how their rivals will behave that need not be correct. MAKOWSKI (1987) also criticizes the approach and asks for more sophisticated dynamic game solutions of strategic interactions in which the actions at each point in time are modelled explicitly. The relationship between dynamic oligopolistic competition and static conjectural variations equilibrium is analyzed by DOCKNER (1992). He shows that it is possible to interpret a conjectural variations equilibrium as the outcome of dynamic strategic interactions. In real life, the decision-makers are likely to operate repeatedly, and this creates the basis for long-run interactions within a set of firms.

3.2. Repeated games and cartel stability

The purpose of this chapter is to examine the relationship between concentration and cartel stability. As the previous chapter, this part will examine the case of a symmetric noncooperative oligopoly in which the only interdependence between the firms is the recognition of the same industry demand. The difference is that the game is repeated over time periods. The game can be called a *supergame*, where the *stage game* is played over and over again by two or more players (KREPS 1990, p. 506). In each period, the firms choose their strategic variables simultaneously.

In the static conjectural variations framework, industry profits are maximized when an industry acts collusively. An industry produces monopoly output and receives monopoly profits that can be allocated to the firms in accordance with the market shares. For instance, a market can be segmented geographically and each firm is a monopolist within its area. Operating of one firm in another's territory can be quickly and surely detected, and leads to countermeasures by the other firm. However, if there is a potentiality that one firm can increase its profits per period by producing a larger quantity than the collusive equilibrium without detection, the collusive equilibrium is no longer the Nash equilibrium. In static games, *tacit collusion* (no explicit contracts) is actually not possible since firms always have an incentive to cheat on the agreement. If oligopolists wish to maintain a collusion, they need to devise some kind of penalty which would more than offset the gain from cheating.

In the following model, the stucture of the industry is assumed to be stable over time. Output is the strategic variable and firms are not able to achieve product differentation or to divide their markets regionally. Information about the industry's environment is public. Furthermore, firms are assumed to be able to monitor the output levels of other firms. The information is almost perfect in the sense that, at time t, firms only know the outcomes at t-1 and before. The stage game is repeated *infinitely*. A strategy for firm i is an infinite sequence $q_i = (q_{i1}, q_{i2}, \ldots)$, where q_{i1} is the initial output and q_{it+1} determines the output at time t+1 as a function of the actions chosen by all players in all preceeding periods $q_{it+1}\,(Q_1, Q_2, \ldots, Q_t)$. Playing the stage game repeatedly produces a stream of profits for each player, which can be discounted to the first period by the factor $\delta \in (0,1)$.

A subgame is a piece of the supergame that starts at a point in which the history of the game is common knowledge and that includes all the stage games that follow this point. Due to the assumptions, the stage game at time t starts a new subgame. A *subgame perfect equilibrium* (SELTEN 1975) requires that, following any t-1 period of the history of the play, the strategy profile gives firms instructions that constitute a Nash equilibrium of the subgame beginning in period t.

Because an individual firm is likely to have an incentive to deviate from the collusive output choice in the stage game, that kind of equilibrium does not fulfill the Nash condition of subgames and the collusion cannot be a subgame perfect equilibrium. Therefore, the repeated collusion equilibrium must be supported by punishment strategies. A punishment at some point in the game specifies a strategy for each firm from that point on. To be credible, a punishment must itself be a perfect equilibrium of that subgame. The more severe the credible punishment, the more likely it is that the collusive outcome path can be supported. The collusion equilibrium can be enforced, for instance, by *trigger strategies* of the following type (e.g. DAVIDSON and DENECKERE 1984): each firm produces its share of the industry monopoly output ($q_i^*=s_iQ^*$) and charges the monopoly price until some firm cheats. When such a defection occurs, all firms revert to the Cournot-Nash output (q_i^C) and maintain that level from that on. The credibility means that if each firm is using this trigger strategy and if $q_{i,\,t-s} \neq s_iQ^*$ at time t for some $i = 1,\dots,n$; $s = 1,\dots,t-1$, then it is optimal for each firm to produce q_i^C, given that all other firms are also producing the Cournot-Nash output. This eliminates the possibility of empty threats.

If firm i cheats at period t, it chooses quantity (note q_i^{Ch}) to maximize profits, given that all other firms produce their share of the industry monopoly output. The immediate one period gain from cheating is $\pi_i^{Ch} - \pi_i^*$. From the period t+1 firm i will receive Cournot-Nash profits. Cheating is profitable if gains exceed the future losses due to the trigger strategy of other firms. Thus, if the following condition holds, no firm will cheat and the trigger strategy is a noncooperative equilibrium:

$$\frac{\delta}{1-\delta}(\pi_i^* - \pi_i^C) > \pi_i^{Ch} - \pi_i^* \forall i = 1,\dots n. \tag{3.11}$$

It is easy to see that the closer δ is to 1, the more obviously the industry can maintain a collusion. How self-enforcing the equilibrium is also depends on the demand conditions, cost functions, and industry structure (parameters of the profit function). To illustrate this, consider the linear inverse demand function to be $P = a\text{-}bQ$. This kind of linear demand structure has been studied e.g. by BOUER and MOREAUX (1986), and VIVES (1988). In the symmetric oligopoly structure each firm produces at a constant marginal and average costs of c, with c<a. The Cournot-Nash and collusive equilibrium values for industry price and per firm quantity and profit for all i=1,...,n in the quantity setting stage game are:

$$q_i^C = \frac{a-c}{b(n+1)}; P^C = \frac{a+nc}{n+1}; \pi_i^C = \frac{(a-c)^2}{b(n+1)^2};$$
$$q_i^* = \frac{a-c}{2bn}; P^* = \frac{a+c}{2}; \pi_i^* = \frac{(a-c)^2}{4bn}. \tag{3.12}$$

Note that price c and zero profits are limits of the Cournot game when the number of firms becomes large. PALFREY (1985) shows that the same limit in price also holds in the Cournot game of large markets when the firms have incomplete information about cost and demand parameters. He also uses linear demand and constant marginal costs in constructing the equilibrium. Furthermore, according to KREPS and SCHEINKMAN (1983), the Bertrand price competition can yield Cournot outcome in the two stage game in which capacities are set in the first stage and demand is then determined by price competition. Reversely, the collusive price does not depend on the number of firms.

If firm i takes the quantity produced by all other firms to be q*, it can maximize its profits at period t by producing quantity q_i^{Ch}. The maximization problem of firm i is

$$Max_{q_i}\left\{\left[a-\frac{a-c}{2n}(n-1)-bq_i\right]q_i-cq_i\right\}. \tag{3.13}$$

When firm i cheats, it produces the following quantity and receives the following price and profits for the period t:

$$q_i^{Ch} = \frac{(n+1)(a-c)}{4bn}; P^{Ch} = \frac{a(n+1)+c(3n-1)}{4n}, \pi_i^{Ch} = \frac{(n+1)^2(a-c)^2}{16bn^2}. \tag{3.14}$$

The collusion output is the best strategy for all i, if the present value of the periodic future losses exceeds the gains from cheating. From Equation 3.11 it can be solved (see Appendix 3) that losses dominate if and only if

$$\delta > \frac{(n+1)^2}{4n+(n+1)^2}. \tag{3.15}$$

This result supports an intuitive *relationship* between high concentration and collusion (see e.g. TIROLE 1990, pp. 247-248), and the view that concentration indices, despite the ad hoc nature, can be useful in assessing the state of competitiveness in markets. When n decreases, the condition on δ becomes weaker and the collusion is more likely. However, by adding the capacity constraints of firms to the model (BROCK and SCHEINKMAN 1985), it is possible to show that an increase in the number of firms can result in more stable collusion in certain circumstances. An increase in n can lead to an increase in the maximum sustainable price due to the increase in the threat power of the cartel caused by the increased excess capacity. The credible trigger strategy against a cheater is more severe in the industry in which total capacity is clearly above the capacity needed in monopoly output.

The fear of retaliation may lead to different outcomes, as it is shown by the *folk theorem*. RUBINSTEIN (1979) shows that any individually rational outcome can arise as a subgame perfect equilibrium in infinitely repeated games with no discounting. FUDENBERG and MASKIN (1986) demonstrate that this result survives the introduction of a discount factor which is slightly below one. Any strategy giving each firm at least its security profit level can be seen as individually rational. A security level is determined through the minimax strategy, in which every firm uses a strategy that minimizes their competitors' maximum profits after any cheating. The folk theorem shows that essentially all distributions of profits (e.g. between zero and cartel profit in the Bertrand game) in a repeated one-shot game can be equilibrium of the repeated game. Quite often, it would be realistic to enrich the structure of the supergame by allowing for *imperfect information*. Above, it was assumed that, at the beginning of each period, firms observe the quantity produced by other firms. The trouble with this formulation is that incentives for maintaining the collusive equilibrium are often so strong that deterrent mechanisms are never observed. When imperfect information is included in the model, optimal incentive structures may involve periods which would be characterized as price wars. SLADE (1990) classifies price war models into imperfect monitoring, learning, and cyclical theories.

In the model of GREEN and PORTER (1984), which is perhaps the most frequently referred model in the class of *imperfect monitoring*, firms monitor the market price that imperfectly reflects the output levels of other firms, and whether the cartel is in a collusive or in a reversionary state. The observed price at time t is $P_t = \theta_t p(Q_t)$, in which θ_t is a demand shock random variable having continuous density function with $E(\theta)=1$. The collusion contra Cournot trigger strategy is adopted. GREEN and PORTER (1984) conclude that, when the industry is stable over time, no firm defects from the cartel if no firm has more private market information than its competitors. However, it is rational for every firm to produce temporarily Cournot output when the price level decrease sharply, although all firms know that this is not a result of overproduction by competitors. If a firm continues to produce collusive output, it will revise its beliefs about how much other firms have produced. Then the original equilibrium strategy ceases to be individually optimal for firms, and price wars can be involuntarily caused by demand shocks. The theory views price wars as necessary to maintain incentives to collude with imperfect information. The theoretical model has been empirically tested by using time series data on the Joint Executive Committee railroad cartel (see e.g. ULEN 1983). PORTER (1983) uses this data in order to identify periods in which price wars occured, and PORTER (1985) tests predictions about the incidence and duration of price wars.

The basic idea of imperfect monitoring is generally illustrated in Figure 3.2. Monopolistic output yields equilibrium value P* for industry price. Firm i's share of the monopoly output is q_i*. Firm's problem is to find an optimal level of trigger price, say P'. If demand falls from $P_1(Q)$ to $P_2(Q)$ and q_i* yields the price lower than P', firm i will produce Cournot output q_i^C for the duration of a reversionary period regardless of what happens to prices during this time. If the trigger price is set to be lower, for instance P'', change in the demand does not lead to the reversionary period. However, if firms do not revert to Cournot behaviour in response to low prices, the incentive properties would not hold the rest of the time and monopolistic behaviour would cease to be individually optimal for firms.

With *learning models*, some of the structural parameters of industry are unknown to the players. A price-war model of SLADE (1989) uses reaction functions in which prices and quantities, which can be observed, are noisy signals concerning industry conditions. The permanent shifts of unknown parameters imply that the old strategies are not an equilibrium of the new game.

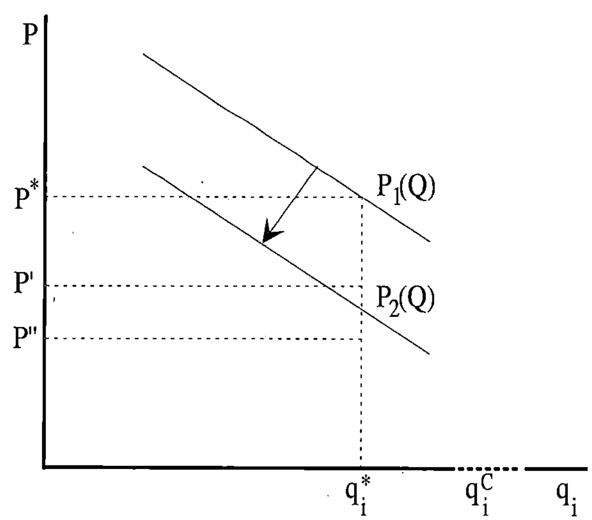

Figure 3.2. The trigger mechanism of imperfect monitoring.

Firms change prices, and this leads to a temporary price war. During the price war, firms learn about conditions in the industry, and the process converges to a new stable price vector.

Cyclical models examine how the stability of a collusive arrangement depends on the aggregate economic activity. The model of ROTEMBERG and SALONER (1986) looks at firms competing in prices, and considers the possible equilibrium that can be supported by reversion to the Bertrand outcome. An essential assumption is that demand, from the firms' viewpoint, is subject to identically and independently distributed random shocks, e.g. due to changes in consumers' preferences or incomes. The random component of demand is observable in advance in each period. A central result is that monopoly pricing may not always be sustainable, if potential punishments are short-lived or firms have small discount factors. The discounted value of future losses may not be sufficient to outweigh the short-term gains from deviation when the random component of demand is large. In order to lessen the incentive to deviate, the cartel must change prices when demand conditions change rapidly. Therefore, the collusive price P* varies over the business cycle.

The stability of a collusive arrangement also depends on the existence of potential new entrants. A potential entrant to an oligopoly analyzes the industry demand, the current competitive or collusive conditions in the industry, and the prospects for rivalry or collusion after the entry. The game theory provides techniques for modelling the formation of beliefs of the entry decision as part of equilibrium. For example, MILGROM and ROBERTS (1982) demonstrated that the presence of informational asymmetries can lead a firm, or a cartel, operating in several markets to adopt a predatory strategy against entrants, even though such behaviour is irrational when viewed in the context of a single market. Their solution employs the concept of sequential equilibrium introduced by KREPS and WILSON (1982). Incumbents may find it profitable to create and maintain a reputation as firms that will fight entry in markets operating under conditions of asymmetric information. This will naturally affect the collusive profits, gains from cheating, and thus the stability of collusion.

An implication of imperfect information and the folk theorem is that the observed conduct within a period does not necessarily provide very much information about the structure of the industry. An assumed infinite time horizon may seem unrealistic, but the results also hold for games with a sufficiently low probability of ending the game in any period. Despite the lack of empirical studies, the theory of repeated games can, however, deepen the basis for understanding many intuitive premises for tacit collusion, like the relationships between cartel stability and market concentration as well as effective acquiring of information.

3.3. Asymmetric firm behaviour

3.3.1. Concentration-profitability relationship in the price leadership model

Until now, the relations between price-cost margins and concentration have been presented in a framework of pure oligopolists. In the price leadership model (or dominant firm model), an industry consists of a *dominant* group of firms and, in addition, there exists a *price-taking* group of firms. Firms in the first group have market power and firms in the second group are price-takers. This is a case of asymmetric oligopoly, where a dominant group of producers imposes a selling price to a competitive fringe. The behaviour of a fringe can be presented by a supply function. The k dominant firms of the industry set up a selling price, knowing the competitive fringe of the industry (n-k firms) will produce at a level such that its marginal cost of production will be equal to the price.

The central element of the price leadership model is that of excess demand. Let $Q = Q(P)$ be the global demand function of the industry and $Q^C = Q^C(P)$ the supply function of the competitive fringe. It is assumed that the supply function is increasing. The demand function of the dominant group, or excess demand, can now be written $Q^D = Q^D(P) = Q(P) - Q^C(P)$. Following the presentation of GISSER (1986), the identity can be written in the form:

$$\frac{P}{Q^D}\frac{\partial Q^D}{\partial P} = \frac{Q}{Q^D}\left[\frac{P}{Q}\frac{\partial Q}{\partial P}\right] - \frac{Q^C}{Q^D}\left[\frac{P}{Q^C}\frac{\partial Q^C}{\partial P}\right]. \tag{3.16}$$

Denoting the elasticity of supply of the competitive fringe as ε and the absolute value of elasticity of global demand as $|\eta|$, the absolute value of elasticity of excess demand, $|\eta|^D$, can be written as:

$$|\eta|^D = \frac{Q}{Q^D}|\eta| + \frac{Q^C}{Q^D}\varepsilon. \tag{3.17}$$

The function of excess demand is assumed to have an inverse form $P^D = P(Q^D)$. The profit function of a firm i of the dominant group (i=1,...,k) is

$$\pi_i = P(Q^D)q_i - c_i(q_i, w); Q^D = \sum_{i=1}^{k} q_i, \tag{3.18}$$

where the price vector of the inputs, w, is assumed to be exogenous. First, consider the case in which competition inside the dominant group is assumed to follow the Cournot mode of behaviour. The equilibrium quantities are solutions of the maximizing programs of individual profits of the k firms. Assuming price-taking in input markets, the necessary condition of the Cournot-Nash equilibrium is that firm i's Lerner index is

$$L_i = \frac{s_i}{|\eta| + \varepsilon(1 - C_D)} \; \forall i = 1, \ldots, k, \tag{3.19}$$

where $s_i = q_i/Q$ and C_D is the aggregate share of dominant firms (derivation is presented in Appendix 3). The values of Lerner indices of competitive firms equal zero. The average market power in the dominant group can be achieved by multiplying each firm's Lerner index by the firm's market share in the dominant group and summing it across k firms. The aggregate market power of the industry, L, is then the Lerner index of the dominant group multiplied by the market share of the dominant firms. This can be written

$$L = \frac{C_D H_D}{|\eta| + \varepsilon(1 - C_D)}, \tag{3.20}$$

where H_D is the Herfindahl index of concentration within the dominant group. The equation shows that an increase of the C_D and increased concentration within the dominant group (higher H_D) will cause a rise of the aggregate market power. Furthermore, a low price elasticity of total demand and a low price elasticity of the supply of the competitive fringe will increase the market power. In comparison to the previous conjectural variations model, it can be noted that the price-cost margin is influenced by a more complicated set of structural elements.

The outcome is different in the dominant firm model with k-dominant firms acting jointly as a leader against a competitive fringe. The members of the dominant group select the market price and the quantity so that they maximize the sum of profits. This case also makes it possible to derive the relationship between profitability and concentration. The general result is first shown by SAVING (1970) and later on e.g. by GEROSKI (1981).

In a cartel the determination of the market power of firm i is distinguished from the Cournot-Nash solution so that the market share of an individual firm in the Lerner Equation 3.19 is replaced by the aggregate market share of the dominant cartel. The competitive firms have no market power, even though their aggregate market share can be considerable. Multiplying 3.20 by C_D, the Lerner index of market power for the whole industry is

$$L = \frac{C_D^{\ 2}}{|\eta| + \varepsilon(1 - C_D)}. \tag{3.21}$$

Thus, profitability is positively related to the market share of the dominant group. Besides, elastic demand makes the equilibrium more competitive, as does an elastic supply response of the competitive fringe. In any case, when the concentration ratio is employed as a concentration measure alone, the basic assumption about the conduct is very restrictive. The dominant firm model presents the concentration ratio as an appropriate measure of concentration, if the actual number of firms in the colluding group happens to be exactly the same as the k value chosen by authors who calculate the concentration ratio. Very likely the popularity of this measure in empirical studies is a consequence of the fact that it is the only measure of concentration published in many countries. E.g. the Finnish Census of Enterprises reports 3-, 5- and 10-firm ratios. Roughly speaking, the concentration ratio can be a reasonable measure in cases where large values indicate more dominance for the leading firms.

3.3.2. Competition with sequential moves

The standard Nash equilibrium assumes that firms move simultaneously. An alternative way to describe oligopolistic competition is to allow firms to move sequentially. In the *Stackelberg* model it can be assumed, for instance, that there is one leader firm on the market (VARIAN 1992, p. 296). The leader maximizes its profits by choosing the output level, recognizing its rivals' responses in the quantity leadership game. The other firms, followers, can then observe the leader's output and choose their optimal levels of output. In the hierarchical Stackelberg model (ANDERSON and ENGERS 1992), the order of moves is fixed during the game. In this case, the optimal output decision of any firm depends on the reactions of all subsequent movers. The equilibrium is the subgame perfect outcome that arises when firms choose their outputs according to some exogenously determined order of moves.

The asymmetry in behaviour can be seen as a result of a historical source of differentiation among the firms. One source of differentiation is the sunk costs of capacity, that is capital which cannot be recovered once it has been invested. For example FUDENBERG and TIROLE (1985) argue that, although the timing of firms' capacity choices is endogenous and simultaneous choices are possible, asymmetric timing is likely to be the equilibrium outcome. Practically, it can be assumed that firms enter the market in sequence because some entrants become aware of a profitable market before others. Following this tradition, the oligopoly model would be extended to cover two phases: a phase in which entry and investments are committed, and a production phase (e.g. EATON and

WARE 1987). First, firms decide if they are going to participate in a certain industry, and later decide the specific way in which they are going to compete. In a multi-stage game, entry occurs in the long-run and quantity or pricing choices take place in the short-run. Thus, in the classification of the structure-conduct-performance paradigm, the decisions affecting structure are chosen in earlier stages of the game, while the decisions on conduct are chosen in later stages. When the Stackelberg model is analyzed, it is implicitly assumed that the structure of the game is stable and competition actually occurs in the short-run.

In the most familiar Stackelberg model, one firm is a leader and n-1 are followers, when n is the number of firms of an industry. The leader recognizes its followers' response patterns, and uses this information to decide on a profit maximizing output level. The follower's output level is the best response to the leader's output and to the other followers' best-response functions. Instead the leader's profit maximizing output level is a best response to the followers' best-response functions.

To illustrate the Stackelberg model, consider a quantity setting duopoly. The profit maximizing procedure of both firms yields reaction functions $R_i(q_j)$ for firm i and $R_j(q_i)$ for firm j. Let us assume that firm i has a Stackelberg leadership position. It moves first, and when the follower (firm j) chooses its strategy it treats the leader's choice as given. However, the leader knows follower's reaction function and takes this into account in its decision. The Stackelberg equilibrium in the homogenous products Cournot case means that the leader will choose q_i to maximize its profits, given that q_j depends on q_i via R_j. Thus, the leader's profit function is

$$\pi_i = P\left[R_j(q_i)+q_i\right]q_i - c_i(q_i,w). \tag{3.22}$$

When maximizing profits, the leader can pick the point on firm j's reaction function that yields the highest profits. Compared to the symmetric Cournot equilibrium (see Figure 3.1b), the equilibrium is no longer the intersection point of reaction functions. Now the leader produces more and the follower less than in the Cournot case. There is a *first mover advantage*, i.e. the leader receives greater profits.

To analyze the Stackelberg equilibrium more formally, consider the perfectly *hierarchical* Stackelberg model with n firms, in which each firm acts as if it were a monopolist facing the residual demand curve remaining from the preceding movers. The order of moves is exogenously determined. A subgame perfect equilibrium arises when firms choose their output sequentially in the game where each firm's output is independent of the number of firms that follow it in the hierarchy, and each firm i (i=1,...,n) maximizes its profits by setting optimal q_i in the following system:

$$\begin{aligned}
&Max_{q_n}\pi_n = P(A_n + q_n)q_n - c_n(q_n, w) \\
&Max_{q_{n-1}}\pi_{n-1} = P(A_{n-1} + q_{n-1})q_{n-1} - c_{n-1}(q_{n-1}, w) \\
&\quad \dots \\
&Max_{q_1}\pi_1 = P(q_1)q_1 - c_1(q_1, w),
\end{aligned} \tag{3.23}$$

where A_i is the total output of firm i's preceding firms in the hierarchy.The model is special because (q_i,π_i) for i<k does not appear directly in the marginal conditions dated k and later. This makes it feasible to use the backward recursive solution strategy used in dynamic programming. Whatever the preceding firms have produced, the last firm in the sequence, firm n, maximizes its profits at the residual demand curve. The choice function $q_n=q_n^*(A_n)$ is derived as the solution to the first-order equation, assuming the second-order conditions of the demand and cost functions hold. The value function for firm n

$$\pi_n^* = P[A_n + q_n^*(A_n)]q_n^* - c_n(q_n^*, w) \tag{3.24}$$

is the maximum value of the objective function at every level of quantity produced by other firms. There is no incentive to depart from the original plan. According to the envelope theorem (SILBERBERG 1990, pp. 192-195), differentiating the value function with respect to A_n gives

$$\frac{\partial \pi_n^*}{\partial A_n} = \frac{\partial P(A_n + q_n)}{\partial A_n} q_n, \tag{3.25}$$

because firm n's optimal choice already combines the consistent link between q_i^* and A_n. This means that only the direct influence of other firms' production over the demand determines the maximum value of firm n's profit. The calculation of each firm's equilibrium output follows the same method. Obviously, the first firm's A_1 is zero.

If the inverse demand function is again assumed to be P=a-bQ, and each firm produces at a constant marginal and average costs of c (c<a), firm i's equilibrium output is

$$q_i^* = \frac{a - bA_i - c}{2b} = \frac{a-c}{2^i b} \forall i = 1,\dots,n, \tag{3.26}$$

i.e. each firm produces half the output of its immediate predecessor. After summing each firm's optimal quantities across the industry and substituting the sum in the demand function, the total industry output and the Stackelberg equilibrium price are

$$Q^{HS} = \frac{a-c}{b}\left(1-\frac{1}{2^n}\right); P^{HS} = \frac{a-c}{2^n}+c. \tag{3.27}$$

Comparing the equilibrium price (P^{HS}) to the Cournot price (P^C in 3.12) indicates that the equilibrium price is always higher under Cournot if 2^n-n > 1, i.e. the number of firms n > 1. More asymmetric industry structure leads to a lower market price. Clearly the equilibrium total quantity is lower for the Cournot case. In Cournot competition, the conjectural variations term is zero, while in the hierarchical Stackelberg case all firms, except the last, face the conjectural variations term less than zero that provides an extra incentive to increase production at the margin. For instance, if firm i in the hierarchy increases its quantity by dq_i, its followers decrease their total production by dq_i times (1-1/ 2^{n-i}). However, all Stackelberg firms do not produce more than Cournot ones. The first firm produces (n+1)/2 (>1) times, and the last firm produces (n+1)/ 2^n (<1) times the Cournot output. A firm that produces the Cournot quantity is ranked by i = ln(n+1)/ln2 in the hierarchy.

Combining the quantity produced by firm i and the market price of the Stackelberg equilibrium yields the profit for firm i as

$$\pi_i^{HS} = \frac{(a-c)^2}{b2^{i+n}} \forall i = 1,\dots,n, \tag{3.28}$$

where the profit is a decreasing function of the number of firms and the position of the firm in the hierarchy. Because the market price is lower than Cournot price, and firms moving before i = ln(n+1)/ln2 produce more than Cournot output, it is impossible to say directly whether firm i's profit is below or above the Cournot profit. However, a simple computation shows that the first firm (i=1) can receive $\pi_1^{HS} \geq \pi_1^C$ if and only if n ≤ 3. All other firms earn less than their Cournot courterparts regardless of n.

Since even the first firm is likely to prefer all firms to play a Cournot game, in which outputs are chosen without observing the output chosen by any other firms, the question is whether the hierarchical Stackelberg game is in principle feasible at all. If the first firm knows that without revealing its output to other firms the game is Cournot, this would be a rational strategy.

In the subgame perfect equilibrium, however, every firm reveals its output to the followers. This is a direct result of the backward recursive structure of the model and SELTEN's (1975) definition of the subgame perfect equilibrium. If the structure of the game is fixed, every firm in the sequence, say firm i, takes the production of previous firms as given or makes estimates about it when it is not revealed. Then firm i operates at its residual demand curve and chooses whether or not to reveal its output to the next firm. To reveal is a better strategy, because without revealing the next firm i+1 can act as a Cournot rival and produce the same output, which means that the market price will decrease. This strategy is optimal for all firms: in every subgame, the strategy has to be the best response against strategies chosen by other firms. Individual rationality yields a result that is not optimal for the industry as a whole.

In the Stackelberg models the leaders encounter a reacting fringe. In the hierarchical case the order of movements is important, and games give the first movers advantages. The first moving firms are able to restrict the choices open to rivals, for example, by controlling an input base or a distribution network. Alternatatively, dominance can be difined as a particular sort of price leadership in which the leader has control over the industry price and its own output, but not over rivals' output. In such a price leadership oligopoly model derived in Chapter 3.4.1, a dominant group of producers imposes a selling price to a competitive fringe of producers, each too small to exert a perceptible influence on price through individual output decisions. The dominant firm or group behaves passively in regard to the output of small firms, estimates the excess demand at each price, and competes strategically against other firms of the dominant group. However, the problem in calling such a price leader the dominant firm is that it is actually the follower who has the less constrained choice (GEROSKI and JACQUEMIN 1984). As long as the price leader enjoys no cost advantages, the output of the competitive fringe will asymptotically approach the total industry output, and the price leadership declines. Thus, in this sense, the leader can be seen to have greater dominance in the hierarchical Stackelberg model compared to the price leadership model.

To see what happens to the previously shown relations between aggregate monopoly power and concentration indices in the case of Stackelberg oligopoly, the Herfindahl index of concentration with linear demand and constant marginal costs can be derived (see Appendix 3) to be

$$H=\frac{1}{3}\left(\frac{1}{1-2^{-n}}\right)^{2}\left(1-\frac{1}{2^{2n}}\right). \qquad (3.29)$$

The Herfindahl index declines when the number of firms rises and asymptotically approaches value 1/3. In the Cournot case the index approaches zero when the number of firms rises. Despite the lower average profit level than in the symmetric Cournot equilibrium, the value of the concentration index is always higher in the hierarchical Stackelberg case. Such a market can be classified to be highly concentrated, although it results in lower profits and, from the viewpoint of social efficiency, Pareto dominates the Cournot equilibrium. Strategic asymmetry results in *higher concentration* but yields *greater efficiency*. The relationship between concentration and profitability is not straightforward. The form of competition is decisive.

A similar implication, i.e. that measures of concentration may have little to do with indicating average profits, can also be shown in the model of leading and following groups in which firms play Cournot against firms of the own group. A model of beneficial concentration from society's viewpoint is presented by DAUGHETY (1990). In this model the relation between average profit and the Herfindahl index can be negative, if there are 'too' many firms in the leading group. Furthermore, similar relationship exists when the concentration ratio, i.e. the aggregate market share of the leading group, is used. DAUGHETY (1990) also demonstrates that mergers can lead to higher welfare in the case where two followers merge and the result is a firm that behaviourally is a leader. If the conduct is symmetric, actions that reduce the number of firms or increase concentration are socially harmful, but in the asymmetric situation the result can be welfare-enhancing. Therefore, one has to be very careful in using concentration indices to estimate, for instance, the market power of an industry. Conduct must be taken into account, especially in comparing different industries and in the planning of antitrust policies.

3.4. Some implications for the foreign trade

In recent years, the adoptation of the industrial organization theory in the research of international trade has led to critiques of the standard neoclassical approach that free trade is the best policy regardless of the trade policies of competing countries. When the elements of imperfect competition and *strategic trade theory* are used, protection can be justified under certain circumstances. A government can increase national welfare by shifting monopoly rents from foreign to domestic firms through *export subsidies* and *import restrictions*. Although there has been little discussion on the applicability of the new strategic trade theory to agricultural markets, MCCORRISTON and SHELDON (1992) argue that the main characteristics of the theory are relevant to agricultural trade policy analysis. They also note that traditionally agricultural trade economists have assumed perfectly competitive markets or have been interested in the role of government trading organizations in international trade (e.g. ALAOUZE et al. 1978, KARP and PERLOFF 1989). However, food products are mainly manufactured and distributed by private firms operating in markets that can be described as imperfectly competitive. In this case, a government can directly or indirectly influence the decision variables of the domestic and foreign firms and determine the outcome of the oligopolistic game.

3.4.1. The role of export subsidies

In this chapter the effects of export subsidies are briefly explored by reviewing some of the most important studies. A great part of literature (see, for example, BRECHER and FEENSTRA 1983, FEENSTRA 1986, as well as ITOH and KIYONO 1987) focuses on cross-market effects of export subsidies. These models share the characteristic that the subsidy-induced terms-of-trade loss in one market is offset by a terms-of-trade gain in another, raising the possibility of national benefit from a policy of export subsidization. This chapter concentrates on the *profit-shifting motive* of export subsidies. The role of export subsidies, then, is to enhance the strategic position of domestic firms engaged in the competition for world markets with foreign rivals.

Following the work of BRANDER and SPENCER (1985), where industry is modelled as a Cournot duopoly, a government can increase national welfare through export subsidies. The model includes one domestic firm and one foreign firm, who export to third markets. An essential element of the model is what BRANDER and KRUGMAN (1983) refer to as a 'segmented markets' perception. In the model of Brander and Spencer this means that firms can price discriminate between the home and foreign market (this is a very relevant assumption for agricultural and food markets), and each enjoys a monopoly in its home market. In the first part of their model they assume that there is no consumption in the producing countries because, if marginal cost is constant, the existence of domestic consumption does not affect the level of sales and the export subsidy levels. If the domestic government only plays Stackelberg against firms and sets the subsidy level using its understanding of how subsidies influence the output equilibrium, it has unilateral incentive to offer an export subsidy to the domestic firm. If governments play Nash against other governments, noncooperative behaviour provides incentives for export subsidies in both exporting countries. In the cooperative framework, producing countries have incentives to get together to agree not to use subsidies, but they also have an incentive to cheat on any resulting agreements.

In the case where all production is for export, the subsidy of home government shifts out the reaction function of the domestic firm, increasing its exports, reducing foreign firm's exports, lowering the export price, but still increasing domestic profits. The subsidy can increase domestic welfare and, therefore, export subsidies can appear to be attractive policies from a domestic perspective. By acting first, the government can actually move the domestic firm to the Stackelberg leader position in the output space. According to MCCORRISTON and SHELDON (1992), this can be shown as in Figure 3.3, where

RF^D is the reaction function of the domestic firm and RF^F is the reaction function of the foreign firm. The Cournot-Nash equilibrium without export subsidies is N. The subsidy shifts the domestic firm's reaction function to the right to $RF^D{}_1$. The new Cournot-Nash equilibrium is at S, which is formally equivalent to the Stackelberg outcome. Due to symmetry, the two producing countries face similar incentives for export subsidies, and the foreign government pays its firm an export subsidy shifting RF^F out. The equilibrium is now at M, where both firms' outputs have expanded and profits as well as national welfares are lower compared to point N.

Introducing both governments into the analysis shows that export subsidies are not effective policies from the point of view of producing countries. This follows from the noncooperative game that has the structure of a prisoners' dilemma. Cooperation between the governments to not use subsidies at all would be Pareto-superior, but noncooperative behaviour provides incentives for subsidy policies. This means that international regulations which attempt to discourage subsidization, such as GATT regulations, are likely to require regular reinforcement if they are to survive.

In the model it is assumed that consumption does not exist in producing countries, or firms can price discriminate between the home and foreign market. If marginal cost is constant, an export subsidy does not affect the equilibrium level of price in the domestic market. However, if marginal cost is increasing, the optimal noncooperative export subsidy would be lower or even negative. Conversely, it would be higher if marginal cost is decreasing.

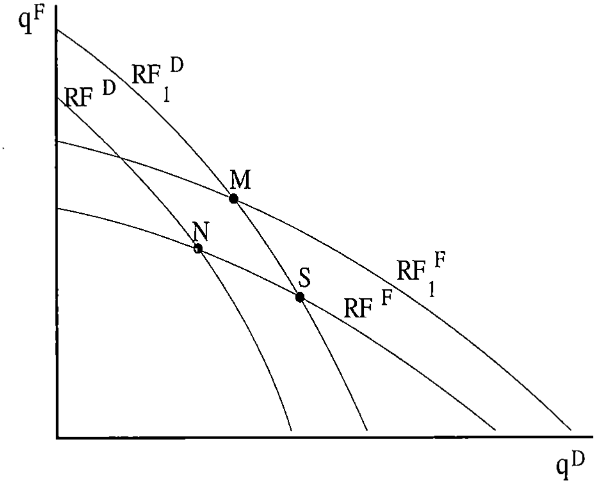

Figure 3.3. The effects of export subsidies on the Cournot-Nash equilibrium outputs. Source: McCorriston and Sheldon (1992).

What if the firms and governments cooperate to maximize joint profits as an implicit collusion? This kind of analysis is familiar from Chapter 3.2. BRANDER and SPENCER (1985) argue that the jointly optimal policy of exporting countries can be to tax exports. Optimal taxes would ensure that each firm would produce half of the output of a monopoly, acting as a joint monopoly against the rest of the world.

The analysis outlined above is based on the assumption that quantity is the strategic variable of firms. However, the optimal policy intervention is highly sensitive to the choice of the strategic variable. EATON and GROSSMAN (1986) consider alternative forms of oligopolistic competition and show that in a Bertrand duopoly the rent-shifting motive for policy intervention presumptively indicates a production or a per unit export tax. The export tax results in a reduction in domestic firm's market share and raises prices. The gains from the policy arise due to the revenue gains from the export tax. With conjectural variations model, the transfer of rents to the domestic firm is impossible, and free trade is optimal. The conclusion of the effectiveness of subsidy policy is also modified and extended by DIXIT (1984). He considers a more general Cournot model where trade-offs with consumer surplus are analyzed. As a result, the optimal policy intervention turns from an export subsidy to an export tax as the number of firms increases. The basic model can also be extended to incorporate some general equilibrium effects. Until now, the model explicitly assumes that firms are too small to influence factor markets. In the model of DIXIT and GROSSMAN (1986) the general equilibrium effects on welfare work through the factor market. If several industries are oligopolistic, a government subsidy to the exports of one such industry will work at least in part by reducing profits of the other industries. The problem is especially serious when these industries are tightly linked together by factor endowment constraints. Then the subsidizing industry is likely to generate net welfare losses or, generally, the optimal subsidy policies are less beneficial than a partial-equilibrium analysis would suggest.

A quite different motive for export subsidies is provided if there are *informational asymmetries* among consumers. The notion that incomplete information about product quality is a barrier to entry has been studied by e.g. SCHMALENSEE (1982) and FARRELL (1986). When applied to strategic trade theory, the basic idea in this approach is that imported goods may initially be of unknown quality to consumers and asymmetric information about quality leads to socially insufficient entry. Export subsidies enable high-quality producers to begin exporting profitably and subsidies can increase social welfare. BAGWELL and STAIGER (1989) construct a two-country model in which the foreign firm has first an introductory phase and then an infinite mature phase after entering the market. A foreign firm uses R&D investment to produce either low or high quality products. In the absence of export subsidies, high quality firms may be unable to find buyers in the market because they cannot distinguish themselves from low quality firms. In the most effective case, the foreign government can increase welfare by undertaking an export subsidy programme which supports a separating equilibrium with only high quality firms exporting. An important characteristic of this export subsidy is that the passive importing country is not harmed or, more effectively, it can set up a tariff policy to extract the mature phase rents. Naturally, the problem is more complicated if the importing country has notable production in the industry.

3.4.2. Tariffs and quotas as strategic trade instruments

What the previous section shows is that noncooperative behaviour provides incentives for export subsidy policies. Similarly, an importing country also has an incentive to set a tariff on the imports of the imperfectly competitive good, so as to extract some of the rent earned by exporters. The *optimal tariff* for the case of a foreign Cournot oligopoly is analyzed e.g. by BRANDER and SPENCER (1984). Later, they expand the analysis to how export subsidies of producing countries might affect the optimal import tariff (BRANDER and SPENCER 1985). A general result is that the optimal tariff is positive if the rate of change of the consumer price with respect to the tariff is less than one. Also, the introduction of export subsidies increases the optimal import tariff. However, a restrictive element of these papers is that they are only examining the special case of oligopoly equilibrium. It is difficult to see from these results how optimal policies depend on the nature of competition.

The study of CHENG (1988) investigates how optimal policies toward domestic markets are affected by the nature of oligopolistic competition. He constructs an oligopoly model consisting of a domestic firm and a foreign firm. If goods are differentiated, demand is linear, and the cost advantage of the foreign firm is not too large, the optimal policy under either Cournot or Bertrand competition consists of a tariff. However, the policy is different under Cournot and Bertrand competition. In the case of perfect substitutes, the optimal tariff is zero under Bertrand competition. In the Cournot equilibrium, the tariff may be positive or negative depending on the shape of the demand function. In the collusive equilibrium, the sign of the optimal tariff is the same as under Cournot competition. However, collusion leads to an optimal tariff that is always higher compared to the optimal tariff in Cournot competition. Thus, optimal policies under different forms of oligopolistic competition can be quite different.

It can also be asked whether such tariff policies are able to change the form of oligopolistic competition. The paper of DAVIDSON (1984) considers effect of tariffs on the ability of international oligopoly to act as a cartel. As a result, he shows that low tariffs lead to more stable cartels than before the imposition of the tariffs. However, when the tariff is high, the cartel is weakened. The intuitive explanation is that when tariff is high, domestic firms' profits are higher in the static non-cooperative equilibrium and foreign firms cannot remunerate domestic firms enough at the cartel point of the repeated game to keep them from cheating. On the other hand, for low values of the tariff, the foreign firms can redistribute cartel profits to the domestic firms in order to keep them from cheating. Furthermore, there exists some critical tariff rate that has no effect on the stability of the cartel. This critical rate is a decreasing function of the number of firms and the share of domestic production.

The policy analysis can be extended to allow other policy instruments. A great deal of trade instruments in the agricultural sector consists of *non-tariff barriers* to trade, such as import quotas. For example, KRISHNA (1989) as well as MAI and HWANG (1989) have investigated the *equivalence* between tariffs and quotas as alternative trade instruments in oligopolistic settings. The result of these studies is that market structure and the form of competition matter in determining whether tariffs and quotas are equivalent.

Following MAI and HWANG (1989), consider a duopoly model with a domestic firm and a foreign firm. Assume that the second order and stability conditions are satisfied so that the first order conditions give the equilibrium values of q_D* and q_M*. At the equilibrium the ratio of imports to domestic production is

$$r = \frac{q_M^*}{q_D^*} > 0. \tag{3.30}$$

Assume that the government imposes an import quota so that the ratio is r. Now foreign firm's reaction function becomes $q_M = rq_D$, and the domestic firm can maximize its profit subject to this constraint. The ratio quota changes the game to a Stackelberg leader-follower one with the domestic firm acting as the leader. Thus, the domestic firm's profit becomes:

$$\pi_D^r = P(q_D + rq_M)q_D - c_D q_D, \tag{3.31}$$

where r denotes the *ratio quota.* The first order condition for profit maximization is

$$\frac{\partial \pi_D}{\partial q_D} = P + q_D^r P' (1+r) - c_D = 0, \tag{3.32}$$

where q_D^r is the equilibrium level of output produced by the domestic firm under the ratio quota for imports. Calculating the difference between the amount of production by the domestic firm under the ratio quota and under the equivalent tariff yields

$$q_D^r - q_D^* = \frac{q_D^*(\alpha_D - r)}{1+r} \gtreqless 0, \ if\ r \gtreqless \alpha_D, \tag{3.33}$$

i.e. the difference is positive, zero, or negative when the ratio r is, respectively, greater, equal, or smaller than the domestic firm's conjectural variations parameter α_D ($=dq_M/dq_D$). Furthermore, since $P' < 0$, the relationship between domestic equilibrium price under the ratio quota and under the tariff is

$$P^r \gtreqless P^*, if\ r \gtreqless \alpha_D. \tag{3.34}$$

Thus, the domestic price under a ratio quota will be identical to that under the equivalent tariff only if the target ratio of imports to domestic production is exactly equal to the value of the domestic firm's conjectural variation. The domestic price under a ratio quota is always higher when the conjecture is Cournot or more competitive. When conjecture is more collusive than a Cournot one, the relationship of prices depends on the ratio of imports to domestic production. A higher quota ratio gives the domestic firm a more inelastic demand, and a ratio quota that is smaller than the value of the conjectural variations parameter gives the domestic firm a more elastic demand. For this reason, it is profitable to raise the price and produce less or lower the price and produce more than with the equivalent tariff, respectively.

Similarly, the relation between a ratio quota and a *volume quota* can be investigated. Assume that a volume quota is set at the equilibrium quantity imports under the tariff, and the foreign firm's reaction function is $q_M = q_M$*. Now, the domestic firm acts as a monopoly knowing the imported quantity. The first order condition is

$$\frac{\partial \pi_D^v}{\partial q_D} = P + q_D^v P' - c_D = 0, \tag{3.35}$$

where q_D^v is the equilibrium output of the domestic firm under volume quota. Calculation shows that $q_D^v - q_D^r$ is positive, i.e. the price under the volume quota is always lower than that under the ratio quota, regardless of the value of conjectural variations. Hence, these non-tariff barriers are not equivalent from the society's viewpoint.

The conjectural variations model of HWANG and MAI (1989) focuses on the pure-strategy equilibrium. In the study of KRISHNA (1989) the non-equivalence of tariffs and volume quotas is analyzed with price as the strategy choice. In this case, there is no equilibrium in pure strategies. However, as KRISHNA (1989) shows, the unique mixed-strategy is one where the foreign firm always chooses to charge only one price and the domestic firm randomizes over two prices, which give it equal profit. If firms produce substitute goods, the imposition of the quota raises both firms' prices and profits compared to the free trade levels. The equilibrium prices are higher than under an equivalent tariff. Furthermore, REITZES and GRAWE (1994) show that imposing a quota that constraints imports from exceeding a specified share of the domestic market leads to the mixed-strategy equilibrium in a Cournot duopoly. The equilibrium consists of a domestic firm that uses a pure strategy based on its type (either contract or expand output in response to the quota) and a foreign firm that, when making its output decision, only knows the probability that the domestic firm is of a given type. The effect on welfare depends on which strategy the domestic firm employs. Market-share quotas have less predictable effects on welfare than tariffs. If markets are oligopolistic, the change in firms' behaviour following the imposition of quantity restrictions can have important welfare effects, and the potential benefits of market interventions are highly dependent on the trade instruments used.

3.5. Oligopoly models as the theoretical framework of this study

The structuralist S-C-P paradigm posits a chain of causation running from structure to conduct to performance. The determination of structure is explained by reference to various exogenous barriers to entry. The next generation of empirical studies draws attention to the need to consider a possible reverse link from conduct or performance to structure. However, only the game theoretical formulation offers an analytical way of analyzing this two-way link. In this study the market structure is assumed to be exogenous. Even in the simple case of homogenous products, it was shown that the link between structure and performance is greatly dependent on the model selection.

In the simultaneous moves case, a conjectural variations model can be used to investigate the short-run relationship between concentration and market power. This relationship depends on the degree of price competition. Furthermore, higher concentration is likely to lead to higher industry profits because it facilitates collusion. This supports the view that concentration indices can be useful in assessing the state of competitiveness in markets. The Herfindahl index is an appropriate measure of concentration in the conjectural variations model. When firms behave asymmetrically, different sets of concentration indices correspond to different solution concepts of optimizing firms. How to measure concentration is an important issue, when the connection between concentration and the degree of oligopoly is studied.

In the case of asymmetric behaviour, even the simple exogenous structure and homogenous products models reveal a basic problem of the S-C-P paradigm: concentration measures may provide little insight into welfare, or the degree of market power. For example, a merger that reduces the number of firms and increases concentration can be welfare improving even if there are no cost advantages to the merger itself. In the hierarchical Stackelberg model the value of the Herfindahl index of concentration is higher than in the Cournot model despite the lower average profit level than in symmetric Cournot competition.

Using the elements of imperfect competition and the strategic trade theory, the studies reviewed in this chapter show that a government can potentially increase national welfare by shifting monopoly rents from foreign to domestic firms through export subsidies and import tariffs. If governments play Nash against other governments, noncooperative behaviour provides incentives for subsidies or tariffs. The game has the structure of the prisoners' dilemma: cooperation between the governments to not use protective policies at all would be Pareto-superior, but noncooperative behaviour provides incentives for cheating. However, optimal policies under different forms of oligopolistic competition can be quite different. Besides, different trade barriers are not equivalent from society's viewpoint. This is an important factor when the effects of the membership of Finland in the EU are analyzed.

Different formulations of strategic competition lead to a wide range of possible equilibriums. We do not have a general theory of oligopoly. Thus, the following analysis needs to take into account the *market characteristics* and the *effects of institutions* when modelling the causation from structure to performance. A common response of research is to focus analysis on some very specific market. The knowledge of market features might allow to restrict the range of candidate models.

4. Models to evaluate welfare losses due to oligopoly

Using Marshallian analysis to measure welfare losses by consumer surplus is an attempt to have a money measure of the loss in utility when commodities are sold at prices other than the marginal cost. Oligopolistic competition results in the market price equalling the marginal costs in the homogenous goods Bertrand competition or, for instance, in the asymmetric price game in which the follower can always capture all the market by undercutting slightly the price quoted by the leader (see GAL-OR 1985). However, as it has been shown, the market price usually exceeds marginal costs when the supply sector is characterized by oligopolistic competition and quantity is the decision variable of firms. In this case, part of consumers' loss is offset by the additional revenue that the producers obtain, but a portion of this loss, the deadweight loss, is not offset by any gain to any group in the economy.

In this chapter the objective is to derive applicable models to estimate welfare losses due to the oligopolistic competition so that the special characteristics of the foreign trade of food products in Finland, like import quotas and import levies, are included in the analysis. This kind of trade regulation usually causes a trade-off between consumer surplus and domestic firms' profits and lead to the question of optimal trade policy (see e.g. MCCORRISTON and SHELDON 1994). Furthermore, our intention is to derive models that allow for empirical findings without detailed firm-level information about sales, costs, and profits. The estimation of welfare losses is based on the observed values of concentration, market shares, and demand elasticities.

Quantity is assumed to be the decision variable of firms. The starting point is GISSER's (1986) well-known *price leadership* model, in which a dominant group of producers imposes a selling price to a competitive fringe. MAIER (1993), for instance, uses this model to evaluate the implications of agricultural policy interventions. Both of them assume equal supply elasticity for the leaders and the price-taking fringe. WILLNER (1989) questions whether it is reasonable to assume that all firms have identical technologies. He assumes a vertical marginal cost for fringe firms and horizontal marginal costs for the leading group. In this study the leading group is also assumed to have constant marginal costs, at least in the region of relevant output. Thus, it can be assumed that the price level of inputs is given and firms have constant returns-to-scale technology. However, the assumption of constant marginal and average costs also allows for U-shaped average costs at the plant level, since firms may avoid production diseconomies by operating a number of efficiently scaled plants. This can yield a horizontal firm-level average cost curve to the right of the minimum efficient scale level of one plant (see e.g. SHEPHERD 1990 for discussion on the determinants of market structure). For instance, LYONS (1980) lists some of the empirical studies which tend to confirm the horizontal costs assumption. Furthermore, including foreign trade and the small country hypothesis into the analysis leads to an identical situatiton as compared to the horizontal marginal cost assumption. A horizontal marginal and average cost curve corresponds to exports to the markets where demand is perfectly elastic. A firm chooses an equilibrium in which the marginal revenue from domestic markets equals the marginal revenue of exports.

Domestic firms are assumed to be in a position to use oligopolistic strategies. Chapter 4.1 considers a model in which quantitative import restrictions, more precisely, volume quotas, are adopted. Foreign firms are supposed to take prices as given in their individual export decisions within the permitted quota. It is implicitly assumed that domestic firms have higher average costs than foreign competitors e.g. due to the higher price of agricultural inputs. Thus, an import quota is fully utilized within a range from perfect competition to full collusion among domestic producers. The model to estimate welfare losses draws on GISSER (1986) and WILLNER (1989) in this case. The contribution of this study is to model competition between domestic firms by using conjectural elasticities and to take into account the influence of government's policy that allows for the collection of quota rents earned by importers. If, however, markets are totally possessed by domestic firms, welfare losses caused by imperfect competition can be estimated from an industry-wide oligopoly model (see DICKSON and YU 1989). Otherwise, when the import quota is increased, the market power of domestic firms decreases. In the simulation procedure, the market share of domestic firms is an observed variable. When the government sets a volume quota, the market share of domestic firms eventually depends on the form of competition. As shown in Chapter 3.4, another way to restrict imports should be to fix the market shares, i.e. to set a ratio quota which is nonequivalent to the volume quota assumed here. The effect of a ratio quota is to raise domestic prices and increase welfare losses, relative to those that would have prevailed in the presence of a volume quota.

In Chapter 4.2 it is assumed that quantitative import restrictions do not exist. However, because the average cost level of domestic firms is higher than foreign firms' costs due to the higher prices of agricultural raw materials, government imposes an import levy (tariff, tax) or a subsidy per unit of domestic production. If this levy or subsidy equals the difference between domestic and foreign costs, the application of the price leadership model to a small economy leads to the socially optimal output. However, international and especially European food markets are quite concentrated, and firms can be assumed to have some degree of market power. Therefore, a model that allows for imperfect competition among foreign producers is used to derive welfare losses. In this context, the *Stackelberg* model, in which domestic firms are assumed to be in the leadership position, is used. The domestic and foreign group choose quantities in a strict sequence, and foreign firms are fully informed of domestic firms' previous choices before their export decisions. Competition inside the groups is modelled by employing conjectural variation elasticities. This asymmetric solution is also compared to the situation in which competition between groups is modelled as the Cournot game. Later in Chapter 6 these applications are used when the effects of the integration into the EU are studied. It is assumed that market integration changes the structure of the game firms play. Imports from the EU can no longer be treated as a fringe, and domestic firms turn to operate on the wide European markets.

Chapter 4.3 presents two potential extensions of the models. First, the effects of vertical relationships of the food chain on the possibility of the food processing industries to use their market power are discussed. Bargaining power between food manufacturing and downstream industries, as well as potential vertical contracts are factors that influence the level and spread of welfare implications in the food chain. Second, in many Finnish food industries, e.g. in dairy and meat sectors, cooperative firms owned by agricultural producers have a dominant position. The basic cooperative principles often include open membership, which means that anybody is allowed to join the cooperative, and the cooperative is obligated to buy all the raw material the members decide to produce (VOLK 1993). Following SEXTON (1990), open membership cooperatives are pro-competive forces limiting their for-profit rivals' opportunities to exercise monopoly or monopsony power. A short section illustrates the potential effects of open membership cooperatives on the models to evaluate welfare losses due to oligopoly.

4.1. Quantitative import restrictions

The purpose of this chapter is to derive a method for finding out the potential welfare losses due to oligopolistic competition between domestic firms, when imports are restricted by means of import quotas. The analysis assumes perfect competition between importing firms in domestic markets. The objective is to show how the amount of allowed imports, concentration of domestic production, and demand elasticity determine domestic firms' market power, i.e. the possibilities to set price above marginal costs, and what is the size of welfare losses associated with this market power when different oligopoly solutions between domestic firms are employed.

Before outlining the theoretical model, the framework of the model is illustrated graphically. The model outlined in Figure 4.1 refers to GISSER's (1986) price leadership model. On the left, Q(P) represents the aggregate demand curve of the industry which is, for simplicity, assumed to be linear. The quota level for imports is given by Q_M*. This results in the residual demand curve of domestic production to be Q_D, which is the remainder of the quota-constrained market. In other words, the residual demand curve is the difference between total demand and imports. In this case, the residual demand is also linear.

As a special case, assume that domestic firms maximize joint profits by producing monopoly output Q_D^M at the point in which marginal revenue curve of monopoly MR^M cuts constant marginal costs of domestic firms denoted by c_D. This yields a market price of P^M. On the other hand, if domestic firms behave competitively, they produce a quantity Q_D^C with a price P^C. These are the two extreme cases. If the leaders (domestic firms) play Cournot or some other intermediate form between full collusion and perfect competition, the quantity produced by them in the aggregate will be determined at a point between Q_D^M and Q_D^C (not shown in Figure 4.1), where a more elastic marginal revenue curve intersects with the aggregate marginal costs of the leaders. The equilibrium market price will then lie between the monopoly price and competitive price.

Let us assume that the constant marginal costs of importers are given by c_M. This also denotes a supply curve for imports or a world market price level, if the small country assumption is adopted. If the domestic government is passive, i.e. it does not collect quota rents by using tariffs or by selling import quota licenses, the rationality condition for full utilization of the quota is that a domestic market price exceeds c_M. Let us assume, further, that c_M is lower than c_D, corresponding to the situation of Finnish food markets before the EU-membership. Then, the rationality condition always holds, because the competitive output of domestic firms leads to a market price equaling c_D with total

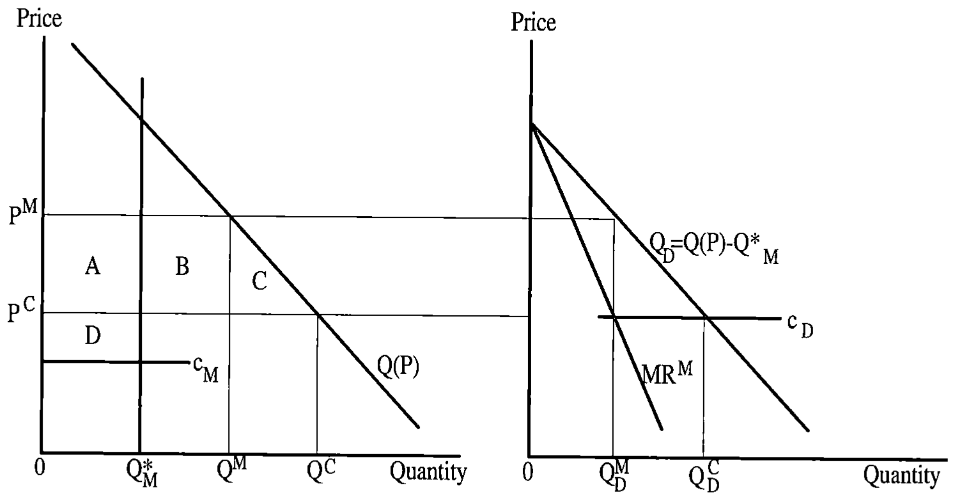

Figure 4.1. A price leadership model and import quota.

demand Q^C. Another extreme case, joint profit maximization, yields total quantity Q^M in Figure 4.1.

In the monopoly case, the domestic welfare loss due to the imperfect competition relative to the competitive level of consumption (Q^C), assuming no quota rent redistribution, is A+C. The loss of consumer surplus is A+B+C, and domestic firms' profits are B. Area A+D is the profit earned by foreign exporters.

Despite the degree of competition among domestic firms, importers obtain profits (quota rents) when the domestic government does not use other strategic trade instruments than import quotas, and importers' costs are lower than domestic producers' costs. From the viewpoint of the society, it is optimal that the government uses import levies, tariffs, or, possibly, sells import licenses and collects the profits earned by foreign firms. More precisely, the purpose of a tariff is to recoup the *quota rent* captured by importers to domestic government. This is the rent redistribution argument of protection. Because importers are modelled to be price-takers and the quota is exogenous, this model does not include the additional rent creation argument studied by McCORRISTON and SHELDON (1994), which is associated with the optimal setting of the import quota.

It can be asked whether the government can retain all of the quota rent from importers. The answer is yes only when the government can set, for instance, the import levy after observing the market price level. In this study three possible policy scenarios are examined. Assume the unit levy is t. First, it is assumed that t equals P^M-P^C in Figure 4.1. Then, the deadweight loss is area C. This method is close to common use of variable levies on imports to ensure that importers do not enter markets at prices that can undercut the domestic price level. In the following analysis this policy forms the basis of the model building, and other policy analyses are simple extensions of it.

Note that the optimal import levy equals the difference between P^M and c_M, resulting in welfare loss C-D. In this case the government retains all of the quota rent. Because the aim of the analysis is to evaluate welfare losses relative to the competitive equilibrium of domestic firms ($P=c_D$), the first policy scenario corresponds to the optimal import levy from the society's viewpoint. The second policy scenario assumes that t is c_D-c_M, i.e. it is the cost difference. Then, the domestic deadweight loss is A+C. The third and the most general procedure is to set an exogenous $t=t^*$ that causes the deadweight loss A+C-$t^*Q_M^*$ in Figure 4.1.

In order to generate predictions of deadweight losses due to collusion or any other mode of oligopolistic behaviour, the form of total demand has to be specified. Because different demand conditions yield different models, two specifications, constant-elasticy demand and linear demand curve, are treated as special cases.

4.1.1. Constant elasticity demand function

First, consider the constant-elasticity industry demand. Although the elasticity along this demand curve is constant, the elasticity of the residual demand curve of domestic production is not constant. Let us assume that the aggregate industry demand is given by

$$Q = GP^{\eta}, \tag{4.1}$$

where η is the price elasticity and G the demand shifter. Total import is restricted to be Q_M*. This quantity is, for instance, based on the administrative quota that permits to import some fixed amount per year. Importers are price-takers, i.e. they do not have market power on the domestic markets. The market price level is determined by domestic producers. Domestic firms are assumed to have constant marginal costs. The profit function for a domestic firm i is

$$\pi_i = G^{-\frac{1}{\eta}}(Q_D + Q_M{}^*)^{\frac{1}{\eta}} q_i - c_i q_i. \tag{4.2}$$

The firms (i=1,2,...,n) choose quantities to maximize profits non-cooperatively, but they have conjectures about other firms' responses. The first order condition for maximization of Equation 4.2 is

$$P + \frac{\partial P}{\partial Q_D} q_i \left(1 + \frac{\beta_D Q_{D-i}}{q_i}\right) - c_i = 0, \tag{4.3}$$

in which Q_{D-i} is the output of firm i's all domestic rivals and $\beta_D=(dq_j/dq_i)(q_i/q_j)$ for all j≠i and for all i, i.e. β_D is the elasticity of rivals' output changes with respect to firm i's output change. The conjectural derivative can be interpreted as firm i's belief about the way firm j's output changes as firm i's output changes. Thus, the conjecture term β_D can be interpreted as an index of industry collusion. If C_D is determined as a market share of domestic firms and $|\eta|$ is the absolute value of the demand elasticity, the first order condition can be rewritten to be

$$P - \frac{1}{|\eta|} C_D P \left[\beta_D + \frac{q_i}{Q_D}(1-\beta_D)\right] - c_i = 0. \tag{4.4}$$

After multiplying throughout by (q_i/Q_D) and summing each firm's optimal quantities across the industry, the aggregate condition for Nash equilibrium is

$$P-\frac{C_D P}{|\eta|}\left[\beta_D+H_D(1-\beta_D\right]-c_D=0, \tag{4.5}$$

where H_D is the Herfindahl index of concentration among domestic firms and c_D denotes the average of all c_i weighted by the market shares of domestic firms. The second term determines the ability of domestic firms to set price above marginal costs. As it can be seen from Equation 4.5, the market power of domestic firms is a function of the value of conjectural variations parameter, the degree of concentration, the market share of domestic firms, and the elasticity of industry demand.

Using Equation 4.5 the equilibrium price, P^O, and total quantity of oligopoly, Q^O, are obtained to be

$$P^0=\frac{|\eta| c_D}{|\eta|-C_D\left[\beta_D+H_D(1-\beta_D)\right]};\ Q^0=G(P^O)^{-|\eta|}. \tag{4.6}$$

The competitive price is c_D. If the competitive output is noted to be Q^C and an optimal import levy (scenario 1) is assumed, the deadweight loss can be computed as follows:

$$DWL=\int_{Q^O}^{Q^C} P(Q)dQ-c_D(Q^C-Q^O). \tag{4.7}$$

Integrating and substituting the equilibrium values of the competitive and oligopoly equilibrium yields the deadweight loss due to the oligopolistic competition to be

$$DWL=Gc_D^{\,1-|\eta|}\left\{\begin{array}{l}\dfrac{|\eta|}{|\eta|-1}\left\{1-\left\{1-\dfrac{1}{|\eta|}C_D\left[\beta_D+H_D(1-\beta_D)\right]\right\}^{|\eta|-1}\right\}\\ -1+\left\{1-\dfrac{1}{|\eta|}C_D\left[\beta_D+H_D(1-\beta_D)\right]\right\}^{|\eta|}\end{array}\right\}. \tag{4.8}$$

The deadweight loss can be computed through this expression using statistics on costs and the full structure of the demand function. However, the data requirement can be diminished by deriving the equation to the more useful form. Equation 4.8 includes the unknown parameters of demand function (G) and marginal cost (c_D). They can be eliminated, if the deadweight loss is divided by total sales in an industry. Total sales are

$$P^O Q^O = G\, c_D^{\,1-|\eta|} \left\{ 1 - \frac{1}{|\eta|} C_D \left[\beta_D + H_D (1-\beta_D) \right] \right\}^{|\eta|-1} \qquad (4.9)$$

and the deadweight loss per total sales is

$$\frac{DWL}{P^O Q^O} = \left(\frac{1}{|\eta|-1} \right) \theta^{1-|\eta|} + \theta - \frac{|\eta|}{|\eta|-1},$$

where:

$$\theta = 1 - \frac{1}{|\eta|} C_D \left[\beta_D + H_D (1-\beta_D) \right]. \qquad (4.10)$$

This formula offers a very straightforward way to measure the possibility of firms to set price above marginal costs, and to what extent this reduces welfare. The *relative deadweight loss* (RDWL) is decreasing function with respect to the absolute value of the price elasticity of demand. In contrast, the relationship between RDWL and the market share of domestic firms, the Herfindahl index, as well as the degree of competition is always positive.

As a reference, it can be noted that DICKSON and YU (1989) present a method in which the competitive price and output are set at \$1 per unit and 100 units. This means the demand shifter G in Equation 4.1 is set at 100. Substituting for oligopoly quantity in Equation 4.7 results in welfare losses based on the assumption that competitive sales are \$100.

Table 4.1. A comparison between different import levies.

Import levy	Relative deadweight loss	Relative output loss
$t = P^O - P^C$	$RDWL_1 = 1/(\lvert\eta\rvert-1)\theta^{1-\lvert\eta\rvert} + \theta - \lvert\eta\rvert/(\lvert\eta\rvert-1)$	$\theta^{-\lvert\eta\rvert} - 1$
$t = c_D - c_M$	$RDWL_2 = RDWL_1 + (1-C_D)(1-\theta)$	-"-
$t = t^*$	$RDWL_3 = RDWL_1 + (1-C_D)[1-\theta-(t/P)]$	-"-
	where $\theta = 1-(1/\lvert\eta\rvert)C_D[\beta_D+H_D(1-\beta_D)]$,	
	t/P = the ratio between unit import levy and market price	

Consumer surplus is an exact measure of welfare change only in special circumstances. The compensating and the equivalent variation measures include consumer surplus as a special case. Therefore, like WILLNER (1989) argues, estimation of the influence of diminishing marginal utility on the evaluation of the loss includes many tentative elements. Since fewer assumptions are needed to approximate output changes, the relative output loss (ROL) due to the oligopolistic competition is also offered. In the model the loss of output compared to competitive output can be derived to be

$$\frac{Q^C - Q^O}{Q^O} = \frac{G c_D^{-|\eta|} - G\left(\frac{c_D}{\theta}\right)^{-|\eta|}}{G\left(\frac{c_D}{\theta}\right)^{-|\eta|}} = \theta^{-|\eta|} - 1, \tag{4.11}$$

where θ follows from Equation 4.10 comprising the structural parameters of the model. It can be noted that ROL may receive considerably greater values than RDWL, especially when demand is very elastic. When the model is derived in the case of optimal import levy (policy 1), only the concentration measure (Herfindahl index), the share of domestic production, and the estimate of demand elasticity are needed to predict welfare (output) losses for different kinds of competition (measured by β_D).

As a reference, the corresponding equations are derived for the other policy experiments, although the empirical part of the study will concentrate on policy 1 only. If the second policy experiment ($t=c_D-c_M$) is considered, requirements for data are similar. The additional loss in domestic welfare is $(1-C_D)(P^O-c_D)Q^O$. After dividing by the value of sales and substituting for the equilibrium price, the cost parameter can be eliminated. The deadweight loss is always higher compared to the first policy. Finally, if the import levy is set to be exogenous t*, the government can collect an extra share of the quota rent $[(1-C_D)Q^O t]$, and increase domestic welfare. Table 4.1 summarizes these results for all three policy scenarios. Note that the models are not solvable under unitary elasticity and, furthermore, there exists a condition $C_D \leq |\eta|/[\beta_D+H_D(1-\beta_D)]$ for the existence of equilibrium.

4.1.2. Linear demand function

So far, demand has been assumed to have constant elasticity with respect to price. WILLNER and STÅHL (1992) argue that competitive quantity is then likely to be overestimated and the model predicts too large deadweight losses. BRACK (1987), for instance, proposes that linearity can give better predictions than constant elasticity in oligopoly models.Therefore, the model is also derived assuming linear demand ($P=a-b(Q_D+Q_M^*)$), and the predictions can be presented as the interval between the values obtained. When demand is linear, the profit function for a domestic firm i is:

$$\pi_i = \left[a - b(Q_D + Q_M^*)\right]q_i - c_i q_i, \tag{4.12}$$

where c_i stands for the average and marginal costs of the firm i. The first order condition for profit maximization can be derived to be

$$P - (a-P)C_D\left[\beta_D + \frac{q_i}{Q_D}(1-\beta_D)\right] - c_i = 0. \tag{4.13}$$

Let c_D denote again the average of all c_i weighted by the market shares. Thus, under linear demand and constant marginal costs the equilibrium price and quantity are

$$P^O = \frac{aC_D\left[\beta_D + H_D(1-\beta_D)\right] + c_D}{1 + C_D\left[\beta_D + H_D(1-\beta_D)\right]};$$
$$Q^O = \frac{a - P^O}{b}. \tag{4.14}$$

Employing the optimal policy in which the government collects all quota rents earned by importers ($t=P^O-P^C$), the value of deadweight loss can be solved (Appendix 3) by using Equation 4.7:

$$DWL = \frac{a-c_D}{b}\left\{\frac{1}{2}(a-c_D) - \left\{a - \frac{aC_D[\beta_D + H_D(1-\beta_D)] + c_D}{1 + C_D[\beta_D + H_D(1-\beta_D)]}\right\}\right\}$$
$$+ \frac{1}{2b}\left\{a - \frac{aC_D[\beta_D + H_D(1-\beta_D)] + c_D}{1 + C_D[\beta_D + H_D(1-\beta_D)]}\right\}^2. \tag{4.15}$$

Further, let $|\eta|$ denote the absolute value of the demand elasticity at the equilibrium point P^O. After dividing by the value of total sales, the unknown elements a and c_D can be eliminated (Appendix 3) by using the fact that $|\eta|=P/(a-P)$ under linear demand:

$$\frac{DWL}{P^O Q^O}=\frac{1}{2|\eta|}\left\{\frac{(a-c_D)^2}{\left\{a-\frac{aC_D[\beta_D+H_D(1-\beta_D)]+c_D}{1+C_D[\beta_D+H_D(1-\beta_D)]}\right\}^2}-\frac{2(a-c_D)}{\left\{a-\frac{aC_D[\beta_D+H_D(1-\beta_D)]+c_D}{1+C_D[\beta_D+H_D(1-\beta_D)]}\right\}}+1\right\}$$

$$=\frac{1}{2|\eta|}\left\{\{1+C_D[\beta_D+H_D(1-\beta_D)]\}^2-2\{1+C_D[\beta_D+H_D(1-\beta_D)]\}+1\right\} \tag{4.16}$$

$$=\frac{1}{2|\eta|}C_D^{\,2}[\beta_D+H_D(1-\beta_D)]^2.$$

Analogously, the relative loss of output is

$$\frac{Q^C-Q^O}{Q^O}=C_D[\beta_D+H_D(1-\beta_D)], \tag{4.17}$$

i.e. it is determined by the structural elements of the model only. The elasticity of demand does not affect the value of output loss. The model can predict the output loss to be relatively high even when the deadweight loss is quite small, especially if demand is very elastic with respect to price.

Table 4.2 includes the predictions of losses also for other policy scenarios. If the import levy is set to be the cost difference (policy two), the linear model does not allow as straightforward a way to eliminate parameters as the constant-elasticity model does. Therefore, we need to approximate deadweight losses by using an empirically observable profit/sales ratio (denote π/S) for domestic firms. This is a performance indicator that characterizes the negative equilibrium relationship between welfare and price-cost margins. Because the post import levy costs for importers are c_D, the profit/sales ratio implicates the quota

Table 4.2. A comparison between different import levies.

Import levy	Relative deadweight loss	Relative output loss
$t = P^O-P^C$	$RDWL_1 = 1/(2\|\eta\|)C_D^{\,2}[\beta_D+H_D(1-\beta_D)]^2$	$C_D[\beta_D+H_D(1-\beta_D)]$
$t = c_D-c_M$	$RDWL_2 = RDWL_1 + (1-C_D)(\pi/S)$	-”-
$t = t^*$	$RDWL_3 = RDWL_1 + (1-C_D)[(\pi/S)-(t/P)]$	-”-
	where: t/P = the ratio between unit import levy and market price, π/S = the average profit/sales -ratio for domestic firms	

rent of importers, i.e. $\pi/S = (P^O\text{-}c_D)/P^O$. The relative deadweight loss is always higher compared to the first policy. When the import levy is exogenous t* (policy three), the ratio between unit levy and market price is needed as in the constant-elasticy model. All cases result in the same relative output loss.

4.2. International oligopoly

The procedure of setting importers to act as passive price-takers can be justified on the basis of their restricted import volumes. Removing quantitative import restrictions in the previous price leadership model leads to the socially optimal output (DWL=0), if foreign firms do not face cost disadvantages compared to domestic firms. However, if quantitative import restrictions do not exist, it can be asked why importers would not use their potential market power, especially because it is often argued that international food markets are also imperfectly competitive (see e.g. MCCORRISTON et al. 1993). From one aspect, a key element of international markets for agricultural primary products is the existence of state trading organizations and marketing boards. From another aspect, an increasing proportion of trade is in processed products, and these products are mainly manufactured by private firms operating on markets that can be described as imperfectly competitive (MCCORRISTON and SHELDON 1992).

In this chapter domestic firms are assumed to be in Stackelberg leadership position against importing firms. It is assumed that groups choose quantities in a strict sequence and that a foreign group is fully informed of a previous choice. This asymmetry can be seen as a result of a historical source of differentiation between domestic and foreign firms in the domestic markets. A natural source of historical differentiation is the sunk cost of capacity e.g. in delivery and marketing channels. Thus, asymmetry is regarded as the result of dominance by the domestic group. Alternatively, Stackelberg seems a plausible solution to a situation where one group believes that its rival expects and is able to win a price war (DOWRICK 1986). In such a situation, this group expects that its rival will act strongly against tighter competition, in which case the group will prefer to comply by accepting the weak role. In this case, it is also possible that the foreign group takes the leadership position, because it can be seen to have greater capacity to endure short-term losses in many cases.

As in the previous chapter, homogenous products and constant returns to scale are assumed. Competition inside the groups can vary from perfect competition to full collusion. A general conjectural variations model is used in modelling this game. Let c_i stand for the marginal costs of the ith firm. Q_D and Q_M are the total quantities of domestic production and imports, respectively. Industry demand is downward sloping and weakly concave. Profits for a firm i in each country are given by

$$\pi_{iM} = P(Q_D + Q_M)q_{iM} - (c_{iM} + t)q_{iM};$$
$$\pi_{iD} = P(Q_D + Q_M(Q_D))q_{iD} - (c_{iD} - s)q_{iD}, \tag{4.18}$$

where t is unit import levy for foreign production, s is a subsidy of home production, and subscripts D as well as M represent the domestic group and imports (foreign group), respectively. Firms reactions to one another in the country in question are treated as conjectural variation elasticities. The domestic group is, however, assumed to have a Stackelberg leadership position against the foreign group. The leader (domestic group) will be able to infer the follower's (foreign group's) choice and take this into account in its decision. Thus, the aggregates of the first order conditions for profit maximization of the respective profit functions are

$$P(Q_D + Q_M) + P' Q_M[\beta_M + H_M(1-\beta_M)] - c_M - t = 0;$$
$$P(Q_D + Q_M(Q_D)) + P' Q_D[\beta_D + H_D(1-\beta_D)] - c_D + s = 0, \tag{4.19}$$

where c_M and c_D denote the averages of c_{iM} and c_{iD} weighted by the market shares inside the respective groups. Further, β_M and β_D represent the conjectural elasticities. The demand function is not specified to any particular form.

Let us assume that demand is linear. Combining the optimality conditions with the inverse linear demand function (P=a-bQ), an explicit solution for the quantities can be obtained to be

$$Q_D{}^o = \frac{1}{bV_M(1+V_D)}[(a-c_D+s)(1+V_M)-(a-c_M-t)];$$
$$Q_M{}^o = \frac{1}{bV_M(1+V_D)}\left[(a-c_M-t)(1+V_DV_M(1+V_M)^{-1})-(a-c_D+s)\right], \tag{4.20}$$

where index o indicates oligopoly equilibrium as before, $V_D = \beta_D + H_D(1-\beta_D)$, and $V_M = \beta_M + H_M(1-\beta_M)$, i.e. V_D as well as V_M collect parameters that characterize competition and structure among domestic firms and importers respectively. Combining domestic production and imports, the total oligopoly output is

$$Q^o = \frac{1}{b(1+V_D)(1+V_M)}\left[(a-c_D+s)(1+V_M)+(a-c_M-t)V_D\right]. \tag{4.21}$$

Table 4.3. Comparative static effects in the Stackelberg equilibrium.

	Of an increase in					
Effect on	c_D	c_M	V_D	V_M	t	s
Q_D	-	+	-	+/-	+	+
Q_M	+	-	+	-	-	-
Q	-	-	-	-	-	+
P	+	+	+	+	+	-

The equilibrium price can be solved by substituting the total output of Equation 4.21 to the linear inverse demand function, i.e. $P^O = a\text{-}bQ^O$.

The comparative static effects of changes in costs, market conduct, and import levy or domestic support (Table 4.3) differ to some extent from DIXIT's (1988) homogenous products model, in which competition between domestic and foreign firms is modelled through conjectural variations. The leadership position of the domestic group causes that more aggressive competition between importers (lower V_M) can result in greater output of the domestic group. However, unequal costs and very low V_D or V_M can yield solutions where either Q_D or Q_M falls to zero. The effect of a decrease in V_M on Q_D is positive, if c_D- s < c_M+t, and this does not necessarily yield a corner solution where Q_M is zero. However, $dQ_M/dV_D<0$ is negative only if c_D-s > $(aV_M+c_M+t)/(1+V_M)$, but this condition yields a corner solution where Q_D falls to zero. Thus, the effect of V_D on Q_M is always positive.

So far, the levels of the import levy or domestic subsidy have not been determined. Let us assume that the government imposes an import levy, tariff, import tax, or/and a subsidy such that the C.I.F. cost of imports equals domestic costs. This corresponded to the earlier practice in Finland to set an excise on imports that corresponds to the price difference of agricultural raw materials between Finland and the world markets. In cases where Finnish food manufacturers exported their products and bought their agricultural raw materials from Finland at prices which were higher than the world market prices, so-called internal measures to compensate for the price differences of agricultural raw materials were applied. In the policy of the EU, it can be observed that this assumption corresponds to the import levy on pigmeat, eggs, and poultry meat sectors, where the import levy is fixed at a level which ensures that EU producers are not adversely affected when importers' production costs are below EU costs.

The determination of total supply, when $t=c_D-c_M$ (s=0), is presented in Figure 4.2. Foreign firms' aggregate reaction curves (RF_M^1 and RF_M^2 are drawn for illustrative purposes) show their profit-maximizing output given the output of

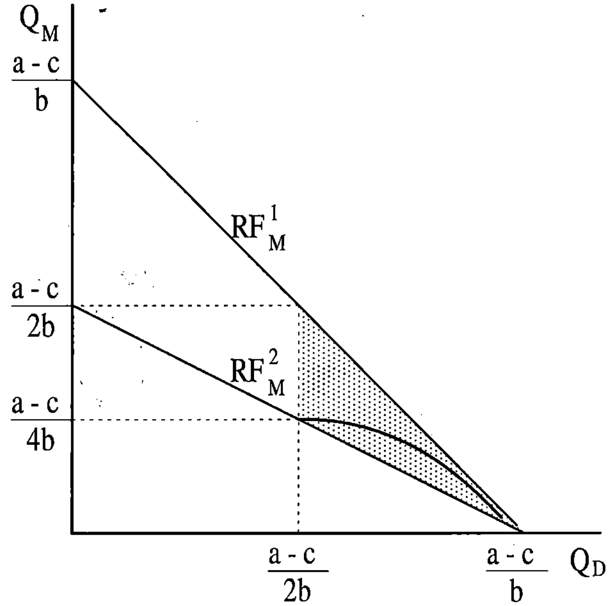

Figure 4.2. Determination of supply in the Stackelberg model.

domestic firms. By moving first, the domestic group can pick the point on foreign group's reaction curve that yields it the highest profits. If the domestic group produces the competitive market-clearing output $Q_D=(a-c_D)/b$, foreign firms always maximize profit by exporting nothing. The reaction curve $RF_M{}^1$ corresponds to perfect competition between foreign firms, i.e. it leads to the same situation as a price leadership model with no cost differentials between the groups. Total supply is always at the competitive level, and the result is socially optimal along the upper line. Another extreme case is shown by the reaction curve $RF_M{}^2$, where foreign firms produce monopoly output with regard to the production of the domestic group, i.e. the foreign group consists of only one firm or firms that collude. For example in the case of two firms (1 domestic and 1 foreign), the domestic firm produces $Q_D= (a-c_D)/2b$ and foreign firm $Q_M=(a-c_D)/4b$. Because this is the minimum of domestic output, the relevant range of output for both groups is the shaded area. The nonlinear and decreasing reaction curve inside the shaded area corresponds to a situation in which the degrees of competition and concentration are similar for both groups ($V_D=V_M$).

Derivation of welfare losses due to oligopolistic competition follows the method of the previous chapter. The starting point is Equation 4.7. The domestic deadweight loss compared to the competitive output $P=c_D$ can be solved (Appendix 3) to be

$$DWL = \frac{1}{2b}(a-c_D)^2(\phi-1)^2 + \pi_M,$$

where

$$\phi = \frac{1+V_D+V_M}{(1+V_D)(1+V_M)}. \tag{4.22}$$

The first term is the loss of consumer surplus minus the sum of domestic and foreign firms' profits. Because the target is to evaluate domestic losses, foreign firms' profits (the second term) are added in Equation 4.22. Furthermore, it can be seen that ϕ characterizes the degree of competition. It varies between 3/4 (both V_D and V_M are 1) and 1 (V_D or V_M is 0). The first corresponds to the case in which both groups consist of one firm, and the second is a perfectly competitive situation.

The model to evaluate deadweight losses can be written in a more manageable form. Let $|\eta|$ again denote the absolute value of the demand elasticity at the point P^O. Observing that $|\eta| = P/(a-P)$ under linear demand, the deadweight loss per total sales in an industry can be written as follows (Appendix 3):

$$\frac{DWL}{P^O Q^O} = \frac{1}{|\eta|}\left[\frac{1}{2\phi^2} - \frac{1}{\phi} + \frac{1}{2}\right] + \frac{(1-\phi)V_D}{|\eta|\phi(1+V_D+V_M)}. \tag{4.23}$$

The procedure for finding out welfare losses requires only the estimate of demand elasticity, the concentration indices, and the measures of the degree of competition. In this model the relative loss of output due to oligopolistic competition is simply $(1-\phi)/\phi$. The share of imports is $1-C_D=V_D/(1+V_D+V_M)$. Utilizing this result yields an indirect measure of the degree of foreign competition to be $V_M=[C_DV_D/(1-C_D)]-1$, and the parameter ϕ to be $\phi = 1/[C_D(1+V_D)]$. Thus, for example, the share of domestic production may obtain 'too high' values, indicating possible differences in consumer preferences and transportation cost, or the existence of trade barriers. This indirectly extends the range of the model from the assumption of equal costs between domestic and foreign groups.

Despite the possible historical sources of differentiation, i.e. the domestic group has a history of market dominance, it is not necessarily the case that the foreign group will accept to be a follower in the long run. As extreme cases, DOWRICK (1986) shows that in the Stackelberg duopoly each firm will prefer to be the leader or, possibly, each firm will prefer that the other be the leader. He argues that, if both firms take the preferred role, they cause mutual damage. In this case, firms may accept some nonpreferred role to minimize damages. This would mean the Cournot solution or some more profitable solution through implicit collusion. In the Cournot competition between the groups, the equilibrium total quantity is (Appendix 3)

$$Q^{O'} = \frac{1}{b\left[(1+V_D)(1+V_M)-1\right]}\left[(a-c_D+s)V_M+(a-c_M-t)V_D\right], \tag{4.24}$$

and the relative deadweight loss

$$\frac{DWL'}{P^{O'}Q^{O'}} = \frac{1}{|\eta|}\left[\frac{1}{2\phi'^2}-\frac{1}{\phi'}+\frac{1}{2}\right]+\frac{(1-\phi')V_D}{|\eta|\phi'(V_D+V_M)}, \tag{4.25}$$

where $\phi' = (V_D+V_M)/[(1+V_D)(1+V_M)-1]$, the relative loss of output is $(1-\phi')/\phi'$, and the share of imports $1-C_D = V_D/(V_D+V_M)$. In this case, the equilibrium price would be higher and output lower compared to the Stackelberg case. This would yield a lower consumer surplus and lower domestic profits. Therefore, market dominance of domestic firms relative to the imperfectly competitive foreign group is beneficial from the domestic society's viewpoint.

4.3. Potential extensions of the models

There are some potential limitations to using models presented in the above chapter to compute welfare loss estimates. First, the approach is one of partial equilibrium such that the state in the rest of the economy is given. Second, product differentiation associated with special brands and spatial differentiation is ignored. Studying the structure-performance relationship of the differentiated products markets may involve many problems in the determination and limitation of real markets. However, product differentiatiation is mainly related to the determination of the market structure and, when the structure-performance relationship is analyzed, it is possible that product differentiation is implicitly accounted for by variation in the elasticity of demand. Furthermore, even if products are assumed to be differentiated, it is possible to derive almost similar results as compared to the homogenous goods case when price is used as the decision variable of firms and the conjectural variations parameters are reformulated as e.g. CUBBIN (1983) formulates. Third, the models do not consider the effects of vertical relationships, for instance between food manufacturing and retailing, in the food chain. Fourth, a special feature of many Finnish food industries is the dominant role of cooperative firms, and the cooperative principles may lead to differences in conduct and performance between cooperatives and investor-owned firms. The last two aspects are analyzed more in depth in the following.

First, the food chain consists of many vertically related markets. Vertical control refers to the relationships between upstream firms, usually the manufacturers, and downstream firms, usually the dealers or retailers. The downstream firms could equally well be wholesalers or industrial users, but, for simplicity, they are called retailers. Food processing and retailing sectors are usually characterized by a high degree of concentration such that they have potential market power, and their vertical behaviour may have implications for economic performance. SHELDON (1995) argues that policy analysis in agricultural economics typically ignores the existence of the food retailing sector and, thus, the vertical contractual relations between stages of the food chain, the main exception being the analysis of vertical integration. He notes that vertical arrangements ought to be accounted for in the analysis of the food sector, although theories provide no unambiguous predictions about their welfare effects.

A common method to model vertical relationships is a linear price mechanism in which a retailer chooses the quantity and pays a manufacturer an amount proportional to the quantity bought. Vertical relationships, however, often involve vertical restraints such as resale price maintenance, exclusive territories, franchise fees, and exclusive dealing (TIROLE 1990). The manufacturer can observe and control some decision variables, e.g. prices, of each retailer, but cannot control some other variables, such as the number of retailers, their locations, or their selling efforts (REY and TIROLE 1986). This lack of control may cause undesirable externalities like double marginalization that leads to both lower profits and lower consumer surplus compared to total vertical integration. Externalities may be eliminated if manufacturers can use the tools of vertical restraints to control retailers' actions. Of course, the situation is more complex when there exist informational problems or transaction costs in the food chain.

Second, an important characteristic of many agricultural markets in Finland is the large market share of cooperatives. The role of cooperatives is based on the characteristics of many agricultural markets where a large number of farmers produce the raw products, which are then processed by relatively few firms having oligopsony power over farmers. Cooperatives are a way to exercise market power, exploitate size economies, and spread risk (SEXTON 1995). A cooperative maximizes its members' profit from producing and marketing their product jointly. For example, if the number of members of the cooperative is exogenously given and the quantity of the raw product produced by an individual member is also exogenous, the problem of the cooperative is to decide how to use other inputs so that the price of the raw product is maximized with respect to the given amount of the raw product (VOLK 1993). If other inputs of the processing cooperative are treated to be fixed, the cooperative is only a link between its members and final markets.

A cooperative that can restrict the number of members and purchases may use its potential market power effectively over the downstream stages of the food chain and consumers. Open membership cooperatives are, however, usually seen as procompetitive forces in the economic literature and in the implementation of public policy, despite the criticism that cooperatives may be productively less efficient than other organization forms (see SEXTON 1990). One explanation follows from the cooperative principles of the Rochdale tradition, which state that it is not possible to prevent a farmer from becoming a member and the cooperative is obliged to accept members' supplies. These principles lead to the situation in which it is difficult for the cooperative to maximize the joint profits of its members. Even if it would be optimal for the cooperative to restrict its domestic market sales, the problem is that the members may produce too much because of free riding among themselves, i.e. each member takes the price of the raw material as given and will produce more than the cooperative's optimal quantity as long as the price of raw material exceeds the marginal costs of production. The cooperative can maximize joint profits only if it is able to control the supply of raw materials. The strategy of the cooperative would be to introduce contractural arrangements, such as quantity fixing. Thus, it can be assumed that the production control programmes applied in agricultural production (their quantitative and economic efficiency is studied by KOLA 1991) may have increased the market power of producers' cooperatives.

To conclude, it is possible that the open membership cooperative has to operate at its maximum capacity determined by supplies of its members. This may eliminate a large share of the cooperative's market power. However, the situation becomes different when the public sector sets a quaranteed minimum price system for processed food items. This can be realized, for example, through intervention mechanisms or export subsidies. Hence, the processing cooperative can allocate its production between domestic sales and exports or intervention stores. In this study the strategies and welfare implications of cooperatives are not modelled formally. The special features of cooperative behaviour should be taken into account when the results of the next chapter are interpreted. The predictions of welfare losses are more likely to be overestimated in the case of industries dominated by the cooperative firms when compared to the investor-owned industries.

5. Welfare losses of oligopolies in the Finnish food manufacturing

The magnitude of the static partial equilibrium welfare losses of oligopolistic competition in the Finnish food manufacturing is evaluated in this chapter. The analysis is based on the measures derived in the previous sections of this study. Consumer surplus is defined as the area between the inverse demand curve and the equilibrium price level. The existence of oligopolistic market power reduces consumer surplus, but from the society's viewpoint a portion of this loss is compensated by additional profits that producers obtain. The net loss to society, the deadweight loss, is evaluated first at the aggregate level of food manufacturing (Chapter 5.2), and then it is estimated for different Finnish food manufacturing industries based on 1993 data (Chapter 5.3). The deadweight losses are measured as a ratio to total sales. The estimates can be interpreted as potential losses, if the firms utilize their possibilities to use market power. Chapter 5.4 presents a brief analysis of how these possibilities are observed in the profitability of industries.

As presented earlier in this study, there are many possible models that can be applied in evaluating welfare losses due to the oligopolistic market power. The magnitude of losses for an industry depends greatly on the model selection. Important decision variables are the form of competition (the degree of the conjectural variations elasticity) and the existence of possible asymmetry in competition. Furthermore, the price elasticity of demand, seller concentration, and the share of imports on the domestic markets have a decisive effect on the magnitude of deadweight loss. Comparison of the estimates under different model assumptions constitutes an important part of this chapter.

5.1. Data and classification of industries

In order to calculate estimates of deadweight losses to the society, numerical values have to be determined for parameters describing concentration, the share of domestic production, and the degree of competition. The estimates begin with the national industry sales concentration data collected by the Statistics Finland. The concentration statistics are based on the data of the Statistics Finland's Business Register, which covers, in terms of personnel, 99 percent of the non-agricultural enterprise sector. Enterprises are natural persons (self-employed persons), legal persons (e.g. limited companies), public financial institutions, or un-incorporated central government enterprises. Data sources of the Business Register are the files of the National Board of Taxation, which provide information on economic activity, and enquiries addressed to all new registered employers and enterprises subject to turnover tax, to all multi-establishment enterprises, and to single-establishment enterprises with more than 20 employees. Because the Statistics Finland publish only 3, 5 and 10 firms' concentration ratios at the two-digit level of the SIC system, the data at the four-digit level were collected and the Herfindahl indices were calculated from the unpublished basic statistics of the Business Register.

Data on the total sales of goods produced by food, beverages, and tobacco industries in 1993 were collected from the Industrial Statistics. These statistics were supplemented by the Foreign Trade Statistics published by the National Board of Customs. Furthermore, some profitability measures are computed for industries including a sufficient number of firms to be reported. These accounting measures were collected from the Financial Staments Statistics.

Sensitiveness of the estimates to the different forms of competition is analyzed by employing different oligopoly models. Because the deadweight loss estimates are also very sensitive to the own-price elasticity of demand, a value of price elasticity is allowed to vary within a large range. Some precise point elasticity estimates obtained by previous studies are presented for different industries. The study mainly referred to is the demand analysis of LAURILA (1994), in which the Almost Ideal Demand System was employed to estimate price and expenditure elasticites of food products in Finland. The estimates of some other studies which employ single equation models are also used (e.g. LAURILA 1985 and MELLIN 1985).

For model selection between the restricted imports model and the international oligopoly model, food industries are divided into two groups. At the four-digit level of the SIC system, the following industries are classified as industries characterized by quantitative import restrictions:

- slaughtering
- meat processing
- fruit and vegetable processing
- margarine manufacture and manufacture of other vegetable and animal oils and fats
- dairy products manufacture
- grain mill products manufacture
- beet sugar manufacture and sugar refining
- malt manufacture
- starch manufacture
- feed manufacture.

The industries above produce mainly commodities that were subject to import licensing in 1993. Decisions concerning imports were made by the Agricultural Marketing Council. Imports have a very minor role within industries with quantitative import restrictions. The most important exception is fruit and vegetable processing, in which a considerable amount of processed fruit products were imported without licensing. Thus, the main part of total food imports consisted of agricultural raw materials and processed free trade products. The industries classified to the free trade group are the following:

- fish processing
- fresh bread and pastries manufacture
- crispbread manufacture
- biscuits manufacture
- chocolate and confectionary manufacture
- coffee roasting
- manufacture of malt beverages and soft drinks
- tobacco products manufacture.

Although the SIC group 1159 'other food manufacture' includes the production of many important free trade commodities, such as baby foods, soups, sauces, and flavourings, it is excluded from our investigation because of the low rate of substitution of these products in the consumption. It can be assumed that the SIC classification does not correspond to the real product markets in this case. Furthermore, the lists of industries do not involve the manufacture of spirits and fermented alcoholic beverages due to the public sector monopoly ownership and strict regulation of prices.

5.2. Estimates at the aggregate level

Before the industry-level analysis, the effects of the elasticity of demand and the degree of competition are illustrated by considering an industry with the Herfindahl index of concentration corresponding to the weighted average of Finnish food manufacturing (0.25). According to Industrial Statictics, shipments of own products of food industry amounted to FIM 46.77 billion in 1993, of which FIM 4.47 billion were exported. Because imports of processed food accounted for FIM 3.80 billion (ELINTARVIKETEOLLISUUS 1995), the average share of domestic production on Finnish markets is roughly estimated to be 91.7 percent.

Table 5.1 illustrates the properties of the quantitative import restriction model. Welfare losses are computed for different combinations of the elasticity of demand (from -0.2 to -2.2), and the degree of competition (from Cournot competition to full collusion) is first based on the assumption that demand can be modelled by using a constant-elasticity demand function. Then, losses for the same values of the point elasticities are computed assuming that a linear demand function is an accurate approximation of industry demand.

As it can be seen from Table 5.1, even the Cournot-Nash oligopoly produces deadweight losses amounting to more than 2 percent of the sales, although the demand elasticity is relatively high. It is obvious that quite low but still realistic values of demand elasticity (see e.g. LAURILA 1994) may yield losses larger than 4 percent in the Cournot competition. The full collusion results in deadweight losses to be dramatically larger. In the intermediate case, the conjectural variations elasticity parameter β_D is set equal to the Herfindahl index. This is based on the assumption that coordination among sellers is easier the more concentrated the market is. The intermediate case yields losses that are about 3 times larger compared to the Cournot equilibrium, if demand is linear. Assuming a constant-elasticity demand yields considerably higher deadweight losses compared to linear demand. In the case of constant-elasticity demand, competitive quantity is likely to be overestimated for very low elasticities, resulting in deadweight losses that are probably unrealistically high.

In the model of quantitative import restrictions with the assumption of constant-elasticity demand, the equilibrium is nonexistent if the value of demand elasticity is too low compared to the value of the combination of the structural parameters of the model, i.e. if $|\eta| < C_D[\beta_d+H_D(1-\beta_d)]$ (see Equation 4.10). This corresponds, for example, to the monopoly situation in which the optimal output of the monopoly is always at a point of the demand curve at which $|\eta| > 1$. Furthermore, note that at $|\eta| = 1$ there is no equilibrium solution, as can be seen from Equation 4.10.

Assuming that markets are characterized by the model of international oligopoly, so that domestic firms have the Stackelberg leadership position against foreign

Table 5.1. The percentage deadweight loss in the model of quantitative import restrictions.

	Constant-elasticity demand			Linear demand		
	Cournot	Interm.	Collusion	Cournot	Interm.	Collusion
Demand elasticity[1]		The percentage deadweight loss				
0.20	*	*	*	13.2	40.3	210
0.60	5.59	22.4	*	4.38	13.4	70.1
1.00	3.08[2]	11.0[2]	151[2]	2.63	8.06	42.1
1.40	2.17	7.51	67.3	1.88	5.75	30.1
1.80	1.66	5.66	45.1	1.46	4.48	23.4
2.20	1.35	4.54	34.2	1.20	3.66	19.1

[1] The absolute value.
[2] The elasticity used is 1.01.
*) The condition $|\eta| > C_D[\beta_d+H_D(1-\beta_d)]$ is violated.

Table 5.2. The percentage deadweight loss in the model of international oligopoly (Stackelberg competition between the groups).

Imports[1] Domestic production[2]	Cournot competition			Intermediate competition			Collusion		
	Cournot	Interm.	Collusion	Cournot	Interm.	Collusion	Cournot	Interm.	Collusion
Demand elasticity[3]	The percentage deadweight loss								
0.20	1.13	2.64	7.28	2.06	4.88	13.7	9.26	24.2	83.3
0.60	0.38	0.88	2.43	0.69	1.63	4.58	3.09	8.05	27.8
1.00	0.22	0.53	1.46	0.41	0.98	2.75	1.85	4.83	16.7
1.40	0.16	0.38	1.04	0.29	0.70	1.96	1.32	3.45	11.9
1.80	0.12	0.29	0.81	0.23	0.54	1.53	1.03	2.68	9.26
2.20	0.10	0.24	0.66	0.18	0.44	1.25	0.84	2.20	7.58
Domestic share[4]	80.9	70.8	51.5	81.7	71.8	52.8	88.9	82.1	66.7

1) Competition between importing firms.
2) Competition between domestic firms.
3) The absolute value.
4) The percentage share of domestic production in domestic consumption predicted by the model.

competitors, yields the percentage deadweight losses presented in Table 5.2. In this case the average concentration of importing firms is approximated using the concentration of imports statistics based on the goods classification by use of goods, which is published by the National Board of Customs. Within imports of food, beverages, and tobacco products for consumption, the share of five largest importers (CR_5) accounted for 53.1 percent in 1993 ($CR_{10} = 63.8\%$, $CR_{20} = 73.5\%$, ... , $CR_{200} = 98.1\%$), and the approximated Herfindahl index of concentration is 0.06. This measure is very rough, but it is used in this context to illustrate the features of the model. A numerical example considers three alternative forms of oligopolistic competition within the groups resulting in nine different combinations of the Stackelberg game.

The percentage losses of Cournot competition between domestic and foreign groups are shown in Table 5.3. The Stackelberg model yields the percentage deadweight loss that is always lower compared to Cournot model. For example, assuming that competition within the groups follows the Cournot model results in about 18 times smaller relative deadweight losses than the inter-group Stackelberg competition. The difference becomes lower, if there exists some degree of collusive behaviour within domestic producers. In the extreme case, considering a situation in which both groups are characterized by full collusion yields about

Table 5.3. The percentage deadweight loss in the model of international oligopoly (Cournot competition between the groups).

Imports[1] / Domestic production[2]	Cournot competition			Intermediate competition			Collusion		
	Cournot	Interm.	Collusion	Cournot	Interm.	Collusion	Cournot	Interm.	Collusion
Demand elasticity[3]	The percentage deadweight loss								
0.20	20.0	23.9	27.5	28.7	38.4	49.4	30.0	69.5	187
0.60	6.70	7.95	9.17	9.56	12.8	16.5	10.0	23.2	62.5
1.00	4.02	4.78	5.50	5.73	7.68	9.88	6.00	13.9	37.5
1.40	2.87	3.41	3.93	4.10	5.49	7.06	4.29	9.92	26.8
1.80	2.23	2.66	3.06	3.19	4.27	5.49	3.33	7.71	20.8
2.20	1.83	2.17	2.50	2.61	3.49	4.49	2.73	6.32	17.1
Domestic share[4]	19.4	12.1	5.7	31.8	21.0	10.4	80.0	69.6	50.0

[1] Competition between importing firms.
[2] Competition between domestic firms.
[3] The absolute value.
[4] The percentage share of domestic production in domestic consumption predicted by the model.

two times higher percentage deadweight loss in the Cournot model. This Cournot case leads to a higher equilibrium price and lower output, and results in a lower consumer surplus and lower domestic profits. Correspondingly, as shown in the last rows of Tables 5.2 and 5.3, the models yield the share of imports to be higher in the Cournot case.

According to the industrial and foreign trade statistics, the share of domestic production can be computed to be about 82.5 percent on the average within the free trade sector of food industry. Thus, the predicted market shares of the previous models based on very aggregate data support the assumption that domestic firms are in the Stackelberg leadership position against importing firms. In another case, the existence of non-tariff or non-quota trade barriers, imperfect substitution between domestic and foreign products in consumption, higher production costs of foreign firms, or tighter competition (than Cournot) between domestic firms may lead to these 'too low' shares of imports.

However, the model of international oligopoly includes a possibility for indirect measurement of the degree of foreign competition. This implication is utilized in the estimates presented in Table 5.4, in which the average Herfindahl index (0.25) and the share of domestic production (82.5 %) are used in order to estimate the deadweight loss. This yields the percentage deadweight loss estimates

Table 5.4. The percentage deadweight loss in the model of international oligopoly and the observed share of domestic production.

Model[1] Domestic production	Stackelberg competition Cournot	 Interm.	 Collusion	Cournot competition Cournot	 Interm.	 Collusion
Demand elasticity[2]	The percentage deadweight loss					
0.20	3.01	24.9	163	28.7	64.1	242
0.60	1.00	8.32	54.2	9.56	21.4	80.8
1.00	0.60	4.99	32.5	5.73	12.8	48.5
1.40	0.43	3.56	23.2	4.10	9.16	34.6
1.80	0.33	2.77	18.1	3.19	7.13	26.9
2.20	0.27	2.27	14.8	2.61	5.83	22.0

[1] Competition between the groups.
[2] The absolute value.

that usually exceed the levels of Tables 5.2 and 5.3. Assuming that domestic firms act independently, i.e. they follow the Cournot mode of behaviour, the deadweight loss is 3.01 percent of the value of total sales for $|\eta| = 0.2$, and only 0.27 percent for $|\eta| = 2.2$, if the domestic firms have the Stackelberg leadership position. The inter-group Cournot competition yields the estimates of 28.7 and 2.61 percent, respectively. Because of the unavailabily of the relevant industry specific concentration data on imports, this indirect approach to measure the degree of foreign competition within free trade industries is used in the following industry-level analysis.

5.3. Estimates for different industries

The industry-level welfare losses are estimated on the basis of the level of concentration and the shares of domestic production estimated on the basis of 1993 data. Sensitivity analyses are made with respect to the elasticities of demand and the conjectural variations parameters. In the majority of cases, the Cournot model and the partially collusive mode of competition, i.e. the intermediate case in which the conjectural variation elasticity parameter equals the Herfindahl index of concentration, are assumed to be the limits of the degree of oligopoly. The assumption that full collusion is a reasonable approximation of the industry behaviour would lead to remarkably higher losses. For the magnitude of losses in this case, see Tables 5.1-5.4 above. The assumption of linear demand curve will be used for all industries.

5.3.1. Industries with quantitative import restrictions

The slaughtering and meat processing industries are considered first. They produce articles that were subject to very tight quantitative import restrictions resulting in only marginal volumes of imports in 1993. According to the statistics on imports in terms of the HS Nomenclature, imports of the headings 0201-0209 (fresh, chilled or frozen meat) accounted for about FIM 39 million (incl. import levies) and the headings 0210, 1601, and 1602 (dried, salted or smoked meat, sausages and other meat products) only FIM 3.3 million of which FIM 1.3 million are different import taxes. Because the value of shipments of own products minus exports was FIM 8,239 million in the first group and 4,413 in the second group, the shares of domestic production are approximated to be 99.5 in slaugtering and 99.9 percent in meat processing, respectively. Thus, the model in practice follows industry-wide oligopoly pricing.

The deadweight loss estimates for slaughtering (Figure 5.1) for different combinations of the demand elasticity and the degree of oligopoly are very tentative because of the large share of industrial demand and many vertical contracts between slaughtering and meat processing. Only a third of domestic shipments is directed to consumption and two thirds to further processing. Furthermore, the range of the estimated price elasticity of demand is very wide. LAURILA (1994) estimated a small own-price elasticity (-0.11) in the demand of carcass meat, while an estimate of -1.27 was obtained by LAURILA (1985). The former leads to the percentage deadweight loss amounting to 24 percent and the latter only to two percent of the sales in the case of Cournot oligopoly. The assumption that domestic competition follows intermediate collusion yields more than three times larger relative losses.

In the case of meat processing, more than two thirds of the production consist of consumer goods and, therefore, the demand elasticities based on consumer behaviour are more usable indicators of producers' ability to use their potential market power than in slaughtering. Due to the less concentrated market structure, the models result in considerably lower deadweight losses compared to slaughtering (Figure 5.2). However, since demand for meat products has been found to be insensitive to price changes, the elasticity estimates yield the relative deadweight losses that are from 2 to 10 percent in the Cournot model.

In fruits and vegetables, the estimated own-price elasticities vary from -0.32 (LAURILA 1994) to -0.61 (for fruits by LAURILA 1985). VIRÉN (1983) has estimated an elasticity of the same magnitude as LAURILA (1994). The data sets of these studies include mainly unprocessed fruits and vegetables. However, let us assume that these estimates apply to demand responses of processed commodities, too. The value of total sales, i.e. what Finnish firms together with importing firms sold on the domestic markets, was FIM 2,174 million in 1993. The share of domestic production was 67 percent. Imports classified into fruit and vegetable processing consist of the HS headings 0710-0713 (frozen, dried, or in other forms conserved vegetables), 0811-0814 (conserved fruits), 1105 (flours and flakes of potatoes), and 2001-2009 (prepared fruit and vegetable products). In fruit and vegetable processing, the quite low level of concentration (H=0.128) yields the deadweight loss profiles for different elasticities of demand presented in Figure 5.3. The Cournot model suggests that the deadweight loss is less than

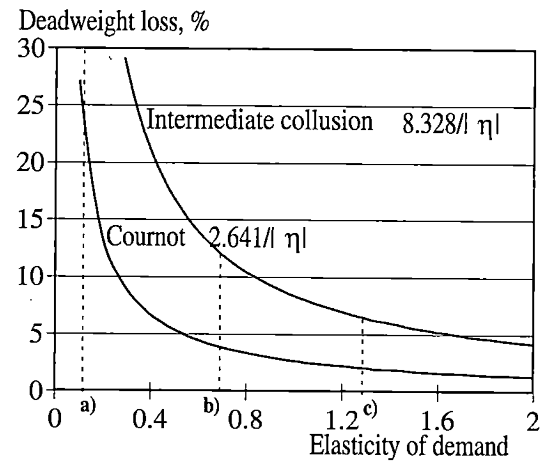

Figure 5.1. Deadweight loss profiles for slaughtering.
a) LAURILA (1994), b) LATVALA and LAURILA (1995), c) LAURILA (1985).

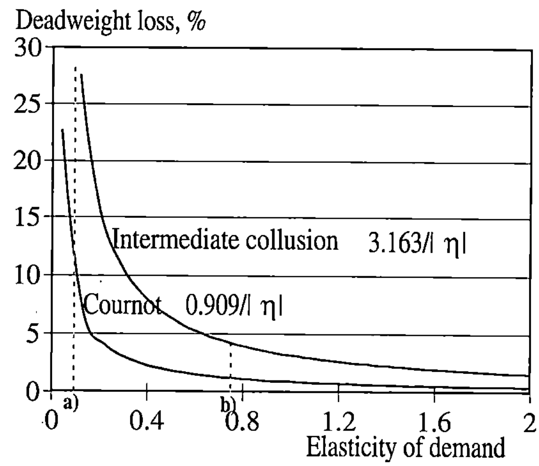

Figure 5.2. Deadweight loss profiles for meat processing.
a) LAURILA (1994), b) ROUHIAINEN (1979).

one percent of the sales, if the absolute value of the demand elasticity exceeds the value 0.4. At the same limit, the intermediate collusion model predicts the deadweight loss close to 3.2 percent, and losses are larger than one percent until the absolute value of the demand elasticity attains the value 1.3. Generally, the fruit and vegetable processing industry can be classified into the group with the smallest welfare losses within the Finnish food processing industries.

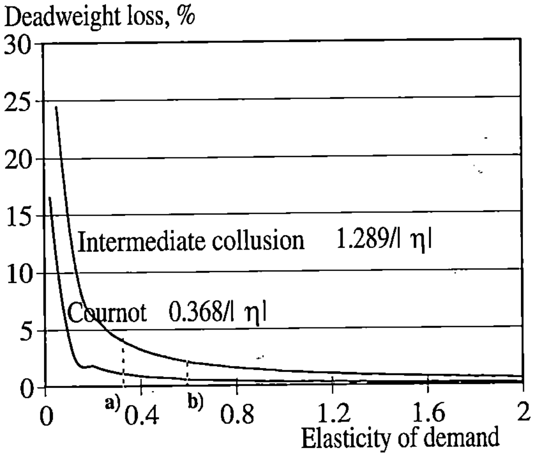

Figure 5.3. Deadweight loss profiles for fruit and vegetable processing.
a) LAURILA (1994), b) LAURILA (1985).

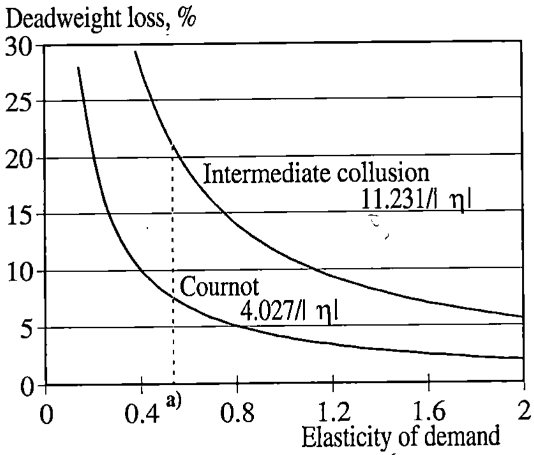

Figure 5.4. Deadweight loss profiles for margarine and other oils and fats manufacture.
a) LAURILA (1994).

The calculations of margarine manufacture and manufacture of other vegetable and animal oils and fats show considerably higher deadweight losses for different elasticity measures than fruit and vegetable processing (Figure 5.4). LAURILA (1994) obtained the own-price elasticity of -0.52 for margarine, which results in the relative deadweight loss to be 8 percent and 22 percent in the Cournot model and in the intermediate case, respectively. The share of domestic producers on the domestic market is estimated to be 86 percent (according to the HS heading 15). The market classification of this group of industries includes in fact two four-digit SIC groups (1115 and 1116) and, thus, it may underestimate the real degree of concentration of real product markets. Despite this, the manufacture of margarine, oils, and fats is characterized by high concentration (H=0.33). On the one hand, considering only margarine manufacturing would yield a standard duopoly situation (Van den Bergh Foods and Raisio), but, on the other hand, the production of some very close substitutes, such as butter, is included in the dairy products manufacture. Therefore, the value of 0.33 for the Herfindahl index of concentration is seen as an acceptable approximation of concentration in real markets.

The procedure of deadweight loss estimates for dairy products manufacture is problematic for many reasons. First, products like fresh milk, cheese, and butter are not very close substitutes with each other. Second, the cooperatives owned by farmers did not in practice compete with each other in 1993, but markets were vertically and horisontally coordinated by Valio. According to a market survey of FAKTA (1995), the market shares of Valio group were, for example, 94 percent in fresh milk, 77 percent in cheese, 64 percent in yoghurt, and 53 percent in ice-cream. Third, the theory of cooperative firms shows that open membership cooperatives are not able to use their potential market power effectively despite the high market shares. Especially in fresh milk and cheese production, considerable welfare improvements can be achieved if the principles of open membership cooperatives are realized, i.e. the oligopsony power of manufactures over the producers of raw materials disappears.

The deadweight loss estimates for dairy products manufacture based on the SIC classification are presented in Figure 5.5. The share of domestic production was about 98 percent in 1993. Imports (the HS heading 04) included mainly cheeses. The CIF value of imports was FIM 97 million, the import levies accounted for FIM 14 million, and the excises of processed food slightly more than FIM 1 million. Due to large variations of the estimated price elasticities for different dairy products, the range of deadweight loss estimates remains very large for the both type of competition.

In the manufacture of grain mill products, sugar, malt, and starch, products are mainly directed to industrial use. The existence and the forms of vertical contracts will largely determine the magnitude of welfare losses associated with concentration and market power. Therefore, more detailed analysis of these industries is omitted, but it can be mentioned that they are characterized by higher than average concentration and thus they are candidates for high potential welfare losses. The deadweight loss profiles of these industries would show a higher level of losses than feed manufacture in Figure 5.6. In feed manufacture the CIF value of imports (HS 2309) accounted for FIM 226 million, import levies were FIM 33 million, and tariffs FIM 16 million in 1993. The share of

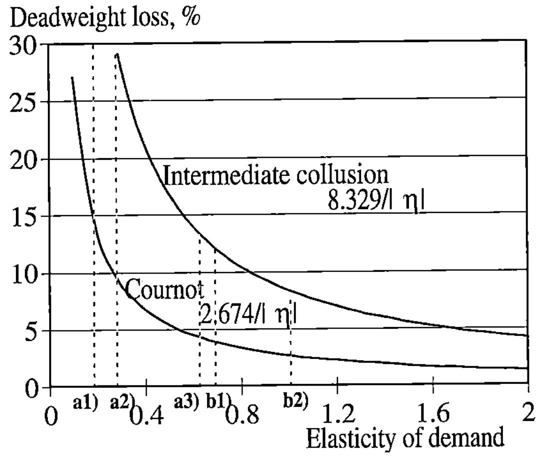

Figure 5.5. Deadweight loss profiles for dairy products manufacture.
a1-a3) LAURILA (1994) for cheese, fresh milk, and butter, b1-b2) LATVALA and LAURILA (1995) for fresh milk and sour milk.

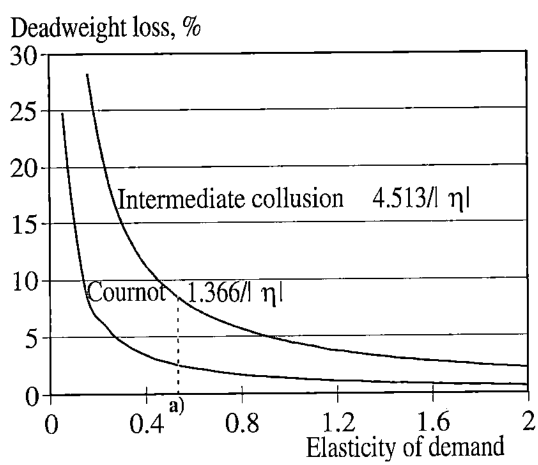

Figure 5.6. The deadweight loss profiles for feed manufacture.
a) RYHÄNEN (1994).

domestic production is estimated to be 90.8 percent on the domestic market. Feeds are mainly consumed as inputs of livestock farms, and the demand is based on the optimizing behaviour of farm enterprises. The estimates show, for example, that the own price elasticity of purchased feed for dairy farms (-0.54) obtained by RYHÄNEN (1994) yields the relative deadweight loss close to three percent of the sales in the Cournot model and about eight percent in the intermediate case of competition.

5.3.2. Free trade industries

The estimation of welfare losses due to oligopolies is based on the indirect method in which the observed market shares are used as indicators of the degree of foreign competition. Usually, large market shares of domestic production support the use of the Stackelberg model of competition between the domestic and foreign group. However, fish processing industry is an exception, in which the deadweight loss estimates are based on the inter-group Cournot model. The share of domestic production on the domestic markets was only 34 percent in 1993. This has been obtained by employing the production, exports, and imports values of the HS headings 0303-0305 (frozen, salted, dried, or smoked fish, fish fillets), 1604 (prepared or preserved fish), and 1605 (prepared or preserved crustaceans and molluscs). Although the Cournot model tends to yield higher deadweight losses compared to the Stackelberg model, the curves of Figure 5.7 show a relatively low level of welfare losses due to the fragmented market structure of domestic production. For example, using the own-price elasticity estimate of -0.69 for fish obtained by LAURILA (1994) accounts for 1.6 percent of the loss, if competition between domestic firms follows the Cournot model, and 3.1 percent of the loss, if some degree of collusion is assumed (β_D=H_D in the intermediate case). The parameter V_M derived in Chapter 4.2 measures the degree of competition among importers. Using the observed market shares, the value of V_M is approximated to be 0.02 in the Cournot and 0.05 in the intermediate case. Thus, it seems that these international markets are close to the competitive ideal.

According to the four-digit SIC system, the manufacture of bakery products is divided into fresh bread and pastries, crispbread, biscuits, and macaroni (which is omitted in this analysis) manufacture. Because firms classified into different industries may produce close substitutes and firms are classified as belonging to a particular industry on the basis of their main activity, the four-digit level data is aggregated to include all bakery products manufacture in this study. The Herfindahl indices of concentration are weighted by the value of shipments. This yields the value of index to be 0.13 for bakery products manufacture. The domestic share of production is 95 percent. This is computed on the basis of the HS heading 1905 (breads, cakes, biscuits, etc.). The value of domestic production minus exports was FIM 3,990 million, the CIF value of imports was FIM 167 million, and collected excises amounted to FIM 53 million.

The estimated deadweight loss profiles for bakery products are presented in Figure 5.8. If domestic competition follows the Cournot behaviour, the price elasticity of bread and cake obtained in the study of VIRÉN (1985) results in the relative deadweight loss of 3.9 percent, while the elasticity estimated by LAURILA

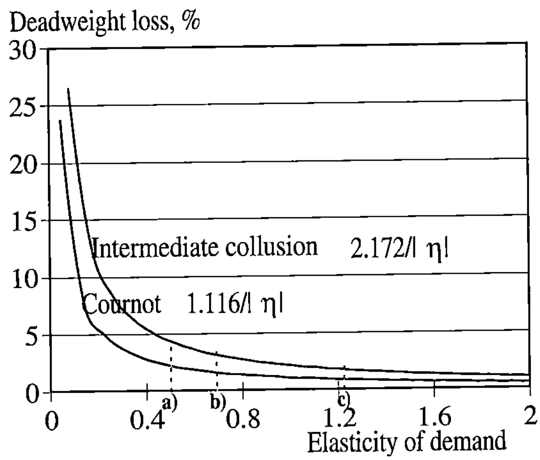

Figure 5.7. Deadweight loss profiles for fish processing.
a) MELLIN (1985), b) LAURILA (1994), c) LAURILA (1985).

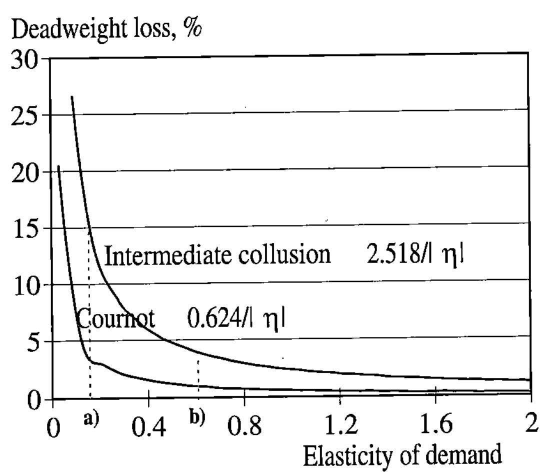

Figure 5.8. Deadweight loss profiles for bakery products industries.
a) VIRÉN (1983), b) LAURILA (1994).

(1994) yields the deadweight loss that is only one percent of the total sales. In the intermediate case, the model predicts losses that are 15.7 and 4.1 percent, respectively. However, the observed share of domestic production is so high that even the Cournot competition between domestic firms leads to values of parameter V_M that are considerable higher than one. Thus, if one accepts that domestic and imported bakery products are perfect substitutes and there exist no trade barriers, domestic competition has to be tighter than the Cournot model supposes. However, it can also be claimed that the demand for freshness of products limits foreign trade and, thus, makes Cournot or more collusive behaviour of domestic firms possible. Furthermore, it should be noted that the models are unable to evaluate the market power due to the locally or regionally more concentrated markets. This kind of situations are likely to exist in the markets of fresh products.

Chocolate and confectionary processing industry is clearly more concentrated than bakery products manufacture. The value of the Herfindahl index obtained is 0.28. Domestic production faces, however, a higher level of foreign competition. The value of domestic production of sugar confectionaries and chocolate products (HS 1704 and 1806) was FIM 1,921 million in 1993. Exports were FIM 608 million and imports FIM 341 million, i.e. the share of domestic production on the domestic markets was about 79 percent. For this reason, the Cournot competition among domestic firms leads to relatively low deadweight losses, but the change in the game towards the intermediate collusion results in a sharp rise in the losses due to the high level of concentration (Figure 5.9). It is obvious that realistic values of demand elasticity yield deadweight losses amounting to less than one percent of the sales in the Cournot oligopoly. However, the upper limit of Figure 5.9 shows relative losses that exceed 5 percent, even if the elasticity of demand is more than unitary elastic. If domestic competition follows the Cournot model, behaviour within the group of importers is very competitive (V_M=0.07). If we accept some degree of collusive behaviour among domestic producers (intermediate case), the value of parameter V_M obtained is 0.845, which is very close to the situation of one following firm. Although imports of chocolate and confectionary products by countries of origin are relatively concentrated, e.g. Sweden accounted for 33 percent in 1993, the intermediate case is likely to underestimate the pressure of foreign competition on the Finnish markets and, therefore, overestimates the level of percentage deadweight losses.

The rest of the free trade industries, i.e. coffee roasting, manufacture of malt beverages and soft drinks, as well as tobacco products manufacture, are characterized by very high degree of market concentration and low import competition on the domestic markets. Thus, setting the conjectural elasticity parameter to be equal to the Herfindahl index of concentration would yield unrealistically high welfare losses, taking account that import competition is at least potentially possible. Furthermore, these industries are more than the average export oriented, and exports may have a negative influence on the degree of implicit collusion on the domestic markets. The reason is that exporting firms have to work with a relatively large excess capacity in order to be able to satisfy demand throughout the business cycles. Large excess capacity is an obstacle to output restricting decisions on the home markets. When foreign demand is low, it will be tempting for the firms to increase domestic supply.

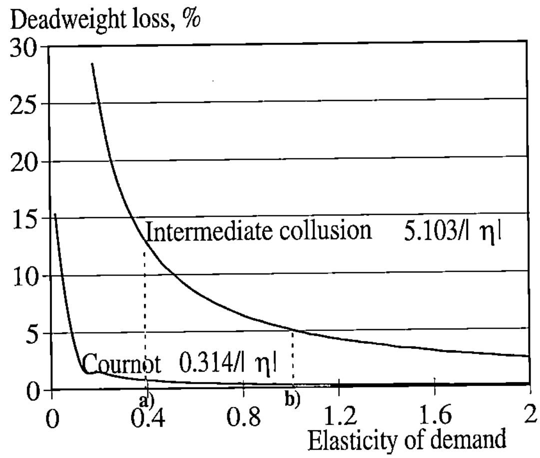

Figure 5.9. Deadweight loss profiles for chocolate and confectionary manufacture.
a) LAURILA (1994), b) LAURILA (1985).

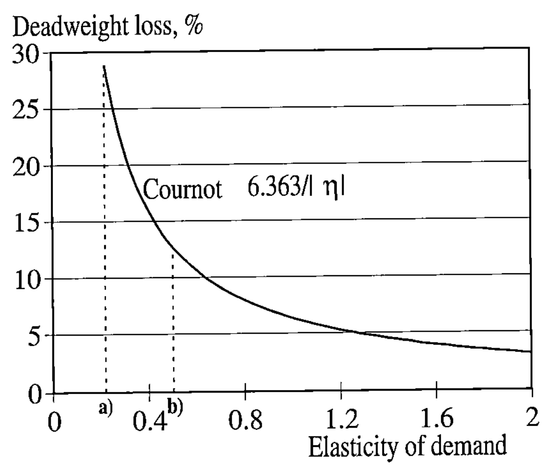

Figure 5.10. Deadweight loss profile for coffee roasting industry.
a) LAURILA (1994), b) VIRÉN (1983).

Therefore, the profile of the deadweight loss estimates is derived only on the basis of the Cournot model of competition among domestic producers. Even in this case, the parameter V_M predicted to imports receives high values that indicate the existence of considerable trade barriers, such as transportation costs. It is also possible that domestic and foreign products are imperfect substitutes, which would explain the low shares of imports on the domestic markets. Further-

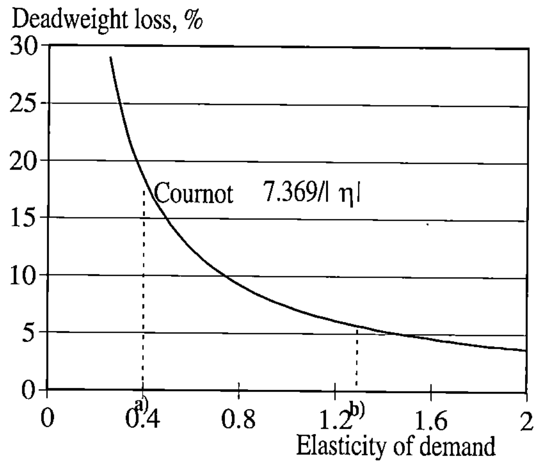

Figure 5.11. Deadweight loss profile for manufacture of malt beverages and soft drinks.
a) and b) LAURILA (1994) for alcoholic drinks and soft drinks, respectively.

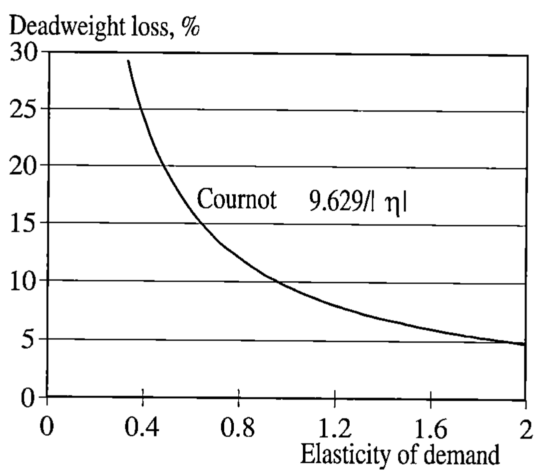

Figure 5.12. Deadweight loss profile for tobacco products manufacture.

more, although the Cournot model does not allow collusive behaviour between the firms, actual behaviour of firms can be more competitive than Cournot.

In coffee roasting, the Herfindahl index of concentration was 0.37 and the share of domestic production of roasted coffee as well as extracts, essences, and concentrates of coffee (HS 090121 and 21011020) amounted to 97 percent in 1993. The deadweight loss profile of the Cournot model of competition in Figure 5.10 shows welfare losses that account for more than 10 percent of the total sales for obtained price elasticities of demand.

The manufacture of malt beverages and soft drinks is to a great extent dominated by the two largest companies. According to the estimates of FAKTA (1995), Hartwall had the market share of 58 percent and Sinebrychoff 32 percent in the production of beer (class 3) in 1993. In soft drinks they both accounted for the market shares of 45 percent. Using the classification of the SIC system and the data of the Statistics Finland's Business Register, the Herfindahl index of concentration was computed to be 0.40. Imports of soft drinks amounted to about FIM 32 million and those of beer about FIM 34 million. The domestic share of the sales was as large as 97 percent in 1993. Thus, employing the Cournot model of competition between domestic producers yields relatively high welfare losses for different levels of demand elasticity (Figure 5.11). For example, the own-price demand elasticity of -0.40 for alcoholic drinks obtained by LAURILA (1994) results in the relative deadweight loss to be 18.4 percent of the total sales. Laurila's elasticity estimate of -1.28 for soft drinks yields a deadweigth loss of 5.8 percent in the Cournot model.

In tobacco products manufacture, domestic production consisted of three manufacturers and thus the Herfindahl index of concentration was 0.49 in 1993. The share of domestic producers on the domestic market was 91 percent. The most popular products are international brands produced in Finland under licences bought from multinational companies. This kind of international contracts are likely to restrict the degree of international competition and may lead to the relevance of the Cournot assumption in Figure 5.12. In this case, domestic welfare losses would be even higher, because a portion of oligopoly profits is directed to the multinational companies. However, due to the decrease of consumption (overcapacity) and the strict public price regulation by means of taxation, the ability of producers to regulate prices with respect to consumer demand can be assumed to be quite limited. Therefore, the deadweight loss profile of Figure 5.12 should be taken with reservations. Comparing tobacco products manufacture to food and beverages industries is difficult due to the differences in the market environment.

5.4. Evaluating the range of welfare loss estimates

The range of welfare loss estimates for different industries was obtained to be very large. It can be seen from the previous results that welfare losses decrease as the value of demand elasticity increases, ceteris paribus. Welfare losses also decrease when the value of conjectural variations elasticity becomes smaller, i.e. which of the values of the estimated losses are reflections of reality depends on which model of behaviour is relevant in the real markets. The following analysis aims at specifying the combinations of the demand elasticity and the conjectural variations elasticity on the basis of the profitability statistics of Finnish food processing industries.

The first step of the analysis is to solve the ratio of price minus marginal cost to price, i.e. the Lerner index, for different models of competition. In the model of quantitative import restrictions with the linear demand curve, using the equilibrium price of Equation 4.14 yields the industry-average Lerner index as follows:

$$L = \frac{C_D[\beta_D + H_D(1-\beta_D)]}{|\eta|}. \tag{5.1}$$

In the international oligopoly model, the equilibrium price can be obtained by inserting the quantity of Equation 4.21 to the linear demand function and assuming that the average costs after tariffs and subsidies are equal between domestic and foreign producers. Using the result that the degree of competition within importing firms, V_M, can be evaluated through the observed market shares results in the industry Lerner index:

$$L = \frac{C_D[1+\beta_D + H_D(1-\beta_D)]-1}{|\eta|}. \tag{5.2}$$

The Lerner index is a theoretical measure of industry profitability. If returns to scale are constant, the Lerner index is the same as the price-average cost margin. The problem is how to find a real world's counterpart to the Lerner index. The studies of structure-performance relationships offer a large spectrum of different methods used as a measure of profitability (see e.g. MARTIN 1988 and 1993). Accounting data contains many candidates which can be used as indicators of the Lerner index, even if the accounting concepts of, for example, income, expense, assets, and liabilities do not necessarily match the corresponding economic concepts. An example of criticism against accounting data is suggested by FISHER and MCGOWAN (1983). They argue that the only measure of profitability which is suitable for economic analysis is the internal rate of return of an investment project, i.e. the discount rate that equates the present value of the expected net revenue stream to the initial outlay. Despite the criticism, tests of the determinants of market power in the empirical studies are usually based on accounting data. It can be assumed that the lack of detailed information makes it impossible to use the internal rate of return as a measure of performance. In addition to the profitability measures of accounting, data on financial markets, such as the ratio of equity to assets or the ratio of the market value of a firm to the replacement value of its assets (Tobin's q ratio), are used as a source of measures of risk (e.g. NGUYEN and BERNIER 1988). Not only market structure and firm conduct, but also different risk positions lead to the differences in the market performance.

To analyze some combinations of the point elasticity of demand $|\eta|$ and the parameter of conjectural variations elasticity β_D, the value of $|\eta|$ is approximated by using a procedure that links $|\eta|$ and β_D. Assuming, for example, the Cournot model of competition, the approximated point elasticity of demand ($|\eta|^*$) can be solved by rearranging Equations 5.1 and 5.2 so that they solve $|\eta|^*$ for different values of approximated Lerner index (L^*). The procedure along the same lines is presented by DICKSON and YU (1989), but the method of determination of the Lerner index is different. To approximate the price-cost margin for seven industries of which detailed data of unpublished Financial Statements Statistics are available, three alternative performance indicators will be used:

1) return on investment (L_1^*)
2) ratio of operating profit after depreciation to turnover (L_2^*)
3) ratio of total value added minus wages minus return on capital to total value of sales (L_3^*).

These profitability measures are computed for seven industries including a sufficient number of firms to be reported by employing the statistics from 1993 as well as the average of the time period from 1990 to 1993. The first two are standard accounting measures from the financial statements statistics, but in the third the data for value added, wages, and value of sales are from industrial statistics. The ratio of the capital stock to the value of sales refers to the ratio of total fixed assets to turnover obtained from the financial statements statistics. This is done because the net capital stock of the National Accounts is computed only at the two digit level of the SIC. The rate of return on capital is calculated as the opportunity cost by using the percentage yield on government bonds calculated by the Bank of Finland.

These three methods yield the estimated demand elasticities and deadweight losses for the Cournot model presented in Table 5.5. Note that the demand elasticities and the conjectural variations elasticities are positively related, i.e. some degree of collusive behaviour would imply higher values of the demand elasticity compared to the Cournot model, for given values of L^*.

The received elasticities of demand tend to get very high values in Table 5.5 compared to the elasticity estimates presented in Chapter 5.3 that are based on consumer behaviour. These indirect measures of demand elasticity would result in relative deadweight losses that are usually under one percent of sales.

Supposing that the return on investment measures the degree of profitability and gives a real world counterpart to the theoretical price-cost margins within an

Table 5.5. Estimated deadweight losses based on industry profitability in the Cournot competition for selected industries.

	1993			1990-1993 on the average		
	L* (%)	|η|*	DWL (%)	L* (%)	|η|*	DWL (%)
1) L_1 = Return on investment*						
Slaughtering	8.01	2.88	0.92	5.78	3.99	0.66
Meat processing	6.42	2.10	0.43	7.24	1.86	0.49
Fruit and vegetable processing[1]	-	-	-	8.34	1.02	0.36
Dairy products manufacture	8.95	2.58	1.04	8.85	2.61	1.02
Bakery products manufacture	2.20	3.24	0.19	5.91	1.21	0.52
Malt beverages and soft drinks	9.71	3.70	1.99	7.89	4.55	1.62
Feed manufacture	11.19	1.48	0.92	7.84	2.11	0.65
2) L_2 = Ratio of operating profit after depreciation to turnover*						
Slaughtering	2.23	10.35	0.26	1.26	18.32	0.14
Meat processing	6.35	2.12	0.43	2.50	5.39	0.17
Fruit and vegetable processing[1]	-	-	-	7.03	1.21	0.30
Dairy products manufacture	2.41	9.60	0.28	2.04	11.34	0.24
Bakery products manufacture	0.43	16.57	0.04	1.78	4.00	0.16
Malt beverages and soft drinks	5.67	6.34	1.16	4.18	8.60	0.86
Feed manufacture	4.95	3.34	0.41	4.28	3.86	0.35
3) L_3= Ratio of total value added minus wages minus return on capital to total value of sales*						
Slaughtering	5.31	4.44	0.59	5.98	3.86	0.68
Meat processing	4.75	2.84	0.32	3.83	3.52	0.26
Fruit and vegetable processing[2]	11.79	0.72	0.51	12.52	0.68	0.54
Dairy products manufacture	4.67	4.96	0.54	2.87	8.06	0.33
Bakery products manufacture	13.56	0.53	1.18	12.12	0.59	1.06
Malt beverages and soft drinks	34.59	1.04	7.09	29.57	1.21	6.09
Feed manufacture	9.10	1.82	0.75	1.07	15.44	0.09

[1] Only in 1990.

[2] The ratio of capital to value of sales is based on 1990 data.

industry would mean that the deadweight losses due to the Cournot competition are between 0.19 percent in bakery products manufacture and 1.99 percent of total sales in malt beverages and soft drinks, using the 1993 data. Employing the averages between 1990 and 1993 yields deadweight losses from 0.36 percent in fruit and vegetable processing to 1.62 percent in malt beverages and soft drinks.

Comparisons of the estimates of Table 5.5 show, however, that alternative performance measures result in very different magnitudes of welfare losses. Employing the ratio of operating profit after depreciation to turnover as a measure of industry profitability usually yields the highest values of the demand elasticity and, thus, the lowest relative deadweight losses. Losses higher than one percent are obtained only in the case of malt beverages and soft drinks in 1993.

The third ratio measure of profitability differs from the method presented by DICKSON and YU (1989) only in the determination of the opportunity cost of capital. In this case, the deadweight losses are estimated to be between 0.32 percent in meat processing and 7.09 percent in the production of malt beverages and soft drinks when the data from 1993 is employed. Using the averages of 1990-1993 results in relative deadweight losses that vary from 0.09 percent in feed manufacture to 6.09 percent in malt beverages and soft drinks.

It can be observed that the levels of deadweight losses based on industry profitability differ considerably from those estimated in Chapter 5.3 by using the previously obtained point elasticities of demand. Assuming that the estimates of the price elasticity of demand obtained from consumer behaviour are relevant measures of price elasticity also at the level of food manufacturing results in relative deadweight losses that are usually considerably higher compared to the results of Table 5.5. Because the profitability indicators correspond to very elastic demand in most the cases, it can be argued that the food manufacturers are not able to utilize consumers' inelastic demand for food items. It seems possible that manufacturers face a higher demand elasticity than food retailers and the vertical relationships may lead to a situation in which profitability at the manufacturing stage remains low. Bargaining power of the retailers and the further processing of intermediate goods in the food chain limits the possibilities of manufacturers to use their potential market power. Taking into account the vertical relationships would cause demand to be more elastic at the manufacturing level, compared to final consumption. Especially if production is mainly directed to industrial use, the effects of vertical relationships can be assumed to be considerable.

However, it should be noted that the results involve a high degree of uncertainty. The use of estimates of actual profits does not separate the proportion of profits that is due to the oligopolistic competition from the proportion that is, for example, due to favourable demand conditions or technical efficiency. Therefore, these short-run profitability measures do not make it possible to draw conclusions about the relationships between market concentration and overall performance. Barriers to entry, excess capacity, and many non-structural sources of variation in the profitability, like market growth, sales diversification, and product quality differences, should be taken into account in that kind of analysis.

Despite the limitations in the measurement of profitability, it can be observed that the results do not offer any support for the claim that welfare losses due to allocative inefficiency are necessarily the largest in the industries with quantitative import restrictions. For example, in slaughtering and dairy products manufacture the estimated Lerner indices correspond to the point elasticities of demand that are very high, yielding relatively low deadweight loss estimates in regard to the concentrated market structure. However, it must be noted that price-cost margins indicate only one of several dimensions of market efficiency, i.e. allocative efficiency. The estimates of welfare losses in Chapter 5.3 were based on the assumption that firms are able to use their potential market power effectively. The low average profit rates, especially in the case of quantitative import restrictions, support the view (e.g. RASIMUS and KORHONEN 1992) that technical efficiency of these industries is low. Thus, the relative effects of low technical efficiency on welfare are probably greater than the market power effects. Industries that may be less profitable due to inefficiency are likely to receive low deadweight loss estimates in Table 5.5, even if low profits are not socially beneficial because they are generated by higher costs. In these cases, low profitability corresponds to consumer welfare by no means. Correspondingly, Table 5.5 shows low profitability and, therefore, high demand elasticities as well as low deadweight losses for slaughtering, meat processing, and dairy products manufacture. These are the industries that are the most clearly dominated by farmer-owned cooperatives. Figures may indicate that part of the possible oligopoly profits has been directed to the owners in the price of raw materials, or that the principles of open-membership cooperatives restrict the possibilities of manufacturers to maximize the joint profits of their members.

In some cases, employing the profitability measures with the models of quantitative import restrictions and international oligopoly yields, however, demand elasticities that are relatively close to the previously obtained consumers' elasticities. In fruit and vegetable processing and bakery products manufacture, the third ratio measure, L_3*, shows relatively high profitability despite the low level of concentration. Therefore, the evaluated absolute values of the demand elasticity remain smaller than one. If these industries are not technically more effective than others or if their negotiation power against retailers is not stronger than the average, there is some evidence that competition between domestic producers is more collusive than the Cournot model. Furthermore, the results of the manufacture of malt beverages and soft drinks, in which relatively high level of profitability was observed, offer support for the hypothesis that product differentiation is posively associated with profitability (CONNOR 1990). The effects of product differentiation on the relationship between profitability and concentration are not formally explained in terms of the models used in this chapter.

It must also be noted that the estimates are based on the models derived in a strictly partial equilibrium framework. Thus, the assumed demand curve for each industry is independent of the prices of goods in other industries. It is obvious that ignoring the relationships between food manufacturing industries on the one hand, and the rest of the economy on the other, might bias the estimates of potential welfare losses due to oligopolistic competition. Because the observed profit rates for different industries have been realized in a more complex general equilibrium environment, direct comparisons between the potential deadweight loss estimates and the estimates roughly derived from industry profitability are not reasonable. The main idea was to show that many of the very low estimates of consumers' demand elasticities are different when considering the concentrated food manufacturing stage of the food chain. If highly concentrated markets are analyzed, assuming that the demand for food at the manufacturing stage is very inelastic may require the assumption that Cournot or more competitive pricing represents firm behaviour. Similarly, assuming elastic demand may require that some degree of collusive behaviour does exist.

As it has been shown, the welfare loss estimates for Finnish food manufacturing involve a considerable number of possible reservations. This is, however, a general problem of the industrial organization literature. The earlier parts of this study have presented how the outcomes of different oligopoly models tend to depend decisively on the method of modelling the game. This chapter combined some of the features of the domestic market structure, degree of foreing competition, and the public regulation of foreign trade as the determinants of social welfare in the oligopolistic framework. The deadweight loss estimates based on the 1993 data show that welfare losses due to oligopolistic competition are potentially high in the Finnish food manufacturing, but the level of losses is very sensitive to the specific form of oligopolistic competition and the demand conditions. In applying competition and anti-trust policies, influencing the process of competition is likely to be more efficient than operating with the aspects of market concentration. Finally, it has to be noted that the results do not justify the claim that deconcentration would yield socially more efficient outcomes than the current concentrated market structure in the Finnish food manufacturing. It is possible that a less concentrated market structure would yield a higher level of average and marginal costs. All the results of this chapter were compared to marginal cost pricing with the cost level of the current oligopolistic structure.

6. The welfare effects of the EU membership

Finland's membership in the EU liberalized the trade of processed food between Finland and the other union countries, which increases the international competition in the food manufacturing sector in Finland. As a member of the EU Finland no longer applies tariffs and quantitative restrictions against imports from the single market of the EU. Furthermore, Finnish agriculture is adjusted to the Common Agricultural Policy (CAP) of the EU. This means that producer prices of agricultural products are reduced to the EU levels.

The effects of the application of the CAP on Finnish agriculture have been studied widely. E.g. KUHMONEN (1994) presents a survey of the literature on this. Farmers' incomes have been estimated to decrease considerably as a result of the accession to the EU and, therefore, different forms of support are directed to agriculture for ensuring the incomes of existing farms in Finland (see KETTUNEN and NIEMI 1994).

In the field of food manufacturing, the potential effects of market integration are usually linked to the cost efficiency and competitiveness of Finnish industries (e.g. RASIMUS and KORHONEN 1992, HERNESNIEMI et al. 1995). HYVÖNEN and KOLA (1995) analyzed how the linkages between the policy environment and business strategies of the Finnish food industries may change due to integration. The largest food manufacturers need not only to reduce production costs but also to develop stronger brands and marketing orientation based on consumer preferences. Small- and medium-sized firms will concentrate on national and regional markets, but their success is dependent on the access to the retailing channels.

TÖRMÄ and RUTHERFORD (1993) have evaluated the economic effects of the EU membership for agriculture and food processing industries by using an applied general equilibrium model. Even if the volume of agricultural production is predicted to decrease considerably, they found out that most food processing industries are able to maintain their production volumes.

The competitive effects of the reduction of the potential market power due to the concentration on the nationally segmented markets have usually not been considered in the previous studies. The study of ISOSAARI (1993), in which the effects of the EU membership on the Finnish sugar market are considered, forms an exception to this. The adoption of the CAP and removal of the domestic monopoly power are found to lead to welfare improvements compared to the earlier policy in Finland. Furthermore, the partial equilibrium analysis of HOLM (1994) shows, assuming a monopoly in the domestic food manufacturing industry, that the reduction of the input price level due to the EU membership increases unambiguously domestic welfare.

The purpose of this chapter is to derive and use a model to evaluate the economic effects of three different policy experiments linked to the process of integrating Finnish food sector to the internal markets of the EU. The first is a *reduction of the average domestic costs* as a result of the lower price level of agricultural raw materials. In the second, the effects of the *removal of trade barriers* are evaluated. The third examines the effects of the *decrease in the market power of domestic firms* on the national markets. The last experiment is supposed to be essential, because the findings of Chapter 5 showed that the welfare losses due to oligopolistic behaviour have been at least potentially high in the Finnish food manufacturing. The study is a predictive, *ex ante*, analysis of the potential effects on welfare.

First, a brief methodological introduction to different approaches for analyzing the economic effects of market integration is presented. In Chapter 6.2 a partial equilibrium model is derived to be used in the evaluation of the effects of these three policy experiments. The model of *differentiated oligopoly* in which domestic firms have the Stackelberg leadership position against imports is used in this context. Domestic and foreign products are assumed to be imperfect substitutes. This assumption differs from the previous models of this study. This change in modelling consumer behaviour is based on the results of Chapter 5. Under the assumption of product homogeneity, the usually low market shares of imports even in the case of so-called free trade industries had to be due to transportation costs, higher production costs of foreign producers, or some artificial trade barriers. A similar explanation may arise from consumer preferences and, therefore, the effects of imperfect substitution are added to the model. This leads to the model structure, which differs from that of Chapter 4. The assumption of Stackelberg competition between the domestic and foreign group of producers is still maintained. Finally, in Chapter 6.3 the model is *calibrated* for 1993 data for some specific product markets and the effects of policy experiments on consumer surplus and domestic firms' profits are simulated.

The method used in this part of the study is very similar to that employed with computable general equilibrium models. First, a theoretical model, which captures certain features of imperfectly competitive markets, is specified. It contains a number of parameters and endogenous variables. Some of the parameters are taken from external estimates and the rest are calibrated to the model. Second, the model is used to simulate changes in policy and the welfare effects are calculated. A limitation of this technique is that calibration exercises do not allow the data used to reject the theoretical model, i.e. no statistical significance can be attributed to the results. Therefore, sensitivity analyses are needed to investigate the direction and magnitude of the welfare changes.

6.1. Approaches for analyzing the effects of integration

Studying the effects of integration requires, first, the construction of a model of trade in the absence of integration and, secondly, evaluating the changes in the model to permit conclusions to be drawn about the consequences of integration for economic welfare. The best method is that all changes are measured not just through time, but relative to what trade would be in the absence of integration (WINTERS 1987).

The traditional tools for analyzing the effects of market integration are the concepts of *trade creation and trade diversion*. In the former case, new imports replace sales previously internal to the newly associated country, for example, due to the decline in tariffs, which stimulates consumption. In the latter case, new imports displace imports previously bought from third, non-partner, countries.

An example of the basic framework of trade creation and trade diversion in the partial equilibrium analysis is presented in Figure 6.1. For simplicity, consider a case in which a portion of domestic consumption is imported. Before union, Finland (F) buys from the world market (W) at P_W levying a tariff at rate t. Domestic consumption is $Q_D{}^0$, output $Q_S{}^0$, imports $Q_D{}^0$-$Q_S{}^0$, and tariff revenue area C_1+C_2. After the EU membership, internal prices become equal to the price level of the EU (P_E). Domestic consumption increases to $Q_D{}^1$, increasing consumer surplus by A+B+C_1+D. Domestic production falls to $Q_S{}^1$, reducing producer surplus by D. Imports grow to $Q_D{}^1$-$Q_S{}^1$, but now no tariff revenue is collected. The net effect on welfare is (A+B)-C_2, i.e. the gains from trade creation less trade diversion, which is equivalent to part of the tariff revenue

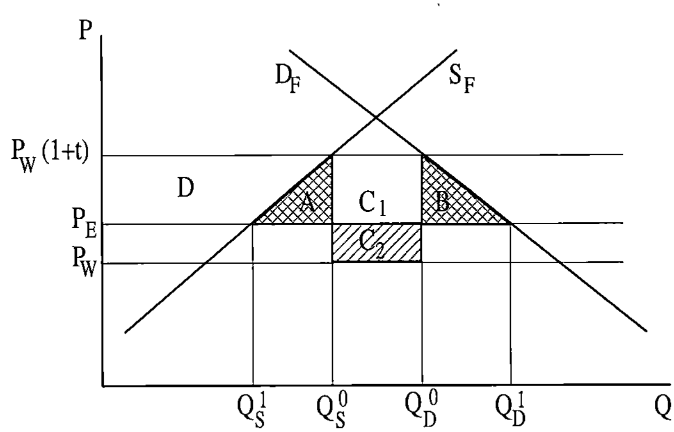

Figure 6.1. The welfare effects of trade creation and diversion in the partial equilibrium framework.

lost. Naturally, a corresponding procedure can be presented for the exporting country. If internal prices exceed the price levels of the world market as well as the union and exports of domestic surpluses are subsidized, the net effect on welfare is greater compared to the case of the importing country.

Further changes may result from integration if the increase in the market size induces economies of scale, or if there are changes in the macro-economic policy. Dynamic welfare gains from integration may arise if liberalization induces capital formation and raises output more than static effects alone would predict (BALDWIN 1992). In this context, analyses need to operate at the level of general equilibrium. Some industries are expanding and some are declining, so that additive effects result from new allocation of recources between industries. Similar dynamic gains may arise, for example, from increased spendings on R&D or other factors of productivity growth due to increased competition.

At the micro level, the effects of market integration are visible as lower trade costs, more aggressive competition, and lower unit production costs (EMERSON et al. 1988). In addition to the abolition of national tariffs and import quotas, lower trade costs will result from the reduction of border controls and the harmonization of product standards. Lower trade costs will promote exports and automatically lead to more aggressive competition. The effect can be significantly greater if the dominant firms no longer have the possibility to exploit their large market shares in pricing on the domestic markets. If markets become fully integrated, these firms will no longer be able to capitalize on a dominant position on their home markets. Finally, average production costs will be reduced, for example, if high-cost producers lose market shares due to increased competition, if reduced market power leads to larger output and exploitation of scale economies, or if increased competition reduces X-inefficiency. Furthermore, as in the case of Finnish food manufacturing, integration may change the policy environment by reducing production costs also through the decrease of the administratively regulated prices of agricultural raw materials.

An essential feature of the current tradition to model integration is to use a modelling framework with imperfectly competitive markets. For example, the general equilibrium model of HAALAND and NORMAN (1992) is based on the Cournot competition with differentiated products and pre-integration segmented markets, in which firms can charge higher prices at home than abroad due to the larger market shares in the domestic markets. Within the partial equilibrium framework, SMITH and VENABLES (1988) found out that removing the monopoly power that firms have in the segmented markets will result in more substantial welfare improvements than a reduction in the existing trade barriers in intra-EU trade. However, the predictions of integration effects are usually highly sensitive to the way in which imperfect competition, e.g. modelling oligopolistic interactions, is captured.

6.2. The simulation model

The model applied is a conjectural variations model of heterogenous oligopoly. Heterogeneity is limited to two products: the production of domestic food manufacturing and imports of processed food are considered imperfect substitutes for each other. Hence, domestic products are assumed to be perfect substitutes, and so are imports within their group.

The formulation of the demand system and the process of calibrating the demand parameters are based on DIXIT's (1988) and SHELDON's (1992) studies. With the subscripts D and M denoting domestic products and imports respectively, the direct demand functions are written as:

$$Q_D = A_D - B_D P_D + KP_M, \qquad (6.1)$$
$$Q_M = A_M + KP_D - B_M P_M,$$

where P_D and P_M are the prices and Q_D and Q_M the aggregate quantities. All the parameters A_D, A_M, B_D, B_M, and K are positive and $B_D B_M - K^2 > 0$ if the products are imperfect substitutes. The inverse demand functions are

$$P_D = a_D - b_D Q_D - kQ_M, \qquad (6.2)$$
$$P_M = a_M - kQ_D - b_M Q_M,$$

with a_D, a_M, b_D, b_M, $k > 0$ and $b_D b_M - k^2 > 0$. The five parameters of the inverse demand functions can be derived from those of the direct demand functions as:

$$a_D = \frac{A_D B_M + KA_M}{B_D B_M - K^2}, \quad a_M = \frac{A_M B_D + KA_D}{B_D B_M - K^2},$$
$$b_D = \frac{B_M}{B_D B_M - K^2}, \quad b_M = \frac{B_D}{B_D B_M - K^2}, \quad k = \frac{K}{B_D B_M - K^2}. \qquad (6.3)$$

Other sectors of the economy are regarded as a competitive numeraire. The demand system is assumed to be generated by a representative consumer whose utility function is both separable and linear in the numeraire. Let CS be the consumer surplus from the consumption of the Q_D and Q_M. In the partial equilibrium analysis CS is

$$CS = U(Q_D, Q_M) - P_D Q_D - P_M Q_M. \qquad (6.4)$$

The aggregate utility function $U(Q_D,Q_M)$ is in the following form:

$$U(Q_D,Q_M)=a_DQ_D+a_MQ_M-(b_DQ_D^2+b_MQ_M^2+2kQ_DQ_M)/2, \qquad (6.5)$$

where the inverse demand functions are $P_D=\delta U/\delta Q_D$ and $P_M=\delta U/\delta Q_M$.

In order to calibrate the demand system to the actual data, which means calculating the parameters of Equations 6.1-6.3, supplementary equations are needed to determine the parameters A_D, A_M, B_D, B_M, and K. This will be done, like in SHELDON (1992), by deriving equations for the elasticities of demand and substitution. The total price elasticity of demand is treated as the effect of an equiproportionate change in the price of the two products on the corresponding quantity aggregate. The total price elasticity is defined as:

$$\eta=\frac{E_D}{E}(\eta_{DD}+\eta_{DM})+\frac{E_M}{E}(\eta_{MM}+\eta_{MD}), \qquad (6.6)$$

where E is the total expenditure, E_D is the expenditure of domestic products, E_M, the expenditure of foreign products, and η_{ij} the demand elasticity of i with respect to the price of j for i=D,M and j=D,M. By using Equation 6.1, the total price elasticity is

$$\eta=\frac{-(B_DP_D^2+B_MP_M^2-2KP_DP_M)}{E}. \qquad (6.7)$$

Furthermore, let us define the elasticity of substitution between domestic products and imports, σ, as follows: $\sigma = -(d\log(Q_D/Q_M) / d\log(P_D/P_M))$. Because the demand functions determine Q_D/Q_M as a function of the vector (P_D,P_M), a further condition is needed to define Q_D/Q_M as a function of the ratio P_D/P_M at least locally at the initial point. Therefore, let us assume that the utility function is homothetic. This implies that multiplying both Q_D and Q_M at the initial utility-maximizing bundle by a constant, say r, yields the new optimum in which dQ_M/dQ_D is equal to the initial price ratio $-(P_D/P_M)$. Multiplying Q_D and Q_M by r and totally differentiating the utility function at the given level yields

$$dU(Q_D,Q_M)=r\left[(a_D-b_DrQ_D-krQ_M)dQ_D+(a_M-b_MrQ_M-krQ_D)dQ_M\right]=0. \qquad (6.8)$$

According to the property of homotheticity of the utility function, the following condition can be written:

$$\frac{P_D}{P_M}=\frac{a_D-b_DrQ_D-krQ_M}{a_M-b_MrQ_M-krQ_D}. \tag{6.9}$$

Using the inverse demand functions and the definitions of a_D and a_M from Equation 6.3, we can write

$$\frac{P_D}{P_M}=\frac{P_D-\left(1-\frac{1}{r}\right)\left(\frac{A_DB_M+KA_M}{B_DB_M-K^2}\right)}{P_M-\left(1-\frac{1}{r}\right)\left(\frac{A_MB_D+KA_D}{B_DB_M-K^2}\right)}. \tag{6.10}$$

After rearranging the terms, it is observed that the parameters have to satisfy the following condition:

$$P_D(A_DK+A_MB_D)=P_M(A_MK+A_DB_M). \tag{6.11}$$

Given the definition of σ and the homotheticity of the utility function, after solving (Q_D/Q_M) and multiplying by $1/P_M$, the expression for the elasticity of substitution can be derived as

$$\sigma=\frac{\frac{P_D}{P_M}\left(B_DB_M-K^2\right)}{\left(B_D\frac{P_D}{P_M}-K\right)\left(B_M-K\frac{P_D}{P_M}\right)}. \tag{6.12}$$

The simultaneous equation system of Equations 6.1, 6.7, 6.11, and 6.12 determines estimates of A_D, A_M, B_D, B_M, and K. Values for a_D, a_M, b_D, b_M, and k can be derived from Equation 6.3. Base-line values of prices and quantities and the estimates of the elasticities can be obtained from outside sources. The solution calibrates the demand system such that the parameters are consistent with equilibrium in any given period.

On the supply side, it is assumed that importing firms are in the *Stackelberg* follower position against domestic producers on the domestic markets. This situation correspond to the model of international oligopoly in Chapter 4.2. Domestic producers are able to maximize profits along a residual demand curve that takes importers actual behaviour into account. Using the first order conditions of Chapter 4.2 for profit maximization produces the reaction function of imports as

$$Q_M = \frac{a_M - kQ_D - t - c_M}{b_M(1+V_M)}, \tag{6.13}$$

where t is an import tariff, c_M constant marginal cost that includes e.g. transportation costs, and V_M is the competition parameter for the group of importers. V_M is equal to the Herfindahl index of concentration in the Cournot case, one in the perfect collusion, and zero in the case of perfect competition.

Due to the Stackelberg leadership position of domestic producers, the marginal revenue function perceived by domestic firm i is given by

$$MR_i = a_D - \frac{k(a_M - t - c_m)}{b_M(1+V_M)} + \left(\frac{k^2}{b_M(1+V_M)} - b_D\right)\left(Q_D + q_i + \frac{dQ_{D-i}}{dq_i}q_i\right), \tag{6.14}$$

where q_i is output produced by firm i and Q_{D-i} is output of the domestic group excluding firm i. Aggregating over domestic firms yields the perceived marginal revenue of the domestic group as

$$MR_D = a_D - \frac{k(a_M - t - c_m)}{b_M(1+V_M)} + \left(\frac{k^2}{b_M(1+V_M)} - b_D\right)Q_D(1+V_D), \tag{6.15}$$

where V_D describes competition between domestic firms and depends on market concentration and firm conduct. In the equilibrium, the marginal revenue of each domestic firm is equal to the marginal cost. The explicit solutions for the equilibrium quantities and prices are

$$\begin{aligned} Q_D &= \frac{b_M(1+V_M)}{\Delta}(a_D - c_D) - \frac{k}{\Delta}(a_M - t - c_M), \\ Q_M &= \frac{1}{b_M(1+V_M)}\left(1 + \frac{k^2}{\Delta}\right)(a_M - t - c_M) - \frac{k}{\Delta}(a_D - c_D), \end{aligned} \tag{6.16}$$

and

$$P_D = a_D - \frac{1}{1+V_D}(a_D - c_D) - \frac{kV_D}{b_M(1+V_D)(1+V_M)}(a_M - t - c_M),$$

$$P_M = a_M - \frac{\Delta - k^2 V_M}{(1+V_M)\Delta}(a_M - t - c_M) - \frac{kb_M V_M}{\Delta}(a_D - c_D), \tag{6.17}$$

where $\Delta = (1+V_D)(b_D b_M(1+V_M)-k^2)$. From b_D, b_M, $k > 0$, $b_D b_M - k^2 > 0$ and V_D, $V_M \geq 0$, it follows that $\Delta > 0$.

However, as it has been established earlier, *quantitative* import restrictions in terms of the system of import licensing have formed the most important measure of agricultural trade protection in Finland. The review presented in Chapter 3.4.2 of this study demonstrated that tariffs and import quotas are not necessarily equivalent instruments of trade policy if markets are imperfectly competitive. For example, MAI and HWANG (1989) have presented a general conjectural variations duopoly model of homogenous goods, in which the quota can have either pro- or anti-competitive effects. As a result of the quota, the home firm knows that changing its output does not affect imports, which is identical to Cournot behaviour. In this case, the quota has anti- (pro) competitive effects, if the home firm was initially playing more (less) competitively than Cournot against the foreign firm. MCCORRISTON et al. (1993) have extended this model to the framework of differentiated oligopoly. They found corresponding conditions for nonequivalence but, in addition, the degree of nonequivalence is sensitive to the degree of product differentiation.

In order to analyze the effects of quantitative import restrictions in the Stackelberg model, let us suppose that the government imposes a quota on imports, which is set at the equilibrium quantity of imports under a tariff (Q_M from Equation 6.16). In this case, the reaction function of imports is simply $Q_M = Q_M{}^q$. A domestic firm i takes imports as given and the marginal revenue function of firm i is

$$MR_i{}^q = a_D - kQ_M{}^q - b_D\left(Q_D + q_i + \frac{dQ_{D-i}}{dq_i}q_i\right). \tag{6.18}$$

Aggregating and setting marginal revenue to equal marginal cost yields the equilibrium quantity of domestic production in the case of import quota as:

$$Q_D{}^q = \frac{\Delta + k^2}{b_D(1+V_D)\Delta}\left(a_D - c_D - \frac{k}{b_M(1+V_M)}(a_M - t - c_M)\right). \tag{6.19}$$

If the domestic output under the quota is compared to the domestic output under the tariff, these two alternative trade restrictions result in *nonequivalence* as follows:

$$Q_D{}^q = \left(1 - \frac{k^2 V_D}{b_D b_M (1+V_D)(1+V_M)}\right) Q_D. \tag{6.20}$$

Because $k^2 < b_D b_M$, the domestic output under the quota is lower than under the tariff, which results in the same volume of imports. These two are equivalent only if behaviour within the domestic group is perfectly competitive ($V_D=0$) or if domestic production and imported products are not substitutes in consumption (k=0). If we denote $Q_D{}^q = (1 - \psi)Q_D$, where ψ implicates the effects of import quota on domestic output as in Equation 6.20, equilibrium prices under the quota compared to the prices under the tariff can be written as:

$$\begin{aligned} P_D{}^q &= P_D + \frac{b_D \Psi}{\Delta}\left[b_M(1+V_M)(a_D - c_D) - k(a_M - t - c_M)\right]; \\ P_M{}^q &= P_M + \frac{k\Psi}{\Delta}\left[b_M(1+V_M)(a_D - c_D) - k(a_M - t - c_M)\right]. \end{aligned} \tag{6.21}$$

Evaluation of the effects of reductions in the domestic costs and trade barriers as well as the change in the degree of domestic competition on consumer surplus can be carried out using the model outlined above. The demand system can be solved by using base-line values of Q_D,Q_M,P_D, and P_M, and external estimates of η and σ. Furthermore, in order to simulate the equilibrium conditions for prices and quantities, values of c_D, c_M, t, V_D, and V_M are required. By using the expression for the initial quantities given in 6.16 and 6.20, two of these can be obtained if data on the other three variables are available. Due to limited information about domestic and foreign costs, the model is allowed to solve c_D and c_M for given levels of competition (V_D and V_M) and the magnitude of tariff or import levy (t).

6.3. Certain product market estimates

In this chapter the model of differentiated oligopoly is applied to investigate the level of welfare changes on the Finnish food markets caused by the EU membership. Three different effects are considered. Two are directly due to the institutional arrangements of the CAP: (1) Prices of agricultural raw materials are reduced to the EU level, i.e. the average costs of domestic production decrease, and (2) import restrictions, such as quotas, tariffs, and import levies, are abolished. They are the most immediate impacts of the membership. The abolition of trade barriers will promote exports, lead to more severe competition, and reduce the aggregate market power of domestic firms. The domestic firms' market share decreases since part of their competitive advantage, due to the trade barriers, is lost. This may lead to excess capacity of the domestic firms. As a result, the third potentially important effect of integration stems from the increased competition: (3) pricing and output decisions within the domestic group of producers will be more competitive than before Finland joined the EU.

It is assumed that competition between the domestic firms follows the Cournot model before integration into the EU. This means that the parameter V_D, which determines the degree of competition between domestic firms, is equal to the Herfindahl index of concentration. The potential effects of increasing competition are then simulated by lowering the initial value of V_D. In addition to the oligopolistic competition within the domestic group of producers, markets are assumed to be oligopolistic at the EU level. The parameter V_M determines the degree of competition between firms that are exporting to the Finnish markets. In the following, V_M is presented in terms of the Cournot-equivalent number of firms (N). For example, if there are N symmetrically sized firms and firms act in the Cournot fashion, $V_M = 1/N$, and as N increases, the more competitive the Cournot equilibrium becomes. If the conduct of firms is more competitive than the Cournot model presumes, the Cournot-equivalent number of firms is greater than the actual number of firms. The welfare effects are evaluted by employing different values of the Cournot-equivalent number of firms.

Calibrating the model to actual data requires information about sales quantities and unit prices at a stage preceding the distribution of the product. At the industry level, the statistics of production and foreign trade combine different products, the unit prices and product characteristics of which differ significantly. Therefore, the analysis concentrates on relatively specific product markets. The model is calibrated to actual data of two product groups: bovine meat and cheeses for the year 1993. In that way, the comparison between the three different impacts of integration is naturally very product specific. However, it can be assumed that the relative changes can be generalized to the industry level, at least for slaughtering and dairy products manufacture. In the case of other industries with quantitative import restrictions, the relative changes are also likely to occur along the same lines. The impacts of the third scenario, increasing domestic competition, will differ between industries according to the level of pre-integration deadweight losses associated with oligopolistic competition.

The model is applied first to the Finnish bovine meat market. Data for the model calibration is from 1993. According to the statistics on foreign trade in terms of the HS Nomenclature, 99.8 percent of total imports of bovine meat consisted of boneless meat (HS 02013000 and 02023000). Imports consisted mainly of fillets and pieces of beef for roast. Furthermore, because a large share of domestic carcasses is shipped to industrial use, the model is applied for boneless meat only. In 1993, the volume of licensed imports (Q_M) was 835 tonnes and the corresponding import price was FIM 5.47/kg. It is obvious that this price did not correspond to the marginal cost of production, and the imports were highly subsidized. The average import levy was FIM 36.89/kg and, thus, P_M is set to FIM 42.36/kg. Domestic sales figures are obtained from Industrial Statistics, which contain quantity and value data by commodity on shipments based on the HS Nomenclature (Q_D= 41,632 tonnes and P_D= FIM 30.95/kg). The price elasticity of demand (η) is assumed to be -0.67. This is based on the average of estimates obtained by LAURILA (1985) and LAURILA (1994). No estimates of the elasticity of substitution (σ) are available for the Finnish meat market. In the study of TÖRMÄ and RUTHERFORD (1993) the elasticity range from 1 to 8, and the average value 4 is assumed in the basic scenario of this analysis.

The *welfare consequences* of the three different impacts of integration are presented in Table 6.1. The Cournot-equivalent number of importing firms is allowed to range from 1 to 10. Reduction of domestic average costs is assumed to be 20 percent from the level that existed before the integration into the EU. Althought the farm level producer prices are assumed to decrease considerably more (45%), the actual input prices of slaughterhouses decrease about 25 percent due to the tax subsidy applied before joining the EU (deduction of sales tax). Taking into consideration the other costs of processing reported by RASIMUS (1993), a 20 percent reduction of costs is estimated.

The new prices and quantities are solved for the lower cost level, and the difference between the initial and the new level of consumer welfare and domestic firms' profits is reported. The model solves cost reduction to be FIM 4.20/kg, which yields a FIM 3.30/kg decrease in P_D, when N=10. In the Cournot competition between domestic firms, the *degree of transmission* from cost change to product price is about 80 percent. Naturally, the efficiency of transmission will be higher, the lower the market concentration. Because of the decreased prices, P_M is about one percent lower than before, consumer welfare is estimated to increase by FIM 143-145 million, depending on the Cournot-equivalent number of importing firms. The degree of price transmission is higher, the higher the degree of foreign competition. Domestic profits will also be higher and, thus, the net effect will be clearly positive.

The welfare improvements through the abolition of trade barriers (import levies and quotas) will be considerably smaller than those resulting from the cost reduction. This result is based, first, on the assumption that the demand curve for foreign products does not shift after the removal of the quota and import levies and, therefore, the market share of imports remains low (4 percent). Second, it is assumed that domestic and foreign average costs become equal in the new situation. This means that the cost level of importers becomes higher compared to the calibrated initial level, in which the subsidized low import price naturally leads to low average costs.

Although the net gain arising from the abolition of trade barriers is only FIM 4.4 - 21.6 million, the effects on the distribution of income between consumers and domestic firms are more notable (Table 6.1). The impacts on the government's revenue are not taken into consideration in this analysis. The abolition of import levies would reduce the goverment's revenue, but as a counterbalance, the government is able to reduce the expenditure on national export subsidies. The net effect on the state budget would be slightly positive. However, including the state budget in the formal model would require the modelling of many other political variables, like the determination of export subsidies and payments to the EU budget, or directing of support to food processing and agriculture.

The third potential impact of the integration, increasing domestic competition, leads to an improvement of the total welfare by about FIM 17-18 million over the level corresponding to trade without quota and import levies. This result is based on the assumption of a decrease of 20 percent in V_D, i.e. in the degree of competition between domestic firms. Sensitivity analysis for different values of V_D is presented in Table 6.3. Despite the relatively small net change, increasing competition leads to a considerable redistribution of welfare between consumers and domestic firms. Consumer welfare increases by FIM 81 million, while the loss in the firms' profits is about 64 million (N=10). If, as it has been previously noted, a great part of potential oligopoly profits of Finnish food manufacturers has possible been lost due to technically inefficient production, the net gain will be higher in the long-run. This requires that increased competition results in additional cost savings and higher productivity in the processing.

In the last column of Table 6.1, it can be seen that the total improvement of welfare is FIM 235-251 million, i.e. an increase of 15-17 percent over the situation before the integration. The gain in consumer surplus is many times larger than the loss in the firms' profits. However, 85-90 percent of the total improvement is due to the decrease of the domestic cost level. If this decrease is linked to corresponding national support to livestock production, the total welfare gain becomes quite marginal and mainly involves a redistribution from the government and manufacturers to consumers. Considering consumer welfare, the results show, however, that the consequences of the abolition of trade barriers and, especially, increasing competition are considerable.

Table 6.1. Welfare effects on the bovine meat market (HS 02013000 and 02023000), FIM mill.

	Cost reduction	Abolition of trade barriers	Increasing competition	Total effect
N=1[1]				
Consumer welfare	144.86	17.12	85.06	247.04
Domestic firms' profits	67.90	-12.70	-66.77	-11.57
Net change	212.76	4.42	18.29	235.47
N=5[1]				
Consumer welfare	143.49	48.90	81.60	273.99
Domestic firms' profits	69.01	-31.53	-64.35	-26.87
Net change	212.50	17.37	17.25	247.12
N=10[1]				
Consumer welfare	143.17	57.39	80.71	281.27
Domestic firms' profits	69.27	-35.80	-63.78	-30.31
Net change	212.44	21.59	16.93	250.96

[1] The Cournot-equivalent number of importing firms.

Table 6.2. Sensitivity analysis (N=10): Changes in elasticities, FIM mill.

	Cost reduction	Abolition of trade barriers	Increasing competition	Total effect
Low price elasticity (η = -0.4), heterogenous products (σ = 1.5)				
Consumer welfare	91.40	25.51	132.92	249.83
Domestic firms' profits	42.18	-5.35	-105.36	-68.53
Net change	133.58	20.16	27.56	181.30
High price elasticity (η = -1.2), heterogenous products (σ = 1.5)				
Consumer welfare	183.29	22.44	56.10	261.83
Domestic firms' profits	84.58	-3.95	-44.46	36.17
Net change	267.87	18.49	11.64	298.00
Low price elasticity (η = -0.4), close substitutes (σ = 8)				
Consumer welfare	91.02	142.13	114.47	347.62
Domestic firms' profits	47.93	-110.73	-90.28	-153.08
Net change	138.95	31.40	24.19	194.54
High price elasticity (η = -1.2), close substitutes (σ = 8)				
Consumer welfare	180.93	87.95	46.68	315.56
Domestic firms' profits	95.35	-67.76	-36.72	-9.13
Net change	276.28	20.19	9.96	306.43

Table 6.3. Sensitivity analysis (N=10, η=-0.67, σ=4): Changes in domestic competition, FIM mill.

Change of V_D	-5%	-10%	-15%	-25%	-30%
Consumer welfare	19.33	39.20	59.66	102.38	124.69
Domestic firms' profits	-14.93	-30.52	-46.80	-81.54	-100.07
Net change	4.40	8.68	12.86	20.84	24.62

In order to analyze how sensitive the results are to changes in elasticities, the welfare changes for different values of and are presented in Table 6.2. As the absolute value of the price elasticity of demand increases, the total improvement of welfare increases because of the high impact of the cost reduction. The effects of the abolition of trade barriers and increasing competition become lower as the price elasticity increases. Closer substitution between imports and domestic production induces higher improvements of total welfare. Especially in the case of low price elasticity and high elasticity of substitution, the effects of the abolition of trade barriers and increasing competition on consumer welfare both exceed the magnitude of the improvement resulting from cost reduction. Correspondingly, Table 6.3 presents the sensitivity of the results with respect to the assumed level of changes in domestic competition. These welfare changes are closely associated with the re-distribution of oligopoly rents.

The second application of the model concerns the cheese markets. Imports of cheeses have mainly been realized within the framework of the cheese agreement with the EU, which allowed an import quota with reduced import levies. In 1993 99.97 percent of the value of imports consisted of other cheeses than emmenthal and edam. Although emmenthal and edam cheeses accounted for the greatest part of domestic production, the model is calibrated for other cheeses to make the parameters of the demand system more reliable in analyzing the demand changes without the quota. A rough exercise representing the total cheese market can be developed by extrapolating the following welfare effects over the entire market.

Import prices and quantities are obtained from the Foreign Trade Statistics. The average import price adjusted for the import levy was FIM 40.13/kg and the quantity imported was 2,634 tonnes. The domestic price and production figures are from the Industrial Statistics. The average domestic price at the manufacturing stage was FIM 24.63/kg and the quantity produced minus exports accounted for 33,261 tonnes. The elasticity of demand (-0.52) is based on the average of the estimates of LAURILA (1985) and LAURILA (1994). The elasticity of substitution is assumed to be 4 in the basic scenario.

Table 6.4. Welfare effects on the cheese markets, FIM mill.

	Cost reduction	Abolition of trade barriers	Increasing competition	Total effect
N=1[1)]				
Consumer welfare	15.82	29.00	59.71	104.53
Domestic firms' profits	7.98	-20.57	-44.73	-57.32
Net change	23.80	8.43	14.98	47.21
N=5[1)]				
Consumer welfare	15.05	123.51	50.20	188.76
Domestic firms' profits	8.46	-69.61	-38.21	-99.36
Net change	23.51	53.90	11.99	89.40
N=10[1)]				
Consumer welfare	14.87	150.22	47.73	212.82
Domestic firms' profits	8.58	-80.60	-36.75	-108.77
Net change	23.45	69.62	10.98	104.05

[1)] The Cournot-equivalent number of importing firms.

Table 6.5. Sensitivity analysis (N=10): Changes in elasticities, FIM mill.

	Cost reduction	Abolition of trade barriers	Increasing competition	Total effect
Low price elasticity (η = -0.4), heterogenous products (σ = 1.5)				
Consumer welfare	11.21	73.59	79.93	164.73
Domestic firms' profits	5.45	-13.41	-62.42	-70.38
Net change	16.66	60.18	17.51	94.35
High price elasticity (η = -1.2), heterogenous products (σ = 1.5)				
Consumer welfare	21.70	66.12	27.41	115.23
Domestic firms' profits	10.54	- 8.98	-21.37	-19.81
Net change	32.24	57.14	6.04	95.42
Low price elasticity (η = -0.4), close substitutes (σ = 8)				
Consumer welfare	11.00	267.50	47.43	325.93
Domestic firms' profits	8.38	-182.70	-35.99	-210.31
Net change	19.38	84.80	11.44	115.62
High price elasticity (η = -1.2), close substitutes (σ = 8)				
Consumer welfare	20.00	182.72	12.02	214.74
Domestic firms' profits	15.25	-97.19	-8.80	-90.74
Net change	35.25	85.53	3.22	124.00

Table 6.6. Sensitivity analysis (N=10, η=-0.52, σ=4): Changes in domestic competition, FIM mill.

Change of V_D	-5%	-10%	-15%	-25%	-30%
Consumer welfare	11.42	23.17	35.27	60.58	73.81
Domestic firms' profits	-8.58	-17.55	-26.93	-47.01	-57.76
Net change	2.84	5.62	8.34	13.57	16.05

Table 6.4 presents the effects of the domestic cost reduction, abolition of trade barriers, and increasing competition on consumer welfare and domestic firms' profits. First, the cost reduction alone yields an improvement of overall welfare by 2 percent (FIM 23 million) over the previous level, when N=10. The effects are relatively independent of the number of importing firms. The reduction of the average cost is 4 percent, following an estimated decrease of about 5 percent in the price of milk. In the Cournot competition between domestic firms, the degree of transmission from cost change to product price change is 78 percent, i.e. increase in consumer welfare is lower than what it would be under perfectly competitive conditions. Second, the elimination of the quota and import levies leads to an additional increase of FIM 69.6 million in the total welfare. However, the degree of competition between importers is a decisive determinant of the magnitude of this effect. For example, if only one foreign firm is entering Finnish markets, the net improvement of welfare remains FIM 8 million. Similarly, in the third case the effects of increasing domestic competition, when V_D is decreased by 20 percent, depend greatly on the Cournot-equivalent number of importing firms. The less competitive the foreign group, the higher will be the potential gains from re-allocating the domestic oligopoly rents. In consumer welfare, the improvement resulting from increasing competition is about 3-4 times higher compared to the effects of cost reduction. The net effect remains relatively low due to the remarkable decrease in the domestic profits. Considering the obtained total effect shows that the gain in consumer welfare is almost two times larger than the loss in the firms' profits.

Sensitivity analyses of Tables 6.5 and 6.6 show the effects of changes in price and substitution elasticities as well as in the degree of domestic oligopoly. The tendency away from marginal cost pricing at the initial equilibrium is linked to the price elasticity and the degree of substitution between domestic and foreign products. Therefore, inelastic demand makes the initial equilibrium less competitive and leads to higher welfare improvements resulting from increasing competition. The closer substitutes products are, the lower the relative importance of increasing competition. In the latter case, the abolition of trade

Table 6.7. The percentage welfare changes from the pre-integration level. (N=10, σ=4, and η=-0.67 and -0.52 for bovine meat and cheese, respectively).

	Cost reduction	Abolition of trade barriers	Increasing competition	Total effect
<u>Bovine meat</u>				
Consumer welfare	14.49	5.81	8.17	28.47
Domestic firms' profits	15.98	-8.26	-14.71	-6.99
Net change	14.95	1.52	1.19	17.66
<u>Cheese</u>				
Consumer welfare	1.67	16.89	5.37	23.93
Domestic firms' profits	2.48	-23.32	-10.63	-31.47
Net change	1.90	5.64	0.89	8.43

barriers leads to considerably higher welfare improvement compared to the situation in which products are heterogenous. Cost reduction yields gains that are positively related both to the absolute value of the price elasticity and the degree of substitutability between domestic products and imports.

Taking the limitation of the analysis into account, i.e. concentrating on very concise product markets, the percentage changes in welfare (Table 6.7) can be assumed to provide information about welfare effects on the larger aggregated markets and in the industries. In the static partial equilibrium framework, the unweighted average of the total improvement of welfare is obtained to be 13 percent over the level corresponding to the situation before the integration. Consumers would gain an increase of 26 percent, but manufacturers would lose 19 percent from the previous margin over average variable costs. Because of the existence of fixed costs, which are in fact treated as sunk costs of capacity in the model, this reduction leads to a need for dynamic long-run consequences by means of further cost savings and higher productivity. Because the model considers only a single stage of the food chain, the actual spread of gains and losses will be more complicated. From the consumers' viewpoint, a portion of gains is likely to remain at the stage of food retailing. At the manufacturing stage, it may be possible to compensate for the losses by means of lower producer prices paid for agricultural raw materials. Attempts to quantify the effects on resource allocation along the whole food chain would need to capture many vertically related and imperfectly competitive market stages. Furthermore, analysis of the effects of resource allocation on the rest of the economy would require the application of the general equilibrium framework.

7. Examination of the results and conclusions

This study analyzed the structure, conduct, and perfomance of the Finnish food manufacturing industries. Some methods to evaluate welfare losses of oligopolies were presented and applied to the Finnish food manufacturing. The results support the 'losses are high' view of economic literature. The analysis showed that a concentrated market structure may lead to considerable welfare losses even in the absence of collusive practices in the food manufacturing. If firms are able to collude, national or regional monopoly power is a substantial problem in the economy. In addition to the competition policy, one way to influence the degree of implicit collusion and increase competition is to stimulate foreign trade and increase the openness to the world market. Thus, membership in the EU affects competition within the food industry and leads to redistribution of welfare. However, the effects of the EU membership on the food economy depend heavily on the nature of strategic interactions between firms and the structural features of the specific market. The results presented in this study imply some important conclusions regarding competition, public policies, and economic research in Finland.

The framework to analyze welfare effects of agricultural trade liberalization and other public policies has traditionally been based on an analysis between consumers, taxpayers, and farmers. This kind of analysis ignores the effects of other stages of the food chain. The downstream markets of agricultural production between food processing (including food, drink, and tobacco industries) and consumption have been analyzed in this study. Studying the food manufacturing is necessary, because the importance of food manufacturing in the food chain has increased steadily. About 30 years ago, the share of the Finnish food manufacturing of the total value added was only half of that of agriculture. By the end of the 1980s, the value added in the two sectors was about the same, and now the food manufacturing accounts for a larger share than farming.

Compared with the other manufacturing industries in Finland, the food manufacturing has a low ratio of value added to sales. In 1993 the ratio was 25.6 percent in the food manufacturing and 34.6 percent in manufacturing on the average. The lowest ratios are achieved in dairy products manufacture (12.9%), slaughtering (13.3%), manufacture of margarine and other vegetable and animal oils and fats (17.6%), grain mill products manufacture (18%), and feed manufacture (18.2%). They are industries operating at the first stage of transformation. Industries operating at the second stage typically have a higher ratio of value added to sales. The highest ratios can be found in the manufacture of malt beverages and soft drinks (56.2%), tobacco products manufacture (52.3%), manufacture of alcohol (50%), and fresh bread and pastries manufacture (48.7%). Compared with the EU ratios reported by VIAENE and GELLYNCK (1995), the ratio of value added to sales in the Finnish food manufacturing industry exceeds clearly the EU average of 20.7 percent. At the first stage of transformation, Finnish ratios are along the same lines with the EU, but at the second stage they clearly exceed the EU level.

The low ratio of value added to sales at the first stage of transformation corresponds to the high share of raw materials in the acquisition costs of inputs. In slaughtering, grain mill products and feed manufacture, sugar manufacture and refining, dairy products manufacture, and meat processing, the acquisition costs of raw materials account for more than 60 percent of total shipments. This share remains below 30 percent in the manufacture of malt beverages and soft drinks as well as in fresh bread and pastries manufacture. Industries characterized by high costs of raw materials typically account for low margins over purchases of intermediate goods and services as well as wages. Since the S-C-P models to estimate welfare losses due to oligopolistic competition traditionally employ price-cost margins as a measure of market power, Finnish statistics present industries at the second or higher stage of processing as candidates for high market power. However, determination of the competitive margin that covers fixed costs and the assessment of X-inefficiency are problems associated with these studies. Furthermore, firms in these industries are likely to have more strategic options, like product differentiation or R&D, available in competition, compared to the firms at the first stage of transformation.

Price-cost margin adjusted by the changes in demand conditions can be treated as an indicator of the existence of market power, while the domestic market structure and the ease of foreign market entry are potential explanatory variables of market power. Market concentration has been treated as the main dimension of market structure in this study. It is known from the theory that price-cost margins may be directly related to different measures of concentration, depending on the prevailing conduct of firms within the industry. Within this framework, the Herfindahl index of concentration is related to the industry-wide oligopoly model, while the concentration ratio is consistent with the collusive price leadership oligopoly. In terms of the Herfindahl index and different concentration ratios, most of the Finnish food manufacturing industries are found to be very concentrated. Different concentration measures have been computed on the basis of the four-digit SIC system, which is quite an aggregated classification ignoring, for example, the aspects of regional concentration as well as horizontal and vertical coordination. In 17 out of the 20 industries for which data is available, the three-firm concentration ratio was 50 percent or greater in 1993. The Herfindahl index was 0.2 or greater in 14 industries. Although combining firm behaviour with the industry structure is not without risk, the high level of concentration suggests that a considerable portion of firms has opportunities for strategic production and pricing decisions. The model of perfectly competitive markets does not provide a reasonable framework for analyzing Finnish food processing industries. According to the description of market structure and conduct presented in this study, these industries have to be analyzed by means of the oligopoly models.

Although this study does not aim at evaluating market power and the degree of competition on the basis of industry profitability, it includes a brief description of industry performance that calls for some comments. First, the price of food products has followed approximately the same rate as the wholesale price index during the period 1980 to 1993. This implies that processed food products have low inflationary effects. Second, the economic recession at the beginning of the 1990s affected the profitability of food industry less than manufacturing on the average. In fact, operating margin as a percentage of turnover increased in the food manufacturing at the beginning of the 1990s. According to the models of collusive behaviour with imperfect monitoring, it is not clear *a priori* whether firms with market power tend to increase or decrease their margins in a recession. A potential explanation for the Finnish phenomenon is that firms operating in concentrated industries have chances to increase margins during recession, because the existence of excess capacity may tend to maintain collusion by making the threat of retaliation more credible. Testing the different hypotheses of collusive behaviour over the business cycles remains a question for further research.

Most of the Finnish food processing industries are highly home-market oriented. One factor in the background of the home-market orientation is agricultural policy with objectives relating, for example, to self-sufficiency in food commodities and safeguarding the income level of farmers. Foreign trade has been regulated in order to keep the domestic farm prices at the set level. Carrying out the policy objectives has relied on border protection, taking the form of import licences, quotas, and variable import levies. When competitive pressure from potential imports is weak, domestic producers have wider possibilities to use their market power associated with the high level of concentration. Even in the case with no collusive behaviour between the domestic firms, high concentration may lead to socially inefficient equilibrium prices. Furthermore, the central hypothesis common to almost all oligopoly models is that high concentration induces collusive behaviour. As a result of the theoretical analysis of implicit collusion (Chapter 3.2), the pressure from potential imports may reduce the stability of collusion due to the increasing number of competing firms and greater uncertainty. Small and closed food markets lead to the conclusion that high concentration is potentially a problem for the Finnish food economy in the sense of giving market power to some firms.

The purpose of the theoretical part of this study was to analyze the effects of market structure and conduct on the allocative efficiency of the economy at the partial equilibrium framework. The analyses operated at the simple framework in which structure was considered exogenous, i.e. the strategic behaviour affecting industry structure was ignored. Even in this case the problem of the S-C-P paradigm, i.e. that concentration measures possibly provide quite limited information about welfare or the degree of market power, was revealed. Several conclusions can be drawn from the analysis. First, concentration indices can be useful in evaluating the competitiveness in markets, but this requires exact formulation of the form of competition. Second, actions that reduce the number of firms or increase concentration can improve welfare. This benefit does not depend upon scale economies, but it may be achieved if increased concentration leads to asymmetry in firms' behaviour (Stackelberg form of competition). Thus, the possibility of asymmetric competition within an industry offers a reason for competition agencies to avoid too straightforward policy against industry concentration. Analyses of asymmetric competition are still quite limited in the economic literature, and more attention should be paid to these aspects. Third, the analysis shows the importance of taking into account the special market characteristics when modelling the causation from structure to performance.

Studies in the field of the strategic trade theory have shown that, under certain circumstances, a government can increase national welfare by using export subsidies and import restrictions. Because international food markets are imperfectly competitive, it may be possible to shift monopoly rents from foreign to home firms. This is not the only motive for protectionism in the food markets, but the application of the strategic trade theory may deepen our understanding, for example, of the agricultural trade problems of the GATT Uruquay round and the challenges of the WTO process.

This study presented an example of how to measure welfare losses of imperfect competition in markets where foreign competition is restricted by means of various kinds of import restrictions. Methodology adopted follows the standards of the new I.O. literature in the sense that a behavioural model is formally derived from a theoretical model of profit maximization. One problem involved is the necessity of choosing the form of conduct and the set of strategic instruments of firms when many potential candidates are possible. The solution of this study was to model competition between domestic firms by using firms' conjectural variations, i.e. firms' expectations about the reactions of rival firms to a change in the quantity of output. It can be said that capturing the different dimensions of imperfect competition to conjectural variations does not reveal much about strategies employed by firms. Many of the policy-relevant factors, such as the impacts of product differentiation, entry conditions, and strategic entry deterrence, are not included in the firms' conjectural variations. Using conjectural variations may be an unsatisfactory modelling choice with respect to the models of the formal game theory, but at this moment the formal game theory offers mainly empirically useless sets of firm strategies or multiple equilibria as alternatives.

In this framework, the derivation justified the use of the Herfindahl index as a measure of concentration and the elasticity of demand with respect to own price as a measure of demand conditions. A problem is that the income effects on demand, e.g. the annual growth rate of industry demand, which is a central explanatory variable of the S-C-P tradition to investigate profit margins, were not included in the models to evaluate welfare losses. Furthermore, due to the assumed asymmetry in the competition between domestic firms and importers, the derivation justified the use of the market share of domestic producers as a measure of the degree of foreign competition. The institutional background was taken into account by deriving separate models for industries with quantitative import restrictions and for so-called free trade industries.

As an exception to the mainstream tradition, profit margins and marginal costs were treated as unobservable. Difficulties associated with the observed profits and costs exist because, for example, fixed costs are often high in imperfectly competitive industries and it is impossible to distinguish between production costs, expenditures of gaining market power, or X-inefficiency caused by imperfect competition. This leads, however, to the situation in which it is impossible to estimate specific values for the conjectural variations parameters or, in other words, to specify the form of competition. Analysis has to operate with different assumptions about firm conduct. On the one hand this can diminish the chances that the results will be of direct policy usability but, on the other, information about the sensibility of the results to the different assumptions of conduct can be useful from the viewpoint of practical policy experiments.

The assumptions and potential limitations of the models are important to note when considering the estimated industry specific deadweight losses of oligopolistic competition in the Finnish food manufacturing. Analysis of the Finnish food manufacturing industries reveals that the magnitude of deadweight losses depends decisively on the form of competition. Therefore, considerable welfare gains could be expected from the public policies that are able to restrict collusive practices. Implicit collusion is, however, a problematic question from the viewpoint of competition agencies, because it can be a result of individual rationality and does not need any explicit commitments of price setting between firms. For example, the Finnish competition legislation (480/1992) does not prohibit very clearly the forms of collusive activities that are less tangible than agreements and decisions of the firms at the same production or distribution stage to set prices, limit production, or segment markets. Similarly, Articles 85 and 86 of the EC's Treaty of Rome prohibit explicit cartels. Because the incentives of maintaining implicit collusion are positively related to market concentration, public policies can be directed against concentration. However, the preceeding analysis shows that the effects of increased concentration on welfare are not unambiguous.

The demand for food with respect to own-price has generally been estimated to be quite inelastic. Employing the obtained elasticity estimates resulted in relatively high deadweight losses for a substantial part of the food manufacturing industries, even if firms were assumed to be Cournot-Nash competitiors. The results suggest that, in the Cournot competition, the industries with the best possibilities for welfare reducing margins were coffee roasting, tobacco products manufacture, margarine manufacture, manufacture of malt beverages and soft drinks, slaughtering, and dairy products manufacture. The averages of obtained price elasticity estimates yielded losses that are 5-15 percent of total sales. The manufacture of grain mill products, malt and starch as well as beet sugar manufacture, and sugar refining are also candidates for high potential welfare losses. Although cardinal estimates of the magnitude of deadweight losses vary substantially, the method used can identify industries that should arouse the interest of competition authorities and further research. Comparing the estimates of this study with the cross-industry rankings for the U.S. food manufacturing obtained by PETERSON and CONNOR (1995) reveals that there is considerable overlap in the lists of industries with the largest potential for high deadweight losses between Finland and the U.S. For example, the manufacture of malt beverages and soft drinks, coffee roasting, and margarine manufacture are candidates for high welfare losses in both countries. The existence of such uniformity may reflect the fact that technology and other market characteristcs are quite similar across countries. However, the magnitude of deadweight losses is higher in Finland, corresponding to the view that industries are less concentrated in countries where the size of the market is larger.

In contrast, the group with the lowest estimated losses in the Cournot competition consisted of chocolate and confectionary manufacture, fish processing, fruit and vegetable processing, and bakery products manufacture. In this group, the welfare losses were estimated to amount to 0.5-3 percent of total sales, depending on the obtained elasticity estimates. Especially in the case of chocolate and confectionaries, the level of estimated losses is likely to be sensitive to the assumption of product homogeneity. The intensive introduction of new products and heavy advertising are determinants of product differentiation in chocolate and confectionary manufacture and, because market power that follows from product differentiation was not considered, the analysis probably underestimated the level of welfare losses. Furthermore, it must be noted that the models were unable to evaluate market power due to local concentration or due the fact that several firms may have the same owner. These two features are particularly important in bakery products manufacture.

Because Finnish food manufacturing industries appeared to have considerable welfare losses even under Cournot behaviour, public policies directed to lower entry barriers can be excepted to be efficient even in the absence of collusive behaviour between the firms. Public policies can be expected to be quite inefficient against entry barriers like large capital requirements for entrants, incumbents' absolute cost advantages, or product differentiation. However, policies can act against many strategic entry barriers manipulated by incumbents. For example, the Finnish competition legislation prohibits the use of exclusive sales and purchase rights. Since the market structure is quite stable over time and entries occur gradually, public policies need to consider the problem of market power in a dynamic context. Further industry-specific research is needed to determine the potential existence and nature of entry barriers in the Finnish food manufacturing.

The deadweight loss estimates were based on the assumption that firms are able to use their potential market power effectively. In this case, the deadweight losses correspond to allocative inefficiency of industries. Employing different short-run profitability measures as indicators of price-cost margins revealed, however, that industry profitability had usually not reached the level predicted by the structuralistic model. A potential explanation is that the conduct of firms was more competitive than the Cournot outcome. However, this conclusion alone is too straightforward, because profitability measures cannot separate the potential effects of X-inefficiency from the minimum level of production costs. The low average profit rates, especially in the case of quantitative import restrictions, may be a result of low technical efficiency supported by weak competition. Furthermore, it is likely that the bargaining power of the concentrated retailing sector and the further processing of intermediate goods limit the possibilities of food manufacturers to use their potential market power.

The deadweight loss estimates are highly sensitive to the choice of the equilibrium concept and to the level of demand elasticity obtained from the previous studies. Therefore, the conclusions are more qualitative than quantitative. The analysis showed that welfare losses due to the oligopolistic competition are at least potentially a matter of concern in the Finnish food manufacturing.

In addition to the potential static welfare losses associated with oligopoly market power, the welfare effects of public policies depend on the degree of market imperfections. This study presented a procedure to analyze the effects of the EU membership on consumer welfare and on the domestic food manufacturers' profits. The first policy experiment was a reduction of the domestic prices of agricultural products to the EU level. In this case, the degree of transmission from manufacturers' cost changes to product prices depends on the degree of oligopolistic competition. Assuming perfect competition would overestimate the improvements in consumer welfare. The second experiment considered the abolition of institutional trade barriers. Because tariffs and quotas are not equivalent instruments of the trade policy if markets are imperfectly competitive, the abolition of an import quota yields higher *ex-ante* welfare improvements than the abolition of a tariff which has led to the corresponding volume of imports before the accession. In the third experiment it was assumed that, for example, lowered entry barriers of importers and excess capacity of the domestic firms lead to increased competition within the domestic food manufacturers. In this case, assuming perfect competition would ignore the considerable redistribution of welfare between consumers and domestic manufacturers resulting from the integration.

The effects of different policy experiments are highly sensitive to the way in which imperfect competition and demand characteristics are captured. This is a common problem of oligopoly models. The overall lesson is that one should be cautious when making generalizations regarding the effects of different public policies. Nevertheless, the concequences of market imperfections in the food chain should be taken into account when studying the effects of trade interventions, taxation, and different farm policies. For example, the value added tax on food, production quotas of agricultural production, price support of farm products, or direct agricultural support may lead to price and welfare effects depending a great deal on the stucture and conduct in the different stages of the food chain.

8. Summary

The objectives of the study were (1) to study the effects of market structure on performance by using the game theoretical model formulations, (2) to derive measures of welfare losses associated with oligopolistic market power for a number of equilibrium types, (3) to estimate welfare losses of oligopolies for the Finnish food manufacturing by employing alternative oligopoly solutions, and (4) to predict how the membership in the EU affects the oligopoly equilibriums, consumer surplus, and firms' profits in the Finnish food manufacturing.

The study began with a description of the market structure, firm behaviour, and performance in the Finnish food manufacturing. The sector is important in the national economy. In 1993 it accounted for 13 percent of the value added and total employment in all manufacturing. Foreign trade was, however, of little importance due to the close relationship between agricultural policy and food manufacturing. In terms of different concentration measures, most of the Finnish food manufacturing industries were found to be very concentrated. One explanation is the often empirically observed negative relationship between market size and concentration. The high level of concentration suggests that markets are oligopolistic. The actions of firms are interdependent, i.e. firms take into account how the rival firms are likely to react.

The theoretical analysis in Chapter 3 formulated the framework for the model constructions and empirical analyses of the latter parts of the study. The strategic behaviour of firms was modelled as noncooperative games. In modelling such games, there is considerable scope for designing the structure of moves or the degree of competition. Conjectural variations models presented the positive relationship between concentration and market power, the theoretical basis of the Herfindahl index of concentration, and the principles of reaction function analysis. Because an individual firm is likely to have an incentive to deviate from the collusive output, collusion must be supported by punishment strategies. It was shown that higher concentration is likely to lead to higher industry profits because it supports the stability of collusion, and concentration indices may be useful in assessing the state of competitiveness in markets. Comparison between the Cournot model and the hierarchical Stackelberg model revealed, however, that the form of competition is decisive in the analysis of structure-performance relationships. The studies reviewed showed that it may be beneficial, from the point of view of a single country, to impose trade-distorting policies in imperfectly competitive markets. Optimal policies under different forms of oligopolistic competition can be different, and different trade barriers are not equivalent from the society's viewpoint.

Different formulations of strategic competition lead to a wide range of possible equilibriums. In Chapter 4 the models to evaluate welfare losses due to oligopoly were based on the data on market features in the food manufacturing. The first model corresponded to the situation in which quantitative import restriction, more precisely volume quotas, are used. Competition within the domestic firms was demonstrated by employing conjectural variations elasticities. Imports were treated as a price-taking fringe restricted to the level of the administrative quota. The second model considered the case in which quantitative import restrictions do not exist. However, it was assumed that the government imposes an import levy, tariff, or tax, which equals to the difference between domestic and foreign costs. In this context, the Stackelberg model, in which domestic firms are assumed to be in the leadership position, was derived. In the model domestic and foreign groups compete against each other, and competition within the groups was modelled using conjectural elasticities.

The models were applied to Finnish food manufacturing industries in Chapter 5. The results showed relatively high deadweight losses for a substantial part of the food manufacturing, even if firms were assumed to be Cournot-Nash competitors. Although the estimates of the magnitude of losses varied substantially with respect to the price elasticities of demand, the analysis identified industries in which the room for welfare reducing margins is the largest. In the Cournot competition, the models yielded losses that are 5-15 percent of total sales in coffee roasting, tobacco, and margarine manufacture, manufacture of malt beverages and soft drinks, slaughtering, as well as dairy products manufacture. The manufacture of grain mill products, malt and starch as well as beet sugar manufacture, and sugar refining are also candidates for high welfare losses. Welfare losses were obtained to be 0.5-3 percent of total sales in chocolate and confectionary manufacture, fish processing, fruit and vegetable processing, and bakery products manufacture. However, product differentiation and local concentration may increase firms' market power in this group of industries. The analysis revealed that the magnitude of deadweight losses depends decisively on the form of competition. Welfare losses due to the oligopolistic competition are a matter of concern in the Finnish food manufacturing. Considerable welfare gains could be expected from the public policies that are able to restrict collusive practices and to lower entry barriers.

Chapter 6 presented a procedure to analyze the effects of the EU membership on consumer welfare and domestic food manufacturers' profits. Three different policy experiments linked to the process of integrating the Finnish food sector to the internal markets of the EU were analyzed. The reduction of the average domestic costs due to lower price level of agricultural raw materials increases both consumer welfare and domestic profits. The degree of transmission from manufacturers' cost changes to product prices depend on the degree of oligopolistic competition. The abolition of institutional trade barriers increases consumer welfare, but reduces manufacturers' profits. The net effect on welfare was found to be positive. Furthermore, it was assumed that, for example, lowered entry barriers of importers and excess capacity of the domestic producers lead to increased competition in the Finnish food manufacturing. The analysis showed that this leads to considerable redistribution of welfare between consumers and domestic food manufacturers. The net effect is welfare improving. Increasing competition leads to a need for further cost savings and higher productivity in the food manufacturing.

The need for further study is evident. The approaches of industrial economics are quite unexplored in the research on agricultural economics in Finland. For example, strategic behaviour of food manufacturers in the input markets is not analyzed in this study. If food manufacturers can influence farm prices through strategic behaviour, the analyses of welfare implications of agricultural policies for farmers need to take into account this oligopsony power. Since this study used the conjectural variations approach in modelling competition, one way to deepen the analysis would be to use a larger spectrum of oligopolistic strategies. In the future research, more attention should be paid to the effects of product differentiation associated with special brands and spatial differentiation, advertising, research and development strategies, and vertical relationships in the food chain. The application made in this study can be extended by considering technical factors and firm strategies that influence industry structure.

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APPENDIX 1. Concentration of the Finnish food manufacturing[1].

1986

	n[2]	CR3[3]	CR5[3]	CR10[3]	H5[4]	H[5]
Slaughtering	26	74.7	84.7	94.4	0.31	0.22
Meat processing	110	54.7	69.7	82.9	0.23	0.12
Fruit and vegetable processing	84	71.3	81.2	89.8	0.38	0.25
Fish processing	70	25.0	37.6	58.5	0.20	0.04
Manufacture of margarine, oils and fats	8	86.7	96.2	100	0.27	0.25
Dairy products manufacture	99	47.9	53.2	63.3	0.59	0.14
Ice-cream manufacture	5	99.5	100	100	0.88	0.88
Grain mill products manufacture	101	63.8	77.1	88.3	0.26	0.16
Fresh bread and pastries manufacture	786	38.1	40.8	45.6	0.58	0.10
Crispbread manufacture	4	94.7	100	100	0.45	0.45
Biscuits manufacture	12	90.1	94.1	99.1	0.42	0.37
Beet sugar manufacture and sugar refining	2	100	100	100	0.72	0.72
Chocolate and confectionary manufacture	25	98.5	99.3	99.7	0.90	0.89
Coffee roasting	2	100	100	100	0.99	0.99
Manufacture of other food products	44	72.0	88.4	95.5	0.26	0.20
Malt manufacture	5	99.9	100	100	0.97	0.97
Manufacture of malt beverages and soft drinks	15	91.4	99.7	99.9	0.30	0.30
Tobacco products manufacture	3	100	100	100	0.45	0.45
Starch manufacture	3	100	100	100	0.58	0.58
Feed manufacture	65	81.4	85.1	90.4	0.43	0.31

1989

	n[2]	CR3[3]	CR5[3]	CR10[3]	H5[4]	H[5]
Slaughtering	24	51.6	69.6	91.7	0.23	0.12
Meat processing	120	49.4	66.9	84.0	0.22	0.11
Fruit and vegetable processing	122	79.5	86.6	92.8	0.43	0.32
Fish processing	79	31.3	45.3	65.4	0.21	0.05
Manufacture of margarine, oils and fats	8	92.6	98.4	100	0.39	0.38
Dairy products manufacture	87	48.2	54.3	65.4	0.56	0.17
Ice-cream manufacture	3	100	100	100	0.89	0.89
Grain mill products manufacture	92	63.6	71.7	83.0	0.21	0.11
Fresh bread and pastries manufacture	858	44.0	47.0	51.5	0.41	0.09
Crispbread manufacture	2	100	100	100	0.68	0.68
Biscuits manufacture	17	84.4	91.8	97.9	0.31	0.26
Beet sugar manufacture and sugar refining	2	100	100	100	0.71	0.71
Chocolate and confectionary manufacture	28	96.3	98.8	99.7	0.54	0.53
Coffee roasting	2	100	100	100	0.99	0.99
Manufacture of other food products	62	57.7	73.8	86.1	0.23	0.13
Malt manufacture	4	99.9	100	100	0.97	0.97
Manufacture of malt beverages and soft drinks	16	94.7	99.8	99.9	0.31	0.31
Tobacco products manufacture	3	100	100	100	0.42	0.42
Starch manufacture	6	82.8	96.2	100	0.28	0.26
Feed manufacture	73	77.6	85.6	91.3	0.31	0.23

[1] Concentration in 1993 is presented in Chapter 2. [2] Number of firms. [3] The concentration ratio of 3, 5 and 10 largest firms. [4] The Herfindahl index of concentration for 5 largest firms. [5] The Herfindahl index of concentration for the industry.

APPENDIX 2. Profitability measures for some Finnish food manufacturing industries.

1990

Industry	1111	1112	1113	1121	1141	1164	1190
Frequence	5	15	8	35	37	4	9
Turnover, FIM mill.	1019.58	10889.68	769.86	16133.03	2578.23	2189.44	2761.81
Operating margin	38.71	538.01	81.66	593.21	185.53	253.05	172.55
Operating profit after depreciation	-10.40	234.13	54.12	254.57	104.03	69.93	59.33
Profit after financial items	-43.96	94.43	24.95	62.07	70.01	79.94	-121.96
Net profit for accounting period	-6.27	45.04	37.75	78.53	95.50	72.02	82.94
Fixed assets, FIM mill.	277.15	2073.73	448.57	2172.12	716.99	1405.50	3589.72
Key ratios:							
Operating margin -%	3.80	4.94	10.61	3.68	7.20	11.56	6.25
Financial result -%	0.31	3.30	5.29	2.18	2.71	11.26	-1.68
Net result -%	-4.51	0.51	1.72	0.08	-0.45	2.89	-5.78
Total result -%	1.24	0.47	4.44	0.51	1.17	2.88	4.22
Return on investment -%	0.55	8.70	8.34	7.15	9.95	8.20	3.23
Total liabilities -%	50.89	32.66	62.74	28.60	49.87	83.38	126.12
Debt:capital ratio	4.02	2.70	1.26	2.21	1.93	1.62	1.99
Equity ratio	19.92	27.01	44.15	31.19	34.10	38.10	33.39
Current ratio	1.69	1.64	1.69	1.50	1.79	1.38	0.98

1991

Industry	1111	1112	1121	1141	1164	1190
Frequence	8	14	30	46	4	10
Turnover, FIM mill.	1307.47	10372.28	14906.31	2414.37	2340.45	2806.25
Operating margin	57.32	453.57	488.24	164.56	301.99	216.29
Operating profit after depreciation	24.47	192.27	151.17	40.76	127.04	128.54
Profit after financial items	-14.52	-75.86	-39.08	2.41	66.02	-168.35
Net profit for accounting period	4.89	5.94	100.16	3.88	13.71	20.68
Fixed assets, FIM mill.	288.29	2285.99	2381.00	1031.87	1661.14	3692.32
Key ratios:						
Operating margin -%	4.38	4.37	3.28	6.82	12.90	7.71
Financial result -%	1.21	1.56	1.73	4.64	9.87	-3.54
Net result -%	-1.30	-0.96	-0.54	-0.49	2.40	-6.67
Total result -%	-1.17	-0.89	-0.54	-0.83	2.54	-0.85
Return on investment -%	7.76	5.57	5.36	6.72	8.40	4.49
Total liabilities -%	45.47	39.76	30.79	58.91	89.72	135.07
Debt:capital ratio	4.36	3.46	1.90	2.18	1.90	2.25
Equity ratio	18.65	22.41	34.48	31.49	34.43	30.74
Current ratio	1.66	1.58	1.49	1.37	1.27	1.12

1992

Industry	1111	1112	1121	1141	1164	1190
Frequence	6	19	20	40	5	4
Turnover, FIM mill.	790.58	10371.99	17966.98	2062.20	2614.16	2313.87
Operating margin	33.53	601.43	934.03	154.47	211.92	165.77
Operating profit after depreciation	15.59	327.60	567.54	19.91	63.44	125.88
Profit after financial items	-14.62	-16.13	212.68	-21.23	-47.99	121.36
Net profit for accounting period	-12.35	37.49	118.02	-43.06	-34.69	7.35
Fixed assets, FIM mill.	232.17	2285.99	2945.61	953.25	1924.40	735.60
Key ratios:						
Operating margin -%	4.24	5.80	5.20	7.49	8.11	7.16
Financial result -%	0.07	2.28	2.84	5.09	3.49	6.73
Net result -%	-2.20	-0.36	0.80	-1.44	-2.19	5.00
Total result -%	0.39	0.69	0.10	0.11	-0.30	3.27
Return on investment -%	6.81	8.26	13.95	4.75	5.26	12.44
Total liabilities -%	51.34	41.49	26.95	55.55	139.50	41.53
Debt:capital ratio	4.14	2.79	2.05	1.93	3.71	1.07
Equity ratio	19.45	26.39	32.78	34.10	21.23	48.29
Current ratio	1.73	1.49	1.53	1.23	1.06	1.55

1993

Industry	1111	1112	1121	1141	1164	1190
Frequence	7	18	15	38	4	7
Turnover, FIM mill.	2136.01	7085.41	16096.63	2142.13	2536.61	2857.88
Operating margin	92.54	449.93	761.80	143.16	264.21	222.31
Operating profit after depreciation	47.55	201.23	387.55	9.15	143.73	141.35
Profit after financial items	11.61	-33.11	151.81	-36.70	51.43	133.44
Net profit for accounting period	6.16	-3.26	191.64	64.67	0.32	55.62
Fixed assets, FIM mill.	442.80	2150.06	3942.84	993.70	1384.47	988.74
Key ratios:						
Operating margin -%	4.33	6.35	4.73	6.68	10.42	7.78
Financial result -%	2.39	2.89	2.78	3.54	6.66	6.80
Net result -%	0.29	-0.62	0.46	-2.72	1.91	3.96
Total result -%	0.59	-1.20	0.76	2.06	1.87	-1.57
Return on investment -%	8.01	6.42	8.95	2.20	9.71	11.19
Total liabilities -%	32.44	39.36	31.12	52.94	88.45	34.10
Debt:capital ratio	2.34	2.12	1.42	1.53	2.45	0.85
Equity ratio	29.92	32.08	41.33	39.46	28.98	53.98
Current ratio	1.67	1.64	1.45	1.45	1.11	1.51

1111 Slaughtering
1112 Meat processing
1113 Fruit and vegetable processing
1121 Dairy products manufacture
1141 Fresh bread and pastries manufacture
1164 Manufacture of malt beverages and soft drinks
1190 Feed manufacture

Source: Financial Statements Statistics

APPENDIX 3. Some mathematical derivations.

Equations 3.6 and 3.7

Let an n-firm homogenous product industry face an inverse demand curve P(Q), where Q is industry output. Firm i's output is q_i and the cost function $c_i(q_i,w)$, where the input price vector w is exogenously given. Firm i maximizes its profits $\pi_i = P(Q)\, q_i - c_i(q_i,w)$ by choosing q_i so that, for i=1,...,n,

$$\frac{\partial \pi_i}{\partial q_i} = P(Q) + P'(Q)q_i + P'(Q)\frac{d(\Sigma_{j\neq i} q_j)}{dq_i} q_i - \frac{\partial c_i(q_i,w)}{\partial q_i} = 0. \tag{A.1}$$

This can be rewritten as:

$$P(Q) + P'(Q)q_i\left(1 + \frac{d(\Sigma_{j\neq i} q_j)}{dq_i}\frac{q_i}{\Sigma_{j\neq i} q_j}\frac{\Sigma_{j\neq i} q_j}{q_i}\right) = \frac{\partial c_i(q_i,w)}{\partial q_i}, \tag{A.2}$$

and using the definition $\beta = (d\Sigma_{j\neq i}\, q_j \,/\, dq_i)(q_i/\Sigma_{j\neq i}\, q_j)$ yields Equation 3.6, in which $\beta=\beta_i=\beta_j$ for all i,j. If MC_i is marginal cost for firm i, it can be written

$$P(Q) + P'(Q)\frac{Q}{P(Q)}P(Q)\frac{q_i}{Q}\left(1 + \frac{\Sigma_{j\neq i} q_j}{q_i}\beta + \frac{q_i}{q_i}\beta - \beta\right) = MC_i, \tag{A.3}$$

and thus

$$P(Q) + \frac{1}{\eta}P(Q)\left[\beta + s_i(1-\beta)\right] = MC_i, \tag{A.4}$$

where η is the price elasticity of demand and $s_i = q_i/Q$. Taking the absolute value of price elasticity and rearranging the terms leads to Equation 3.7.

Equation 3.15

The immediate one-period gain from cheating is

$$\pi_i^{Ch} - \pi_i^* = \frac{(n+1)^2(a-c)^2}{16bn^2} - \frac{(a-c)^2}{4bn} = \frac{(n-1)^2(a-c)^2}{16bn^2}. \tag{A.5}$$

Future losses discounted to the first period are

$$PDV_i^{Ch} = \delta(\pi_i^* - \pi_i^C) + \delta^2(\pi_i^* - \pi_i^C) + \delta^3(\pi_i^* - \pi_i^C)\ldots$$
$$= \sum_{t=1}^{\infty} \delta^t(\pi_i^* - \pi_i^C) = \frac{\delta}{1-\delta}\left(\frac{(n-1)^2(a-c)^2}{4bn(n+1)^2}\right). \tag{A.6}$$

Losses dominate and no firm will cheat if

$$\frac{\delta}{1-\delta}\left(\frac{(n-1)^2(a-c)^2}{4bn(n+1)^2}\right) > \frac{(n-1)^2(a-c)^2}{16bn^2}, \tag{A.7}$$

which leads to 3.15.

Equation 3.19

In the Cournot behaviour context the equilibrium price is a solution of the maximizing programmes of individual profits of the k firms. Firm i maximizes its profits (Equation 3.18) when

$$P(Q^D) + \frac{\partial P(Q^D)}{\partial Q^D} q_i - \frac{\partial c_i(q_i, w)}{\partial q_i} = 0. \tag{A.8}$$

Defining $-[dQ(P)/dP][P/Q(P)] = |\eta|$ and $[dQ^C(P)/dP][P/Q^C(P)] = \varepsilon$, as respectively, the absolute value of elasticity of the global demand function and the elasticity of supply function of the competitive fringe (positive by assumption) and after using Equation 3.17, the following expression is obtained:

$$P(Q^D) - \frac{Q^D}{Q|\eta| + Q^C\varepsilon} P(Q^D)\frac{q_i}{Q^D} - \frac{\partial c_i(q_i, w)}{\partial q_i} = 0. \tag{A.9}$$

This can be rewritten:

$$P(Q^D) - \frac{s_i}{|\eta| + \varepsilon(1 - C_D)} P(Q^D) - \frac{\partial c_i(q_i, w)}{\partial q_i} = 0, \tag{A.10}$$

where $s_i = q_i/Q$ and $C_D = Q^D/Q$. Because $L_i = (P - MC_i)/P$, this leads to 3.19.

Equations 3.26-3.28

Maximizing the profit function π_i=(a-bA$_i$-bq$_i$)q$_i$-cq$_i$ in the quantity setting context yields q_i=(a-bA$_i$-c)/2b for all i=1,...,n. The first firm in the hierarchy produces q_1=(a-c)/2b, the second firm q_2=(a-c)/4b, the third firm q_3=(a-c)/8b, and so on. Thus, q_i=(a-c)/2^i b for all i=1,...,n. Summing each firm's optimal quantity, i.e.

$$Q^{HS}=\frac{a-c}{b}\left(\frac{1}{2}+\frac{1}{2^2}+\frac{1}{2^3}+\ldots+\frac{1}{2^n}\right), \tag{A.11}$$

leads to 3.27, in which P^{HS} is obtained by substituting Q^{HS} in the demand function P=a-bQ. The Cournot price is higher than P^{HS} if (a+nc)/(n+1) > (a+c(2^n-1)) / 2^n, i.e. if 2^n-n > 1. A firm that produces the Cournot quantity can be found by setting (a-c) / 2^i b = (a-c) / b(n+1), i.e. 2^i=n+1, and it is ranked by i=ln(n+1)/ln2 in the hierarchy. Profit for firm i, i=1,...,n, is Q^{HS}(P^{HS}-c) which yields Equation 3.28.

Equation 3.30

The Herfindahl index of concentration is the sum of the squares of the market shares of firms in the industry:

$$H=\sum_{i=1}^{n}\left(\frac{q_i}{Q}\right)^2=\left(\frac{1}{1-2^{-n}}\right)^2\left(\frac{1}{2^2}+\frac{1}{2^4}+\frac{1}{2^6}+\ldots+\frac{1}{2^{2n}}\right). \tag{A.12}$$

After multiplying H by 1/4 and solving (1-1/4) H, this can be written

$$\frac{3}{4}H=\left(\frac{1}{1-2^{-n}}\right)^2\left(\frac{1}{4}-\frac{1}{4^{n+1}}\right). \tag{A.13}$$

Multiplying by 4/3 leads to Equation 3.30.

Equation 4.8

Substituting the equilibrium values of the competitive and oligopoly quantitites yields the deadweight loss to be

$$DWL=\int_{G\left\{\frac{|\eta|c_D}{|\eta|-C_D[\beta_D+H_D(1-\beta_D)]}\right\}^{-|\eta|}}^{Gc_D^{-|\eta|}}\left(\frac{Q}{G}\right)^{\frac{-1}{|\eta|}}dQ-c_D\left\{Gc_D^{-|\eta|}-G\left\{\frac{|\eta|c_D}{|\eta|-C_D[\beta_D+H_D(1-\beta_D)]}\right\}^{-|\eta|}\right\}. \tag{A.14}$$

Hence, the deadweight loss is

$$DWL=G^{\frac{1}{|\eta|}}\frac{|\eta|}{|\eta|-1}G^{\frac{|\eta|-1}{|\eta|}}c_D^{1-|\eta|}-G^{\frac{1}{|\eta|}}\frac{|\eta|}{|\eta|-1}G^{\frac{|\eta|-1}{|\eta|}}\left\{\frac{|\eta|c_D}{|\eta|-C_D[\beta_D+H_D(1-\beta_D)]}\right\}^{1-|\eta|}$$
$$-c_D\left\{Gc_D^{-|\eta|}-G\left\{\frac{|\eta|c_D}{|\eta|-C_D[\beta_D+H_D(1-\beta_D)]}\right\}^{-|\eta|}\right\}. \tag{A.15}$$

Rearranging terms leads to 4.8.

Equation 4.15

The deadweight loss is

$$DWL=\int_{\frac{a}{b}-\frac{aC_D[\beta_D+H_D(1-\beta_D)]+c_D}{b(1+C_D[\beta_D+H_D(1-\beta_D)])}}^{\frac{a-c_D}{b}}(a-bQ)dQ-c_D\left\{\frac{a-c_D}{b}-\frac{a}{b}+\frac{aC_D[\beta_D+H_D(1-\beta_D)]+c_D}{b(1+C_D[\beta_D+H_D(1-\beta_D)])}\right\}$$
$$=a\left(\frac{a-c_D}{b}\right)-\frac{b}{2}\left(\frac{a-c_D}{b}\right)^2-a\left\{\frac{a}{b}-\frac{aC_D[\beta_D+H_D(1-\beta_D)]+c_D}{b(1+C_D[\beta_D+H_D(1-\beta_D)])}\right\}$$
$$+\frac{b}{2}\left\{\frac{a}{b}-\frac{aC_D[\beta_D+H_D(1-\beta_D)]+c_D}{b(1+C_D[\beta_D+H_D(1-\beta_D)])}\right\}^2-c_D\left\{\frac{a-c_D}{b}-\frac{a}{b}+\frac{aC_D[\beta_D+H_D(1-\beta_D)]+c_D}{b(1+C_D[\beta_D+H_D(1-\beta_D)])}\right\}. \tag{A.16}$$

Equation 4.15 is obtained by rearranging the terms.

Equation 4.16

The starting point is

$$\frac{DWL}{P^oQ^o}=\frac{\frac{a-c_D}{b}\left\{\frac{1}{2}(a-c_D)-\left\{a-\frac{aC_D[\beta_D+H_D(1-\beta_D)]+c_D}{1+C_D[\beta_D+H_D(1-\beta_D)]}\right\}\right\}+\frac{1}{2b}\left\{a-\frac{aC_D[\beta_D+H_D(1-\beta_D)]+c_D}{1+C_D[\beta_D+H_D(1-\beta_D)]}\right\}^2}{\left\{\frac{aC_D[\beta_D+H_D(1-\beta_D)]+c_D}{1+C_D[\beta_D+H_D(1-\beta_D)]}\right\}\left\{\frac{a}{b}-\frac{aC_D[\beta_D+H_D(1-\beta_D)]+c_D}{b(1+C_D[\beta_D+H_D(1-\beta_D)])}\right\}}. \tag{A.17}$$

Using the fact that |η|=P/(a-P) under linear demand, it can be observed that

$$\frac{DWL}{P^O Q^O}=\frac{1}{2|\eta|}-\frac{a-c_D}{|\eta|\left\{a-\dfrac{aC_D[\beta_D+H_D(1-\beta_D)]+c_D}{1+C_D[\beta_D+H_D(1-\beta_D)]}\right\}}$$

$$+\frac{(a-c_D)^2}{2\left\{a-\dfrac{aC_D[\beta_D+H_D(1-\beta_D)]+c_D}{1+C_D[\beta_D+H_D(1-\beta_D)]}\right\}\left\{\dfrac{aC_D[\beta_D+H_D(1-\beta_D)]+c_D}{1+C_D[\beta_D+H_D(1-\beta_D)]}\right\}}, \qquad \text{(A.18)}$$

which leads to 4.16.

Equation 4.22

When $t=c_D-c_M$ and s=0, the total oligopoly output is $Q^O=[(a-c_D)(1+V_D+V_M)] / [b(1+V_D)(1+V_M)]$. Let us denote $\phi=[1+V_D+V_M] / [(1+V_D)(1+V_M)]$. Thus, the deadweight loss can be find out from

$$\int_{\frac{(a-c_D)\phi}{b}}^{\frac{a-c_D}{b}}(a-bQ)dQ-c_D\left(\frac{(a-c_D)(1-\phi)}{b}\right)+\pi_M. \qquad \text{(A.19)}$$

Equation 4.23

The deadweight loss per total sales in an industry is

$$\frac{DWL}{P^O Q^O}=\frac{b(a-c_D)^2(\phi-1)^2}{2b(a-(a-c_D)\phi)(a-c_D)\phi}+\frac{b(a-c_D)V_D[b(1+V_D)(1+V_M)]^{-1}(a-c_D)(1-\phi)}{(a-(a-c_D)\phi)(a-c_D)\phi}. \qquad \text{(A.20)}$$

Observing that

$$|\eta|=\frac{P}{a-P}=\frac{a-(a-c_D)\phi}{(a-c_D)\phi} \qquad \text{(A.21)}$$

under linear demand leads directly to 4.23.

Equations 4.24 and 4.25

Let Q_D and Q_M stand for the total quantities of domestic production and imports, respectively. The inverse linear demand function is $P=a-b(Q_D+Q_M)$. Profits for firm i are given by

$$\pi_{iD} = (a-b(Q_D+Q_M))q_{iD} - (c_{iD}-s)q_{iD};$$
$$\pi_{iM} = (a-b(Q_D+Q_M))q_{iM} - (c_{iM}+t)q_{iM}. \quad \text{(A.22)}$$

A conjectural variations model is used in modelling competition within the groups. Firm i maximizes its profits by choosing q_i so that

$$a-b(Q_D+Q_M)-bQ_D[\beta_D+\frac{q_{iD}}{Q_D}(1-\beta_D)] = c_{iD}+s;$$

$$a-b(Q_D+Q_M)-bQ_M[\beta_M+\frac{q_{iM}}{Q_M}(1-\beta_M)] = c_{iM}-t. \quad \text{(A.23)}$$

After summing across the industries, a solution for the quantities can be obtained to be

$$Q_D = \frac{1}{b[(1+V_D)(1+V_M)-1]}[(a-c_D+s)(1+V_M)-(a-c_M-t)];$$

$$Q_M = \frac{1}{b[(1+V_D)(1+V_M)-1]}[(a-c_M-t)(1+V_D)-(a-c_D+s], \quad \text{(A.24)}$$

where $V_D=\beta_D+H_D(1-\beta_D)$ and $V_M=\beta_M+H_M(1-\beta_M)$. Combining domestic production and imports leads to 4.24. If s=0 and $t=c_D-c_M$, the derivation of 4.25 follows the methods presented in Equations A.19-A.21.

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