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EMPIRICAL MODELLING OF EXPORTS OF MANUFACTURES: NORWAY 1962-1987

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MODAG

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PREFACE

In former versions of the annual Norwegian large scale macro model MODAG, export volumes of different commodities were modelled by export demand equations consistent with the Armington approach assuming monopolistic competition. Dynamics were introduced by a simple partial adjustment mechanism, and the theoretical restriction of price homogeneity was imposed in both the short- and the long-run. In this report, export equations with more flexible dynamics (error correction models), which allow short-run price non-homogeneity, are estimated. Important differences across commodities with respect to both estimated elasticities and dynamics are revealed. In addition to Armington equations, also equations consistent with price taking behaviour (the small open economy case) are estimated. The "small open economy" model is assumed particularly promising for raw materials and intermediate goods, and the price taking hypothesis is not rejected for metals.

The merits of alternative ways of measuring the variables describing foreign markets in the Armington model, i.e. world demand and competitors' prices, are also investigated. The conclusion is that both careful modelling of the dynamics and the choice of explanatory variables are important for the encompassing properties and estimated long-run elasticities, and that the restriction of short-run price homogeneity involves misspecification for important commodities. In addition, inference about competitiveness in trading industries depends critically on the choice of variables describing foreign markets.

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Central Bureau of Statistics, Oslo 25 June 1993.

Svein Longva

CONTENTS

1. INTRODUCTION[1]

Norway is often described as a small open economy, and summary statistics support this view[2]. In economic literature, a small open economy is often defined as an economy with no or very little impact on international prices of changes in its export supply or import demand. Thus a small economy is often modelled as facing fixed world market prices, cf. Hansen (1955) and Rødseth (1979). However, even if these assumptions may seem reasonable in markets for homogeneous products, they need not apply to markets with imperfect competition. For example, in a situation with differentiated products or economies of scale, even small economies can influence international prices and exert market power. Empirical analyses of Norwegian data support the assumption of imperfect competition in the export markets: Norwegian export prices on both manufactured goods and other commodities are influenced by domestic costs and capacity utilization as well as by competitors' prices (Bowitz and Eika (1989) and Cappelen (1992)). Despite such empirical "evidence" against the "small open economy" assumption, we systematically try out models which are consistent with price taking behaviour as well as models consistent with price setting behaviour. In the latter case, we estimate export demand equations as implied by the Armington approach assuming monopolistic competition. The small open economy model is clearly rejected by the data for most commodities while the Armington model is not.

In empirical work, there is a general problem of measuring the theory variables, and the "observational" variables may differ from the "true" variables for several reasons (Haavelmo (1944) p. 4): "It is never possible - strictly speaking - to avoid ambiguities in classifications and measurements of real phenomena. Not only is our technique of physical measurement unprecise, but in most cases we are not even able to give precise rules for the choice of things to be measured in connection with a certain theory." This is indeed relevant for the variables describing foreign markets in the Armington model, i.e. world demand and competitors' prices, and one has to choose among empirical proxies with different weaknesses and merits. In this paper, alternative empirical proxies for these theoretical variables are presented and compared. The exact definition of these variables prove to be very important for the estimated

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[1] The author is grateful to Ådne Cappelen, Rolf Golombek, Bjørn Naug, Ragnar Nymoen and Asbjørn Rødseth for valuable comments. I also thank Wenche Drzwi, Anne S. Karlsen, Anne-Kari Lysell and Marit Vågdal for help with figures, tables and the editing of the manuscript.

[2] In 1991, total exports and imports equalled around 81 per cent of gross domestic product (GDP). And, GDP in Norway was 687 billion Nkr or 62 billion £, while for example GDP in the United Kingdom was 573 billion £.

coefficients. Furthermore, the choice of information set affects statistical properties of the export demand (Armington) equations, e.g. fit and stability properties. Different variables describing world demand also have important impact on conclusions concerning the development in market shares over time for Norwegian exports. Such changes, which are often thought to reflect changes in domestic versus foreign firms' competitiveness, are frequently debated and affect policy decisions.

Using error correction models and annual observations based primarily on Norwegian national account data, we estimate export equations for eight manufactured goods, one service and one consumption category. Important differences across commodities regarding estimated long-run elasticities and dynamics are discovered, which would not have been revealed in a more aggregate analysis. We also compare the encompassing properties of our export equations with those in the earlier export model in MODAG[3] and discuss sources of the bias in the "old" long-run elasticities. Ideally, one want economic relations with a high degree of autonomy. Thus the explanatory power, stability and encompassing properties of the equations are of major concern.

In the next chapter we present two alternative models explaining exports; the "small open economy" model and the Armington model. In chapter three we present alternative empirical proxies for the theory variables in the Armington model. The econometric results are given in chapter four, and the main conclusions are summarized in the final chapter. Appendix 1 includes a table which defines the empirical variables and gives the relationship between the theory variables and the variables used in the empirical analysis. Appendix 2 gives the results from using instrumental variables for the export price when estimating export volume equations. Due to poor ex post forecast properties of some equations in chapter 4, we present an alternative specification of the export demand model for commodity 16, 17 and 34 in appendix 3.

[3] MODAG is a macroeconometric model of the Norwegian economy, cf. Cappelen (1992).

2. THEORIES OF INTERNATIONAL TRADE AND EXPORT DETERMINATION

In general, theoretical models for international trade isolate one or a few economic phenomena in a stylized world defined by very restrictive assumptions. In the real world, trade among different countries depends on a wide range of factors which operate simultaneously, and "ceteris paribus" assumptions in the theoretical models are violated. The aim of this chapter is to develop empirical models on the basis of theoretical predictions which capture the main features of Norwegian exports over time. Although we recognize the complexity of the real world, models with a simple interpretation are preferred. Parsimony is used as a rule of thumb rather than as a deep principle though.

In the traditional general equilibrium approach to international trade, trade patterns are explained by comparative advantages or differences between countries. Ricardian theory explains trade with international differences in technology, while in the Heckscher-Ohlin model, trade occurs because of differences in relative factor endowments among countries and factor input intensities across industries. More recent theories of international trade take into account differentiated products, scale economies and other forms of imperfect competition as determinants of trade. See Dixit and Norman (1980), Leamer (1984), Helpman and Krugman (1985) and Krugman (1990) among others.

Since comparative advantage models predict that trade will occur between countries which differ in technology or relative factor endowments, one would expect to find much trade between countries which are significantly distinct with respect to this. Countries with a high capital to labour ratio for example, e.g. developed countries, should trade relatively more with countries with much less capital per worker. And furthermore, for each country, factor input intensities in exported goods should differ from those in imported goods. Because factor input intensities are assumed to vary more across industries than within industries, a country should export and import goods produced in different industries, i.e. different goods.

These conclusions are not consistent with actual trade patterns. A very large share of world trade is among developed countries with relatively similar capital to labour ratios. (For example 73.8 per cent of EC countries' trade in 1990 was with European countries.) Developed countries are probably also relatively similar with respect to technology, at least when compared with less developed countries. Furthermore, national trade statistics indicate prevalent trade in differentiated products. These empirical findings are difficult to explain within theories solely based on comparative advantages and homogeneous goods, even if one takes into account transportation costs and border trade. Hence, comparative advantage models seem unable to explain the salient features of international trade. Trade statistics for Norway show that most of the trade is with other OECD-countries, in particular Sweden, Germany, United Kingdom, the USA and Denmark are of importance. And furthermore, the statistics also show that there is much two-way exchanges of differentiated products. We will therefore focus on theories which can explain intra-industry trade. This is not because we assume comparative advantages to be irrelevant in explaining Norwegian exports, but because mechanisms taken into account by alternative models are assumed to be of major importance. We will also investigate the relevance of the "small open economy" model.

Trade in differentiated products is discussed in chapter 2.1, and the Armington model, where the qualities of a commodity is assumed to vary with place or country of production, is presented. The "small open economy" model is presented in chapter 2.2.

2.1. International trade in differentiated products: the Armington model

As already pointed at, a large share of world trade is two-way exchanges of differentiated products. Differentiated products can be defined as imperfect substitutes for each other with finite elasticities of substitution. Lancaster (1966,1979) proposes the definition that differentiated products possess particular characteristics in different proportions, and the "ideal variety" approach is introduced to explain preferences for differentiated products. Each consumer is assumed to have an ideal product or variety which she would prefer to buy if that variety is available and the price differentials are not too big. Due to the existence of internal economies of scale, not all ideal varieties are produced. The consumers' choice depend on the product prices as well as the distance between the products' characteristics and the ideal variety. If consumers are not identical, the aggregate outcome is well defined demand curves for all products available. The degree of differentiation is expected to be reflected in the price elasticities; the existence of close substitutes should give relatively high price elasticities. In the work of Spence (1976) and Dixit and Stiglitz (1977), the "love of variety" approach is introduced. Consumers are assumed to value variety in its own, and they buy some of each product available, even if the same price is charged for all products or varieties. Also this approach predicts well defined demand curves for all products.

On the supply side we assume monopolistic competition and price setting behaviour.[4] In markets with monopolistic competition, many small firms produce differentiated products, and it is assumed that each firm faces a downward sloping demand curve. It is also assumed that changes in the price of one product have only minor impact on demand facing other firms. Since the interdependence between firms are small, they act as monopolists, cf. Chamberlin (1933). The own price elasticity may be high, as already suggested. Positive profits encourage new firms to enter the market, and in the Chamberlinian approach to monopolistic competition with no barriers to entry, firms will enter until there are zero profits. Alternatively, we may assume only a few firms on the supply side, i.e. the oligopoly pricing model with differentiated products.

We will now present a model with national product differentiation. In the article by Armington (1969), a theory of demand for products distinguished by place of production is put forward. The basic idea is that firms within the same geographical area produce identical products, but products of the same commodity produced in different areas are heterogeneous. If there are n different commodities produced in m geographical areas or countries, there are $n \cdot m$ different products. In each area there are demand curves for all the products, and hence a full trade model contains $n \cdot m \cdot m$ demand and supply functions. When modelling foreign demand facing Norwegian products, the system can be reduced to $n \cdot (m-1)$ export demand equations. By treating foreign markets as one aggregated market, we end up with n export demand equations. In this case the number of geographical areas m equals two; the domestic market and the export market.

We assume separability in demand for different commodities, constant elasticity of substitution between products of the same commodity and that consumers have no money illusion. We use a log-linear specification, and define foreign demand for Norwegian exports in equation (2.1). All variables are measured in Nkr.

$$\log(X_{Ai}) = \alpha_{0i} + \alpha_{1i}\log(M_i) + \alpha_{2i}\log(P_{Ai}/P_{Wi}) \qquad i=1,..,n \qquad (2.1)$$

where

X_{Ai} : Norwegian exports of commodity i in constant prices

M_i : World demand for commodity i in constant prices

P_{Ai} : The Norwegian export price of commodity i

P_{Wi} : Competitors' prices in the world market of commodity i,

[4] This is consistent with the export price determination in MODAG, see Cappelen (1992).

and α_{0i}, α_{1i}, α_{2i} are coefficients in the model. α_{1i} is the market elasticity, while α_{2i} is the price elasticity. The theoretical predictions are that $\alpha_{1i} > 0$, given that Norwegian products are not inferior in demand, and $\alpha_{2i} < 0$.

In the monopolistic competition case, an optimum does not exist if demand is inelastic: If $|El_P X| \leq 1$, the first order condition for profit maximization entails $c_x(x) \leq 0$, where $c_x(.)$ is marginal costs. We should therefore restrict the long-run price elasticity so that $\alpha_{2i} < -1$. However, we analyse aggregate goods rather than single goods, and the assumption of homogeneous goods within a country may be violated. If Norwegian firms produce differentiated products which are substitutes to each other, we may well find small price elasticities at the aggregate level, even if each firm at the micro level faces a price elasticity well below minus one. This is due to the substitution effect between Norwegian products. We will illustrate this with a simple example. Assume that two domestic firms produce close substitutes of the same commodity. Let equation (i) and (ii) define export demand for these two products denoted X_{A1} and X_{A2} respectively, equation (iii) gives total exports of the commodity in question. P_{A1} and P_{A2} are the export prices, M is total foreign demand for the commodity and P_W is competitors' prices in the world market.

$$X_{A1} = A_0 \cdot M^{a_1} \cdot (P_{A1}/P_{A2})^{a_2} \cdot (P_{A1}/P_W)^{a_3} \tag{i}$$

$$X_{A2} = B_0 \cdot M^{b_1} \cdot (P_{A2}/P_{A1})^{b_2} \cdot (P_{A2}/P_W)^{b_3} \tag{ii}$$

$$X_A = X_{A1}+X_{A2} \tag{iii}$$

The price elasticities faced by the domestic firms are given below.

$$\begin{aligned} El_{P_{A1}}X_{A1} &= a_2+a_3 \qquad & El_{P_{A2}}X_{A1} &= -a_2 \\ El_{P_{A2}}X_{A2} &= b_2+b_3 \qquad & El_{P_{A1}}X_{A2} &= -b_2 \end{aligned}$$

We are interested in the effect on aggregate exports, X_A, of a one per cent increase in both P_{A1} and P_{A2}. Let $P_A=P(P_{A1},P_{A2})$ define the aggregate export price, which is homogeneous of degree one by construction. We find that

$$\begin{aligned} El_{P_{A1}}X_A &= El_{P_{A1}}(X_{A1}+X_{A2}) = (X_{A1} \cdot El_{P_{A1}}X_{A1}+X_{A2} \cdot El_{P_{A1}}X_{A2})/X_A \\ &= (X_{A1}/X_A) \cdot [a_2+a_3-(X_{A2}/X_{A1}) \cdot b_2] \end{aligned}$$

$$\begin{aligned} El_{P_{A2}}X_A &= El_{P_{A2}}(X_{A1}+X_{A2}) = (X_{A1} \cdot El_{P_{A2}}X_{A1}+X_{A2} \cdot El_{P_{A2}}X_{A2})/X_A \\ &= (X_{A1}/X_A) \cdot [-a_2+(X_{A2}/X_{A1}) \cdot (b_2+b_3)]. \end{aligned}$$

And hence the aggregate price elasticity is given by the equation below.

$$El_{P_A}X_A = El_{P_{A1}}X_A + El_{P_{A2}}X_A = (X_{A1}/X_A) \cdot [a_3 + (X_{A2}/X_{A1}) \cdot b_3]$$

We estimate the aggregate relationship in (iv).

$$X_A = C_0 \cdot M^{c1} \cdot (P_A/P_W)^{c2} \qquad \text{(iv)}$$

The elasticity of aggregate exports with respect to the aggregate export price is c_2, which should equal the aggregate elasticity calculated above. Hence we have that

$$c_2 = (X_{A1}/X_A) \cdot [a_3 + (X_{A2}/X_{A1}) \cdot b_3].$$

This illustrates that even if each firm faces an own-price elasticity well below minus one, i.e. $(a_2 + a_3) < -1$ and $(b_2 + b_3) < -1$, the aggregate export price elasticity c_2, which is a weighted sum of a_3 and b_3, may well be above minus one. We also see that if the relative share of each product in the aggregate commodity changes over time, i.e. X_{Ai}/X_A is not constant, the result will be time-varying coefficients in an aggregate analysis when $a_3 \neq b_3$. Because the number of firms producing the commodities analysed by us is relatively large, so that X_{Ai}/X_A is relatively small, this issue may not be very serious. In the econometric part we focus on the stability of the estimated coefficients though.

The observed prices are unit value indices which equal one in a base year, and the constant term α_{0i} therefore reflects any differences in price levels in the base year. In the Norwegian national account, export prices of commodities are calculated on the basis of price information on physical units of "main" products rather than on all products classified as the same commodity. We may therefore face a problem with measurement error in the export prices. Furthermore, if we use improperly measured export prices to deflate error-free export values, negatively correlated errors will result between the left hand side variable and the export price in our analysis. The effect of this is that the estimated price elasticity will be biased towards minus one as the variance on the measurement error goes to infinity (Kemp (1962) and Magee (1975)). However, we have no reasons to believe that this variance is very large.

If α_{1i} in (2.1) equals one, this implies constant market share at constant relative prices. "Market share" is defined as the export volume of a commodity divided by the corresponding world demand variable. Changes in market shares are assumed to capture the development in the "overall" competitiveness of trading industries, which includes both price and non-price competitiveness. The development in price competitiveness can be seen directly from the development in relative prices, while the market elasticity is assumed to reflect the development in non-price competitiveness. In general, non-price competitiveness depends on a large number of factors such as production capacity, transportation costs, trade barriers, product design, product choice or quality, product proliferation, marketing and advertising, delivery reliability, after sales service, etc. Because prices are measured on physical units, export volumes and prices will include quality changes. Most variables influencing firms' non-price competitiveness are difficult to observe or express in quantitative terms. For this reason, empirical analysis tend to either neglect most of these factors, i.e. the market elasticity is interpreted as a "gross elasticity", or to add simple deterministic or stochastic trends in the export equations to capture long term trends in these variables. (With respect to the inclusion of trend variables and the interpretation of this, see for example Anderton and Dunnett (1987) and Anderton (1992).) A market elasticity below unity or a negative trend coefficient is assumed to indicate a loss of non-price competitiveness, while the opposite is true with a market elasticity above one or a positive trend coefficient. This interpretation of the market elasticity presupposes that there has been a relatively steady growth in world demand over time. If the data does not support the restriction $\alpha_{1i} = 1$, we will examine whether the deviation from unity can be explained by a trend variable, i.e. we will include a deterministic trend variable in equation (2.1).

The inclusion of a trend may or may not be a good approximation of the processes determining the development in non-price competitiveness. From an economic policy point of view, the problem with a deterministic trend is that since one does not know what determines the trend, it is not possible to adapt targeted policies to influence it. If the econometric model is used for forecasting, the inclusion of a deterministic trend variable is unsatisfactory also because of its long-run interpretation. If all other economic variables remain constant, there will still be changes in the export volumes. In the simple case with a linear or quadratic trend, exports will either decline towards zero or grow to unlimited levels over time. In practice, the forecast horizon will also matter. One is perhaps more reluctant to use a model which includes deterministic trend variables in long horizon forecasting than in short horizon forecasting. To avoid the deterministic growth problem, some studies have included profitability as an indicator for the development in non-price competitiveness in the exporting industries instead of a deterministic trend. The assumption is that increased (decreased) profitability implies a gain in (a loss of) non-price competitiveness. In the Treasury model for the British economy, profitability is proxied by exporters' margins and assumed to capture changes in non-price competitiveness (Wallis et al. (1987)). One problem with this is that profitability or margins is endogenous and vary systematically with economic cycles and thus may reflect other aspects than changes in non-price competitiveness.

We aggregate foreign markets into one single market. This is necessary because there are no data available which allows us to estimate country specific market and price elasticities for the Norwegian commodities which we are interested in. Trade matrices with both value and volume terms for four SITC-commodities[5] developed by the LINK project (Campano (1988)), open the possibility for a certain degree of country specific analysis of Norwegian external trade over the period 1960-1986. We use these trade matrices to identify international trade patterns when calculating world demand variables in chapter 3.

We assume that the elasticity of Norwegian exports with respect to "market growth" is equal and constant by all our principal trading partners. And when aggregating, country specific demand is weighted according to each country's importance for Norwegian exports. Consequently, we use weights which reflect the share of Norwegian products in domestic demand abroad. Equation (2.2) defines the weighted sum of demand for commodity i in L countries. M_{il} represents the demand for commodity i in country l.

$$M_i = \Sigma_l w_{il} \cdot M_{il} / \Sigma_l w_{il} \qquad i=1,..,n,\ l=1,..,L \qquad (2.2)$$

The weights w_{il} are calculated as Norwegian exports of commodity i to country l relative to that country's "demand" for commodity i in a specific year. The weights are treated as constants. For similar reasons, competitors' prices of commodity i is constructed as a weighted average of the price of commodity i in each of Norway's main trading partners. P_{Wil} represents the price of commodity i in country l measured in Nkr.

$$P_{Wi} = \Sigma_l w_{il} \cdot P_{Wil} / \Sigma_l w_{il} \qquad i=1,..,n,\ l=1,..,L \qquad (2.3)$$

In chapter 3.3 we present empirical proxies for the world demand variables based on more aggregate data for foreign demand than suggested by the Armington model, while the empirical proxies for competitors' prices are not. This has an additional implication as relative prices abroad between different commodities should be added to the model. This can be illustrated by the following simple example. We look at two countries, Home and World, which produce and trade products of two commodities, commodity 1 and 2. Equation (i) defines total demand for commodity 1 by country W, M_{1W}, and equation (ii) defines import demand of commodity 1 by W, X_{A1}. The latter equals country H's exports of commodity 1.

[5] The UN Standard International Trade Classification.

M_W denotes total demand by country W, i.e. the demand for both commodity 1 and 2. We assume that country W is relatively large compared with country H, and that the effect on commodity prices in country W, P_{W1} and P_{W2}, from changes in export prices by country H, P_{A1} and P_{A2}, can be ignored.

$$M_{1W} = m(P_{W1}/P_{W2}, M_W) \quad \text{(i)}$$

$$X_{A1} = a(P_{A1}/P_{W1}, M_{1W}) \quad \text{(ii)}$$

Regarding the partial derivatives of m(.) and a(.), we assume that $m_1(.) < 0$, $m_2(.) > 0$, $a_1(.) < 0$ and $a_2(.) > 0$. We now combine (i) and (ii), and this gives the following export demand function for commodity 1 faced by exporters in country H.

$$X_{A1} = A(P_{A1}/P_{W1}, P_{W2}/P_{W1}, M_W) \quad \text{(iii)}$$

where $A_1(.) < 0$, $A_2(.) > 0$ and $A_3(.) > 0$. Thus, an increase in competitors' prices of commodity 1, P_{W1}, has both a positive and a negative effect on exports of commodity 1 from country H to country W. The positive effect is due to a fall in the relative export price, P_{A1}/P_{W1}, while the negative effect is due to a reduction in world demand for commodity 1, M_{1W}, because P_{W1} increases relative to P_{W2}.

In the empirical part of this paper we use the Armington model defined by (2.1)-(2.3) with the generalisation suggested by equation (iii) above when this is relevant. The reason for not analysing the more general case with differentiated commodities both between and within countries, is largely due to the aim and scope of this analysis and the data available. To study a more general case we would need data at the firm level or a more disaggregated industry level. A weaker assumption supporting the chosen approach is that the elasticities of substitution are lower between single products produced by each country than between single products produced by different countries. This may for example be the case if some countries produce high quality and others lower quality products, or if there is a higher degree of stability in deliveries from some countries than others. Also advertising and marketing, which succeed in creating a favourable country specific image may give this result.

2.2. The small open economy (SOE) model

It is convenient to use a static partial equilibrium model to illustrate the SOE model. Only the product market is modelled explicitly, and we suppress the subscript denoting commodity

i. The most important assumptions are:

1. The small economy faces perfectly elastic foreign supply and demand, and changes in demand or supply in the small economy have no influence on international prices.
2. Commodities produced at home and abroad are homogeneous.

In each period, domestic producers make a joint decision of how much to sell at home and how much to export. We assume profit maximizing behaviour and increasing marginal variable costs in the domestic industry. The capital stock is fixed in the short-run. Factor prices are also treated as fixed parameters to the producers. Furthermore, in the simple case we assume no impediments to trade and in particular zero transportation costs. Hence the export and import price will equal the world market price adjusted for changes in the exchange rate. All variables are measured in Nkr.

$$\Pi = P_H \cdot X_H + P_A \cdot X_A - c(X,P_V;K) - F \tag{2.4}$$

$$X = X_H + X_A \tag{2.5}$$

$$D = g[\min(P_H,P_I),P^*,Q] \tag{2.6}$$

$$D = X_H + X_I \tag{2.7}$$

$$P_A = P_I = P_W \tag{2.8}$$

where

P_H : The price of domestic sales of the commodity
P_A : The export price of the commodity
X : Domestic output of the commodity in constant prices
X_H : Domestic sales of the commodity in constant prices
X_A : Exports of the commodity in constant prices
c(.) : Variable costs in the domestic industry
P_V : Domestic factor prices
K : Capital stock of the domestic industry
F : Fixed production costs
D : Total domestic demand for the commodity in constant prices
P^* : The price of other commodities in the domestic market
Q : Total domestic income
X_I : Imports of the commodity in constant prices
P_I : The import price of the commodity
P_W : The international price of the commodity.

Equation (2.4) defines the aggregate profit function in the domestic industry. Variable costs depend on factor prices, the level of domestic production and the capital stock. Let $c_i(.)$ denote the partial derivative of variable costs with respect to variable i. It is assumed that $c_i(.) > 0$ for $i=P_V,X$ and $c_{xx}(.) > 0$, while $c_K(.) < 0$. The latter will only be of interest in a dynamic version of the model, since K is assumed fixed in the short-run. Equation (2.5) says that domestic output can be sold in the home market or exported. Equation (2.6) defines the domestic demand function for the commodity. It is assumed that $\partial g(.)/\partial P_H < 0$ if $P_H < P_I$ and $\partial g(.)/\partial P_I < 0$ if $P_H > P_I$, and $\partial g(.)/\partial Q > 0$. $\partial g(.)/\partial P^*$ is ambiguous. Domestic sales can only be positive if domestic producers charge a price equal to or below the import price.

Given equation (2.8), which says that both the Norwegian export and import price equal the world market price, we need not discriminate between a situation with many small or only a few domestic firms. The marginal income curve for a monopolist or an oligopolist will be constant and equal to the world market price. Charging a price above P_W in the domestic market gives zero sales at home, and profit maximizing producers will never charge a price below P_W, since they are facing the alternative of exporting at this price.

Profit maximization yields the following first order conditions in the home and foreign market for domestic producers:

$$P_H = P_A = c_x(.) \qquad (2.9)$$

Thus in optimum, marginal costs and the price of domestic sales equal the export price, and domestic producers are indifferent between selling at home or abroad.

Because we assume homogeneous goods, two-way trade of a commodity, i.e. at the same time both exports and imports, is inconsistent with the model. There is no motivation for border trade due to the assumption of no transportation costs. In this simple model, three qualitatively different situations can occur:

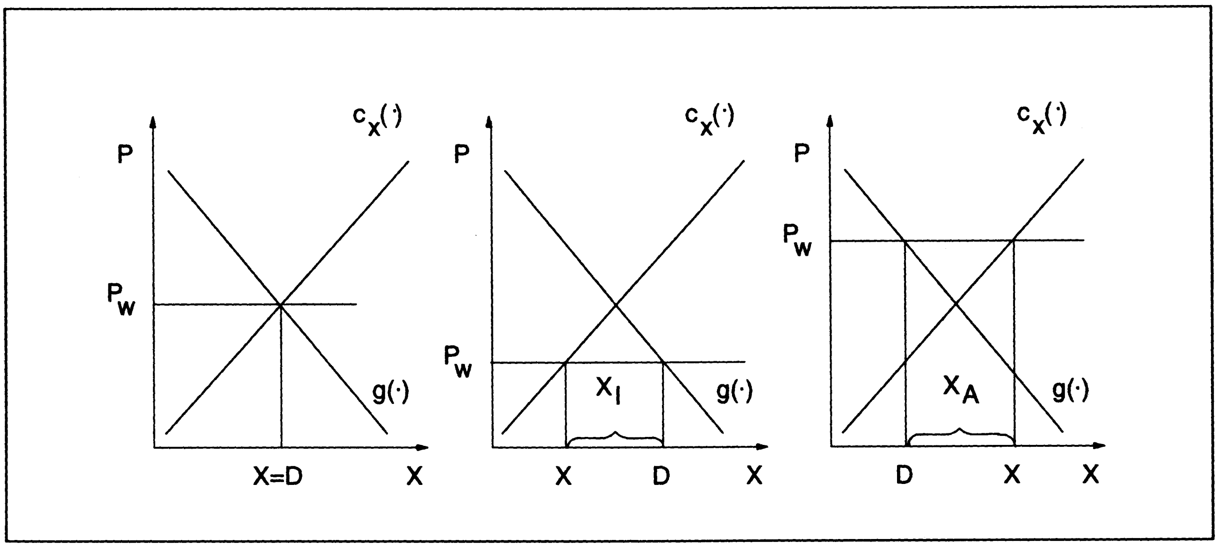
(i) Domestic output equals domestic demand at the international price level, the commodity will neither be exported nor imported.

(ii) Domestic demand exceeds domestic output at the international price level, the commodity will be imported but not exported.

(iii) Domestic output exceeds domestic demand at the international price level, and domestic output is partly exported. There will be no imports.

These three situations are shown in figure 2.1-2.3.

Figure 2.1 *Figure 2.2* *Figure 2.3*



Within this framework, the small country's export supply will equal what is left after subtracting domestic demand from domestic output. This gives a "residual" (i.e. reduced form) export supply function as defined by equation (2.10). If domestic demand exceeds domestic production so that X_A in (2.10) is negative, we have a situation with zero exports but positive imports. For simplicity, the rest of the discussion refers to situations with positive exports; domestic output is assumed to be larger than domestic demand. We replace P_I in the domestic demand function with P_A due to (2.8).

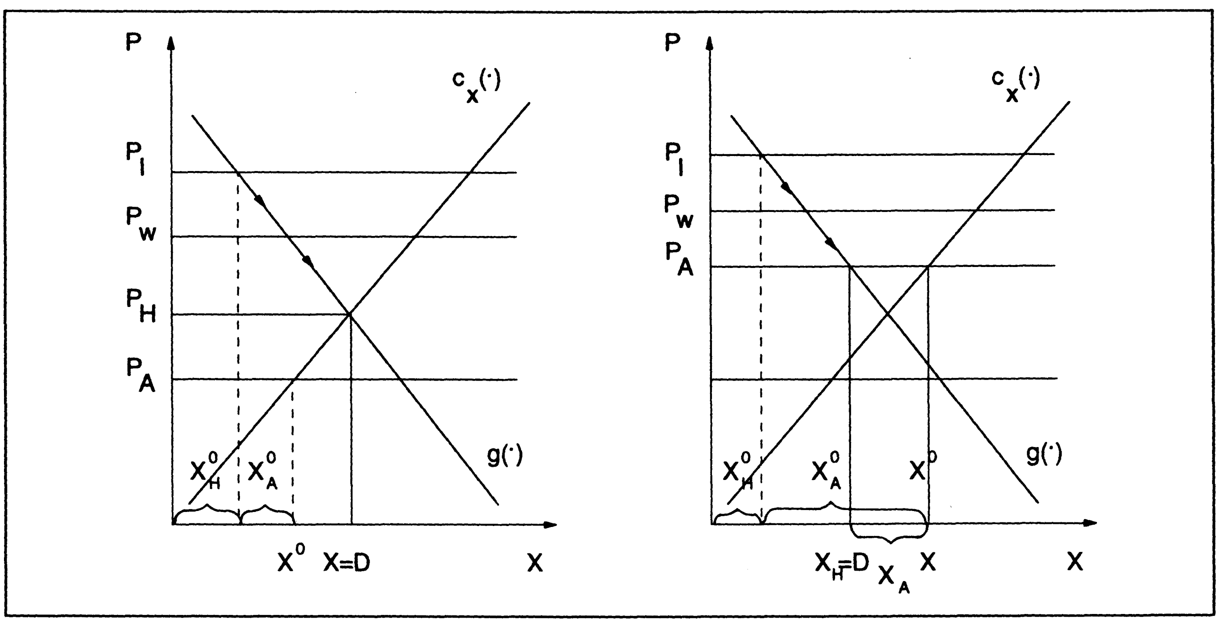
$$X_A = X - X_H = S(P_A,P_V;K) - g(P_A,P^*,Q) = A(P_A,P_V,P^*,Q;K) \qquad (2.10)$$

where $\partial A(.)/\partial P_A > 0$, $\partial A(.)/\partial P_V < 0$, $\partial A(.)/\partial Q < 0$ and $\partial A(.)/\partial K > 0$. $\partial A(.)/\partial P^*$ is ambiguous.

S(.) is the aggregate supply function in the domestic industry consistent with the first order conditions in (2.9). An increase in the world market price, which by assumption increases both the export and import price, will increase domestic production and decrease domestic demand, and so exports must increase. The mechanism behind the negative effect on export supply of increasing factor prices is a reduction in domestic production due to an increase in marginal costs. The negative effect of increasing domestic income operates through an increase in domestic demand. An expansion in the capital stock is assumed to reduce marginal costs and hence increase domestic output and exports. An increase in other domestic prices will influence domestic demand both through a negative income effect and a substitution effect which sign can be either negative or positive. The net effect is therefore theoretically unpredictable. Because of the symmetry between exports and imports in this residual export supply function, the mechanisms affecting exports will also affect imports, but in the opposite direction.

If there are impediments to trade, such as transportation costs or import taxes, the domestic market structure, i.e. whether there are many small or only one or a few firms, can be important for the market solution and thus the residual export function. This is because the export and import price faced by domestic agents may differ. Impediments to trade which rise the import price or reduces the export price compared to the world market price, implies that domestic oligopolists or a monopolist find it profitable to exploit their market power in the domestic market. An upper bound on the price of domestic sales is given by the import price, while a lower bound is given by either the export price or the price that would be realized in the autarky situation, dependent on which of these are highest. Charging a price in the domestic market below the import price rules out threats of competition from imports.

Figure 2.4. ***(a)*** ***(b)***



In a situation with perfect competition in the domestic market, i.e. many small domestic firms, one can argue that the price charged at home should equal either the export price or the autarky price. Assume that we initially have a situation where the price of domestic sales equals the import price, and that this is higher than the export price. Domestic producers will not be indifferent between supplying the domestic or the export market if they are informed about this price differential. This will result in a negative pressure on the price in the home market through a shift in supply from exports to domestic sales. This process will stop when the price of domestic sales equals the export price or the autarky price. The market solution is illustrated in figure 2.4, where variables with a "zero" represent the assumed initial situation. In figure 2.4.a, the autarky price is above the potential export price, the price of domestic sales equals the autarky price, and there are neither exports nor imports. In figure 2.4.b, the export price is above the autarky price, and there are positive exports. In this latter case $P_H=P_A$, and the "residual" export supply equation is equal to equation (2.10).

If we have a stable monopoly or a stable market sharing oligopoly, the first order condition for profit maximization is given in (2.11). It is assumed that the oligopolists face the same price elasticity.

$$P_H[1 + 1/El_{PH}D] = P_A = c_x(.) \tag{2.11}$$

In optimum, marginal income from selling at home or abroad are equal and identical to marginal costs in production. The market solution is illustrated in figure 2.5. (In the market sharing oligopoly case, one should think of figure 2.5 as illustrating the solution for one firm. In this case the demand curve represents the demand faced by one firm.) The "residual" export supply function is given in equation (2.12).

$$X_A = X - X_H = S(P_A,P_V;K) - g(P_H,P^*,Q) = A(P_A,P_V,P_H,P^*,Q;K) \tag{2.12}$$

where $\partial A(.)/\partial P_A > 0$, $\partial A(.)/\partial P_V < 0$, $\partial A(.)/\partial P_H > 0$, $\partial A(.)/\partial Q < 0$ and $\partial A(.)/\partial K > 0$. $\partial A(.)/\partial P^*$ is ambiguous. In this case, P_H is an endogenous variable.

Figure 2.5.

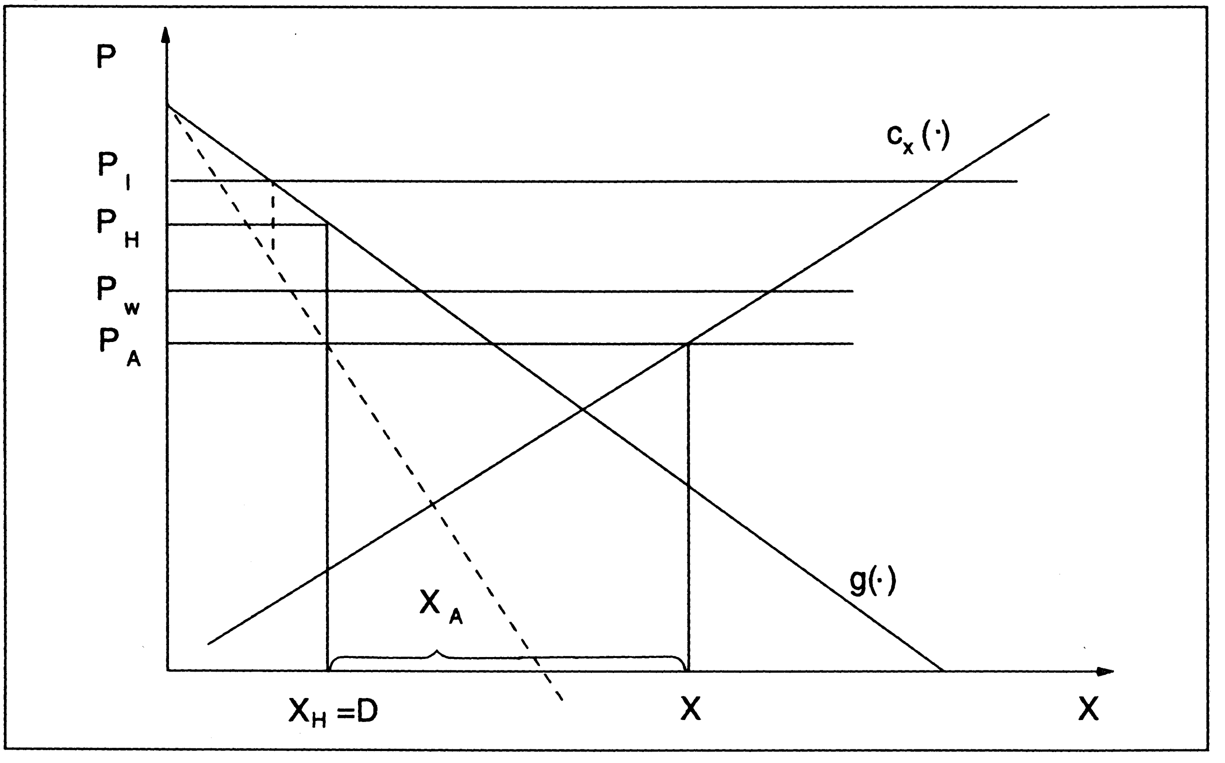
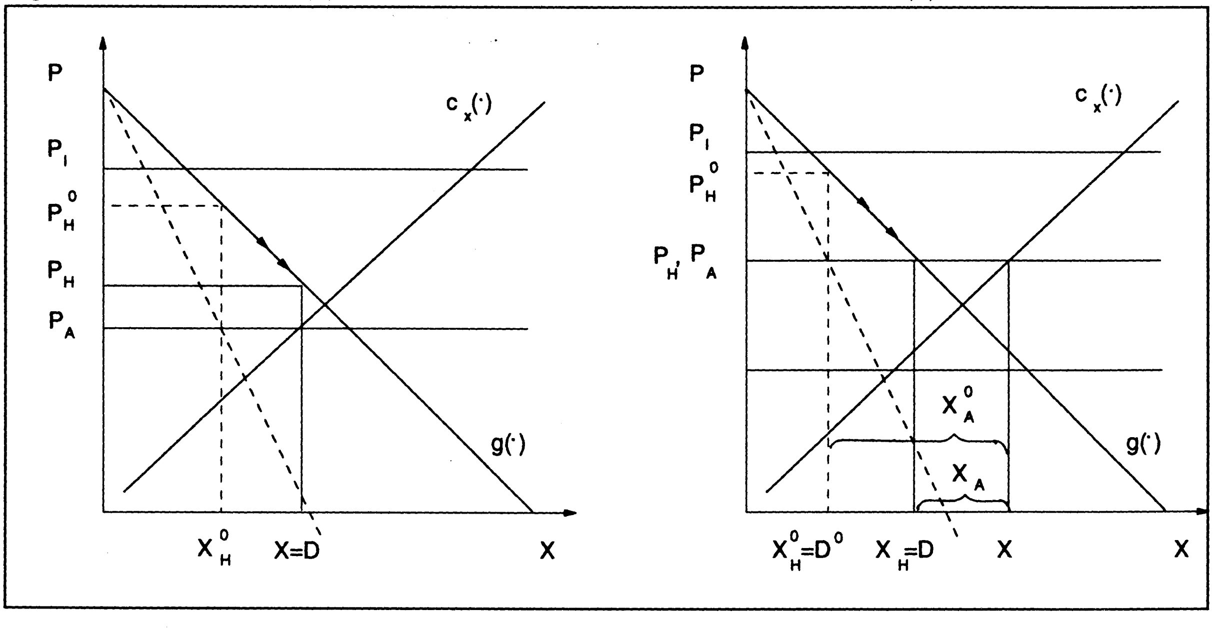


Figure 2.6. *(a)* *(b)*



If on the other hand the monopoly or oligopoly is not stable, competition for domestic market shares and a price undercutting process may result. By undercutting the price slightly, a firm will receive the whole domestic market. The process with price cutting will stop when further re-distribution of firms' sales in the domestic and foreign market pushes marginal income below marginal costs. The market solution in this case is illustrated in figure 2.6. In figure 2.6.a, where the autarky price is above the export price, domestic output equals domestic demand, i.e. there are no exports. In figure 2.6.b, where we assume the export price to be above the autarky price, there will be positive exports, and the price of domestic sales equals the export price. The "residual" export supply function, when we assume that $X_A > 0$, is the same as in equation (2.10).

As already explained, this model rules out the existence of two-way trade of a commodity. Taken at face value, Norwegian trade statistics do not support this. However, the commodities in our data are aggregates of goods with similar but not equal properties; they are groups of goods rather than single goods. If the weights of the single goods in the exported aggregates differ from those in the imported aggregates, this can explain the existence of two-way trade in the statistics. We should add however, that trade statistics on a very disaggregated level still show a lot of exports and imports of similar goods. Some of this may be explained by border trade due to transportation costs, but this phenomenon is not able to explain the large amount of two-way trade. Due to the aggregation effect, it may be adequate to treat exports and imports of an aggregate commodity as two different commodities. And for the same reason, one may argue that commodities produced for domestic sales in trading industries differ from those exported. In this case, firms' short run decision is how much of their production capacity to use in producing commodities for the export and domestic market respectively. Domestic firms are still assumed to be price takers in the world market, but they may have market power in the home market. The aggregate profit function, when we assume that the cost structure is not identical for the two alternative commodities, can now be written as in (2.13).

$$\Pi = P_H \cdot X_H + P_A \cdot X_A - c(X_H, X_A, P_V; K) - F \tag{2.13}$$

Where $c_i(.) > 0$, $c_{ii}(.) > 0$ $i=X_H, X_A$, $c_{PV}(.) > 0$ and $c_K(.) < 0$. Firms are assumed to maximize profits with respect to X_H and X_A. This yields the following first order conditions, where the first describes the optimum condition in the export market and the two last the optimum condition in the domestic market which depends on the market structure.

$$\left.\begin{array}{lll} & P_A - c_{XA}(.) = 0 & \text{and} \\ \text{(i)} & P_H - c_{XH}(.) = 0 & \text{when } P_H \text{ is exogenous, or} \\ \text{(ii)} & P_H[1 + 1/El_{PH}X_H] - c_{XH}(.) = 0 & \text{when } P_H \text{ is endogenous.} \end{array}\right\} \tag{2.14}$$

Hence in optimum, marginal costs in production of commodities for export and domestic sale equal marginal income in the foreign and domestic market respectively. Marginal income in the export market equals the export price. Regarding the domestic market, condition (i) is assumed in force in the following two cases: If domestic and foreign commodities sold in the home market are homogeneous, the price of domestic sales, P_H, will equal the import price, P_I, which we assume is exogenous to domestic agents. If domestic and foreign produced goods are heterogeneous, condition (i) is still relevant if there are many small domestic firms. In this case we assume $P_H \neq P_I$. If on the other hand there are only a few domestic firms producing for domestic sales, condition (ii) is more realistic, and P_H is endogenous. The export supply function consistent with (2.14) is given in (2.15).

$$\left.\begin{array}{lll} & X_A = A(P_A,P_V,P_H;K) & \text{and} \\ \text{(i)} & P_H = P_I \;\text{ or }\; P_H \neq P_I & \text{when } P_H \text{ is exogenous, or} \\ \text{(ii)} & P_H = P(P_I,P^*,Q,X_H) & \text{when } P_H \text{ is endogenous.} \end{array}\right\} \quad (2.15)$$

$\partial A(.)/\partial P_A > 0$, $\partial A(.)/\partial P_V < 0$, $\partial A(.)/\partial P_H < 0$ and $\partial A(.)/\partial K > 0$. Regarding the inverse domestic demand function P(.), we assume that $\partial P(.)/\partial P_I > 0$, $\partial P(.)/\partial Q > 0$, $\partial P(.)/\partial X_H < 0$, while $\partial P(.)/\partial P^*$ is ambiguous.

The general export model, which encompasses all the market situations described in chapter (2.2), i.e. equation (2.10), (2.12) and (2.15), is given in (2.16). We assume price-cost homogeneity in supply and homogeneity in demand, and use a log-linear specification of the export supply function, A(.).

$$\begin{aligned} \log(X_A) = \beta_0 &+ \beta_1 \log(P_A/P_V) + \beta_2 \log(P_H/P_V) + \beta_3 \log(P_H/P^*) \\ &+ \beta_4 \log(Q/P^*) + \beta_5 \log(K) \end{aligned} \quad (2.16)$$

β_j, j=0,..,5, are coefficients in this general small open economy model. β_1 and β_2 represent the price-cost elasticities in domestic supply, $-\beta_3$ the price elasticity and $-\beta_4$ the income elasticity in domestic demand, while β_5 is the capital elasticity in supply. The theoretical predictions are that $\beta_1 > 0$, $\beta_2 < 0$, $\beta_3 > 0$, $\beta_4 < 0$ and $\beta_5 > 0$. If we find that $\beta_j = 0$, j=2,3,4, equation (2.16) is reduced to a simple export supply function consistent with a Cobb-Douglas production function. $\beta_5 = 1$ implies a constant return to scale technology. If $\beta_2 = 0$, equation (2.16) is reduced to a residual export supply function. In this case we are not able to discriminate between the various situations described earlier by exclusion restrictions alone. But, $P_A = P_H \equiv P_W$ according to the simple case with no impediments to trade, $P_A \equiv P_H \neq P_W$

when we have impediments to trade and a competitive domestic market structure or an unstable monopoly or oligopoly, while $P_A \neq P_H$ when we have impediments to trade and a stable monopoly or oligopoly. These predictions regarding the relationship between the export price and price of domestic sales are possible to check on Norwegian data, and also whether there are many or only a few domestic firms in an industry. If we find β_2 to be significant, that is if the data supports the "multiproduct firm" approach, we should test whether P_H is weakly exogenous with respect to X_A or not. The same is true if we find β_3 to be significant.

3. COMMODITY SPECIFIC INDICATORS FOR WORLD DEMAND AND COMPETITORS' PRICES IN THE ARMINGTON MODEL

The theoretical export demand (Armington) model in (2.1) assume separability in demand for different commodities. In this case, the *ideal* world demand variable for a commodity is aggregate demand for the commodity by our trading partners as defined by equation (2.2). Competitors' prices, defined by equation (2.3), should ideally measure foreign prices on close substitutes to Norwegian products. Different levels of aggregation and classification systems for Norwegian commodities and the commodities in international data sources, make it difficult to achieve ideal measures of world demand and the competitors' prices for the commodities of interest, i.e. the commodities defined in table 4.1. We can think of several proxies for the variables describing foreign markets, but it is difficult to choose among them on pure theoretical grounds. Similar studies on foreign data use various proxies for both world demand and competitors' prices. Most frequently used are "world demand" based on data for different production measures or international trade, and "competitors' prices" based on foreign prices of production, imports and exports, or own import prices. Also a competitiveness term based on relative unit costs rather than relative prices is used. See for example Mènil and Westphal (1985), Wallis et al. (1987) and Laroque (1989). Regarding the aggregation technique, both unweighted measures for the whole world or OECD-countries as well as weighted averages across main trading partners are used.

In this paper, we present three different proxies for world demand, one based on data for private consumption and investments abroad and two based on data for foreign imports. The alternative based on consumption and investments attempts to measure total demand for different commodities by our principal trading partners. These variables are discussed in chapter 3.1. The import based alternatives use total imports of goods and imports of four groups of goods respectively and are presented in chapter 3.3 and 3.4. In this case we assume separability in demand between domestic products and imports, and Norwegian firms are assumed to compete with other exporters for shares in import demand abroad. Two alternative proxies for competitors' prices are presented, one where we use Norwegian import prices and one based on foreign import prices. With the exception of Norwegian import prices, all variables describing foreign markets are weighted averages across our trading partners. The weights reflect each country's importance for Norwegian exports. Our conclusion is that both the development in export market shares, relative prices and estimated coefficients in the export demand equations depend on the measures chosen. Export market shares are defined as the ratio of Norwegian exports to the corresponding world demand variable. This demonstrates that the choice of explanatory variables is of great importance.

When constructing the variables describing foreign markets, we are left to use relatively aggregate data and fixed parameters to identify commodity specific variables. We have therefore chosen to use a higher level of aggregation in the explanatory variables than in the commodities analysed. In the following, manufactured goods, i.e. the eight different commodities 16-46 in table 4.1, are aggregated to four groups, and world demand and competitors' prices are computed separately for these four groups:

1: Food, clothing etc. (commodity 16, 17 and 18)
2: Miscellaneous industrial products (commodity 25)
3: Raw materials from mining and manufacturing (commodity 34, 37 and 43)
4: Machinery and metal products (excl. ships) (commodity 46).

This implies that some commodities are assumed to face the same development in world demand and competitors' prices. It is also assumed that the commodities 74 and C70 face the same development in world demand and competitors' prices as group 1 defined above. Commodities facing the same development in foreign markets have important features in common. For example the commodities in group 1 depend mainly on consumption abroad, while the commodities in group 3, which are basically raw materials and intermediate goods, depend relatively more on the activity level in manufacturing industries and construction abroad.

To simplify, when constructing the variables describing Norwegian export markets, the number of countries included have been limited to our principal trading partners. These countries are chosen on the basis of table 3.1. The export shares are calculated as Norwegian exports of goods by country of destination relative to total Norwegian exports of goods. Crude oil and natural gas are not included.

"Other countries" are countries which each has a very small export share. Table 3.1 shows that the most important markets for Norwegian exports of goods (excl. crude oil and natural gas) are Sweden, West-Germany and the UK, and that trade patterns have been relatively stable over time. "Principal trading partners" are Denmark, France, Italy, Japan, Netherlands, Sweden, the UK, the USA and West-Germany, and variables describing foreign markets are based on data for these nine countries. The conclusion regarding which countries are most important for Norwegian exports is not altered if we look at disaggregated commodities rather than the more aggregate export measure in table 3.1.

Table 3.1. The ratio of Norwegian exports of goods by country of destination to total Norwegian exports of goods, excl. crude oil and natural gas. In per cent

	Export share in per cent		
Country	1984	1988	1991
Austria	0.7	0.7	0.7
Belgium	1.7	2.2	1.6
Denmark	6.5	7.4	7.5
Canada	1.2	1.3	0.8
Finland	3.2	3.5	3.4
France	3.8	5.5	5.5
Italy	2.8	4.0	3.9
Japan	3.1	3.0	3.6
Netherlands	5.3	5.0	5.4
Spain	0.7	1.3	1.9
Sweden	14.2	14.5	14.5
Switzerland	1.5	1.5	1.1
UK	12.3	12.0	11.2
USA	8.3	8.5	6.1
West-Germany	13.5	13.1	12.6
Other countries	21.2	16.6	20.3

Source: Monthly Bulletin of External Trade. Central Bureau of Statistics of Norway.

3.1. World demand based on private consumption and capital formation

The world demand indicators used in the earlier export model in MODAG, are based on data for total private consumption and residential and non-residential private investments in eight of Norway's most important trading partners (Tveitereid and Lædre (1981)). Japan is not included in these measures. The aim is to find measures which can be interpreted as total demand by our principal trading partners for the commodities of interest. Equation (3.1) and (3.2) describe the formulaes used when calculating demand for commodity i in country l (M_{il})

and the aggregate world demand variable (M_i). All weights are calculated in a base year and kept constant over time.

$$M_{il} = \Sigma_k \, a_{ik} \cdot d_k \cdot S_{lk} \, / \, \Sigma_k \, a_{ik} \qquad i=1,..,4, \; l=1,..,L, \; k=1,2,3 \qquad (3.1)$$

$$M_i = \Sigma_l \, c_{il} \cdot b_{il} \cdot M_{il} \, / \, \Sigma_l \, c_{il} \cdot b_{il} \qquad i=1,..,4, \; l=1,..,L \qquad (3.2)$$

where

S_{l1} : Total private consumption in country l at constant prices

S_{l2} : Residential private investments in country l at constant prices

S_{l3} : Non-residential private investments in country l at constant prices

a_{ik} : The Norwegian indirect input-output coefficient for commodity i from demand component k

d_k : Coefficient which gives private consumption of goods as the share of total private consumption. d_k equals 0.6 for k=1 and 1 for k=2,3

b_{il} : The import share in total demand for commodity i in country l

c_{il} : The share of Norwegian products in imports of commodity i in country l.

Equation (3.1) uses indirect input-output coefficients on private consumption of goods and investments to measure foreign demand for the four groups of Norwegian goods defined at the beginning of chapter 3. These input-output coefficients measure the total increase in demand for different commodities after a change in S_{lk}. Because it is not possible to identify the input-output coefficients for the countries and commodities of interest, input-output coefficients are calculated on Norwegian data and used on all countries. Since consumption of services has a smaller import share than consumption of goods, total private consumption is scaled down by a factor reflecting the share of services in total consumption. (Forty per cent is used as a common and constant scaling factor for all countries.) The assumption is that services do not generate imports. This does not affect the growth path of the consumption series, but it increases the relative importance of investments in the country specific demand variables and hence affects the growth rates in these.

The country and commodity specific weights, i.e. the products $b_{il} \cdot c_{il}$, play the same role as w_{il} in equation (2.2). Total demand for commodity i in country l is weighted by both the total import share as well as the share of total imports being covered by Norwegian products in a base year. Table 3.2 gives the products of the weights b_{il} and c_{il} multiplied by 100 to give the share of Norwegian exports in domestic demand for different commodities abroad in per cent.

Table 3.2. The share of Norwegian exports in domestic demand for different groups of manufactures by our principal trading partners, 1986. In per cent

Country	Group of manufactures: Food, clothing, etc.	Miscellan. industrial products	Raw materials[1]	Machinery and metal products[2]
Denmark	0.44	0.70	4.08	0.80
France	0.04	0.03	0.20	0.04
Italy	0.05	0.02	0.12	0.01
Netherlands	0.04	0.10	0.73	0.21
Sweden	0.67	0.83	2.09	1.50
UK	0.11	0.24	0.73	0.18
USA	0.01	0.01	0.04	0.01
West-Germany	0.05	0.07	0.68	0.11

1) Excl. crude oil and natural gas.
2) Excl. ships.
Source: Thorvik (1989).

Sweden and Denmark have the highest weights for all the groups of manufactures in table 3.2, illustrating the economic integration of the Scandinavian countries. The relatively small weights for West-Germany and the UK, even though they have large shares of Norwegian exports (see table 3.1), is due to the size of these economies.

In Tveitereid and Lædre (1981), competitors' prices in the world market are defined as world demand in value terms divided by world demand in volume terms. However, in estimated export demand equations, Norwegian import prices replaced these implicit price indices, cf. Bergan and Olsen (1985). They assume that Norwegian import prices follow the development in prices of similar commodities by our principal trading partners. This approach is not valid if foreign firms adopt a high degree of price discrimination between countries, which means that identical products are offered at different prices to different countries. Both a discriminatory and a non-discriminatory pricing policy is consistent with the Armington model. Von der Fehr (1987) and Naug (1990) find that Norwegian import prices depend on both domestic and international prices, which indicates that this approach may face serious problems. This will be further discussed below.

One argument for using Norwegian import prices, is that price information for all the commodities listed in table 4.1 is available. When using the price variables developed by Tveitereid and Lædre, information about competitors' prices is available for only four aggregate groups of commodities. Furthermore, the price variables developed by Tveitereid and Lædre fail to capture the gain in price competitiveness for Norwegian exports relative to domestic deliveries due to the decline in trade tariffs over time. This is because we do not measure the price of Norwegian exports in foreign markets, which include tariffs, but the export price of the Norwegian border (f.o.b. values). In fact, since the price variables developed by Tveitereid and Lædre includes imports and therefore includes reductions in trade tariffs, relative prices will be biased upwards and show a larger decrease or smaller increase in price competitiveness than the true development for Norwegian products over time. Using import prices in c.i.f. values as competitors' prices reduces but does not eliminate this problem; the increase in price competitiveness vis-a-vis domestic deliveries is still not captured. We face a problem with missing variables if changes in tariffs or prices of domestic sales in foreign markets have influenced Norwegian exports directly. Furthermore, the choice to use Norwegian import prices is only satisfactory if they develop in a similar way to import prices measured in c.i.f. values abroad. In addition to the problem with price discrimination, we may face an aggregation problem if the shares of single commodities in Norwegian imports differ from those abroad. If Norwegian import prices differ from import prices by our trading partners, this can be interpreted as measurement error in one of the explanatory variables. The standard conclusion regarding the consequence for OLS estimates in this case is that the price elasticity will be overestimated. However, the long-run elasticities obtained from cointegrating error correction models will be consistent if the measurement error is integrated of order 0 and thus has a finite variance, cf. Engle and Granger (1987). On the basis of the development over time in Norwegian and foreign import prices at the aggregate level, we argue that an assumption of finite variance in this measurement error is a plausible assumption, see chapter 3.5.

The world demand variables based on data for consumption and investments abroad suffer from several weaknesses. This is true for the world demand variables in both value and volume terms, and hence also for the proxies for competitors' prices based on these variables. First, they leave out important demand factors generating imports, e.g. exports. Since the second world war, our trading partners have experienced a more rapid growth in foreign trade than in consumption and investments. Including exports will therefore increase the rate of growth in these world demand variables. Second, the assumption that input-output coefficients are identical across countries and equal to the Norwegians are unlikely to be true. One obvious problem is the relative large oil sector in Norway. To minimize this problem, the base year for the input-output matrix is 1975, i.e. before the oil sector in Norway became large. But, one can also question the assumption of both fixed input-output coefficients and import shares over time. If these coefficients are time varying, the calculated world demand variables for different commodities are biased. Because of increasing international trade, we know that import shares have increased significantly. This is particularly problematic if the development in countries' import shares differ across our trading partners. Furthermore, the relationship between Norwegian imports of SITC-commodities and the commodities of interest is used to identify import data for the commodities of interest abroad. This method is of course unsatisfactory if the import structure abroad differs from the Norwegian.

The base year for the weights c_{il} and b_{il} used to be 1978. It was of interest to check the impact of changing the base year to a more recent year. Calculating the weights on the basis of data from 1986 instead of from 1978 influence the coefficients somewhat, but the total impact on the world demand variables is only minor. Table 3.2 gives the weights calculated in 1986, and the world demand variables used to calculate market shares in figure 3.1-3.4 are based on these new weights.

Figure 3.1-3.4 give the development in market shares and relative prices according to the world demand variables and competitors' prices presented in this chapter. Market shares are calculated as the export volume divided by the corresponding world demand variable, while relative prices are defined as the Norwegian export price divided by the Norwegian import price. All variables are expressed as annual indices (1980=1).

Figure 3.1. The export market share and the relative price for Food, clothing, etc., 1980=1

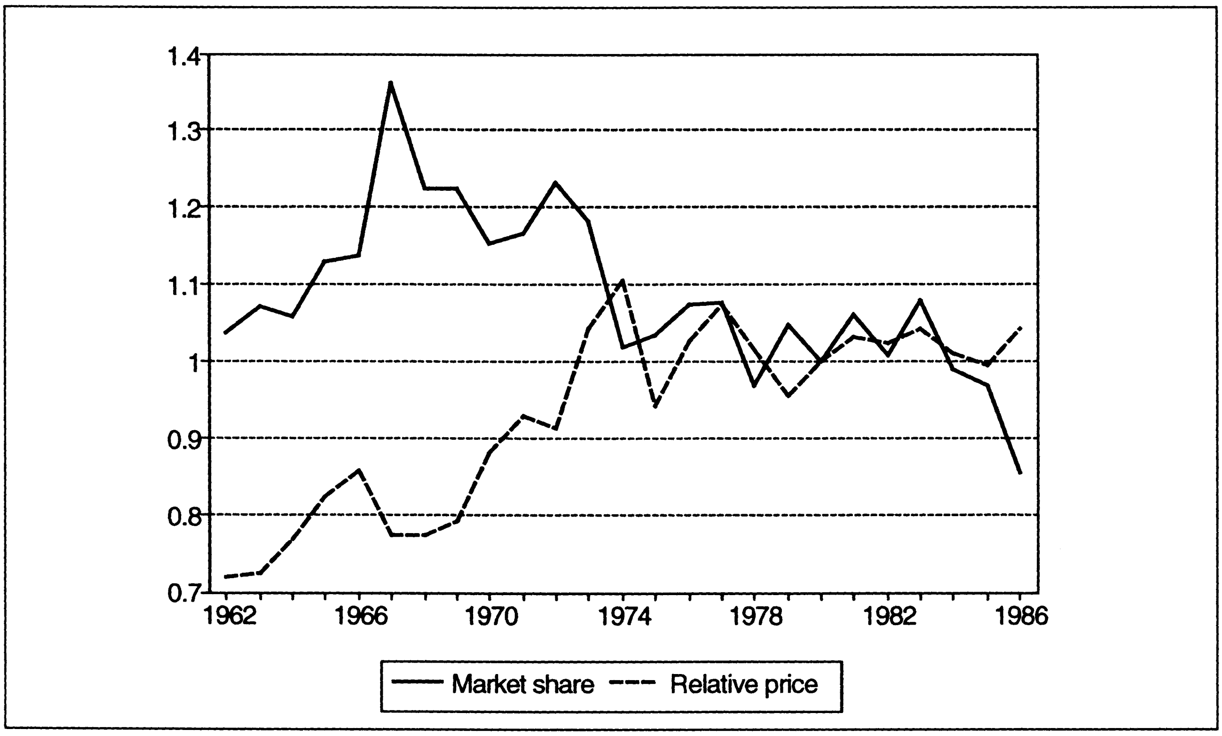


Figure 3.2. The export market share and the relative price for Miscellaneous industrial products, 1980=1

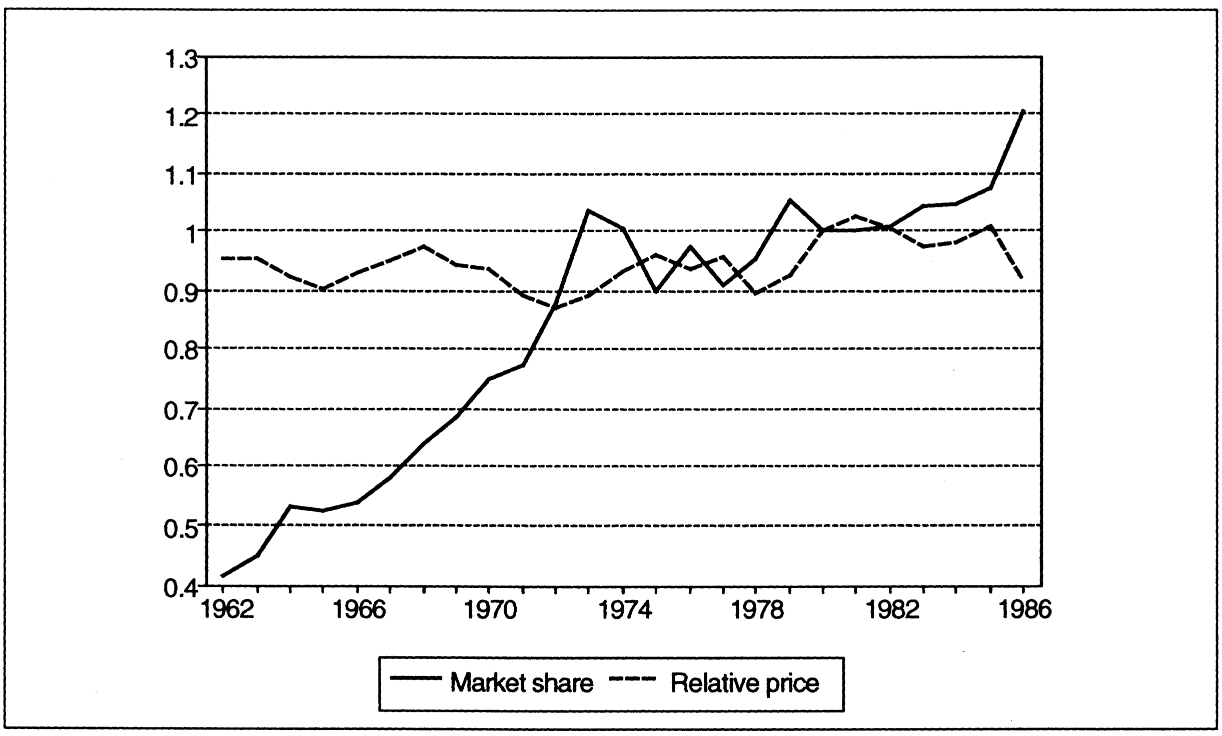


Figure 3.3. The export market share and the relative price for Raw materials from mining and manufacturing, 1980=1

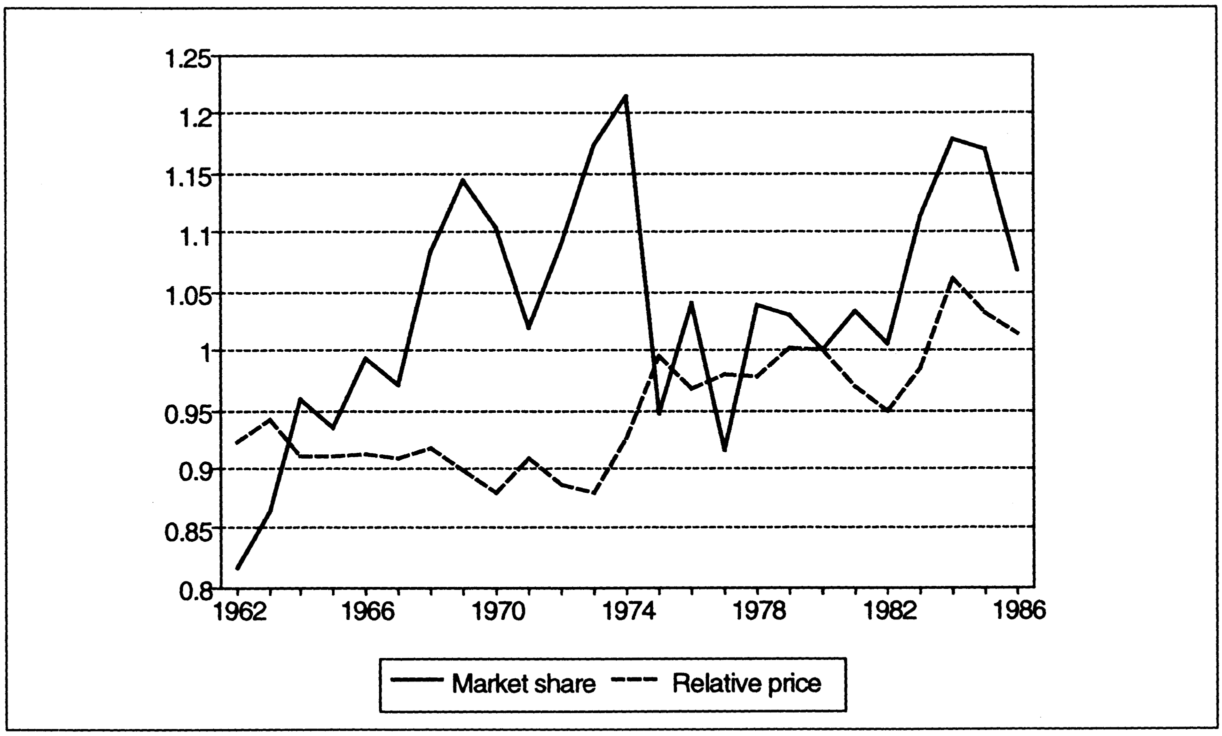


Figure 3.4. The export market share and the relative price for Machinery and metal products (excl. ships), 1980=1

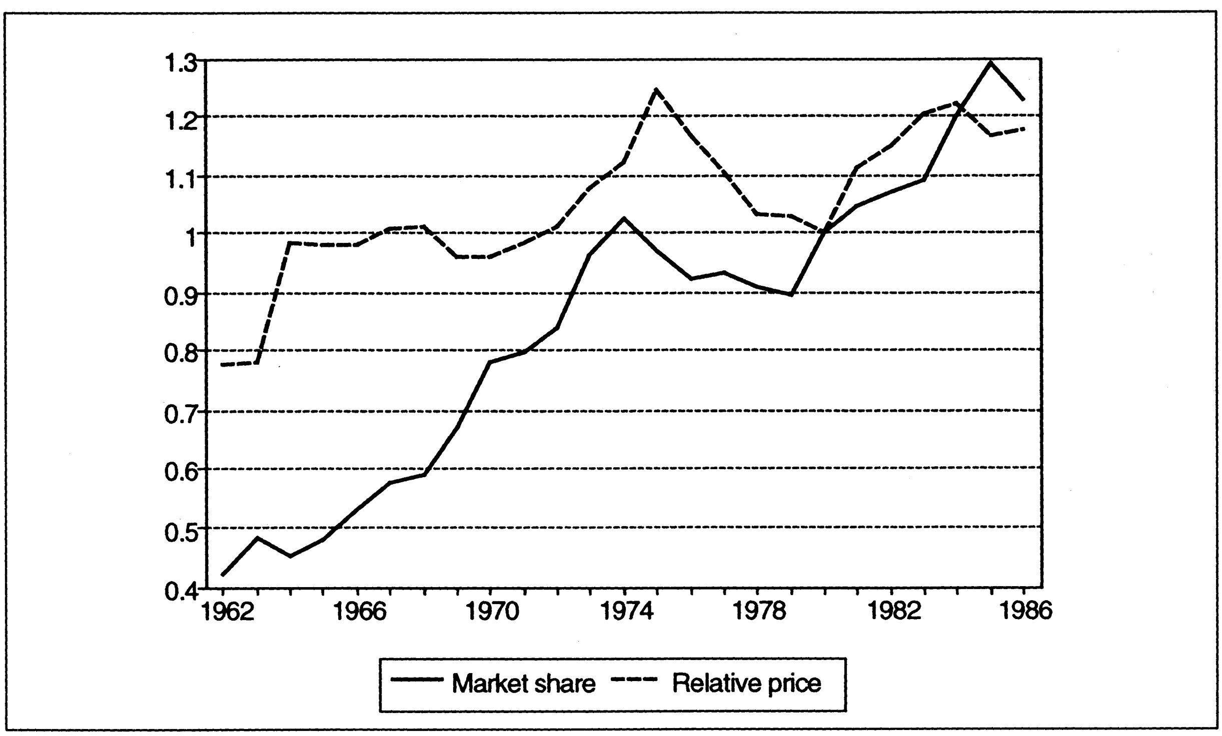


Figure 3.1-3.4 reveal that both Miscellaneous industrial products and Machinery and metal products have increased their market share over the period 1962-1986. Most of the increase for the former group of goods came in the sixties and the early seventies though. The market share performance for Food, clothing, etc. and Raw materials from mining and manufacturing are more complicated to interpret. In particular Raw materials has experienced a volatile development in the market share, but despite several years with a significant loss, the market share has never returned to the low levels at the beginning of the sixties. After some years with a significant increase in the market share for Food, clothing, etc., there was a fall in the market share from the late sixties to the mid-seventies. Then the market share stabilized for a period but seems to have entered a negative trend again after the mid-eighties.

The development in relative prices does not seem to explain much of the development in market shares, except perhaps for Food, clothing, etc. The simple correlation coefficient between the market share and the relative price variable is -0.50 for Food, clothing, etc., 0.19 for Miscellaneous industrial products, 0.05 for Raw materials and 0.78 for Machinery and metal products.

According to these world demand variables and competitors' prices, all commodities except Food, clothing etc., seem to have gained non-price competitiveness. These commodities have increased their market share despite losses in or relatively stable price competitiveness. We therefore expect to find a market elasticity above one or a positive trend variable in the export equations for these commodities. It is difficult to make a similar conclusion on the basis of figure 3.1. The elasticities in the earlier export model in MODAG confirm these predictions about non-price competitiveness. The market elasticity is above one for all commodities except for commodity 16: Food products, which dominates the aggregate in figure 3.1. The commodities analysed are listed in table 4.1. These conclusions regarding competitiveness are very different from the consensus view, and may suggest that these world demand variables are poor. This will be further discussed in a later chapter.

3.2. World demand based on GDP and on industrial production

Some of the commodities exported from Norway are basically raw materials and intermediate goods. For these commodities it may seem relevant to apply world demand variables based on the activity level in manufacturing industries abroad. Limited data availability makes it impractical to calculate more than two measures: (i) Gross domestic product and (ii) Total industrial production.

These alternative world demand variables were calculated and tested out by estimating export demand equations for commodity 43: Metals, and commodity 46: Machinery and metal products (excl. ships). The main conclusion is that the development in these variables does not differ very much from the development in those presented in the previous chapter (Thorvik (1989)). These indicators will therefore not be further discussed here.

3.3. World demand based on total imports of goods

A change from world demand variables based on total demand for each commodity to variables based on total imports of goods, implies a non-trivial change in the definition of the export markets. In the first case, the idea is that Norwegian exporters compete with both domestic firms and other foreign firms exporting to a country. The export markets are defined as total demand for different commodities abroad. In the second case, Norwegian exporters compete with other firms exporting to a country, but not directly with domestic firms. The interpretation is that consumers first allocate their expenditure between domestically and foreign produced goods, and at a second step they decide the share of Norwegian products in their expenditure on imports. In this case, both import prices on other groups of goods as well as on similar products should be included in the export demand equations, as discussed in chapter 2.1. Our problem is that foreign import prices of the commodities of interest are noe published. In the econometric analysis we therefore use an aggregate import price index to capture the development in other commodity prices.

By using import based world demand and competitors' prices, we avoid some of the problems attached to the variables based on consumption and investments presented in chapter 3.1. The problems arising from decreasing trade barriers over time and non-observable prices on Norwegian products in foreign markets are less serious. Neither is increasing import shares a problem in this framework. But, the question whether or not Norwegian import prices are good indicators for the import prices faced by our principal trading partners, is still relevant, see chapter 3.1.

Two types of indicators for world demand based on aggregate imports have been calculated. The first set of variables uses import values of manufactured goods, and world demand variables in volume terms are calculated by deflating weighted averages of these import data with Norwegian import prices. Again the assumption is that our import prices develop in a similar way to international prices. However, it turned out that this procedure gives unrealistic results for the rate of growth in the world demand variables in volume terms in the 1980s. Deflating the world demand variables with Norwegian import prices can be misleading both because of the aggregation problem and because of market imperfections, as discussed in chapter 3.1. A third explanation is that we use relatively disaggregated price indices to deflate world demand variables based on very aggregate import data and constant parameters to find import demand for groups of commodities. If the shares of different commodities in manufacturing imports by our trading partners are not stable over time, this approach may well give misleading growth rates in our constructed volume indicators. Another argument for not going further with this approach is that if the development in Norwegian import prices differ from the development in foreign import prices, we face measurement errors in both the world demand variables and the competitors' price variables in this case.

We therefore decided to construct a second set of import based world demand variables by using total imports of goods in volume terms rather than imports of manufactures in value terms. Quarterly volume data for imports are reported by the International Monetary Fund (IMF). They are given as indices in local currencies. IMF also publishes quarterly data for the unit value of imports. We construct aggregate price indices to capture the development in "other" commodity prices abroad based on these unit value indices. The equations (3.3) and (3.4) give the formulaes used when calculating these world demand variables and aggregate price indices.

$$M_i = \Sigma_l\, w_{il} \cdot I_l \,/\, \Sigma_l\, w_{il} \qquad i=1,..,4,\ l=1,..,L \qquad (3.3)$$
$$PK_i = \Sigma_l\, w_{il} \cdot PK_l \,/\, \Sigma_l\, w_{il}$$

$$w_{il} = X_{AilT} \,/\, \Sigma_l\, X_{AilT} \qquad i=1,..,4,\ l=1,..,L \qquad (3.4)$$

where

I_l : Total imports of goods in country l in volume terms, 1985=100
PK_l : Unit value of imports in country l, 1985 = 1
X_{Ail} : Norwegian exports of commodity i to country l
T : Indicate the base year for the constant weights, the current base year is 1986.

The variables PK_i are interpreted as import prices of other commodities by our principal trading partners. One problem with the weights in (3.4), is that the variables X_{Ail} are not published for our commodities. However, there exist trade matrices for SITC-commodities which identify Norway's imports by country of origin and exports by country of destination. Since Norwegian national account trade data are based on transformations of these trade matrices, it is possible to identify the relationship between the commodities of interest and the SITC-commodities. An aggregate transformation matrix for the national account for 1986 is used. This matrix shows how exports of the four groups of manufactures defined at the beginning of chapter 3 are distributed on principal SITC-commodities. The SITC-commodities are 0-1: Food and beverages, 2,4: Crude materials, 3: Fuels, 5-9: Manufactures.

Table 3.3. The distribution of Norwegian exports of four groups of manufactures on principal SITC-commodities, 1986. In per cent

	Group of manufactures[2]			
SITC-commodity[1]	Food, clothing etc.	Miscellan. industrial products	Raw materials[3]	Machinery and metal products[4]
0-1	76.3	0.0	0.0	0.0
2,4	6.6	19.0	6.8	1.5
3	0.0	11.0	0.0	0.0
5-9	17.1	70.0	93.2	98.5
0-9	100.0	100.0	100.0	100.0

1) The UN Standard International Trade Classification.
2) These commodities are defined at the beginning of chapter 3.
3) Excl. crude oil and natural gas.
4) Excl. ships.

By combining the coefficients given in table 3.3 with data for Norwegian exports of SITC-commodities by country of destination, one obtains the desired variables X_{Ail} in the chosen base year 1986. Table 3.4 presents the weights w_{il}, which are calculated according to equation (3.4). Since imports abroad are given as indices, we have used the Norwegian export shares as weights to express the relative importance of the different countries for Norwegian exports of different commodities.

Table 3.4. The distribution of Norwegian exports of manufactures to our principal trading partners, 1986. In per cent

Country	Group of manufactures[1]			
	Food, clothing, etc.	Miscellan. industrial products	Raw materials[2]	Machinery and metal products[3]
Denmark	10.5	8.8	10.0	10.1
France	7.9	5.1	5.5	5.5
Italy	6.4	3.4	4.0	4.0
Japan	4.4	2.3	2.7	2.7
Netherlands	5.4	8.9	8.9	8.9
Sweden	19.6	18.8	21.0	21.0
UK	16.0	24.4	17.6	17.6
USA	13.9	9.2	10.3	10.3
West-Germany	15.8	19.1	20.0	20.0
Total	100.0	100.0	100.0	100.0

1) These commodities are defined at the beginning of chapter 3.
2) Excl. crude oil and natural gas.
3) Excl. ships.

Figure 3.5-3.8 give the development in market shares and relative prices when using world demand variables based on total imports of goods and Norwegian import prices as indicators for the competitors' prices in the export markets. All variables are expressed as annual indices (1980=1). The ratio of foreign import prices of other commodities to competitors' prices is not included in the figures because it turned out that this variable enters significantly the export equation for only two of the ten commodities analysed, i.e. commodity 34 and C70 listed in table 4.1. And furthermore, of these two commodities, only commodity 34 is included in the following figures.

Figure 3.5. The export market share and the relative price for Food, clothing, etc., 1980=1

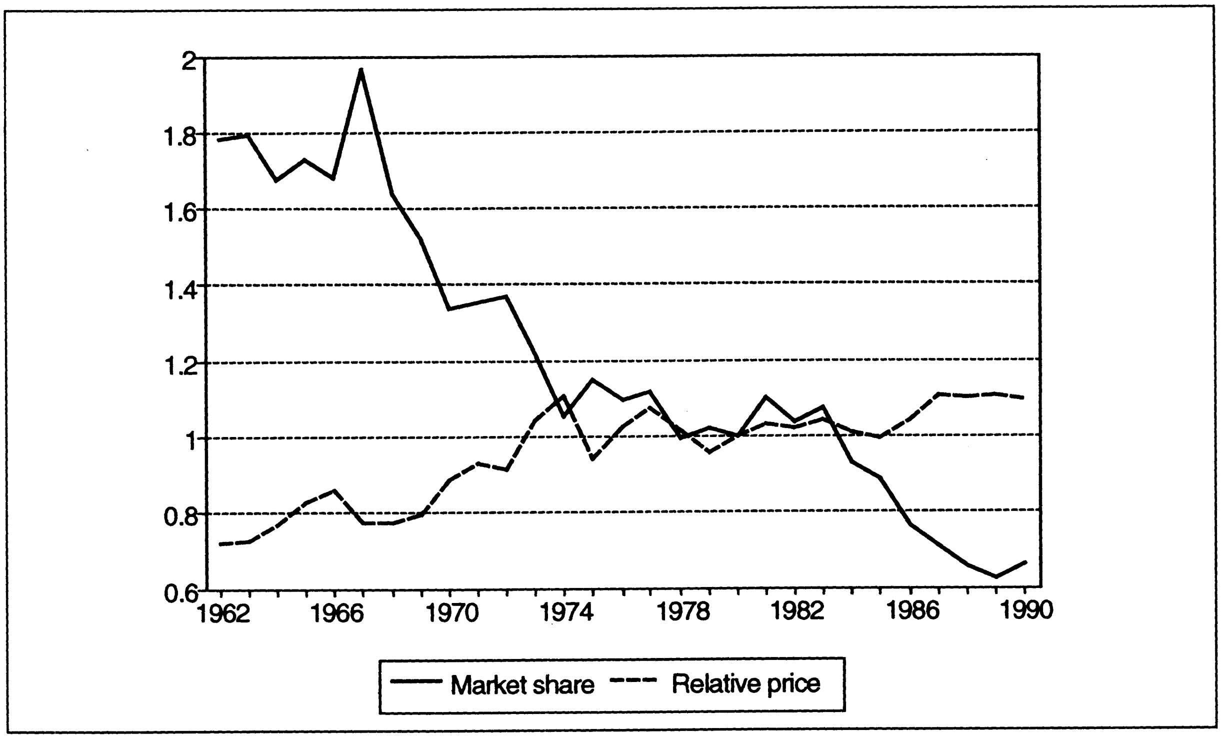


Figure 3.6. The export market share and the relative price for Miscellaneous industrial products, 1980=1

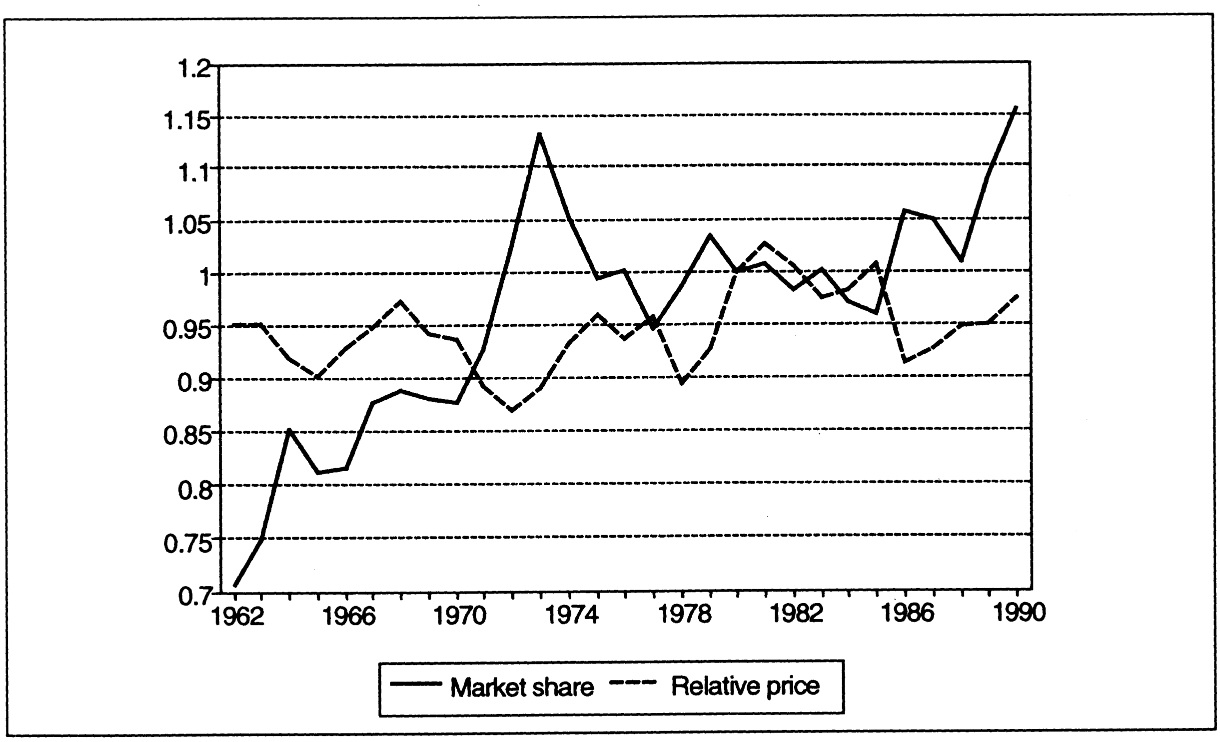


Figure 3.7. The export market share and the relative price for Raw materials from mining and manufacturing, 1980=1

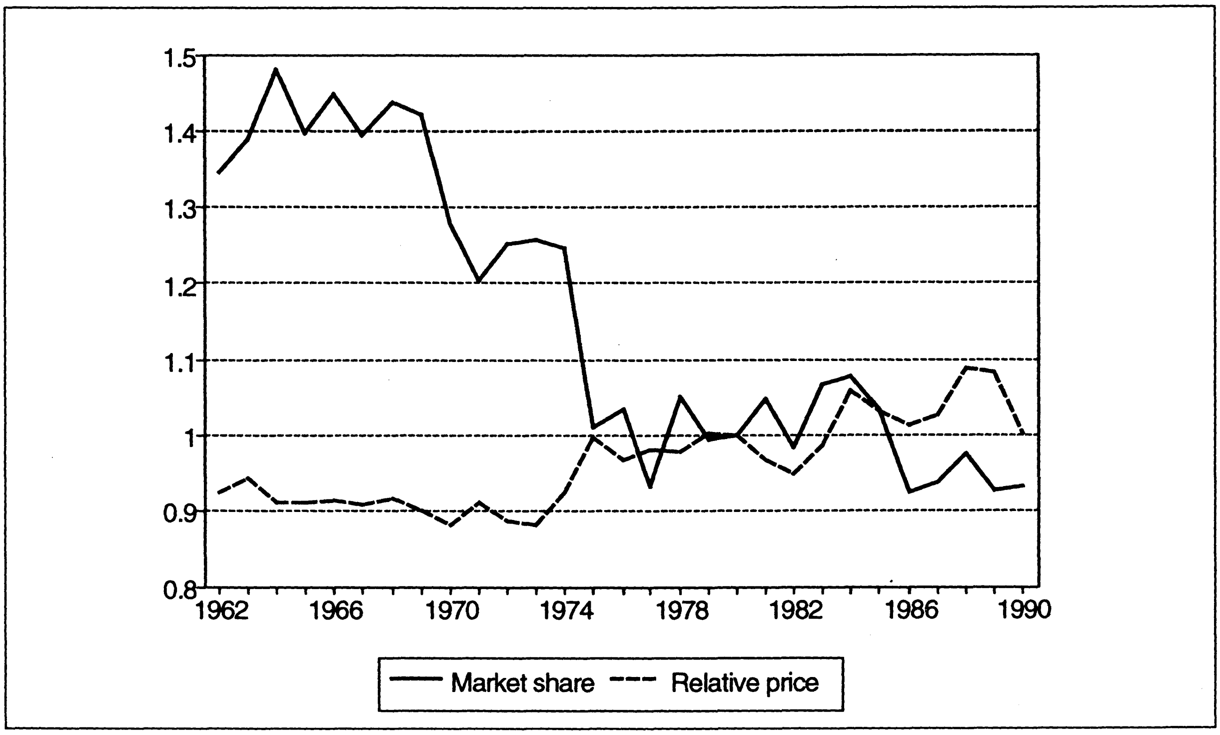


Figure 3.8. The export market share and the relative price for Machinery and metal products (excl. ships), 1980=1

According to these world demand variables, the export market share performance has been very different for Food, clothing, etc. and Raw materials on one hand and Miscellaneous industrial products and Machinery and metal products on the other. The market share for both Food, clothing, etc. and Raw materials have decreased over the period 1962-1990 as a whole. The most dramatic fall occurred from the end of the sixties to the mid-seventies. Market shares were relatively stable from then on and up towards the mid-eighties, when they started to fall again, particularly for Food, clothing, etc. The market share for the other two groups of manufactures have increased from 1962 to 1990, mainly due to a positive development up to the mid-seventies. After some years with a falling market share for both groups of goods from then on, Miscellaneous industrial products had a period with a relatively stable market share before it started to rise again during the second half of the eighties. The market share for Machinery and metal products has been more erratic, but with a small negative trend in the eighties.

When we also take into account the development in relative prices, we see that the development in market shares to a large extent is reflected in relative prices for Food, clothing etc. and also for Raw materials. The simple correlation coefficient between the market share and the relative price is -0.92 and -0.79 for these two groups of goods respectively. For the other two groups of goods, the same strong negative relationship between relative prices and market shares does not exist. In fact, the simple correlation coefficient is 0.02 for Miscellaneous industrial products and 0.62 for Machinery and metal products. Thus, our assumption is that the increase in market shares for these two groups of goods to a large degree must be explained by improved non-price competitiveness over time. And, we expect estimated market elasticities to be above unity or a positive trend variable to enter the export equations.

3.4. World demand and competitors' prices based on imports of different SITC-commodities

Ideally, given the assumption of separability in demand between different groups of goods, we would want to use more commodity specific information about changes in foreign demand over time. We are also interested in developing indicators for competitors' prices in the export markets based on genuine foreign data rather than on Norwegian import prices. The trade matrices for four different groups of SITC-commodities calculated by the LINK-project (Campano (1988)), combined with trade data published regularly by the Organisation for Economic Co-operation and Development (OECD), give such commodity specific information.

The interpretation of world demand variables based on imports of different groups of goods rather than on aggregated import data, is that Norwegian exporters treat import demand for groups of goods as given parameters and compete for shares in the demand for these groups. We assume separability in import demand for groups of goods by our principal trading partners. The corresponding import price indices abroad are defined as competitors' prices in the export market.

In order to utilize the available commodity specific information, it is necessary to identify the relationship between the SITC-commodities and the commodities defined in the Norwegian national accounts. Again, the aggregate matrix linking Norwegian commodities with SITC-commodities in 1986 is used, see table 3.3. Both world demand variables and competitors' prices are calculated in two steps: In the first step, import demand for each SITC-commodity in both volume and value terms are computed as weighted averages across Norway's principal trading partners. The weights are calculated as Norwegian exports of each SITC-commodity to different countries relative to total imports of the same SITC-commodity abroad. LINK's trade matrix for 1986 is used to identify these weights.

$$M_j = \Sigma_l\, w_{jl} \cdot E_{Lt} \cdot I_{jl} / \Sigma_l\, w_{jl} \qquad j=1,..,4,\ l=1,..,L \qquad (3.5)$$

$$VM_j = \Sigma_l\, w_{jl} \cdot E_l \cdot P_{Ijl} \cdot I_{jl} / \Sigma_l\, w_{jl} \qquad j=1,..,4,\ l=1,..,L \qquad (3.6)$$

$$w_{jl} = X_{AjlT} / E_{Lt} \cdot I_{jlT} \qquad j=1,..,4,\ l=1,..,L \qquad (3.7)$$

where

I_{jl} : Total imports of SITC-commodity j by country l in constant prices, local currency
P_{Ijl} : The price of imports of SITC-commodity j by country l, local currency
X_{Ajl} : Norwegian exports of SITC-commodity j to country l in constant prices
E_l : The exchange rate expressed as Nkr over the currency in country l
T : Indicates the base year for the constant weights, the current base year is 1986.

The country and SITC-commodity specific weights w_{jl} used in step one are presented in table 3.5.

Table 3.5. The share of Norwegian products in imports of different SITC-commodities by Norways' principal trading partners, 1986. In per cent

Country	SITC-commodity[1] Food and beverages (0-1)	Crude materials (2,4)	Fuels (3)	Manufactures (5-9)
Denmark	6.58	3.28	8.99	2.62
France	0.79	0.56	1.31	0.23
Italy	0.70	0.30	0.02	0.24
Japan	0.39	0.05	0.00	0.14
Netherlands	0.09	0.73	4.91	0.56
Sweden	8.84	7.07	11.52	3.54
UK	1.04	1.48	4.83	0.81
USA	0.84	0.11	0.73	0.16
West-Germany	0.49	1.36	3.95	0.60

1) The UN Standard International Trade Classification.

In step two, the world demand variables in volume and value terms for the SITC-commodities are used to calculate world demand variables for the commodities of interest. The weights used in these calculations are identical to those in table 3.3. The competitors' prices are defined as the implicit prices found by dividing the world demand variables in value terms by those in volume terms.

$$M_i = \Sigma_j s_{ij} \cdot M_j / \Sigma_j s_{ij} \qquad i=1,..,4,\ j=1,..,m \qquad (3.8)$$

$$P_i = \Sigma_j s_{ij} \cdot MV_j / \Sigma_j s_{ij} \cdot M_j \qquad i=1,..,4,\ j=1,..,m \qquad (3.9)$$

where

s_{ij} : Weights reflecting the distribution of commodity i on the principal SITC-commodity j (see table 3.3).

For example, the world demand variable for Food, clothing etc. consists of 76.3 per cent SITC-commodities 0-1, 6.6 per cent SITC-commodities 2 and 4, and 17.1 per cent SITC-commodities 5-9.

Figure 3.9-3.12 give the development in market shares and relative prices according to the measures for world demand and competitors' prices defined in this chapter. All variables are expressed as annual indices (1980=1).

Figure 3.9. The export market share and the relative price for Food, clothing, etc., 1980=1

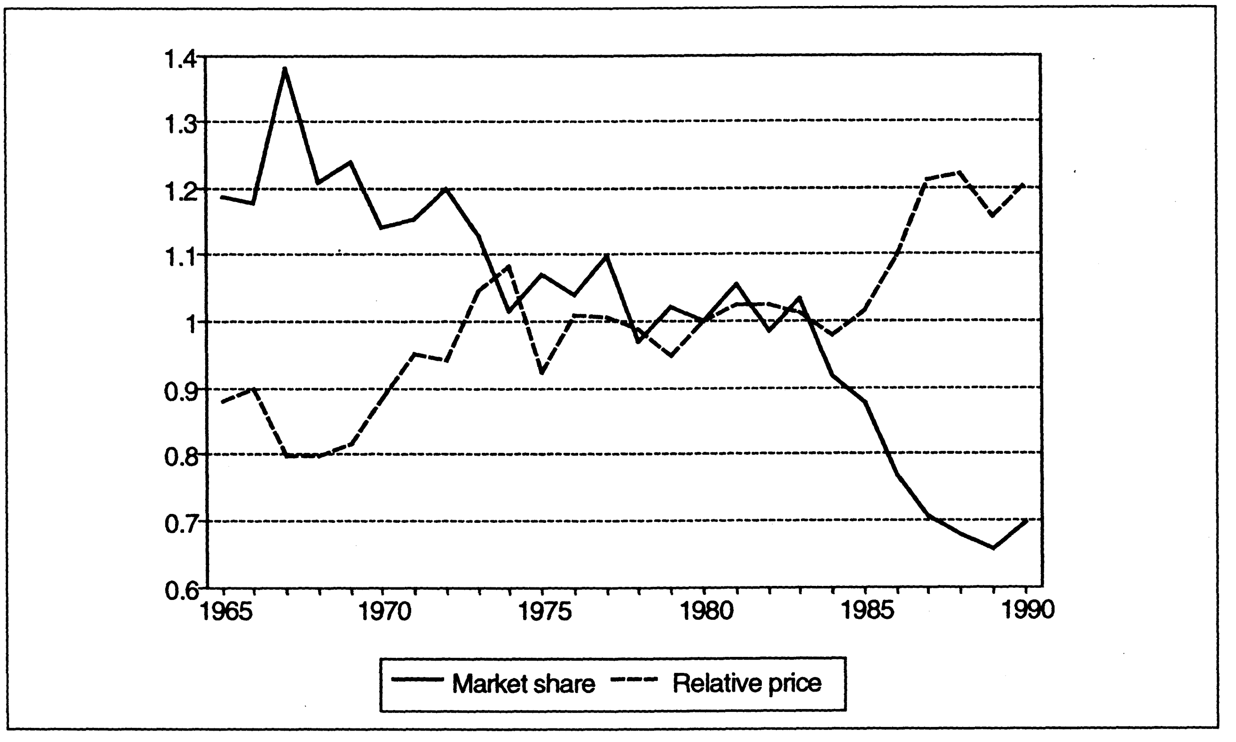


Figure 3.10. The export market share and the relative price for Miscellaneous industrial products, 1980=1

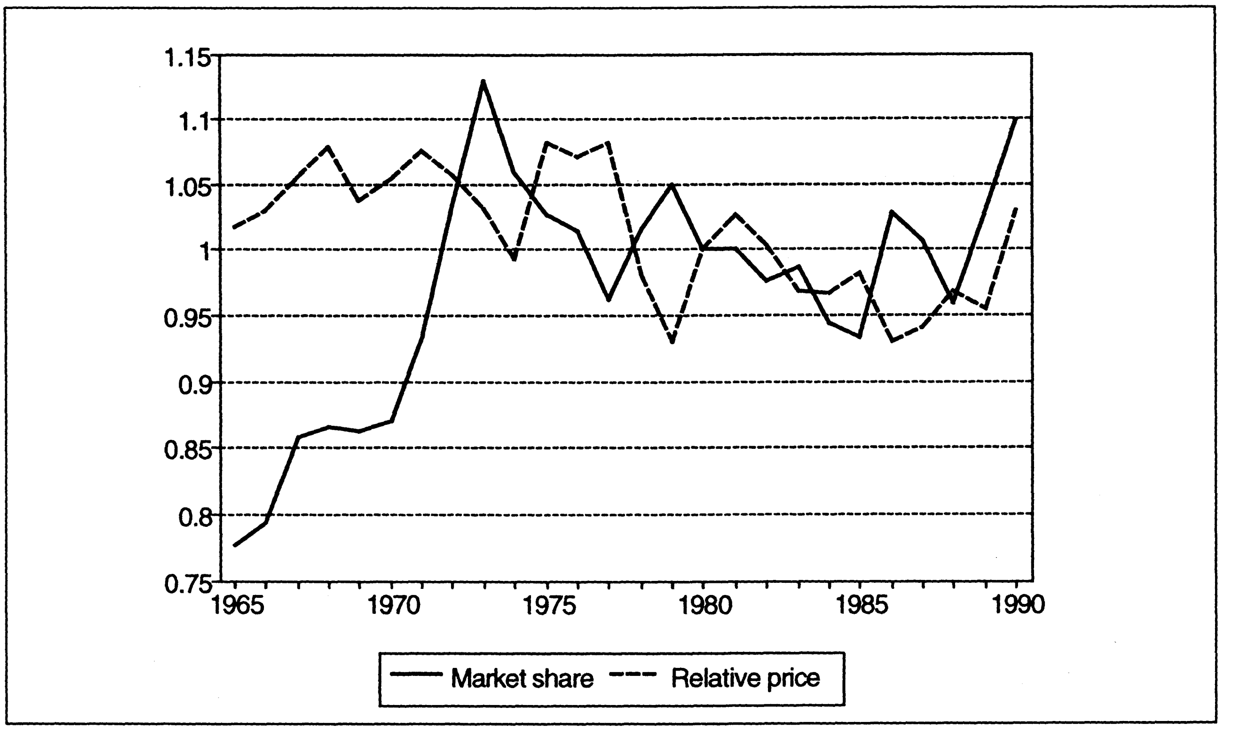


Figure 3.11. The export market share and the relative price for Raw materials from mining and manufacturing, 1980=1

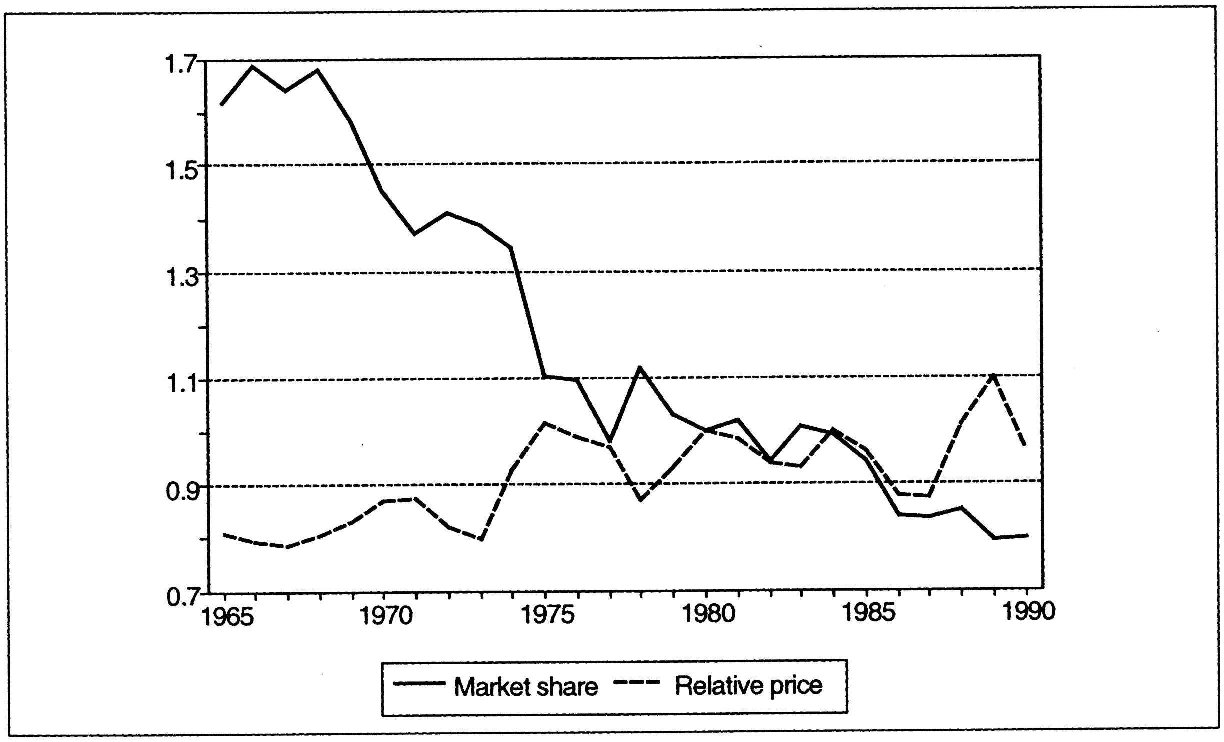
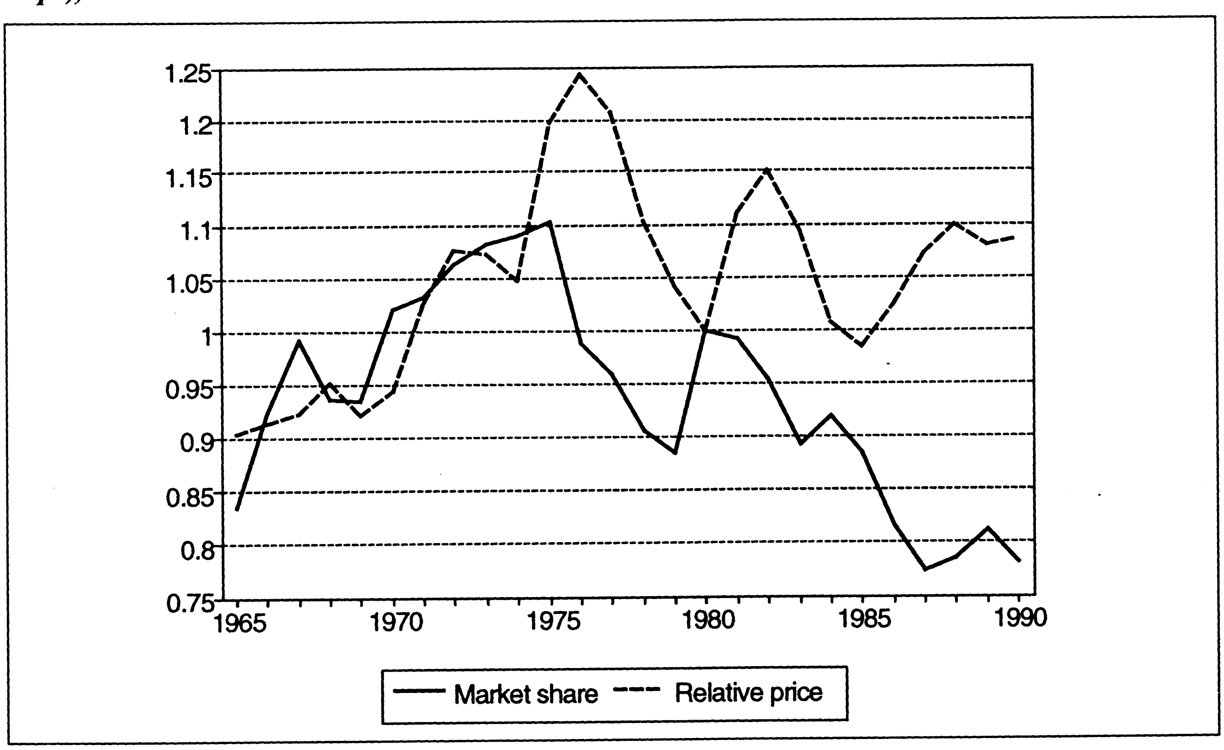


Figure 3.12. The export market share and the relative price for Machinery and metal products (excl. ships), 1980=1



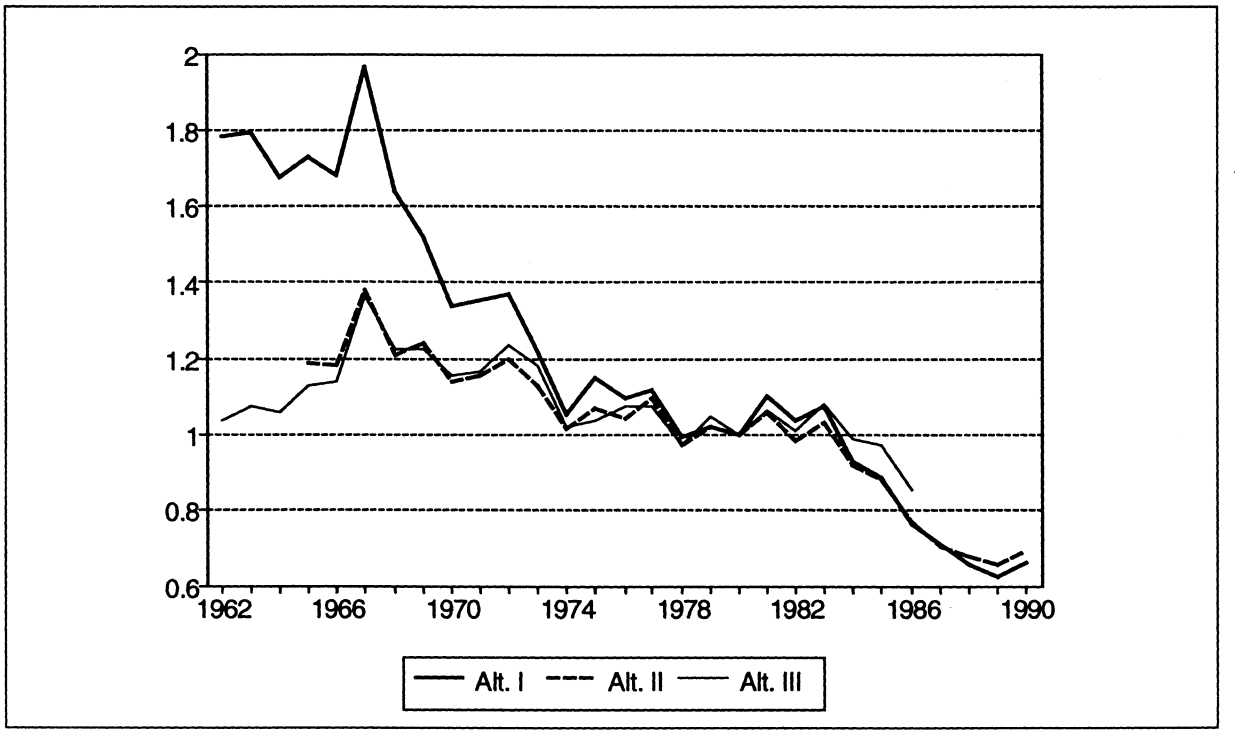
There has been a decline in the market share for all groups of goods except Miscellaneous industrial products over the period 1965-1990 as a whole according to these world demand variables. The overall fall for Machinery and metal products is not very large though. While both Food, clothing, etc. and Raw materials experienced decreasing market shares up to the mid-seventies, the opposite is true for the two remaining groups of goods. The market share has been relatively stable from then on for both Miscellaneous industrial products and Raw materials, although the latter may seem to have entered a positive trend again after the mid-eighties. Also Food, clothing etc. has experienced a relatively stable market share from the mid-seventies and up to the mid-eighties, but from then on the market share has fallen significantly again. Regarding Machinery and metal products, the market share has declined since the mid-seventies.

The figures suggest that relative prices can explain salient features of the market share for Food, clothing, etc. and for Raw materials. The simple correlation coefficient between the market share and the relative price equals -0.90 and -0.76 for these two groups of goods respectively. For the two remaining groups of goods, the simple correlation coefficient is -0.27 for Miscellaneous industrial products and 0.06 for Machinery and metal products. Figure 3.12 suggest gains in non-price competitiveness for Machinery and metal products up to the mid-seventies and a loss from then on. It is difficult to make any à priori predictions about the overall development in non-price competitiveness on the basis of figure 3.9-3.12 though.

3.5. A comparison of the different measurements of demand and competitors' prices in the world market

In this chapter, the alternative world demand variables and competitors' prices will be compared and discussed. In chapter 3.3, we presented world demand variables based on total imports of goods by our principal trading partners. Norwegian import prices are assumed to measure competitors' prices in the export market. This alternative is denoted Alternative I. In chapter 3.4 we presented world demand variables and competitors' prices based on imports of different groups of SITC-commodities. This alternative is denoted Alternative II. Alternative III is the world demand variables based on private consumption and investments abroad put forward in chapter 3.1, i.e. the variables used in the previous export model in MODAG. Also in this case Norwegian import prices are used as competitors' prices. Figure 3.13-3.20 give the development in market shares and relative prices according to these alternative world demand variables and competitors' prices.

Figure 3.13. The export market share for Food, clothing, etc. Alternative I is based on total imports of goods abroad, Alternative II is based on imports of four SITC-commodities, Alternative III is based on private consumption and investments, 1980=1



Alternative II and III show a very similar development in the market share for Food, clothing, etc., with a modest decline up to the mid-seventies, a relatively stable market share from then on and up to the mid-eighties, and a significant fall during the second half of the eighties. Alternative I deviates from the other two alternatives with a much more dramatic fall in the market share up to the mid-seventies. An increase in the market share in 1990 according to Alternative I and II may indicate that the negative trend during the second half of the eighties has ceased. A fall in the market share is assumed to come from a deterioration in the "overall" competitiveness, which includes both price and non-price competitiveness.

From figure 3.14, which compares the two alternative sets of relative prices, we see that both alternatives reveal a loss of price competitiveness. The development is relatively similar up to the mid-eighties, but from then on Alternative II shows a larger loss of price competitiveness than Alternative I. Since Alternative I and III face the same relative price, the larger loss of overall competitiveness according to Alternative I must be explained by a less favourable development in non-price competitiveness. Furthermore, Alternative I indicates a less favourable development in non-price competitiveness than Alternative II, because Alternative I shows a larger loss of overall competitiveness and a more favourable development in price competitiveness. It is difficult to rank between Alternative II and III on this issue.

Figure 3.14. The relative price for Food, clothing, etc. Alternative I (and III) is based on Norwegian import prices, alternative II is based on imports of four SITC-commodities, 1980=1

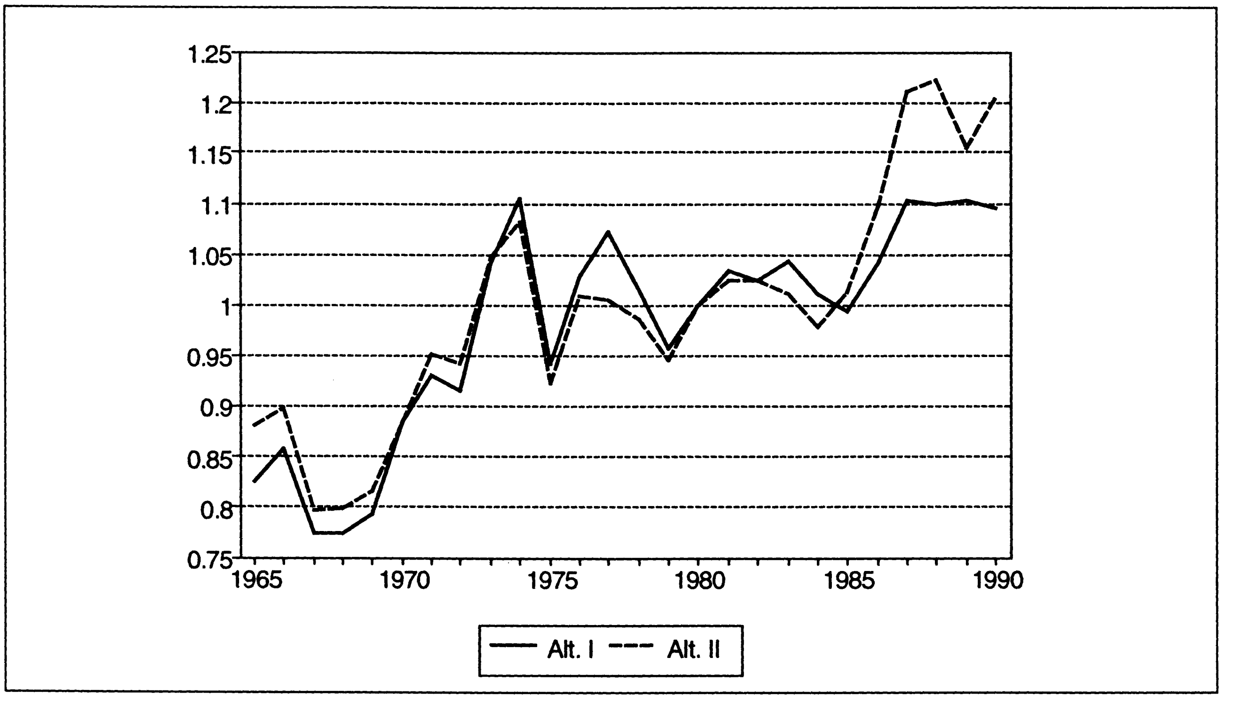


Figure 3.15. The export market share for Miscellaneous industrial products. Alternative I is based on total imports of goods abroad, Alternative II is based on imports of four SITC-commodities, Alternative III is based on private consumption and capital formation, 1980=1

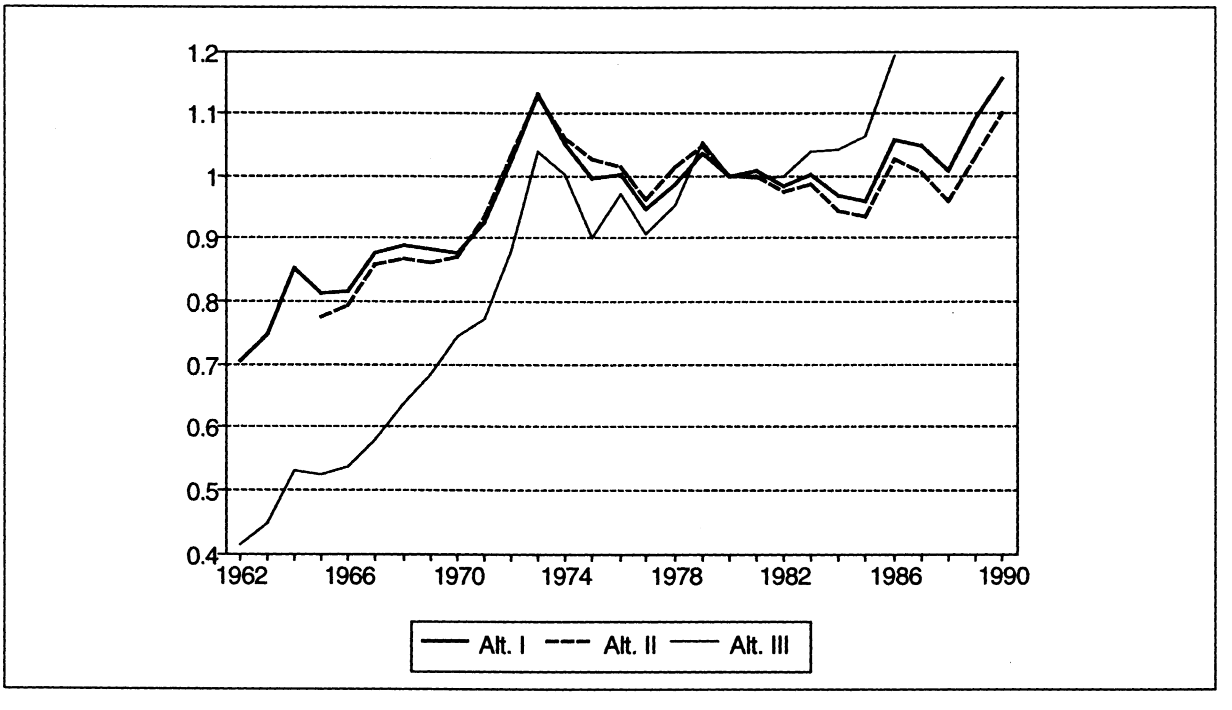
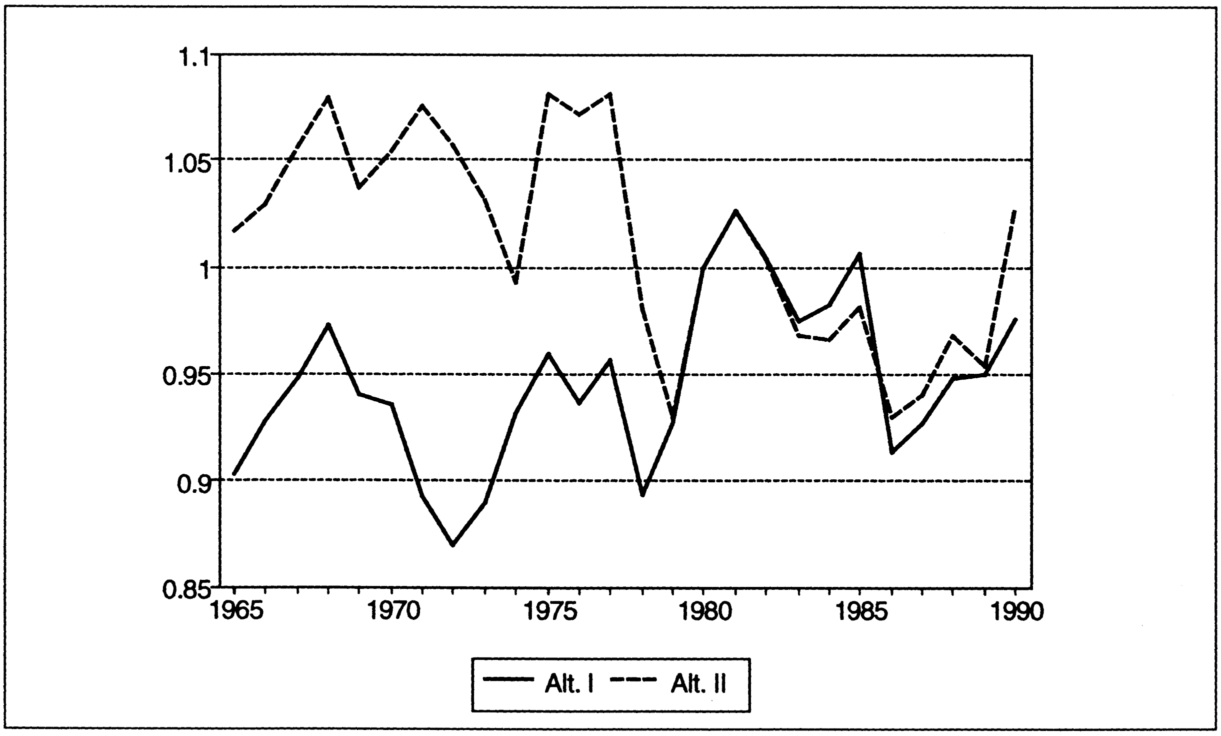


Figure 3.16. The relative price for Miscellaneous industrial products. Alternative I (and III) is based on Norwegian import prices, Alternative II is based on imports of four SITC-commodities, 1980=1



All three world demand variables give a significant increase in the market share for Miscellaneous industrial products up to the mid-seventies, a relatively stable market share from then on and up to the mid-eighties, and a new period with increasing market share during the second half of the eighties. Alternative I and II are very similar, but Alternative III displays a much larger increase in the market share for important periods both before and after 1980.

While the relative price according to Alternative I seems to vary around a positive trend, the opposite seems to be the case for Alternative II. Hence, Alternative I implies a loss of price competitiveness while Alternative II implies a gain. The development in market shares and relative prices indicate a more favourable development in non-price competitiveness according to Alternative II than according to both Alternative I and II, and also that Alternative I can be ranked before Alternative II on this issue. Both Alternative I and II confirm gains in non-price competitiveness for this group of goods, while Alternative III is undetermined.

Figure 3.17. The export market share for Raw materials from mining and manufacturing. Alternative I is based on total imports of goods abroad, Alternative II is based on imports of four SITC-commodities, Alternative III is based on private consumption and capital formation, 1980=1

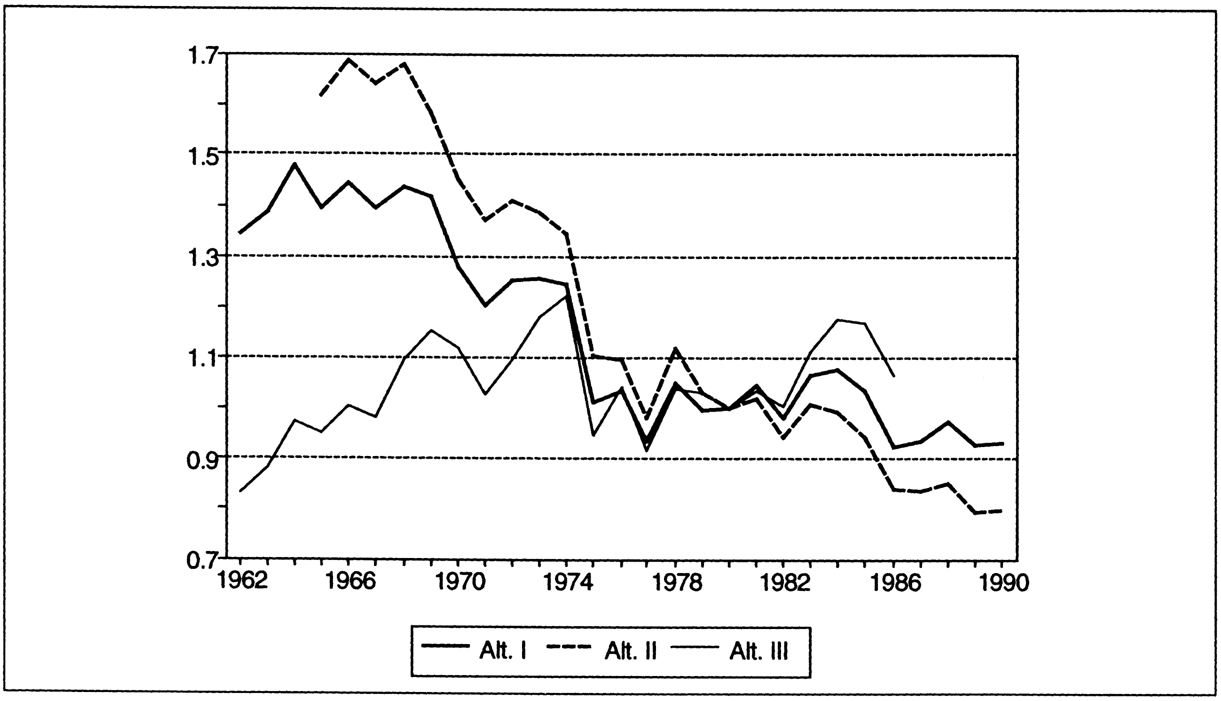
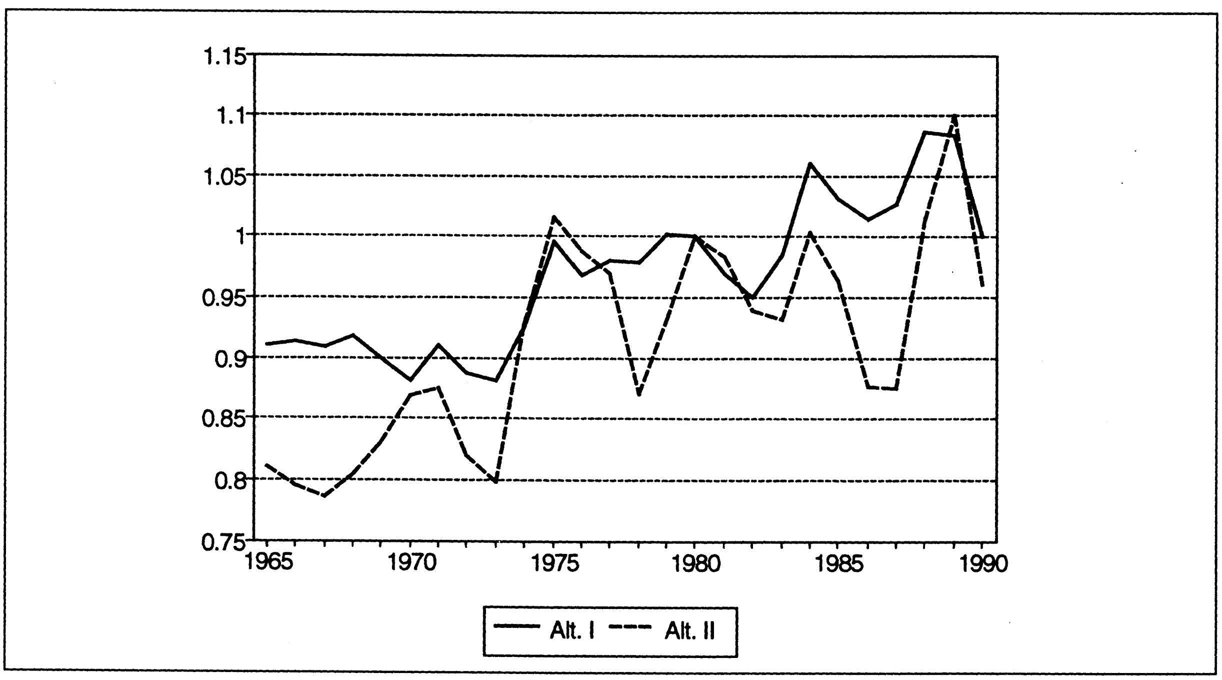


Figure 3.18. The relative price for Raw materials from mining and manufacturing. Alternative I (and III) is based on Norwegian import prices, Alternative II is based on imports of four SITC-commodities, 1980=1

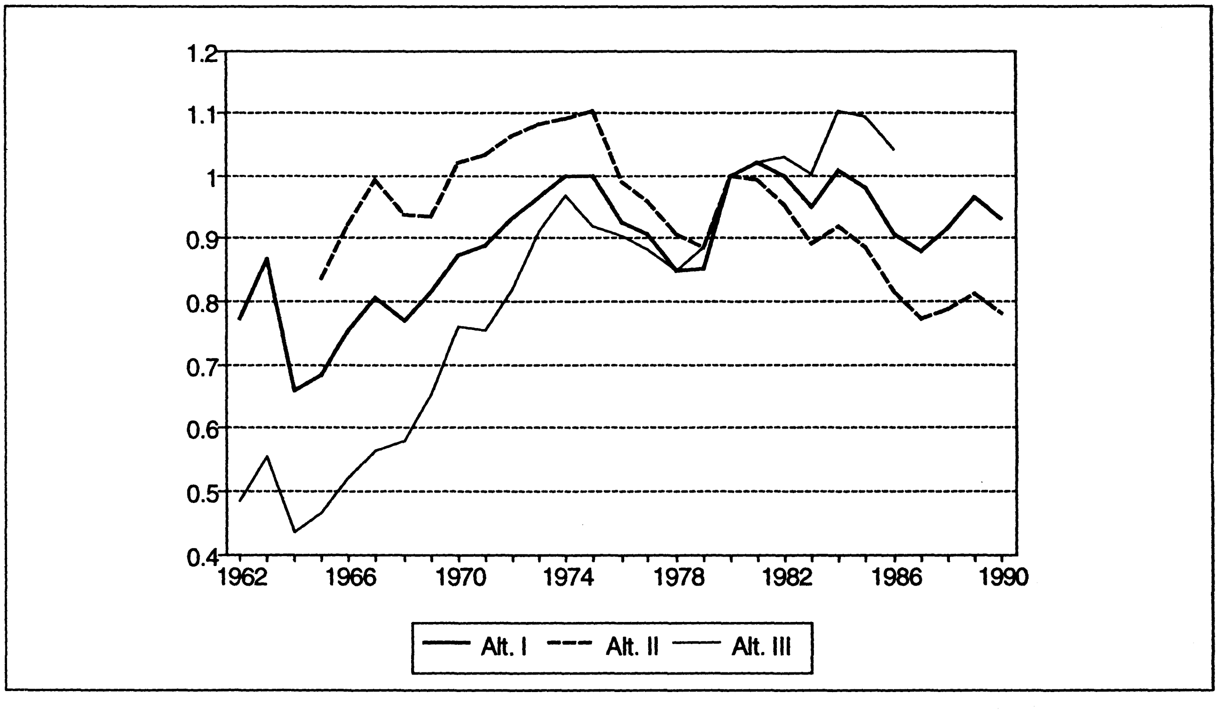


Alternative I and II show an overall fall in the market share for Raw materials, while Alternative III gives an overall increase. The largest fall in the market share came before the mid-seventies according to Alternative I and II, Alternative III exposes a significant increase over the same period. After the mid-seventies, the market share stabilized according to all three alternatives, but Alternative II displays decreasing and Alternative III increasing market share again from the mid-eighties. Thus, conclusions about the development in competitiveness depend heavily on the choice of world demand variable.

From figure 3.18 we see that both alternatives for competitors' prices indicate an overall loss of price competitiveness; both give an increase in the relative price. There are some important differences though, and Alternative II is more erratic than Alternative I.

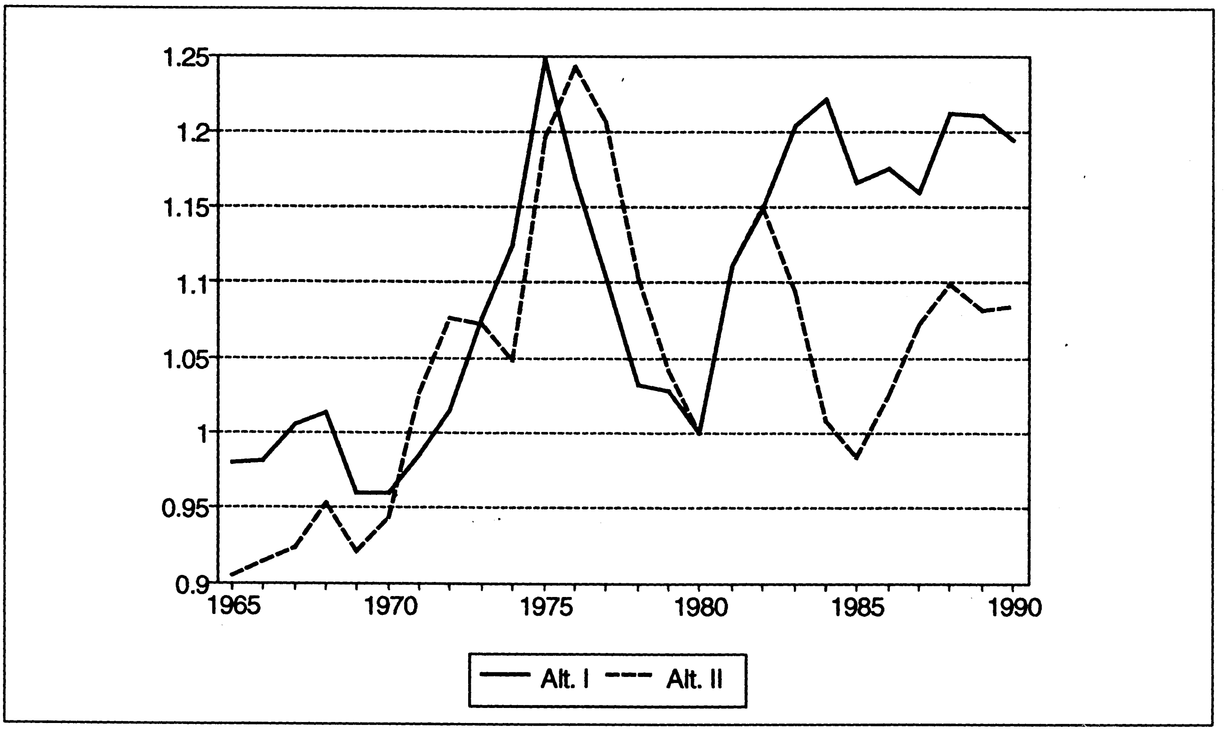
The development in the market share and the relative price indicate a gain in non-price competitiveness according to Alternative III over the whole period and according to Alternative I from the mid-seventies. The overall conclusion for Alternative II and also I is ambiguous. It seems clear though, that Alternative III implies a stronger performance in non-price competitiveness than both Alternative I and II.

Figure 3.19. The export market share for Machinery and metal products. Alternative I is based on total imports of goods abroad, Alternative II is based on imports of four SITC- commodities, Alternative III is based on private consumption and capital formation, 1980=1



Also for Machinery and metal products we see that conclusions about competitiveness depend on the choice of world demand variable. While both Alternative I and III give an overall increase in the market share, this is not true for Alternative II. The development during the eighties is perhaps most salient. While Alternative I displays a relatively stable market share and thus indicating unchanged non-price competitiveness, Alternative II shows a loss of and Alternative III a gain in competitiveness.

Figure 3.20. The relative price for Machinery and metal products. Alternative I (and III) is based on Norwegian import prices, Alternative II is based on imports of four SITC-commodities, 1980=1



Both alternatives for competitors' prices predict a loss of price competitiveness over the period as a whole. There is a period with a significant gain during the second half of the seventies though. According to Alternative II, there is a period with decreasing relative price during the first half of the eighties as well, but most of this gain in price competitiveness is lost again during the second half of the eighties. Both series are relatively erratic. The development in the market share and the relative price alternatives suggest gains in non-price competitiveness according to both Alternative I and III, while Alternative II is somewhat more ambiguous. One can conclude though, that Alternative III implies a larger gain in non-price competitiveness than the other two alternatives, and that Alternative I can be ranked before Alternative II on this issue.

3.6. Conclusions

From the previous discussion, it is clear that conclusions about the development in market shares and both price and non-price competitiveness may depend critically on the definition of the export market and the proxies for competitors' prices chosen. This finding is important since our understanding of the competitive structure in domestic industries influence the targeting and form of governments' industry support. Alternative III displays better market share - or overall competitiveness - performances than both Alternative I and II. Alternative II and III are very similar for Food, clothing, etc. though. Alternative I shows a poorer market share performance compared with Alternative II for Food, clothing, etc., a similar development for Miscellaneous industrial products and a stronger development for both Raw materials and Machinery and metal products. The three alternatives part mostly because of the magnitude of the annual changes and less because of a different sign though.

Regarding price competitiveness, Alternative I (and III) indicates a more advantageous development than Alternative II for Food, clothing, etc. and Raw materials, while the opposite is true for the remaining two groups of goods. With respect to non-price competitiveness, we conclude that Alternative III implies a more favourable development than the other alternatives in most cases, the exception is Food, clothing, etc., where Alternative II and III are relatively similar. In fact, again with the exception of Food, clothing, etc. which is ambiguous, Alternative III indicates gains in non-price competitiveness. We also conclude that Alternative I displays a stronger development in non-price competitiveness than Alternative II for both Miscellaneous industrial products and Machinery and metal products. Alternative I shows gains in non-price competitiveness for those commodities while the conclusion for Alternative II is ambiguous. The conclusion regarding non-price competitiveness is ambiguous according to both Alternative I and II for the two remaining groups of goods, but we suggest that Alternative I can be ranked before Alternative II for Raw materials, while the opposite is true for Food, clothing, etc. However, these hypotheses regarding non-price competitiveness are only based on direct data inspection, and we may of course find that they are rejected by the econometric study.

To get a better view of how different these alternatives are with respect to predictions about competitiveness, we have calculated the market share and relative price at the aggregate level. (I.e. we have aggregated the four groups of goods defined at the beginning of chapter 3.) Figure 3.21 gives the development in the market share at the aggregate level according to the three alternative world demand variables, while figure 3.22 gives the development in the two alternative relative prices.

Figure 3.21. The export market share at the aggregate level. Alternative I is based on total imports of goods abroad, Alternative II is based on imports of four SITC- commodities, Alternative III is based on private consumption and capital formation, 1980=1

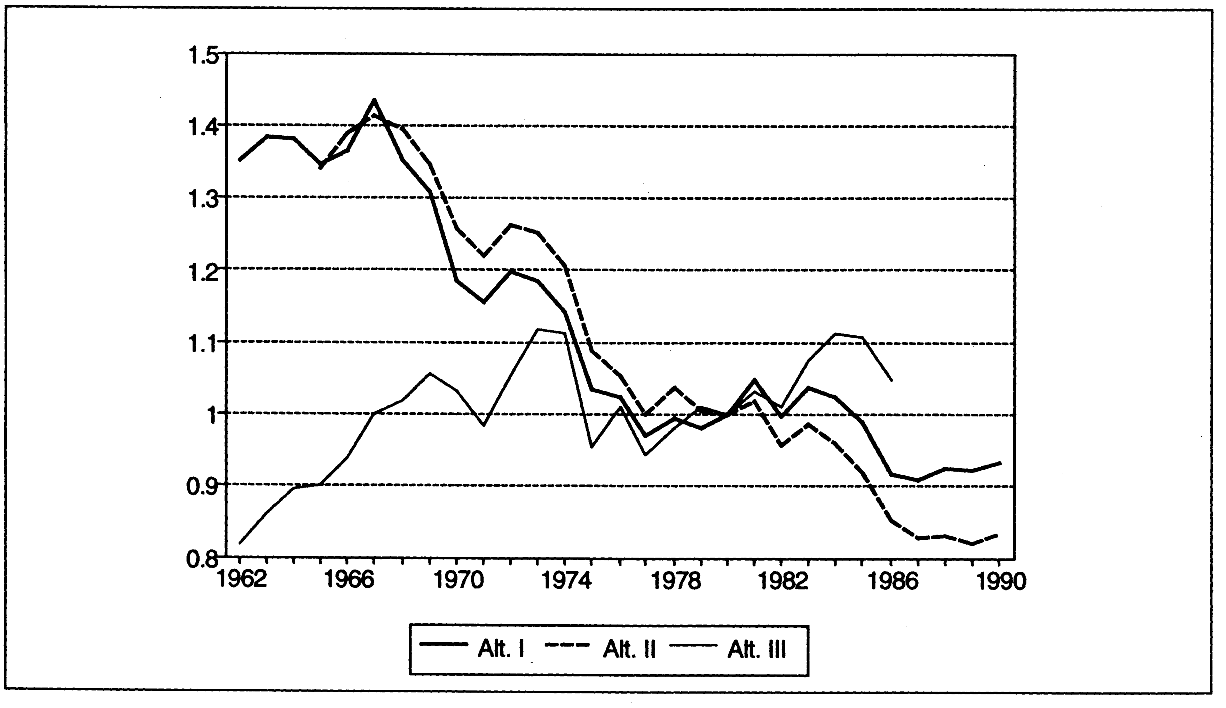


Figure 3.22. The relative price at the aggregate level. Alternative I (and III) is based on Norwegian import prices, Alternative II is based on imports of four SITC-commodities, 1980=1

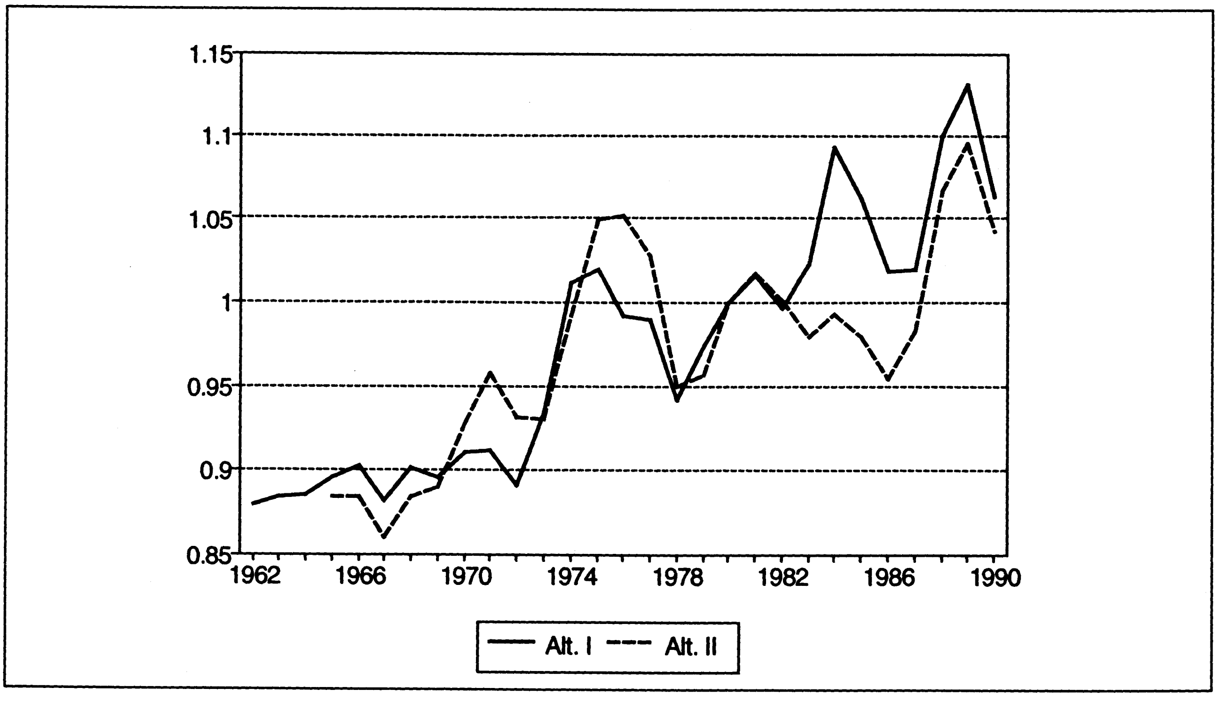


Figure 3.21 confirms that Alternative III implies gains in competitiveness for important commodities, while the opposite is true according to the other two alternatives. The two import based alternatives are quite similar, but Alternative I shows a better development in competitiveness during the eighties than Alternative II at the aggregate level. One interpretation of the difference between Alternative I and II on one hand and Alternative II on the other is that Norwegian products have increased their share in domestic demand by our principal trading partners, but that Norwegian firms have not managed to keep up with the relatively rapid growth in international trade. Exports and imports have grown more quickly than consumption and investments abroad in our data. A second explanation is that the rate of growth in world demand according Alternative III is seriously biased downward for reasons discussed in chapter 3.1. The consensus view is that Norwegian trading industries have lost competitiveness during most of the seventies and the eighties, but that there has been some recovery since the late eighties. These assumptions are supported by the development in relative unit labour costs between Norway and our trading partners and by the development in relative prices at the aggregate level, the latter is shown in figure 3.22. The development in market shares according to both Alternative I and II as well as the measure of export performance for the manufacturing sector in Norway published by the OECD, which is calculated according to the same principle as Alternative I and II cf. Durand (1992), also support these assumptions.

Both Alternative I and II reveal a loss of price competitiveness at the aggregate level, see figure 3.22. OECD's measure of export competitiveness for the manufacturing sector in Norway cf. Durand (1992), conducts very similar to our Alternative II. Norwegian import prices seem to follow the same trend as import prices by our principal trading partners. There are important short-run discrepancies though, particularly at the beginning of the seventies, the mid-seventies and the mid-eighties, that may be due to price discrimination across countries. The difference between these alternative relative prices can be interpreted as the measurement error when using Norwegian import prices as proxies for competitors' prices. It is clearly of interest to test whether this difference is integrated of order 0 or not. The ADF-statistic on the difference is -2.76, we include a constant term. The critical value at the five per cent significance level is -2.98, we use the method suggested in KacKinnon (1991) to calculate the critical value with 25 observations. Hence, our assumption that this difference is integrated of order 0 seems plausible. In that case, Norwegian import prices will not bias the long-run elasticities c.f. Engle and Granger (1987). On the contrary, because our applications of the Armington-model are for relatively disaggregated commodities, Norwegian import prices may be a "better choice". This is true if Norwegian import prices capture important features in import prices abroad which is lost in Alternative II due to the higher level of aggregation. In that case, Norwegian import prices may be closer to the "true" variables than Alternative II. The Norwegian national account publish import prices for all the ten commodities analysed. Alternative II gives import prices on four aggregate groups of goods. In addition, three of these four groups are dominated by the development in SITC-commodity group 5-9: Manufactures, as can be seen by table 3.3 in chapter 3.3.

Regarding non-price competitiveness, Norwegian firms have experienced an improvement at the aggregate level according to Alternative III. It is difficult to make any conclusions regarding this issue for Alternative I and II.

Our conclusion from this is that we favour the proxies based on imports compared to those based on consumption and investments. As for competitors' prices, the alternative based on imports of SITC-commodities may seem most promising since this is based on foreign rather than Norwegian import prices. But, as already explained, the commodity specific information in Norwegian import prices may prove to be important in the econometric analysis. Still, à priori we prefer Alternative II to the others, but between Alternative I and III we would prefer I.

The choice criteria set out above are clearly vague, and it is difficult find scientific satisfactory selection criteria. Goldstein and Khan (1985, p. 1057) suggest the use of a "goodness-of-fit" criterion to choose between alternative "scale" (world demand) variables. In line with this, we will trust the results from the econometric work and prefer the variables which cointegrate strongest with the variables to be explained, that is Norwegian exports of different commodities. The econometric results will therefore be of major importance in the selection process. Of course, this does not ensure that we finally choose the empirical proxies which are "closest" to the theory variables, but we will argue that this method should be preferred to an à priori "blind" choice of explanatory variables.

4. EMPIRICAL RESULTS

In this chapter, the results from estimating export equations for the ten groups of commodities listed in table 4.1 are presented. The classification of the commodities follows that in MODAG, which is primarily based on Norwegian national account data. On the basis of these results, we suggest new export equations to be used in MODAG[6].

Table 4.1. Commodities included in this export analysis

Commodity		Share of total exports in per cent, 1991
16	Food products	4.3
17	Beverages and tobacco	0.1
18	Textiles and wearing apparels	0.6
25	Miscellaneous industrial products	5.4
	Wood products, furniture and fixtures	1.0
	Chemical and mineral products	3.6
	Printing and publishing	0.1
	Mining products	0.7
34	Paper and paper products	3.0
37	Industrial chemicals	3.2
43	Metals	7.8
46	Machinery and metal products (excl. ships)	6.8
74	Domestic transport	1.7
C70	Tourism	3.8
Sum of the commodities above		36.7
Total exports, billion Nkr		307.5

Source: Økonomiske analyser 2/1993. Central Bureau of Statistics of Norway.

We do not include exports of oil and gas or shipping services (with 31.4 and 16.5 per cent of total exports in 1991 respectively) in this analysis. This explains the relatively small

[6] Because of the practise with re-estimating and evaluating MODAG annually when new observations are available, the export equations in the model may deviate somewhat from those presented here. Also, it may be that the equations implemented in MODAG are not those put forward as the preferred by us for all commodities.

percentage for the commodities to be analysed. Commodity 34, 37 and 43 are basically raw materials and intermediate goods. It is plausible that the qualities and characteristics of these goods depend less on place of production than is the case for the remaining commodities in table 4.1. I.e., one may assume that commodity 34, 37 and 43 are relatively homogeneous, while the remaining commodities are more likely to have the character of being highly differentiated products. We therefore assume the "small open economy" model with price taking behaviour to be particularly promising for commodity 34, 37 and 43, and the Armington model with differentiated products to be more promising for the remaining commodities.

The export volume equations in previous versions of MODAG, are based on the Armington approach. In these equations, price homogeneity is imposed as an à priori restriction in both the short- and the long-run, although theoretical predictions in general refer to long-run solutions. Imposing such restrictions without first testing them is likely to involve some misspecification. For example, the existence of contracted trade, where price and quantity are decided in advance, may explain short-run price non-homogeneity. Asymmetric price elasticities in the long-run may for example indicate that the assumption of separability in demand between different groups of goods is not valid or that the empirical variables differ from their theoretical counterpart. Testing the price homogeneity restriction can therefore be viewed as a way of testing the relevance or quality of the empirical variables just as much as testing the theoretical model. We also test systematically whether the long-run market elasticity equals one or not, and in the latter case whether the deviation from unity can be explained by a simple deterministic trend variable. If we find that the process generating exports can be represented by an export supply model, the restrictions of a capital elasticity equal to one as well as price-cost homogeneity are tested.

Most variables in the data set start in 1962, but some are available from 1965 or 1967. The sample used for estimation ends in 1987. We present ex post forecast comparisons over 1988-1990 of alternative export equations in chapter 4.6. The econometric package PC-GIVE Version 6.1 is used, cf. Hendry (1989). To discriminate between different export equations, both significance tests, goodness of fit tests and stability tests are applied.

The theoretical models presented in chapter 2 are long-run equilibrium models, which suggest cointegrating relationships among variables. As often with economic theory, they offer no guidance as how to specify the dynamic short-run structure. For example, the presence of adjustment costs, incomplete information and contracted trade imply that the adjustment of dependent variables will not be instantaneous, and therefore economic agents will not always be on their long-run supply and demand schedules. Since the export volume equations will be used in economic policy analyses, both the long-run equilibrium solution and the short-run dynamic structure are of interest and importance. According to the Granger Representation Theorem, cf. Engle and Granger (1987), cointegrated series can be represented by error correction models. The error correction model is particularly appealing because of its simplicity with respect to imposing restrictions on the long-run components of variables at the same time as the short-run components are not restricted and have a flexible dynamic specification. Equation (4.1) corresponds to a generalization of the export demand model defined by (2.1). In some equations, i.e. the equations in chapter 4.1 and 4.2, we use world demand variables based on more aggregate data than the empirical proxies for competitors' prices. In this case, we also include foreign import prices of other commodities. When we use empirical proxies for world demand consistent with the proxies for competitors' prices, this additional price term is excluded. Lower case letters indicate that the variables are in logarithms, and $\Delta v_t = \log(V_t/V_{t-1})$, i.e. the first difference of the logarithm of a variable. To reduce the number of subscripts, we have changed the notation slightly so that $XA \equiv X_A$, $PA \equiv P_A$, etc. All variables are measured in Nkr.

$$\Delta xa_{it} = \Sigma_j(\alpha_{ij}\,\Delta pa_{i,t-j} + \beta_{ij}\,\Delta pw_{i,t-j} + \gamma_{ij}\,\Delta pk_{i,t-j} + \zeta_{ij}\,\Delta m_{i,t-j} + \mu_{i,j+1}\,\Delta xa_{i,t-j-1}) + \kappa_i + \tau_i(xa_{i,t-k} + \kappa_{i0} + \alpha_i\,pa_{i,t-l} + \beta_i\,pw_{i,t-m} + \gamma_i\,pk_{i,t-n} + \zeta_i\,m_{i,t-o}) \quad (4.1)$$

i = 16, 17, 18, 25, 34, 37, 43, 46, 74, C70, see table 4.1,
j = 1,..,J lags, where J is sufficiently large to include all significant short-run coefficients,
k, l, m, n, o are any number larger than 0, and

XA_i : Norwegian exports of commodity i in constant prices
PA_i : The Norwegian export price of commodity i
PW_i : Competitors' prices in the world market of commodity i
PK_i : Prices of other commodities abroad
M_i : World demand for commodity i in constant prices.

Both XA_i and PA_i are based on Norwegian national account data. The alternative empirical proxies for the variables describing foreign markets, PW_i, PK_i and M_i, are presented in chapter 3. The α_{ij}'s, β_{ij}'s, γ_{ij}'s, ζ_{ij}'s and μ_{ij}'s are short-run coefficients. τ_i represents the error correction coefficient, while α_i, β_i, γ_i and ζ_i are the long-run elasticity of the own price, the price of close substitutes produced abroad, other import prices abroad and the world demand variable respectively. κ_i and κ_{i0} are intercepts. The two-step estimation procedure suggested in Engle and Granger (1987) has proved to estimate the long-run coefficients poorly compared with the one-step approach, see Hendry et al. (1993) chapter 7, we therefore prefer the latter approach. Still, we report the result from the two-step procedure in two cases though, because it turned out that this procedure gives theory consistent price elasticities while the one-step does not in these cases. In the two-step framework, the cointegrating equation defined by economic theory, in our cases equation (4.2) below where $\alpha_{i0} = -\kappa_{i0}$, is estimated first. The residuals or "equilibrium errors" from this regression are included as a right hand side variable and replace the last parenthesis in (4.1) in step two. In the one-step estimation framework, the error correction part of the model is re-organized as in (4.1'), and we estimate this equation.

$$\Delta xa_{it} = \Sigma_j(\alpha_{ij}\ \Delta pa_{i,t-j} + \beta_{ij}\ \Delta pw_{i,t-j} + \gamma_{ij}\ \Delta pk_{i,t-j} + \zeta_{ij}\ \Delta m_{i,t-j} + \mu_{i,j+1}\ \Delta xa_{i,t-j-1}) \quad (4.1')$$
$$+ \tau_{i0} + \tau_i\ xa_{i,t-k} + \tau_{i1}\ pa_{i,t-l} + \tau_{i2}\ pw_{i,t-m} + \tau_{i3}\ pk_{i,t-n} + \tau_{i4}\ m_{i,t-o}$$

where $\tau_{i0} = \kappa_i + \tau_i \cdot \kappa_{i0}$, $\tau_{i1} = \tau_i \cdot \alpha_i$, $\tau_{i2} = \tau_i \cdot \beta_i$, $\tau_{i3} = \tau_i \cdot \gamma_i$, $\tau_{i4} = \tau_i \cdot \zeta_i$.

We can easily find the long-run elasticities defined by equation (4.1) from equation (4.1'). The long-run solution of both (4.1) and (4.1'), is given in equation (4.2). In the one-step estimation approach, we can not identify both intercepts in (4.1), and in this case $\alpha_{i0} = -(\kappa_i/\tau_i + \kappa_{i0})$.

$$xa_i = \alpha_{i0} - \alpha_i\ pa_i - \beta_i\ pw_i - \gamma_i\ pk_i - \zeta_i\ m_i \qquad i=16,..,C70 \qquad (4.2)$$

Long-run price homogeneity implies that $\beta_i = -(\alpha_i + \gamma_i)$ or equivalently that $\tau_{i2} = -(\tau_{i1} + \tau_{i3})$. A market elasticity equal to one in the long-run means that $\zeta_i = -1$, i.e. $(\tau_{i4} / \tau_i) = -1$. Although theory does not say anything about the dating of the level variables in the general error correction model, common practice is that they are dated at t-1. The general model in (4.1') is not restricted to this however, and the specification which gives the best statistical representation of the data generating process will be preferred. In principle dating is arbitrary, since any non-standard dating error correction model can be transformed to one with standard dating.

The re-organized error correction model corresponding to the export supply model defined by (2.16) is given in (4.3). The notation describing lag structures follows largely that in (4.1) and (4.1').

$$\Delta xa_{it} = \Sigma_j (\alpha_{ij} \Delta pa_{i,t-j} + \beta_{ij} \Delta pv_{i,t-j} + \gamma_{ij} \Delta ph_{i,t-j} + \delta_{ij} \Delta p^*_{i,t-j} + \eta_{ij} \Delta q_{t-j} + \lambda_{ij} \Delta k_{i,t-j} + \mu_{i,j+1} \Delta xa_{i,t-j-1}) + \tau_{i0} + \tau_i xa_{i,t-k} + \tau_{i1} pa_{i,t-1} + \tau_{i2} pv_{i,t-n} + \tau_{i3} ph_{i,t-m} + \tau_{i4} p^*_{i,t-o} + \tau_{i5} q_{i,t-p} + \tau_{i6} k_{i,t-q} \quad (4.3)$$

where

XA_i : Norwegian exports of commodity i in constant prices
PA_i : The Norwegian export price of commodity i
PH_i : The price of domestic sales of commodity i
PV_i : Variable unit costs in the domestic industry producing commodity i
Q : Real gross domestic product (GDP)
P^*_i : GDP deflator
K_i : Capital stock of the domestic industry producing commodity i.

All variables are Norwegian national account data. We choose to measure the theoretical variable "Factor prices faced by producers in domestic industries" (PV) by industry specific variable unit costs. This means that not only factor prices are assumed to matter, but also the development in productivity. An increase in factor prices which is completely compensated by an increase in productivity, is not assumed to influence domestic production or exports directly. Productivity is treated as exogenous in this export analysis. (We have also estimated export supply equations using various factor prices, but the problem with this strategy is the large number of explanatory variables.) We face a problem with the industry specific variables PV and K. The classification of industries does not totally coincide with the classification of commodities in MODAG, and commodity 16, 17 and 18 are produced by an aggregate industry. We have chosen to use the variables describing the development in variable unit costs and capital stock of this aggregate industry for all three commodities. The price of other commodities in the domestic market, P^*_i, is measured by the GDP deflator, and as a measure of domestic income we use real GDP.

The long-run solution of (4.3) is given in equation (4.4), and the coefficients represent the long-run elasticities.

$$xa_i = \alpha_{i0} - \alpha_i pa_i - \beta_i pv_i - \gamma_i ph_i - \delta_i p^*_i - \eta_i q_i - \lambda_i k_i \qquad i=16,..,C70 \quad (4.4)$$

where $\alpha_{i0} = -\tau_{i0}/\tau_i$, $\alpha_i = \tau_{i1}/\tau_i$, $\beta_i = \tau_{i2}/\tau_i$, $\gamma_i = \tau_{i3}/\tau_i$, $\delta_i = \tau_{i4}/\tau_i$, $\eta_i = \tau_{i5}/\tau_i$, $\lambda_i = \tau_{i6}/\tau_i$.

The "residual" export supply model in (2.10) and (2.12), with price-cost homogeneity in supply and price homogeneity in domestic demand, implies that $\alpha_i = -\beta_i$ or $\tau_{i1} = -\tau_{i2}$, and $\gamma_i = -\delta_i$ or $\tau_{i3} = -\tau_{i4}$. The export supply model in (2.15), where we assume that commodities produced for exports and domestic sales are not identical, implies in the price-cost homogeneity case that $\beta_i = -(\alpha_i+\gamma_i)$ and $\delta_i = \eta_i = 0$, or $\tau_{i2} = -(\tau_{i1}+\tau_{i3})$ and $\tau_{i4} = \tau_{i5} = 0$. A unit capital elasticity means that $\lambda_i = -1$ or $\tau_{i6} / \tau_i = -1$. If $\alpha_i = -\beta_i$ and $\gamma_i = \delta_i = \eta_i = 0$, i.e. if $\tau_{i1} = -\tau_{i2}$ and $\tau_{i3} = \tau_{i4} = \tau_{i5} = 0$, equation (4.3) reduces to a simple export supply function with price-cost homogeneity where only supply side variables enter.

When estimating (4.3), it turned out impossible to follow the preferred strategy to start out with a very general model with respect to both the number of explanatory variables and lags included. This is due to a relatively short sample of PH_i, which is not available before 1967, and the large number of potential explanatory variables. The chosen strategy is to start with a general model with respect to explanatory variables, and exclude insignificant lags and level variables. We also exclude level variables if the implied long-run elasticities are in conflict with theoretical predictions. However, PA_i and PV_i are defined as "basic" explanatory variables. Hence, we will not accept versions of the export supply model which do not include long-run effects of these variables. Excluded variables and zero restrictions give room for testing out alternative lag structures. It turned out that the data supports the export supply model for only one commodity.

Both the results from using ordinary least squares (OLS) and the instrumental variable (IV) method, where we treat PA_i as endogenous, are reported. The IV regressions are given in appendix 2. If we find that the data generating process can be represented by the model in (2.12) or (2.15.ii), where the price of domestic sales is endogenous, we should also use instruments for PH_i. In chapter 4.1, we report the results from estimating export demand equations when we use the variables presented in chapter 3.3 as proxies for world demand and competitors' prices. We allow short-run price non-homogeneity. A more restrictive model with price homogeneity in both the short- and the long-run is estimated in chapter 4.2. In chapter 4.3, the results from estimating export demand equations with alternative variables describing world demand and competitors' prices are given. These explanatory variables are presented in chapter 3.4. The results from estimating export supply equations are reported in chapter 4.4. We compare our export equations with those in the "old" export model in MODAG in chapter 4.5. Ex post forecast properties of our equations are discussed in chapter 4.6.

In chapter 4.1-4.4, the econometric results are summarized in a table. The t-ratios of the estimated coefficients are given in brackets. The significance of the long-run elasticities are calculated by using the method suggested in Kmenta (1971), see Bårdsen (1989). The long-run elasticities are denoted by $El_V XA_i$, where V represents an explanatory variable in the export volume model for commodity i. When a long-run elasticity is not consistent with the theoretical model, i.e. the predicted sign is not supported by the data, this is indicated by (nc). The standard error of the regressions (SER) is reported as well as the Durbin-Watson statistic (DW). A F-form of the lagrange multiplier test have been applied to test both autocorrelation up to two lags (Harvey (1981)) and heteroscedasticity up to second order (Engle (1982)) in the residuals. These tests are denoted AR(2) and ARCH(2) respectively. The Chi-square test of normality (NORM) is also reported (Jarque and Bera (1980)). The Hausman-Wu test (Godfrey (1988)), is used to test whether the export price is weakly exogenous when estimating export volume equations or not. The Dickey-Fuller (DF) and the Augmented Dickey-Fuller (ADF) tests have been applied to test for cointegration (Engle and Granger (1987)). The interpretation of a significant test in this case is that the level variables cointegrate. One problem with the DF- and the ADF-test is the lack of critical values consistent with the sample size in our regressions[7]. Nevertheless, tables 2 and 3 in Engle and Yoo (1987) provide a rough guide. Since the critical value of the DF-test decreases with the number of observations, this test will tend to reject the null hypothesis too often in our case. Hence the conclusion may too often be that the variables cointegrate. On the other hand, poor power properties are known to be a serious problem with these tests, cf. Banerjee and Hendry (1992) and Kremers et al. (1992). A test with higher power is suggested in Kremers et al. based on the t-ratio of the error correction coefficient (t_{ECM}). We follow the recommended procedure when this statistic deviates from the standard normal distribution and use the DF-critical values. Thus, we will reject the null hypothesis of no cointegration less often than if we use the Gaussian-critical values. For all tests, a "significant" result at the five per cent level is indicated by (s). To test the constancy of the relationships over time, we use recursive Chow-tests and recursive least squares (RLS). The result from the 1-step ahead and the N-decreasing Chow-tests are reported in the text if one or both indicate poor relative forecast.

Restrictions on the coefficients are indicated by an asterix. The validity of a restriction is tested by adding one of the variables with a restricted coefficient and estimating the augmented model. If this variable enters significantly, the restriction is not supported by the data. We report the results from testing restrictions on the cointegrating vector in the tables; we report the t-value of the variable added (Restr. V).

[7] MacKinnon (1991) provides a formulae for calculating critical values for some tests of cointegration and unit roots for all sample sizes. However, this is not very helpful for us because we do not include a constant term in the auxiliary regressions.

In addition to the statistics already mentioned, when choosing between alternative models for a commodity, we have also tested whether a model encompasses the others or not. I.e. we compare formally whether two candidates have something to learn from each other or not. Encompassing tests are not run if the results from the other tests point out one obvious candidate, and indicate that competing models are misspecified. The encompassing test reported is the F-form of the LM-test for omitted variables, where two alternative candidates are tested against the linear nesting model of which the two are reductions. The interpretation of a significant test is that variables in the alternative model explain variation in the left hand side variable not explained by the model in focus, the latter model corresponds to the null hypothesis.

4.1. Empirical export demand equations

In this section we present the results from estimating export demand equations when using empirical proxies for the world demand variables based on total imports of goods abroad. These variables are described in chapter 3.3. Norwegian import prices are used as proxies for competitors' prices. The Norwegian import price of commodity i is denoted PI_i. As explained in chapter 2.1, when we use empirical proxies for world demand based on more aggregate data than the proxies for competitors' prices, we should take into account the substitution effect between commodities and include relative prices between different commodities. In this case we should add relative import prices by our main trading partners, but our problem is that the import prices of interest are not published. Instead, when modelling exports of a commodity, we include an aggregate measure of import prices of other commodities abroad (PK_i) which is based on the unit value of imports by our principal trading partners. These aggregate import price indices are commodity specific; when aggregating across countries we use weights which reflect the importance of each country for Norwegian exports of different commodities. The construction of these aggregate import price indices are also described in chapter 3.3.

It turned out that we find cointegrating vectors which include the ratio of the aggregate import price index of other commodities abroad to competitors' prices in addition to the relative export price for only two commodities, namely commodity 34 and C70. One interpretation of this is that the world demand variables applied reflect the development in demand for the commodities analysed in a sufficient way for most commodities. Or alternatively, it may be the case that including the ratio of the aggregate price indices to competitors' prices is not a good alternative to relative import prices between different commodities. In this case we face a problem with omitted explanatory variables, and the estimated coefficients will in general be inconsistent. We assume that the omitted relative prices and the included relative export price are positively correlated and that the coefficients on the omitted variables are positive, see chapter 2.1 for the latter. In this case, the estimated own price elasticity will be biased upwards. The biases on the elasticity with respect to competitors' prices and world demand are more difficult to predict. For most commodities we find larger price effects in this chapter than in chapter 4.3, where omitted relative prices are assumed not to be a problem. Hence, bias due to omitted variables may not be a very important issue. Furthermore, for most commodities we conclude that the included level variables cointegrate, which supports the chosen approach. Of course, if relative import prices abroad between commodities are integrated of order 0, our conclusions regarding cointegration is consistent with an "omitted variables" problem. The chosen approach implies that the estimated export equations should not be used in analysis where changing relative import prices between commodities abroad is an important issue. Our view is that this limitation is not very important. Because Norwegian products cover relatively small shares of foreign imports, see table 3.5 in chapter 3.4, changes in Norwegian export prices of the commodities modelled are assumed to influence relative import prices abroad only marginally. Thus analysis with changes in Norwegian export prices is valid.

The data used in these regressions supports long-run price homogeneity for all commodities. On the other hand, we find price non-homogeneity in the short- and medium-run for most commodities, the exceptions are commodity 18, 25 and 74. This shows that imposing price homogeneity in both the short- and the long-run may be too restrictive and as a consequence lead to misspecification. (The results when imposing price homogeneity in both the short- and the long-run for all commodities are presented in chapter 4.2.)

Table 4.2. Export demand equations with "world demand" based on total imports of goods abroad and "competitors' prices" proxied by Norwegian import prices. Alternative I

Estimated coefficients[1]					
Variable	Commodity 16	Commodity 17	Commodity 18[2]	Commodity 25	Commodity 34
Δxa_{t-1}				0.32 (1.9)	
Δxa_{t-2}	0.38 (3.2)				
Δm_t		0.54 (1.6)		1.33 (6.9)	1.27 (7.4)
Δm_{t-1}				-0.77 (-3.0)	-0.64 *
Δpa_t	-1.01 (-6.3)	-0.84 (-7.4)		-0.52 (-2.4)	-1.37 (-5.2)
Δpa_{t-1}	1.91 (7.3)	0.84 *		0.78 (2.8)	
Δpa_{t-2}	1.33 (5.9)				
Δpa_{t-3}	0.91 (7.5)				
Δpi_t	1.01 *	3.48 (6.8)		0.52 *	1.37 *
Δpi_{t-1}	-1.91 *	-1.74 *		-0.78 *	
Δpi_{t-2}	-1.33 *				
Δpk_t					0.83 (6.2)
xa_{t-1}	-0.71 (-7.1)	-0.98 (-6.7)	0.57 (5.6)	-0.91 (-5.0)	-0.43 (-3.4)
m_t			0.78 (4.2)		
m_{t-1}		0.20 (1.1)		1.13 (4.9)	0.23 (2.8)
m_{t-2}	0.71 *				
p_t			-1.29 (-3.4)		
p_{t-1}	-2.99 (-7.8)	-1.62 (-7.8)		-1.19 (-4.4)	-1.21 (-5.6)
pki_{t-1}					0.30 (2.8)
Constant	7.54 (7.0)	5.83 (6.5)	4.94 (4.9)	10.29 (5.0)	4.68 (3.3)
TREND		0.08 (5.6)	-0.04 (-5.3)		
$El_M XA$	1.00 *	0.20 (1.0)	1.82	1.25 (44.1)	0.53 (4.0)
$El_{PA} XA$	-4.20 (-21.9)	-1.66 (-9.3)	-2.99	-1.31 (-4.2)	-2.83 (-4.4)
$El_{PI} XA$	4.20 *	1.66 *	2.99 *	1.31 *	2.12 *
$El_{PK} XA$					0.71 (2.1)
Est.period	1966-1987	1965-1987	1966-1987	1964-1987	1965-1987
SER	0.039	0.066	0.045	0.032	0.035
DW	1.95	2.38	2.38	2.33	1.97
AR(2)	0.06	0.44	3.27	1.01	1.08
ARCH(2)	0.20	0.70	0.14	0.47	0.67
NORM	0.86	0.37	0.28	0.47	0.43
Hausman	-0.41	0.90	-1.29	-0.29	-1.38
DF/(ADF)	(-3.79) (s)	-4.48 (s)	-2.54	(-3.91) (s)	(-3.39)
t_{ECM}	(s)	(s)	..	(s)	
Restr. m	-0.53				
Restr.p(ki)	0.73	0.49	0.48	-1.20	-1.50

1) t-statistics in brackets.
2) Left hand side variable is xa_t.
* Restricted à priori.
$p_t = (pa_t - pi_t)$, $pki_t = (pk_t - pi_t)$.
(s) Significant at the five per cent level.

Table 4.2. Continues

Estimated coefficients[1]					
Variable	Commodity 37	Commodity 43	Commodity 46	Commodity 74	Commodity C70
Δm_t	1.00 (5.8)	1.58 (5.1)	0.39 (2.0)		0.37 (2.0)
Δm_{t-1}			1.03 (6.3)		
Δpa_t	-1.10 (-6.9)		-0.55 (-3.4)	-0.38 (-1.9)	-0.62 (-3.1)
Δpa_{t-1}		0.47 (1.6)	0.40 (2.2)		
Δpa_{t-2}	-0.65 (-6.5)				
Δpi_t	1.10 *			0.38 *	0.62 *
Δpi_{t-1}		-0.47 *	-0.40 *		
Δpk_t					-0.52 (-4.5)
xa_{t-1}	-0.24 (-3.7)	-0.83 (-4.8)		-0.67 (-3.8)	-0.72 (-5.9)
xa_{t-2}			-0.29 (-2.2)		
m_{t-1}		0.61 (4.5)		0.67 *	0.72 *
m_{t-2}			0.46 (2.5)		
m_{t-3}	0.37 (5.1)				
p_{t-1}	-0.24 *	-0.54 (-1.9)		-0.34 (-1.9)	-0.85 (-5.5)
p_{t-2}			-0.46 (-3.2)		
pk_{t-1}					0.23 (2.1)
Constant	2.73 (3.8)	10.09 (4.8)	3.37 (2.2)	7.13 (3.8)	8.00 (5.9)
$El_M XA$	1.53 (8.7)	0.73 (15.5)	1.57 (13.0)	1.00 *	1.00 *
$El_{PA} XA$	-1.00 *	-0.64 (-2.0)	-1.58 (-1.5)	-0.50 (-4.1)	-1.18 (-8.7)
$El_{PI} XA$	1.00 *	0.64 *	1.58 *	0.50 *	0.86 *
$El_{PK} XA$					0.32 (2.2)
Est.period	1966-1987	1964-1987	1964-1987	1963-1987	1965-1987
SER	0.036	0.060	0.027	0.075	0.030
DW	1.89	2.01	2.38	2.14	2.00
AR(2)	0.06	0.07	4.07 (s)	2.06	1.41
ARCH(2)	0.43	0.80	0.58	0.52	0.73
NORM	0.04	1.06	0.97	0.34	0.21
Hausman	-0.09	..	-0.06	0.25	0.51
DF/(ADF)	(-2.22)	-4.04	-2.68	-3.75 (s)	(-4.45) (s)
t_{ECM}	(s)	(s)		(s)	(s)
Restr. m				-1.16	-0.37
Restr.p(ki)	1.24	-1.62	-1.11	-0.82	-0.41
Restr. $El_p XA=-1$	0.14				

1) t-statistics in brackets.
* Restricted à priori.
$p_t = (pa_t - pi_t)$, $pki_t = (pk_t - pi_t)$.
(s) Significant at the five per cent level.

Furthermore, we find a long-run relative price elasticity below minus one for most commodities. For manufactured goods (commodity 16-46), the own price elasticity equals –1.67 while the elasticity with respect to competitors' prices equals 1.60. We use export volumes in 1990 as weights when calculating aggregate elasticities. This implies that a one per cent increase in the relative export price will decrease export volumes by more than one per cent. Foreign demand for commodity 16, 17 and 18, which depend very much on private consumption abroad, are relatively price elastic according to these results. This is particularly true for commodity 16 and 18. Commodity 43 and 74 are price inelastic, i.e. the relative price elasticity is estimated to be above minus one. For commodity 37, we find a relative price elasticity equal to minus one. We have earlier argued that commodity 34, 37 and 43, which are mainly raw materials and intermediate goods, are relatively homogeneous, i.e. domestic and foreign products are close substitutes. It is therefore particularly surprising to find a small price elasticity for the two latter commodities. One interpretation of this result is that omitted variables is a serious problem for these commodities. Alternatively this may indicate that the substitution effect between Norwegian products of these commodities are large, or simply that although the qualities of these commodities themselves may be relatively similar and independent of place of production, other aspects of importance form a basis for a very high consumer loyalty in the export markets.

For commodity 34 and C70 we find that the ratio of other import prices abroad to competitors' prices enters significantly in the long-run. For these commodities, an increase in competitors' prices has a negative effect on Norwegian exports in addition to the standard positive effect coming from the fall in the relative export price. The negative effect is due to the fall in total import demand abroad for these commodities when competitors' prices increase relative to other import prices. The positive effect dominates though.

The data supports a long-run market elasticity equal to one for commodity 16, 74 and C70, indicating unchanged non-price competitiveness for these commodities. The market elasticity is estimated to be smaller than one for commodity 17, 34 and 43, indicating a loss of non-price competitiveness, and larger than one for the remaining commodities, indicating a gain in non-price competitiveness. The positive trend coefficient for commodity 17 and the negative trend coefficient for commodity 18 does not alter these conclusions for the period 1962-1990. The aggregate market elasticity for manufactured goods calculated in 1990 is 1.11, which indicates a gain in non-price competitiveness. The aggregate trend coefficient is –0.0004 in 1990, but the negative effect of the trend variable does not change our conclusion regarding a gain in non-price competitiveness. The isolated effect of the trend variable over the period 1962-1990 is a reduction in exports of manufactured goods of 1 per cent, while the isolated effect of growth in world demand is an increase in exports of about 350 per cent over the same period. We find that the hypotheses regarding non-price competitiveness put forward in chapter 3.3 are in line with the econometric results.

With two exceptions, all the estimated long-run price and market elasticities in table 4.2 are significantly different from zero. The standard error of the regressions (SER) are 3-5 per cent for most commodities, the main exceptions are commodity 17 with 6.6 per cent and commodity 74 with 7.5 per cent. Regarding the tests of autocorrelation, heteroscedasticity and normally distributed errors, all but one equation pass the tests at the five per cent level. We find second order autocorrelation for commodity 46, indicating that we have some problems with modelling the dynamics. In general, the stability properties of the equations are good, with possible exceptions for commodity 18 and 74. Our conclusion from the Hausman-Wu test is that export prices may be assumed to be weakly exogenous when estimating export volume equations. The DF- or the ADF-test is significant for commodity 16, 17, 25, 74 and C70, indicating that the level variables in these equations cointegrate. When using the DF-critical values for the t_{ECM}-test, we reject no cointegration for all commodities except commodity 34 and 46. (The estimated equation for commodity 18 is not an error correction model.) If we can assume that t_{ECM} is normally distributed, cointegration is accepted for commodity 34 and 46 as well. Our conclusion from this is that the level variables included in this chapter cointegrate for all commodities except commodity 18 and perhaps also commodity 46.

Another aspect of interest is the relationship between short- and long-run elasticities. Table 4.3 gives standardized interim multiplicators for the equations in table 4.2. We report the initial effect and the cumulated effect at t+2.

Table 4.3. The effect on exports of changes in the explanatory variables. The initial effect and the cumulated effect at t+2. The equations in table 4.2

Commodity	Increase in prices						Increase in world demand	
	Own price		Competitors' prices		Other import prices abroad			
	t	t+2	t	t+2	t	t+2	t	t+2
16	24	58	24	58			0	71
17	51	99	210	98			270	100
18	43	82	43	82			43	81
25	40	80	40	80			106	86
34	48	83	65	88	117	104	240	75
37	110	171	110	106			65	62
43	0	86	0	86			216	104
46	35	28	0	0			25	113
74	76	100	76	100			67	96
C70	53	96	72	98	..	78	37	95

For most commodities, the initial effects are smaller than the long-run effects. The exceptions are commodity 17, 25, 34 and 43 with respect to changes in world demand, and commodity 17, 34 and 37 with respect to changes in prices. In addition, we find overshooting in the medium-run with respect to world demand for commodity 16 and 46, and with respect to prices for commodity 16. Thus, we find elements of overshooting for all commodities except commodity 18, 74 and C70.

For commodity 17 and 46, the standardized interim multiplicator with respect to competitors' prices is negative at t+1 but positive again at t+2. One interpretation of this result is that relative import prices between commodities abroad matter for these commodities, although we have not been able to identify such effects in this analysis. Thus, when competitors' prices increase, a negative effect on Norwegian exports coming from a fall in total import demand abroad for these commodities dominates the positive effect of the decrease in the relative export price in the short-run.

A discussion of each equation

The estimated equation for **commodity 16**: Food products, implies price homogeneity in both the long- and the short-run, but there is an intermediate period with some degree of price non-homogeneity. The long-run price elasticity is -4.20, and the long-run market elasticity is one. All restrictions on this equation pass the LM-test. Imposing price homogeneity also in the medium-run gives unstable coefficients and autocorrelated residuals. This regression passes all tests at the five per cent level, and we conclude that the level variables cointegrate.

We find long-run price homogeneity for **commodity 17**: Beverages and tobacco. The estimated market elasticity is very low, but the equation includes a positive trend coefficient which is relatively large. The effect on exports of growth in world demand and the trend variable from 1962 to 1990 is an increase in exports of about 86 and 213 per cent respectively. We are reluctant to choose an export equation which includes such a large trend coefficient, but commodity 17 is of only minor importance for Norwegian exports, see table 4.1. If we exclude the trend variable, long-run price homogeneity is not a valid restriction. The equation passes most tests applied at the five per cent significance level, but the long-run market elasticity is not significant. On the other hand, both the DF- and t_{ECM}-test indicate that there is a cointegrating relationship between the level variables, and the equation is stable.

For **commodity 18**: Textiles and wearing apparels, we present a model with a simple partial adjustment mechanism rather than an error correction model. I.e., the left hand side variable is xa_t. The restriction of price homogeneity passes the LM-test when we include a deterministic trend variable. The RLS estimates of the coefficients make a jump in 1984, but stabilize at their new level from then on. The changes in all the estimated coefficients are well inside their standard error bounds. The 1-step ahead Chow-test is not significant at the five per cent level, but the N-decreasing Chow-test is in 1984, indicating some problems with stability of this equation. The effect of excluding the trend variable is that long-run price homogeneity is rejected. In general, excluding the trend variable but maintaining the homogeneity restriction result in either a positive long-run price elasticity or a negative long-run market elasticity. In equation (18.2) we present the result when long-run price non-homogeneity is allowed.

$$xa_t - m_t = \underset{(2.9)}{4.41} + \underset{(3.4)}{0.53}\,(xa_{t-1} - m_{t-1}) - \underset{(-2.9)}{1.29}\,p_t - \underset{(-5.3)}{0.36}\,pa_{t-2} \qquad (18.2)$$

Long-run elasticities: Own price = -3.14
Competitors' prices = 2.37
World demand = 1.00 *
Estimation period: 1966-1987 SER = 0.049 DW = 1.93 AR(2) = 0.96
ARCH(2) = 0.13 NORM = 1.01 DF = -2.15 Restr. m = 0.93

According to equation (18.2), the long-run market elasticity equals one, and the trend variable does not enter significantly. Both Chow-tests are significant in 1984, but the N-decreasing Chow-test is only just significant at the five per cent level. The RLS estimates show instability in 1984, but they stay inside their standard error bounds and stabilize already in 1985. When comparing the predictive power (SER) of the two alternative export demand equations presented for this commodity, one sees that the difference is minor but favours the equation with price homogeneity and a trend variable. The DF-test does not support cointegration between the level variables in neither equations, not even at the ten per cent significance level. The estimation period can be extended backwards to 1962/1963, this influence the equation in table 4.2 only marginally, but the properties of equation (18.2) are affected in important ways: SER increases to 0.062 and DW falls to 1.49, at the same time as the long-run price elasticities decrease significantly (in absolute value). Our conclusion is that the equation with price homogeneity in table 4.2 is preferred to (18.2), mainly because it supports the theoretical restriction of price homogeneity, but also because it has a higher degree of autonomy.

Regarding **commodity 25**: Miscellaneous industrial products, the data supports price homogeneity in both the short- and the long-run, but not a long-run market elasticity equal to unity. The equation passes all statistical tests applied at the five per cent significance level, and there are no signs of instability. Both the ADF- and t_{ECM}-test indicate that the variables in the error correction part of this export volume equation cointegrate.

The data supports long-run price homogeneity for **commodity 34**: Paper and paper products. The equation includes two relative price terms; one between the Norwegian export price and competitors' prices and one between other import prices abroad and competitors' prices. The price effects are relatively large. An increase in the own price by one per cent decreases exports by 2.83 per cent in the long-run, while an increase in competitors' prices by one per cent increases exports by 2.12 per cent in the long-run. This latter elasticity is a "net" elasticity and reflects both a positive effect coming from the reduction in the relative export price and a negative effect due to the decrease in the ratio of other import prices abroad to competitors' prices. An increase in other import prices abroad by one per cent will increase Norwegian exports by 0.71 per cent. The long-run market elasticity is well below one. This equation passes most tests applied and is stable. Neither the ADF- nor the t_{ECM}-test is significant though. On the other hand, the t-value of the error correction coefficient is quite large, and no cointegration is clearly rejected if we use the Gaussian-critical values.

The data supports price homogeneity in the long run for **commodity 37**: Industrial chemicals. Furthermore, a long-run relative price elasticity equal to -1 is also valid according to the LM-test. Left unrestricted, the long-run relative price elasticity is estimated to be -0.92. It should be noted however, that the long-run price elasticity is not significantly different from zero in the unrestricted case. The t-value of this elasticity is -1.5. The equation is stable and passes all the statistical tests applied with the exception of the ADF-test. Despite an insignificant ADF-test, we conclude that the level variables in this equation cointegrate due to a significant t_{ECM}-test.

Experience tells us that it is difficult to obtain export demand equations with significant theory consistent price elasticities for **commodity 43**: Metals. The long-run price homogeneity restriction reduces this problem somewhat. But, although the LM-test for omitted variables rejects the inclusion of pa_{t-1}, we find it difficult to conclude that the data supports long-run price homogeneity. The coefficient on "competitors' prices" is far from being significant in the unrestricted equation. Still, the equation is stable, and cointegration is supported by the t_{ECM}-test. The DF-test is not significant at the five per cent level though, but the conclusion regarding the DF-test is changed at the ten per cent level. (The critical value for the DF-test at the five per cent significance level is 4.11 in this case.)

The data supports long-run price homogeneity but not a long-run market elasticity equal to one for **commodity 46**: Machinery and metal products. There is a problem with second order autocorrelation. The residuals are negatively autocorrelated and thus suggest overfitting. (The low SER may support this.) Because of autocorrelation, predictions will be inefficient and F-tests are incorrect when calculated given the assumption of no autocorrelation. The standardized interim multiplicator with respect to competitors' prices is negative at t+1. Furthermore, the long-run price elasticity is insignificant, and the value of this elasticity also varies widely with the specification of the model. To see this, compare the preferred equation in table 4.2 with equation (46.2) and (46.3) below (see also table 4.4 in chapter 4.2).

$$\Delta xa_t = \underset{(1.0)}{1.40} + \underset{(1.5)}{0.30}\,\Delta m_t + \underset{(5.5)}{0.84}\,\Delta m_{t-1} - \underset{(-3.7)}{0.64}\,\Delta pa_t - \underset{(-1.1)}{0.12}\,xa_{t-2} + \underset{(1.4)}{0.23}\,m_{t-2} \qquad (46.2)$$

$$- \underset{(-4.7)}{0.63}\,p_{t-2}$$

Long-run elasticities: Relative price = -5.16 (-1.0)
World demand = 1.90 (3.6)
Estimation period: 1964-1987 SER = 0.029 DW = 1.97 AR(2) = 3.46
ARCH(2) = 0.54 NORM = 1.15 ADF = -2.78 Restr. p = 0.14

$$\Delta xa_t = \underset{(3.9)}{4.22} + \underset{(4.4)}{0.47}\,(m_t - m_{t-2}) - \underset{(-3.8)}{0.48}\,\Delta pa_t + \underset{(5.6)}{0.83}\,\Delta p_{t-1} - \underset{(-3.9)}{0.36}\,xa_{t-2} + \underset{(4.3)}{0.54}\,m_{t-1} - \underset{(-3.0)}{0.39}\,p_{t-1} \qquad (46.3)$$

Long-run elasticities: Relative price = -1.07 (-2.0)
World demand = 1.49 (19.6)
Estimation period: 1965-1987 SER = 0.025 DW = 2.61 AR(2) = 4.88 (s)
ARCH(2) = 0.92 NORM = 0.60 ADF = -3.70 Restr. p = -0.42

From equation (46.2) we see that excluding the relative price difference Δp_{t-1} from the equation in table 4.2, reduces the problem with autocorrelation. (The rejection of autocorrelation is only just valid at the five per cent level though.) The t-value of the long-run relative price elasticity drops to -1.0, at the same time as the price elasticity changes considerably from -1.58 to -5.16. The market elasticity increases somewhat. In (46.3), where the relative price and the world demand variables are dated at t-1 instead of at t-2 (as in the preferred equation), the long-run relative price elasticity is significant. The price elasticity has increased though, and is just below minus one. Furthermore, the problem with autocorrelation has increased. (In chapter 4.2, the result when all the level variables are dated at t-1 is presented. The long-run price elasticity is not significant in this case, and it is estimated to be only -0.35. There is no problem with autocorrelation.)

The low significance of the long-run price elasticities reflects a general problem with finding a cointegrating vector consistent with the export demand model. Both the ADF- and t_{ECM}- test are significant at the ten per cent level for equation (46.3). For the other equations one has to open up for significance levels well above ten per cent to reject the null hypothesis of "no cointegration". On the other hand, the null hypothesis is rejected by the t_{ECM}-test of the preferred equation if we use the Gaussian-critical values. Still, the relatively poor result regarding cointegration may be due to the exclusion of relative import prices between commodities by our principal trading partners. The SER is low in all equations though, indicating that the included variables explain very well the development in exports over the estimation period. Except for the problems already discussed, the statistical properties of the equations are good. The equations are stable; the RLS estimates and Chow-tests do not indicate structural changes.

The LM-test supports both price homogeneity and a unit market elasticity in the long-run for **commodity 74**: Domestic transport. The long-run price elasticity is very small though and equals -0.50. The 1-step ahead Chow-test indicates a structural change in 1978, but the N-decreasing Chow-test does not confirm this at the five per cent significance level. On the other hand, the latter test indicates instability at the beginning of the seventies. The RLS estimates are relatively stable over the whole estimation period, but the standard error bounds are quite wide. This equation passes all other tests, and cointegration is accepted.

Regarding **commodity C70**: Tourism, we find price homogeneity and a market elasticity equal to one in the long-run. As for commodity 34, the equation for commodity C70 includes two relative price terms, i.e. we find a long-run effect of changes in other import prices abroad. While a one per cent increase in the export price reduces exports by more than one per cent in the long-run, the net effect of a one per cent increase in competitors' prices increases exports by less than one per cent. The initial effect on exports of an increase in other import prices abroad is negative, but the cumulated effect at t+1 and later periods are positive. This equation passes all tests applied at the five per cent significance level, the level variables cointegrate, and the equation is stable.

4.2. Empirical export demand equations with price homogeneity in both the short- and the long-run

This chapter presents the results from estimating export demand equations where price homogeneity in both the short- and the long-run is assumed. At the same time, all level variables are dated at t-1. We call this alternative the "restrictive" equation. It is of interest to check whether this restrictive equation involves a loss of predictive power compared with the preferred equation presented in table 4.2 in the previous chapter.

By comparing the results in table 4.2 and table 4.4, we see that we loose predictive power by using the restrictive equation for important commodities, this is particularly true for commodity 16, 34 and 37. Regarding the commodities 18, 25, 43 and 74, the preferred and the restrictive equations coincide. We will therefore not discuss these commodities any further in this chapter.

In addition to a notably higher SER, there are important differences between the restrictive and the preferred equation for **commodity 16**: Food products. According to the restrictive equation, changes in world demand has an immediate effect on exports, while in the preferred equation it takes two periods before such changes influence exports. Also the long-run properties are very different, and both the price and market elasticity are larger (in absolute value) according to the preferred equation. Furthermore, the restrictive equation includes insignificant variables, but excluding these variables worsen the statistical properties.

Table 4.4. Export equations with price homogeneity in both the short- and the long-run and all variables in the co-integrating part of the model dated at t-1

Estimated coefficients[1]					
Variable	Commodity 16	Commodity 17	Commodity 18[3]	Commodity 25	Commodity 34
Δxa_{t-1}				0.32 (1.9)	
Δm_t	0.29 (0.9)			1.33 (6.9)	1.39 (4.8)
Δm_{t-1}	-0.61 (-3.1)[2]			-0.77 (-3.0)	
Δm_{t-2}		-1.19 (-2.9)			
Δp_t	-0.66 (-2.5)	-1.14 (-7.0)		-0.52 (-2.4)	
Δp_{t-1}	0.49 (1.7)	0.76 (3.7)		0.78 (2.8)	
Δp_{t-2}		0.57 (2.9)			
xa_{t-1}	-0.76 (-4.1)	-1.40 (-7.1)	0.57 (5.6)	-0.91 (-5.0)	-0.67 (-3.7)
m_t			0.78 (4.2)		
m_{t-1}	0.25 (1.9)	0.44 (2.0)		1.13 (4.9)	0.24 (1.9)
p_t			-1.29 (-3.4)		
p_{t-1}	-0.87 (-2.0)	-2.31 (-6.3)		-1.19 (-4.4)	-0.77 (-2.2)
pki_{t-1}					0.33 (1.9)
Constant	8.67 (4.0)	8.75 (7.3)	4.94 (4.9)	10.29 (5.0)	7.42 (3.6)
TREND		0.10 (5.6)	-0.04 (-5.3)		
$El_M XA$	0.33 (2.5)	0.32 (2.1)	1.82	1.25 (44.1)	0.36 (2.6)
$El_{PA} XA$	-1.14 (-2.1)	-1.65 (-11.0)	-2.99	-1.31 (-4.2)	-1.16 (-3.1)
$El_{PI} XA$	1.14 *	1.65 *	2.99 *	1.31 *	0.66 *
$El_{PK} XA$					0.50 (1.6)
Est.period	1965-1987	1965-1987	1966-1987	1964-1987	1965-1987
SER	0.056	0.076	0.045	0.032	0.056
DW	2.40	1.87	2.38	2.33	2.60
AR(2)	0.69	0.29	3.27	1.01	1.83
ARCH(2)	0.39	0.38	0.14	0.47	0.61
NORM	1.40	0.81	0.28	0.47	0.04
DF/(ADF)	(-4.00) (s)	-4.48 (s)	-2.54	(-3.91) (s)	(-3.39)
t_{ECM}	(s)	(s)	..	(s)	
Restr. m					
Restr.p(ki)	-0.73	1.36	0.48	-1.20	-2.43 (s)

1) t-statistics in brackets.
2) $\Delta m_{t-1} = (m_{t-1} - m_{t-3})$.
3) Left hand side variable is xa_t.
* Restricted à priori.
$p_t = (pa_t - pi_t)$, $pki_t = (pk_t - pi_t)$.
(s) Significant at the five per cent level.

Table 4.4. Continues

Estimated coefficients[1]					
Variable	Commodity 37	Commodity 43	Commodity 46	Commodity 74	Commodity C70
Δxa_{t-1}	0.29 (1.7)		0.43 (2.6)		
Δm_t	1.12 (3.5)	1.58 (5.1)	0.84 (5.0)		0.47 (2.5)
Δm_{t-1}			0.39 (1.9)		
Δp_t	-0.83 (-2.8)			-0.38 (-1.9)	-0.39 (-1.9)
Δp_{t-1}		0.47 (1.6)	0.84 (4.4)		
Δpki_t					-0.52 (-4.1)
xa_{t-1}	-0.22 (-1.6)	-0.83 (-4.8)	-0.60 (-3.8)	-0.67 (-3.8)	-0.69 (-5.4)
m_{t-1}	0.31 (1.9)	0.61 (4.5)	0.85 (3.9)	0.67 *	0.69 *
p_{t-1}	-0.29 (-1.0)	-0.54 (-1.9)	-0.21 (-1.4)	-0.34 (-1.9)	-0.88 (-5.4)
pki_{t-1}					0.23 (2.0)
Constant	2.37 (1.6)	10.09 (4.8)	7.01 (3.8)	7.13 (3.8)	7.66 (5.4)
$El_M XA$	1.42 (4.6)	0.73 (15.5)	1.41 (27.3)	1.00 *	1.00 *
$El_{PA} XA$	-1.30 (-1.2)	-0.64 (-2.0)	-0.35 (-1.1)	-0.50 (-4.1)	-1.28 (-8.4)
$El_{PI} XA$	1.30 *	0.64 *	0.35 *	0.50 *	0.94 *
$El_{PK} XA$					0.34 (2.1)
Est.period	1965-1987	1964-1987	1965-1987	1963-1987	1965-1987
SER	0.063	0.060	0.031	0.075	0.032
DW	1.82	2.01	2.07	2.14	2.10
AR(2)	0.65	0.07	2.34	2.06	0.96
ARCH(2)	0.45	0.80	0.26	0.52	0.66
NORM	0.66	1.06	0.59	0.34	0.57
DF/(ADF)	-1.66	-4.04	-2.68	-3.75 (s)	(-4.45) (s)
t_{ECM}		(s)		(s)	(s)
Restr. m				-1.16	-1.00
Restr. p(ki)	1.91	1.62	-0.29	-0.82	-0.69

1) t-statistics in brackets.
* Restricted à priori.
$p_t = (pa_t - pi_t)$, $pki_t = (pk_t - pi_t)$.
(s) Significant at the five per cent level.

For **commodity 17**: Beverages and tobacco, the SER is somewhat higher in the restrictive than in the preferred equation. Furthermore, we have to include longer lags on the explanatory variables to compensate for restrictions on the short-run dynamics. The long-run elasticities are not very much affected though.

The SER is significantly higher in the restricted than in the preferred equation for **commodity 34**: Paper and paper products. Furthermore, long-run price homogeneity is not supported by the data in the restricted case, and also the price elasticities are significantly affected by the restriction on the short-run dynamics.

By comparing the restrictive with the preferred equation for **commodity 37**: Industrial chemicals, we see that the restrictive equation involves an important loss of predictive power: The SER increases from 0.036 to 0.063. Furthermore, the long-run homogeneity restriction passes the LM-test with only a small margin in this case. On the other hand, the long-run price elasticity is below minus one, while in the preferred equation, the long-run relative price elasticity was restricted to equal -1, and without the restriction the price elasticity was estimated to equal -0.92. The estimated long-run price elasticity is not significant though, but this is a general problem with this commodity. Although no Chow-tests indicate structural changes, we evaluate the restricted equation to have poorer stability properties than the preferred equation.

The SER increases only marginally when restricting the equation for **commodity 46**: Machinery and metal products, further. The SER of both the restricted and preferred equation are relatively low, indicating that both equations explain well the development in exports of this commodity. The problem with autocorrelation is eliminated in the restrictive equation, but the problem with an insignificant long-run price elasticity is not reduced. Furthermore, the long-run price elasticity is very much affected and estimated to be well above minus one in the restricted case.

The restricted and preferred equations for **commodity C70**: Tourism, are very similar. The SER increases only marginally, and the long-run elasticities changes only a little. The short-run restriction does not pass the LM-test for omitted variables though, and we therefore prefer the unrestricted equation.

4.3. Empirical export demand equations with alternative measures of world demand and competitors' prices

In this chapter we estimate export demand equations using an alternative set of explanatory variables describing foreign markets. Both world demand and competitors' prices are calculated using import volumes and prices of four different SITC-commodities, see chapter 3.4.

Table 4.5. Export demand equations with "world demand" and "competitors' prices" based on imports of four categories of SITC-commodities abroad. Alternative II

Variable	Estimated coefficients[1]				
	Commodity 16	Commodity 17	Commodity 18[2]	Commodity 25	Commodity 34
Δxa_{t-1}		-0.37 (-1.8)	0.30 (1.9)	1.08 (3.4)	
Δxa_{t-2}	0.31 (2.0)				
Δm_t		-1.46 (-1.6)		1.14 (5.1)	1.05 (5.0)
Δm_{t-1}				-1.32 (-3.6)	
Δpa_t	-0.56 (-2.7)	-0.96 (-3.6)	-1.37 (-3.2)		
Δpa_{t-1}			0.92 (2.0)		
Δpa_{t-2}	0.30 (1.7)		-2.01 (-4.1)		
Δpw_t	1.16 (2.4)		1.37 *		
Δpw_{t-1}	-0.69 (-2.2)	-2.38 (-3.5)	-0.92 *	0.78 (2.4)	
Δpw_{t-2}			2.01 *		
$\Delta x13_t$[3]	0.51 (3.1)				
xa_{t-1}	-0.57 (-2.3)	-0.64 (-3.3)		-0.99 (-4.3)	-0.76 (-5.6)
m_{t-1}	0.20 (1.0)	0.64 *		1.26 (4.2)	0.21 (4.3)
p_{t-1}	-0.45 (-1.5)	-1.15 (-3.7)		1.17 (3.2)	-0.59 (-4.0)
Constant	5.51 (2.4)	1.37 (3.2)	0.01 (0.4)	5.27 (4.4)	7.45 (5.3)
TREND		0.04 (4.5)			
ECM_{t-1}			-0.28 (-2.2)		
$El_M XA$	0.35 (1.4)	1.00 *	0.70	1.28	0.27 (5.4)
$El_P XA$	-0.80 (-1.6)	-1.81 (-3.1)	-1.33	1.18 (nc)	-0.77 (-5.2)
Est.period	1967-1987	1967-1987	1968-1987	1967-1987	1967-1987
SER	0.047	0.110	0.060	0.036	0.045
DW	1.85	2.16	2.09	2.71	2.67
AR(2)	0.11	0.47	0.44		1.41
ARCH(2)	0.09	1.16	0.20		0.24
NORM	0.21	0.99	0.34		1.24
Hausman	-1.22	0.74	0.55		..
DF/(ADF)	-3.14	-3.08	(-2.31)		-3.39
t_{ECM}					(s)
Restr. m		-0.03			
Restr. p	-0.52	-0.84	-1.91		-0.95

1) t-statistics in brackets.
2) A two-step estimation procedure is used.
3) $x13_t$ is the volume of production in the Norwegian fishing sector.
* Restricted à priori.
$p_t = (pa_t - pw_t)$.
(nc) Not consistent with theory.
(s) Significant at the five per cent level.

Table 4.5. Continues

Variable	Estimated coefficients[1]				
	Commodity 37	Commodity 43	Commodity 46	Commodity 74[2]	Commodity C70
Δxa_{t-1}		-0.26 (-1.9)	0.79 (2.9)		0.43 (2.3)
Δm_t	0.71 (2.4)	1.50 (6.8)	0.84 (5.2)		-0.51 (-1.5)
Δm_{t-1}			0.56 (2.7)	-1.08 (-1.9)	
Δm_{t-2}				-1.78 (-3.2)	
Δpa_t	-0.65 (-2.4)	-0.43 (-1.7)			
Δpa_{t-1}			0.74 (2.6)		
Δpw_t	1.46 (2.6)	1.53 (3.2)			
xa_{t-1}	-0.18 (-1.2)	-0.66 (-3.4)	-0.60 (-3.3)		-0.72 (-4.0)
m_{t-1}	0.18 *	0.30 (2.4)	0.60 *		0.72 *
p_{t-1}	-0.37 (-1.8)		0.22 (1.3)		-0.36 (-1.5)
p_{t-2}		-0.41 (-1.3)			
Constant	1.10 (1.1)	6.57 (3.4)	4.12 (3.3)	0.16 (4.2)	4.46 (3.9)
TREND					0.01 (2.1)
ECM_{t-1}				-0.61 (-3.4)	
$El_M XA$	1.00 *	0.45 (5.1)	1.00 *	1.83	1.00 *
$El_P XA$	-2.05 (-1.4)	-0.61 (-1.3)	0.37 (nc)	-0.52	-0.50 (-1.6)
Est.period	1967-1987	1967-1987	1967-1987	1968-1987	1967-1987
SER	0.063	0.047	0.036	0.076	0.045
DW	1.52	1.72	1.79	1.74	1.73
AR(2)	0.83	0.27		0.30	0.15
ARCH(2)	0.08	0.15		2.38	0.58
NORM	0.67	0.77		0.50	1.45
Hausman	1.00	-0.30		..	..
DF/(ADF)	(-3.40) (s)	-4.39 (s)		-2.52	(-3.96) (s)
t_{ECM}					(s)
Restr. m	-0.33				0.14
Restr. p	0.15	-1.69		-1.31	-0.99

1) t-statistics in brackets.
2) A two-step estimation procedure is used.
* Restricted à priori.
$p_t = (pa_t - pw_t)$.
(nc) Not consistent with theory.
(s) Significant at the five per level.

The best result for each commodity is presented in table 4.5. We conclude that the data supports long-run price homogeneity at the five per cent significance level for most commodities. The result for commodity 18 is not convincing though. If included, the t-value of the coefficient on pa_{t-1} is -1.91 for this commodity, and long-run price homogeneity is rejected at the eight per cent significance level. For most commodities we find that the long-run price elasticity is not significantly different from zero, the exceptions are commodity 17 and 34. The t-ratio of the long-run elasticities for commodity 18 and 74, where a two-step estimation procedure is used, is not calculated. The two-step estimation approach is applied because the one-step procedure gives a positive long-run relative export price elasticity for these commodities. For commodity 25 and 46 we find a positive long-run relative price elasticity independent of estimation procedure though, and we conclude that the export demand model is rejected for these two commodities. Commodity 25 and 46 will therefore not be further discussed in this chapter. The most price elastic commodities are 17 and 37, with a long-run price elasticity around minus two. Commodity 16, 34, 43, 74 and C70 are price inelastic, i.e. the long-run price elasticity is above minus one. This suggests that Norwegian products of these commodities are not homogeneous but close substitutes in demand. (We assume omitted relative prices not to be a problem in this chapter.) The aggregate long-run price elasticity for commodity 16-46, exclusive commodity 25 and 46, equals -0.94. Export volumes in 1990 are used as weights when calculating aggregate elasticities.

We find a long-run market elasticity equal to unity for commodity 17, 37 and C70. The market elasticity is above one for commodity 74 and below one for the remaining commodities. We find a positive trend coefficient for commodity 17 and C70. From this we conclude that commodity 17, 74 and C70 have gained non-price competitiveness over time, commodity 16, 18, 34 and 43 have lost non-price competitiveness, while commodity 37 has experienced unchanged non-price competitiveness. The aggregate long-run market elasticity for manufactured goods exclusive commodity 25 and 46 is 0.51, and the aggregate trend coefficient is close to zero (0.000). Hence, at the aggregate level we find that Norwegian manufacturing firms, excl. those producing commodity 25 and 46, have lost non-price competitiveness over time.

The SER is around 5-6 per cent for most commodities, commodity 17 is the most important exception with a SER of 11 per cent. There are some problems with the stability of several of the equations in table 4.5, in particular over the eighties, and we find significant Chow-tests for commodity 16, 34 and 74. We accept cointegration for commodity 34, 43 and C70. The ADF-test is significant for commodity 37, but the t-ratio of the error correction coefficient is very low. On the other hand, if we apply the Gaussian-critical values rather than the DF-critical values, "no cointegration" is rejected for all commodities except commodity 37.

Table 4.6 gives standardized interim multiplicators for the equations in table 4.5. We report the initial effect and the cumulated effect at t+2.

Table 4.6. The effect on exports of changes in the explanatory variables. The initial effect and the cumulated effect at t+2. The equations in table 4.5

Commodity	Increase in prices: Own price		Increase in prices: Competitors' prices		Increase in world demand	
	t	t+2	t	t+2	t	t+2
16	70	78	145	103	0	283
17	53	82	0	64	..	9
18	103	214	103	214	0	57
34	0	95	0	95	389	119
37	32	54	71	81	71	80
43	70	87	251	134	333	160
74	0	85	0	85	0	..
C70	72	130	72	130	..	220

Again we find that the initial effects are smaller than the long-run effects in most cases. The exceptions are commodity 34 and 43 with respect to changes in world demand, and commodity 16, 18 and 43 with respect to changes in prices. In addition, we find overshooting in the medium-run with respect to both world demand and prices for commodity C70.

The initial effect on exports of an increase in world demand is negative for commodity 17 and C70, and the standardized interim multiplicator at t+2 is negative for commodity 74. The multiplicator for later periods is positive for all three commodities though. In addition, we find a negative interim multiplicator at t+1 with respect to competitors' prices for commodity 17, the multiplicator at t+2 is positive. Particularly the negative interim multiplicators with respect to an increase in world demand are difficult to interpret.

A discussion of each equation

The data supports long-run price homogeneity for **commodity 16**: Food products. The long-run price elasticity is above minus one, suggesting that Norwegian food products are close substitutes rather than homogeneous products. The long-run market elasticity is well below one, indicating a significant loss of non-price competitiveness over time. None of the long-run elasticities are significant according to the asymptotic t-ratio. There are some problems with the stability of this equation, and both the 1-step ahead and the N-decreasing Chow-test are significant in 1986. Still, the equation passes all tests reported in table 4.5 at the five per cent significance level except the tests for cointegration. A supply side element enters the equation in the short run. We find that the volume of production in the Norwegian fishing sector has a short-run effect on exports. A large share of exports of Food products is manufactured fish. The interpretation is that the domestic food processing industry is rationed in the short-run in its access to raw materials.

Regarding **commodity 17**: Beverages and tobacco, we find long-run price homogeneity and a long-run market elasticity equal to unity. The positive trend coefficient suggests some gain in non-price competitiveness for this commodity. The equation behaves well according to the various tests applied, but we do not reject the null hypothesis of no cointegration at the five per cent significance level. The t_{ECM}-test reject the null hypothesis at the ten per cent significance level though.

The equation for **commodity 18**: Textiles and wearing apparels, is estimated using a two-step estimation procedure. The one-step procedure gives a positive long-run relative price elasticity. Long-run price homogeneity is rejected at the eight per cent significance level. The long-run market elasticity indicates that Norwegian exporters of these commodities have lost non-price competitiveness over time. The equation passes most tests applied, but there are some problems with instability around 1983. Neither the ADF-test nor the t_{ECM}-test are significant in this case.

The equation for **commodity 34**: Paper and paper products is unstable in 1979 according to the 1-step ahead Chow-test and SER. Instability is not supported by the other tests though. The data supports long-run price homogeneity, but the small price elasticity (in absolute value) suggests that Norwegian paper and paper products are not homogeneous products but rather close substitutes. The long-run market elasticity is very small, implying a significant loss of non-price competitiveness over time for these products. Due to the significant t_{ECM}-test, we conclude that the level variables in this equation cointegrate.

We find both long-run price homogeneity and a long-run market elasticity equal to one for **commodity 37**: Industrial chemicals. The long-run price elasticity is relatively large (in absolute value), but the asymptotic t-ratio is small, suggesting that this elasticity is not very precisely estimated. This equation passes most tests applied, but there are some problems with instability even if none of the Chow-tests are significant. Although the ADF-test is significant, we do not accept cointegration because of the low t-ratio of the error correction coefficient, i.e. the t_{ECM}-test is not significant.

Long-run price homogeneity is accepted by the data for **commodity 43**: Metals. The long-run price elasticity is well above minus one, and the asymptotic t-ratio shows that we have problems with the significance of this elasticity. Also the long-run market elasticity is low, which implies a loss of non-price competitiveness. We conclude that the level variables in this equation cointegrate, due to the significant DF-test and the relatively high t-ratio of the error correction coefficient. None of the Chow tests are significant, but there are some problems with the stability around 1983.

For **commodity 74**: Domestic transport, we have to adopt a two-step estimation procedure to find a theory consistent long-run price elasticity. This elasticity is estimated to be positive in the one-step approach. The data supports long-run price homogeneity however, but the long-run price elasticity is well above minus one. The relatively large long-run market elasticity indicates gains in non-price competitiveness over time for this commodity. Both the 1-step ahead and the N-decreasing Chow-test show that this equation is not stable over the eighties. None of the cointegration tests are significant. Still, the large t-ratio of the error correction coefficient may suggest that cointegration is a valid hypothesis. Because we use the DF-critical values for the t_{ECM}-test, we may accept cointegration too seldom.

Regarding **commodity C70**: Tourism, we find long-run price homogeneity and a long-run market elasticity equal to unity. The positive trend coefficient implies some gains in non-price competitiveness for this commodity. This does not necessarily imply that tourism has increased more in Norway than by our main trading partners. Our proxy for "world demand" for this commodity is based on imports of goods rather than on tourism, and our conclusion regarding non-price competitiveness may reflect that tourism have increased more than demand for imported goods in general. This equation behaves well according to the tests applied, and we conclude that the variables cointegrate.

A comparison with the results in chapter 4.1.

A comparison of the econometric models in table 4.2 (chapter 4.1) and table 4.5, which use different explanatory variables describing foreign markets, brings out important differences regarding long-run elasticities and conclusions about non-price competitiveness. The most salient difference is perhaps that the export demand model is rejected for commodity 25 and 46 in table 4.5, while this is not the case in table 4.2. Long-run price homogeneity is rejected for commodity 18 in table 4.5 at the eight per cent significance level, while this is not the case in table 4.2. The t-ratio of the long-run price elasticity is below its critical value for only one commodity in table 4.2, namely commodity 46. In table 4.5 we find insignificant long-run price elasticities for commodity 16, 37, 43 and C70. For commodity 16, 18, 34 and C70 we find that the long-run price elasticities are much larger (in absolute value) in table 4.2 than in table 4.5. The opposite is true for commodity 37 only. The aggregate relative price elasticity for manufactured goods (commodity 16-46) but exclusive commodity 25 and 46, is - 0.94 in table 4.5, while the corresponding aggregate elasticity with respect to the own price and competitors' prices in table 4.2 are -1.80 and 1.68 respectively. Thus the export equations in table 4.2 implies larger prices effects than the equations in table 4.5. (The corresponding aggregate relative price elasticity in the "old" MODAG is -1.38.) Export volumes in 1990 are used as weights when calculating aggregate elasticities.

The market elasticity is also smaller for most commodities in table 4.5 compared with table 4.2. The exceptions are commodity 17, 74 and C70. The long-run market elasticity is significant for most commodities in both tables, the only exceptions are in fact commodity 17 in table 4.2 and commodity 16 in table 4.5. Regarding non-price competitiveness, the conclusions in table 4.2 and 4.4 coincide for commodity 34 and 43 only, also the result for commodity C70 is very similar though. The results in table 4.2 imply that commodity 18, 25, 37 and 46 have gained non-price competitiveness over time, commodity 17, 34 and 43 have lost, and commodity 16, 74 and C70 have experienced unchanged non-price competitiveness. Table 4.5 implies that commodity 17, 74 and C70 have gained, commodity 16, 18, 34 and 43 have lost and commodity 37 has experienced unchanged non-price competitiveness. (The elasticities in the "old" export model in MODAG imply gains in non-price competitiveness for all commodities except commodity 16.) The aggregate market elasticity for manufactured goods exclusive commodity 25 and 46 is 0.51 according to table 4.5, and the aggregate trend coefficient is close to zero. Thus, the results in table 4.5 implies a loss of non-price competitiveness for manufactured goods (excl. commodity 25 and 46). The corresponding aggregate market elasticity in table 4.2 equals 0.91, which together with a small negative aggregate trend coefficient also indicate a loss of non-price competitiveness for these commodities, but of much less magnitude. (The corresponding market elasticity in the "old" MODAG is 1.40, clearly suggesting gains in non-price competitiveness.) Thus, conclusions regarding non-price competitiveness depend on the explanatory variables chosen. If we also include commodity 25 and 46, the aggregate market elasticity according to table 4.2. (and the "old" MODAG) increases significantly, and the overall conclusion regarding the development in non-price competitiveness in table 4.2 is altered.

When comparing the predictive power of the export equations in table 4.2 with the equations in table 4.5, we find that the SER is higher according to the results presented in table 4.5 for most commodities. The only exception is in fact commodity 43. Table 4.7 compares the SER of these two alternative equations for each commodity and also shows encompassing tests: The two alternatives are tested against their linear nesting model. We conclude that the equation in table 4.2 encompasses the equation in table 4.5 for commodity 37. The same is true for commodity 16 and 34 if we allow an eight and a 10 per cent significance level respectively. We find that the equation in table 4.5 clearly encompasses that in table 4.2 for commodity 74, and the same is true for commodity 43 and C70 at the 14 and 10 per cent significance level respectively.

Table 4.7. Encompassing tests. M_1 represents the model in table 4.2, while M_2 represents the model in table 4.5[1]

Com-modity	M_1 encom. M_2	M_2 encom. M_1	SER	
			M_1	M_2
16	F(5,8) = 1.33 (.342)	F(7,5)[2] = 3.91 (.076)	0.039	0.047
17	F(5,8) = 1.25 (.372)	F(5,8) = 1.04 (.456)	0.066	0.110
18	F(6,9) = 1.00 (.479)	F(2,12) = 0.62 (.555)	0.045	0.060
34	F(3,11) = 1.13 (.378)	F(6,10) = 2.49 (.097)	0.035	0.045
37	F(4,12) = 1.24 (.345)	F(5,10) = 3.41 (.047)*	0.036	0.062
43	F(6,9) = 2.23 (.134)	F(4,9) = 0.78 (.567)	0.060	0.047
74	F(4,2) = 4.59 (.018)*	F(3,13) = 1.56 (.246)	0.075	0.076
C70	F(5,10) = 2.51 (.101)	F(4,11) = 1.01 (.442)	0.030	0.045

1) Significance levels in brackets.
2) The estimation period has been increased by one period to allow for this test.

Our conclusion is that the stability properties of the equation in table 4.2 is better for most commodities compared with the equation in table 4.5, the exception is commodity 18. We find significant Chow-tests for commodity 18 and 74 in table 4.2, and for commodity 16, 34 and 74 in table 4.5. We reject the hypothesis of no cointegration for most commodities in table 4.2, the exceptions are commodity 18, 34 and 46. If we assume that the t_{ECM}-statistic is normally distributed, we reject no cointegration for commodity 34 and 46 as well. (The equation for commodity 18 in table 4.2 is not an error correction model.) In table 4.5, we reject no cointegration for only commodity 34, 43 and C70. If the t_{ECM}-statistic is normally distributed, we reject no cointegration for most commodities though, the only exception in this case is commodity 37. In table 4.2 we find that the standardized interim multiplicator with respect to competitors' prices at t+1 is negative for commodity 17 and 46. In table 4.5 we find that the same is true for commodity 17 at t+2. In addition in table 4.5, we find that the initial effect of an increase in world demand is negative for commodity 17 and C70 and that the interim multiplicator with respect to world demand at t+2 is negative for commodity 74. Regarding the results in table 4.2, we have argued that a negative interim multiplicator with respect to competitors' prices when we use aggregate world demand variables may be due to a reduction in import demand abroad for these commodities when competitors' prices increase relative to other import prices. Thus, in the short-run, this negative effect on Norwegian exports dominates the positive effect due the decrease in the relative export price. This explanation is assumed irrelevant for the results in table 4.5, because of the correspondence between the world demand variables and competitors' prices. Furthermore, a negative interim multiplicator with respect to world demand is difficult to interpret.

Our conclusion from comparing the in sample properties of the two alternative equations for each commodity is that we prefer the equation in table 4.2 for all commodities. Particularly the choice for commodity 18 is difficult though. Table 4.8 summarizes the arguments for our choices.

Table 4.8. Model choice based on in sample properties. M_1 from table 4.2 versus M_2 from table 4.5

Commodity	**Preferred model: M_1**
16	M_1 encompasses M_2 at the eight per cent significance level and has a smaller SER. M_2 has insignificant long-run elasticities and significant Chow-tests in 1986. The level variables in M_1 cointegrate while this is not true for M_2 when we use the DF-critical values for the t_{ECM}-test.
17	Our main criticism of M_2 is that the initial effect on exports of an increase in world demand is negative. Furthermore, M_1 has a smaller SER and also rejects no cointegration more clearly than M_2. On the other hand, the long-run market elasticity in M_1 is not significant.
18	Both equations are unstable during the first half of the eighties, and the N-decreasing Chow-test is significant in 1984 for M_1. Price homogeneity is rejected by M_2 at the eight per cent significance level, and M_2 has a higher SER compared with M_1. None of the models can be said to encompass the other, and our choice is not obvious.
25	M_2 does not support the export demand model, i.e. the long-run price elasticity is positive. The level variables in M_1 cointegrate, this equation is stable and passes all tests applied.
34	The 1-step ahead Chow-test is significant in 1979 for M_2. M_1 has a smaller SER and encompasses M_2 at the 10 per cent significance level. On the other hand, M_2 rejects more clearly the hypothesis of no cointegration than M_1.
37	M_1 encompasses M_2, has a smaller SER and better stability properties. The level variables in M_1 cointegrate but not the level variables in M_2. The long-run price elasticity in M_2 is insignificant.
43	M_1 rejects no cointegration more clearly than M_2 according to the t_{ECM}-test, and the long-run price elasticity is not significant in M_2. M_1 has somewhat better stability properties compared with M_2, but the SER is higher. The encompassing test favours M_2 though.
46	M_2 does not support the export demand model, i.e. the long-run price elasticity is positive. The t_{ECM}-test for M_1 rejects no cointegration only if Gaussian-critical values are used. We find autocorrelation, but the equation is stable. The long-run price elasticity is not significant though.
74	Our main criticism of M_2 is that the standardized interim multiplicator with respect to world demand at t+2 is negative. Both Chow-tests show that M_2 is unstable over the eighties. The 1-step ahead Chow-test is significant only in 1978 for M_1. M_1 rejects more clearly the hypothesis of no cointegration than M_2. M_2 encompasses M_1 though, and our choice is not obvious.
C70	Our main criticism of M_2 is that the initial effect on exports of an increase in world demand is negative. Furthermore, M_1 has a smaller SER compared with M_2, and the long-run price elasticity in M_2 is insignificant. On the other hand, M_2 encompasses M_1 at the ten per cent significance level. Both M_1 and M_2 pass all tests applied, the models are stable and the level variables cointegrate. Our choice is not obvious.

4.4. Empirical export supply equations

In this chapter we present the results from estimating export supply equations. We find theory consistent long-run elasticities and long-run price-cost homogeneity for only two commodities, namely commodity 43 and 74. But, only commodity 43 has significant long-run elasticities. For the remaining commodities, the long-run price and cost elasticities have the wrong sign or the equations are unstable. These commodities will not be further discussed in this chapter.

Regarding commodity 43 and 74, variables explaining domestic (Norwegian) demand do not enter neither in the short- nor the long-run. Thus, we do not find any influence of domestic demand on exports, as suggested by the residual export supply model. And furthermore, we do not find any effect of the price of domestic sales as predicted by the multi-product firm model, i.e. the model where we assume that commodities produced for exports and domestic sales differ. The long-run export supply equation for both commodity 43 and 74 can be interpreted as a Cobb-Douglas production function.

The data supports the export supply model for **commodity 43**: Metals. Thus, we can not reject the hypothesis that domestic producers of this commodity take the export price as a fixed parameter when deciding how much to export. (The export share is very high in the domestic metal industry, with 85.2 per cent of domestic production in 1990.) Long-run price-cost homogeneity is not rejected at the five per cent significance level (it is at the nine per cent level though). We find a long-run capital elasticity equal to unity. Hence, an increase in the production capacity through an increase in the capital stock by one per cent will increase exports by one per cent. An increase in variable unit costs or a reduction in the export price by one per cent reduces export volumes by a little more than one per cent in the long-run. The 1-step ahead Chow-test indicates parameter non-constancy in 1977, but this is not confirmed by the N-decreasing Chow-test. Furthermore, the RLS estimates are stable towards the end of the estimation period. Both the DF- and the t_{ECM}-test reject the null hypothesis of no cointegration. The Hausman-Wu test supports the assumption of weakly exogenous export price at the à priori decided significance level of five per cent but not at the 10.4 per cent level. Because simultaneity is assumed to bias the long-run price-cost elasticity downwards, we compare the OLS- and IV-elasticities. When using the IV-method, we find a long-run price-cost elasticity equal to 1.10, while the OLS estimate is 1.02. Hence, one may conclude that OLS bias this elasticity downwards, although not very much. Also when comparing the first year effect of changes in the relative price-cost variable, we find that the effect according to the IV-regression is a little larger than according to the OLS-regression. Still, we use the OLS-regression when testing the export supply model for this commodity further.

Table 4.9. Export supply equations

	Estimated coefficients[1]				
Variable	Commodity 16	Commodity 17	Commodity 18	Commodity 25	Commodity 34
Δxa_{t-1}	0.30 (2.7)			-0.59 (-2.8)	
Δxa_{t-2}					0.39 (3.9)
Δk_{t-1}			6.00 (2.3)		
Δk_{t-2}					-1.52 (-5.3)
Δpa_{t}	-0.42 (-3.3)	-0.70 (-2.6)		-0.89 (-4.8)	
Δpa_{t-1}	0.42 *				
Δpa_{t-2}					0.82 (6.3)
Δpv_{t-1}		-1.56 (-1.8)		-2.16 (-3.7)	-0.96 (-4.9)
Δpv_{t-2}	1.38 (4.7)				
$\Delta q99_{t}$			2.55 (3.3)		
$\Delta pq99_{t}$					0.62 (2.8)
xa_{t-1}	-0.78 (-4.7)	-0.70 (-3.5)	-0.58 (-4.1)	0.30 (1.9)[3]	-0.47 (-4.5)
k_{t-2}	2.94 (3.7)	1.35 (3.7)	0.58 *	-0.30 *	0.86 (4.6)
pa_{t-1}	-1.36 (-4.6)	-0.87 (-2.4)	-0.72 (-1.8)	-0.56 (-2.1)	-0.99 (-4.1)
pv_{t-1}	1.36 *	0.87 *	0.72 *	0.40 (1.8)	0.72 (3.3)
bh_{t-1}	-1.14 (-3.6)		-0.31 (-2.1)		
Constant	-28.86 (-2.8)	-11.35 (-3.5)	-1.96 (-4.4)	0.82 (3.1)	-4.96 (-2.3)
$El_{K}XA$	3.78	1.90	1.00 *	..	1.83
$El_{PA}XA$	-1.75 (nc)	-1.23 (nc)	-1.25 (nc)	..	-2.11 (nc)
$El_{PV}XA$	1.75 (nc)	1.23 (nc)	1.25 (nc)	..	1.53 (nc)
$El_{BH}XA$	-1.46		-0.54		
Est.period	1968-1987	1964-1987	1968-1987	1965-1987	1965-1987
SER	0.037	0.128	0.057	0.040	0.034
DW	2.18	2.27	2.57	2.54	2.78
AR(2)	0.28	0.72	1.38	1.15	2.94
ARCH(2)	1.07	0.93	1.62	1.22	0.60
NORM	1.46	2.18	0.36	0.62	0.54
DF/(ADF)				(-3.21)	
Restr. k			0.64	0.73	
Restr. p[2]	1.22	-1.09	0.86		

1) t-statistics in brackets.
2) Restriction $El_{PA}XA = -El_{PV}XA$.
3) The equation is unstable due to the positive error-correction coefficient.
* Restricted à priori.
(s) Significant at the five per cent level.
(nc) Not consistent with theory.

Table 4.9 Continues

Estimated coefficients[1]				
Variable	Commodity 37	Commodity 43	Commodity 46	Commodity 74
Δxa_{t-1}				-0.57 (-4.7)
Δk_t				7.99 (5.7)
Δk_{t-1}			-2.46 (-3.4)	-6.55 (-5.6)
Δpa_t		0.86 (3.6)	-0.90 (-3.8)	
Δpv_t		-1.44 (-4.2)	0.90 *	1.81 (5.2)
Δpv_{t-1}	-0.47 (-2.7)			
xa_{t-1}	-0.30 (-3.5)	-0.98 (-4.5)	0.10 (1.3)[3]	-0.31 (-2.5)
k_{t-2}	0.07 (0.4)	0.98 *	-0.40 (-3.9)	0.31 *
pa_{t-1}	-0.51 (-2.5)	1.00 (3.8)	-0.69 (-2.9)	0.03 (0.2)
pv_{t-1}	0.67 (3.2)	-1.00 *	0.69 *	-0.03 *
Constant	2.56 (1.4)	0.01 (0.4)	3.95 (5.7)	-1.09 (-2.7)
$El_K XA$	0.25	1.00 *	..	1.00 *
$El_{PA} XA$	-1.71 (nc)	1.02 (4.7)	..	0.11 (0.3)
$El_{PV} XA$	2.25 (nc)	-1.02 *	..	-0.11 *
Est.period	1965-1987	1964-1987	1965-1987	1965-1987
SER	0.055	0.062	0.034	0.042
DW	2.39	2.11	1.88	3.07
AR(2)	0.84	0.08	1.82	4.93 (s)
ARCH(2)	0.21	1.56	0.99	0.00
NORM	0.44	1.73	0.88	0.43
Hausman		-1.72	0.49	
DF/(ADF)		-5.43 (s)	-2.07	(-2.81)
t_{ECM}		(s)		
Restr. k		-0.39		-0.58
Restr. p[2]		-1.84	-0.88	-0.61

1) t-statistics in brackets.
2) Restriction $El_{PA}XA = -El_{PV}XA$.
3) The equation is unstable due to the positive error-correction coefficient.
* Restricted à priori.
(s) Significant at the five per cent level.
(nc) Not consistent with theory.

A comparison of the short- and the long-run elasticities reveals that the initial effect on exports of a change in the export price and variable unit costs is 84 and 114 per cent of the long-run effect respectively. Thus, there is overshooting with respect to competitors' prices. Changes in the capital stock has no initial effect. The cumulated effect at t+2 is 100 per cent with respect to the price variables and 98 per cent with respect to the capital stock.

For this commodity, we prefer the export supply equation in table 4.9 to the export demand equation in table 4.2. The main argument for our choice is the difficulties with the price homogeneity restriction in the export demand equation. The choice is not indisputable though, and none of the equations can be said to encompass the other, see table 4.20. Furthermore, since we conclude that the variables in both equations cointegrate, a modelling strategy where variables from both the export demand and export supply model are included may prove fruitful.

Table 4.20. Encompassing tests. M_1 represents the export demand model in table 4.2 and M_2 the export supply model in table 4.9[1]

Com-modity	M_1 encom. M_2	M_2 encom. M_1	SER	
			M_1	M_2
43	$F(4,14) = 1.21$ (.352)	$F(5,14) = 1.55$ (.238)	0.060	0.062
74	$F(6,14) = 4.19$ (.013)*	$F(3,13) = 0.16$ (.923)	0.075	0.042
	$F(5,11) = 3.58^2$ (.036)*	$F(4,9) = 0.69^2$ (.616)	0.076	0.042

1) Significance levels in brackets.
2) M_1 is the export demand model in table 4.5.

We have also estimated export supply equations where we use wages, the price of raw materials and energy prices faced by the metal industry instead of variable unit costs. A large share of production costs in this industry is raw materials. In this case we find no effect of labour costs. The data supports homogeneity in both the short- and the long-run between the export price and the price of raw materials. A long-run capital elasticity equal to one is confirmed by these regressions. Statistically, the best equation within this framework is not very different from that in table 4.9, but the dynamic adjustment is. The alternative supply equation adjusts very slowly compared with that in table 4.9, and there is more overshooting after changes in the explanatory variables. One may also argue that variable costs per unit output is more important for firms than prices on various input factors alone. The alternative framework does not take into account changes in productivity or variability in the degree of substitution between input factors over time and production level.

We find theory consistent long-run elasticities and price-cost homogeneity for **commodity 74**: Domestic transport. Particularly the low t-value of the long-run price-cost elasticity makes it difficult to conclude that the data supports the export supply model though, and cointegration is not accepted in this case. The long-run price-cost elasticity is very small, 0.11, while the long-run capital elasticity is estimated to equal one. Also, the effect on exports of an increase in variable unit costs (PV) is in conflict with the theoretical model: It takes 16-17 years before the cumulated effect is negative. The equation has some problems with autocorrelation, but to avoid this we have to include a large number of lags in the cointegrating part of the equation, which complicates the dynamic structure and reduces the degree of freedom substantially. The equation is stable according to the Chow-tests. Due to the problems described above, we conclude that this export supply equation is not preferred to the export demand equations despite the fact that it encompasses the export demand equation in both table 4.2 and 4.3. The encompassing properties of the export supply equation indicates that we may gain predictive power by using a mixed model though. I.e. we should model exports of this commodity using both foreign demand side as well as domestic supply side elements as explanatory variables.

4.5. A comparison with the earlier export model in MODAG

We will now compare our export equations with those in earlier versions of MODAG[8], which were export demand (Armington) equations with a simple partial adjustment mechanism and both short- and long-run price homogeneity. The export equations for commodity 43: Metals and commodity C70: Tourism, were in fact static. The world demand variables and competitors' prices in the old model are presented in chapter 3.1. These world demand variables suffer from important weaknesses, and we have reasons to believe that the "old" world demand variables are biased downwards. In chapter 3 we find that conclusions regarding the development in competitiveness, as pictured by the development in market shares when using the "old" world demand variables, are in conflict with both the consensus view and the two set of import based world demand variables. On the basis of *in sample* properties, we conclude that the export demand equation in table 4.2 is preferred to that in table 4.5 for all commodities. Our choice for commodity 18 is not obvious though, and the same is true for commodity 74 and C70 if we accept negative short-run standardized interim multiplicators with respect to an increase in world demand. However, we reject such negative interim multiplicators. For commodity 43, we prefer the export supply equation in table 4.9 to the export demand equations.

It is of major interest to check whether these "new" export equations encompass the old. Encompassing is a test of the "value added" of our analysis, that is from implementing alternative explanatory variables, looking at alternative models and a more careful modelling of the dynamics. The results from the F-test of the new and old model against the linear nesting model of which these two are reductions are given in table 4.21. M_1 represents the new model, while M_2 represents the old model. The table also gives the standard error of the

[8] See Bergan and Olsen (1985) for a documentation of the first export model in MODAG.

regressions. We compare the old model with the equation in table 4.2 for all commodities. For commodity 18 we also compare the old model with that in table 4.5, and for commodity 43 the old model is compared with the supply equation in table 4.9.

Table 4.21. Encompassing tests. M_1 is the export demand model in table 4.2, while M_2 is the export demand model in the "old" MODAG. For some commodities, M_2 is also tested against the export demand model in table 4.5 and the export supply model in table 4.9

Commodity	M_1 encom. M_2	M_2 encom. M_1	SER M_1	SER M_2	Estimation period
16	F(2,12) = 0.77	F(6,11) = 5.70 (s)	0.039	0.067	66-87
17	F(2,13) = 0.06	F(6,13) = 7.89 (s)	0.066	0.130	65-87
18	F(1,16) = 0.17	F(2,16) = 11.13 (s)	0.045	0.067	66-87
	F(2,2) = 0.80[1]	F(6,10) = 2.47[1]	0.060	0.068	68-87
25	F(1,14) = 0.01	F(5,15) = 4.36 (s)	0.032	0.047	64-87
34	F(1,14) = 0.14	F(5,14) = 14.33 (s)	0.035	0.076	65-87
37	F(2,14) = 0.02	F(5,13) = 5.35 (s)	0.036	0.066	66-87
43	F(2,16) = 0.53	F(4,16) = 4.00 (s)	0.060	0.078	64-87
	F(2,17) = 1.93[2]	F(4,17) = 6.83[2] (s)	0.057	0.078	64-87
46[3]	F(3,11) = 0.29	F(7,13) = 8.33 (s)	0.027	0.055	64-87
74	F(2,19) = 0.70	F(2,19) = 1.68	0.075	0.079	63-87
C70	F(1,15) = 0.13	F(5,14) = 3.69 (s)	0.030	0.042	65-87

1) M_1 is the export demand model in table 4.5.
2) M_1 is the export supply model in table 4.9.
3) In the "old" MODAG, commodity 46 was modelled as an aggregate with commodity 47. The encompassing test is based on commodity 46.

With the exception of commodity 74, we conclude that the new export equations encompass those in the "old" MODAG. The export demand equation in table 4.5 for commodity 18 encompasses the old equation at the 10 per cent level. The SER of the new equations are lower for all commodities. Hence, despite any qualms one may have about the new equations, cf. previous chapters, most of them encompass the old export model and thus increase our knowledge about Norwegian export behaviour.

In addition to the encompassing properties, we are also interested in comparing the "old" and "new" long-run elasticities and in analysing the bias in the "old" elasticities. For this reason we pin down the effect on the long-run market and relative price elasticities in the export demand model of using new world demand variables, re-specifying the dynamic structure, allowing price non-homogeneity in the short-run and new observations. To identify the effect of new world demand variables, we estimate export equations identical to the old but where we replace the world demand variables with the new import based. We stop these regressions in 1981 as in the "old" model. The relative price terms in the old and new model are the same, Norwegian import prices are used as proxies for competitors' prices. To analyse the effect of allowing a more flexible dynamic structure and price non-homogeneity in the short-run, i.e. of using the error correction model rather than a simple partial adjustment mechanism, we estimate the new model over the short estimation period. This is compared with the old model where we use new variables. In table 4.22 we compare the elasticities in the export demand equations in table 4.2 with the elasticities in the old equations. For commodity 34 and C70 we give the long-run elasticity with respect to the export price in the first line and the long-run elasticity with respect to competitors' prices in the second line.

By comparing the last two columns in table 4.22 with column five and six, we find the effect of introducing new world demand variables. The effect on the market elasticity is negative for all commodities, and the aggregate market elasticity for manufactured goods is reduced from 1.74 to 1.02. I.e. import based world demand variables tend to decrease the market elasticities. This was expected though, because of a higher growth rate in the import based world demand variables compared with those based on consumption and investments. The relationship between the "old" and the "new" aggregate market elasticity for manufactured goods (the ratio of the "old" to the "new") is 1.7, which should be close to the elasticity of GDP with respect to imports by our principal trading partners. The long-run activity elasticities for imports for industrial countries cited in Goldstein and Khan (1985), show that 1.7 as an aggregate measure is a realistic figure. Hence, the difference in the long-run market elasticities from using the old and the new world demand variables respectively has an economic interpretation, which suggests that the old world demand variables do not bias the long-run market elasticities in important ways. The effect on the long-run price elasticities of new world demand variables is more obscure, but a comparison of the aggregate price elasticity for manufactured goods in column five and seven shows that the old world demand variables bias the price elasticities significantly downwards. The aggregate relative export price elasticity in the old model with old variables is -1.42 compared to -0.88 when we use new world demand variables. This result is a bit surprising to us, given our earlier conclusion that the long-run market elasticities are not biased while the world demand variables are biased downwards. Over time there has been an increase in both world demand and relative prices. In this case, we would except the long-run price elasticities to be biased towards zero to compensate for the downwards bias in the old world demand variables. This may indicate that the long-run market elasticities are in fact biased upwards in the old model.

Table 4.22. A comparison of the estimated long-run price and market elasticities with those in the "old" export model in MODAG

Commodity	New model[1]		New model[1] Short est. per.		Old model New expl.vari.		Old model	
	El_PXA	El_MXA	El_PXA	El_MXA	El_PXA	El_MXA	El_PXA	El_MXA
16	-4.20	1.00	-4.33	1.00	-0.60	0.48	-0.39	0.89
17	-1.66	1.99	-1.78	0.13	-0.82	1.00	-0.92	2.29
18	-2.99	1.82	-4.06	4.46	-0.55	0.86	-1.50	1.08
25	-1.31	1.25	-1.34	1.21	-0.80	1.26	-0.95	2.58
34	-2.83	0.53	-3.32	0.79	-1.89	0.67	-1.86	1.41
	2.12		2.62					
37	-1.00	1.53	-1.00	1.28	-1.28	0.94	-1.00	1.93
43	-0.64	0.73	-0.46	0.74	-0.40	1.12	-1.77	1.42
46	-1.58	1.57	-1.50	1.57	-1.07	1.22	-1.90[2]	2.06[2]
74	-0.50	1.00	-0.47	1.00	-0.66	1.01	-0.37	2.23
C70	-1.18	1.00	-1.02	1.00	-0.26	0.80	-0.16	1.62
	0.86		0.53					

1) For commodity 34 and C70, the own price elasticity is given in the first line while the elasticity with respect to competitors' prices is given in the second line.
2) In the "old" MODAG, commodity 46 was modelled as an aggregate with commodity 47. Commodity 46 dominates this aggregate.
"New" model is the equations in table 4.2. The new export equations are re-estimated over the same estimation period as the old model, i.e. the regressions stop in 1981, this is called the short estimation period. Thirdly, the export equations in the old model are estimated over the short estimation period but using the explanator elasticities in the old export model are given in the last two columns, cf. Bergan and Olsen (1985).

The impact of using error correction models with no a priori restrictions on the dynamics rather than a simple partial adjustment mechanism with both short- and long-run price homogeneity, can be seen by comparing column three and four with column five and six in table 4.22. The aggregate long-run market elasticity of manufactured goods is relatively robust, it increases from 1.02 to 1.15. The aggregate long-run own price elasticity changes from -0.88 to -1.69 and the aggregate long-run elasticity with respect to competitors' prices changes from 0.88 to 1.62 though. I.e. the result is larger price effects. Thus, the partial adjustment mechanism, which implies relatively strong restrictions on the dynamics, tends to bias the long-run price elasticities towards zero while the long-run market elasticities are only little affected. The extension of the estimation period from 1981 to 1987 has only minor influence on the aggregate long-run elasticities, the market elasticity decreases from 1.15 to 1.11, while the own price elasticity increases from -1.69 to -1.67 and the elasticity with respect to competitors' prices decreases from 1.62 to 1.60. From this we conclude that the "old" world demand variables bias the long-run price elasticities downwards and the market elasticities upwards, while the restrictive partial adjustment mechanism bias price elasticities upwards.

By comparing the two first columns with the two last columns in table 4.22, we find the total difference in the long-run elasticities between the new and old export model. We see that the long-run market elasticity is smaller in the new model than in the old model for most commodities. The exceptions are commodity 16 and 18. The new equation for commodity 18 includes a negative deterministic trend variable though, and excluding this variable decreases the market elasticity. And furthermore, in most cases the long-run price effects are larger in the new model than in the old. The exceptions are commodity 43 and 46, the long-run relative price elasticity for commodity 37 is equal. When aggregating across the preferred new demand equations, we find a market elasticity equal to 1.11 and a price elasticity equal to -1.67 on the own price and 1.60 on competitors' prices for manufactured goods (commodity 16-46). The corresponding market and relative price elasticity in the old model are 1.74 and -1.42 respectively. Again we use export volumes in 1990 as weights when calculating aggregate elasticities. Thus the overall effect is smaller long-run effects on exports from changes in world demand and larger long-run effects from changes in prices in the new model compared with the old.

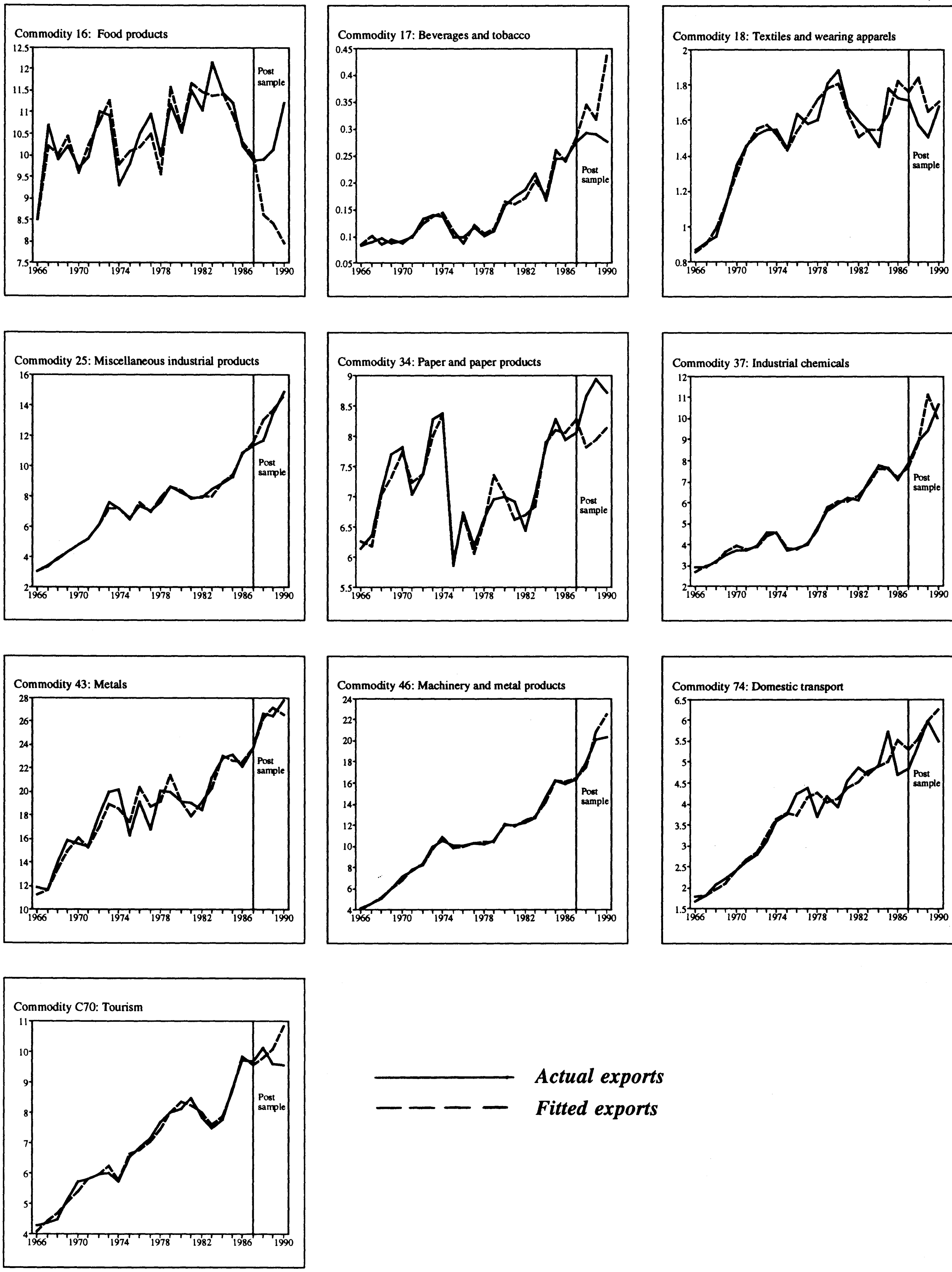
4.6. Ex post forecast comparison of the empirical export equations

In this section, we subject our equations to post-sample forecast test. For this purpose we use data for 1988-1990.[9] [10] For each equation we plot both actual exports and the 1-step predicted values. For periods up to 1987, the 1-step forecasts equal the OLS fitted values, while predictions for 1988-1990 are true ex post forecasts. Figure 4.1 gives the results for the equations reported in table 4.2 (chapter 4.1). In figure 4.2 we give the result at the aggregate level. For this purpose we aggregate all the commodities analysed, i.e. commodity 16-C70 in table 4.1.

[9] We may face a problem with the comparability of Norwegian trade data before and after 1987, due to a change in the external trade statistics. This change particularly affected the reporting practice of the domestic customs stations in late 1987 and early 1988.

[10] The 1990 data are preliminary.

Figure 4.1. Actual and fitted exports for the export demand equations in table 4.2. Ex post forecasts for 1988-1990. Billion Nkr



The graphs in figure 4.1 show that the ex post forecast properties for commodity 16, 17, 34 and C70 are relatively poor. For commodity 16 the equation predicts a large fall in exports while the opposite is true. The predicted fall is due to a considerable increase in relative prices in 1986 and the fall in exports in 1986 and 1987. This equation for commodity 16 includes long lags on both exports and relative prices. A simpler equation with respect to the dynamics may explain the development in the late eighties better. For commodity 17, the predicted volume of exports is particularly poor for 1990. For commodity 34, the predicted volume of exports is well below actual exports. For commodity 16, 17 and 34 we present the result from an alternative model later in this chapter. The predicted level of exports for commodity C70 is well above actual exports in both 1989 and 1990. Also the result for commodity 18 in 1988 and 1989, the result for commodity 37 in 1988 and the result for both commodity 46 and 74 in 1990 are relatively poor though. Still, as illustrated by figure 4.2, the predicted volume of exports at the aggregate level (commodity 16-C70) for the equations in table 4.2, is close to actual exports.

Figure 4.2. Actual and fitted exports at the aggregate level: Commodity 16-C70. The export demand equations in table 4.2. Ex post forecasts for 1988-1990. Billion Nkr

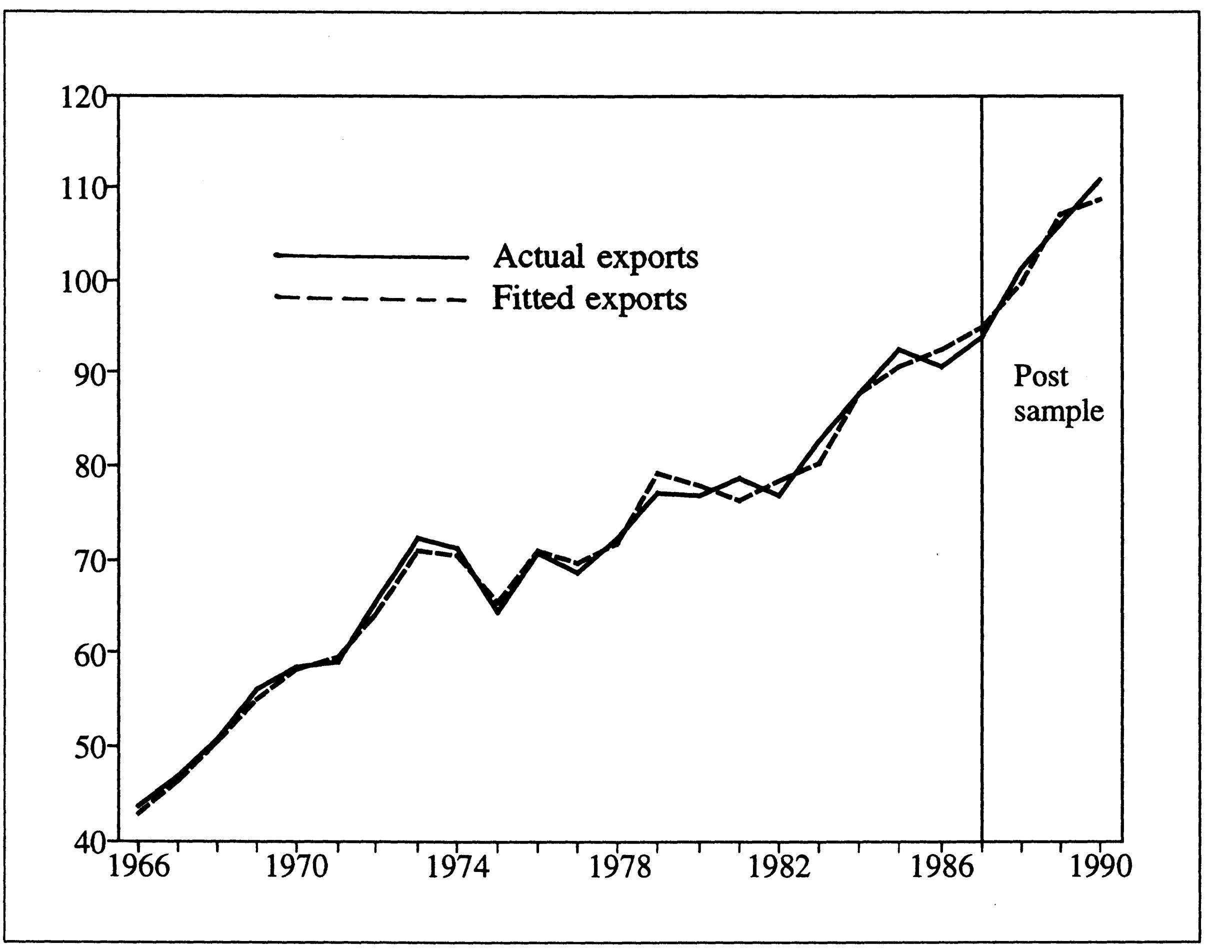
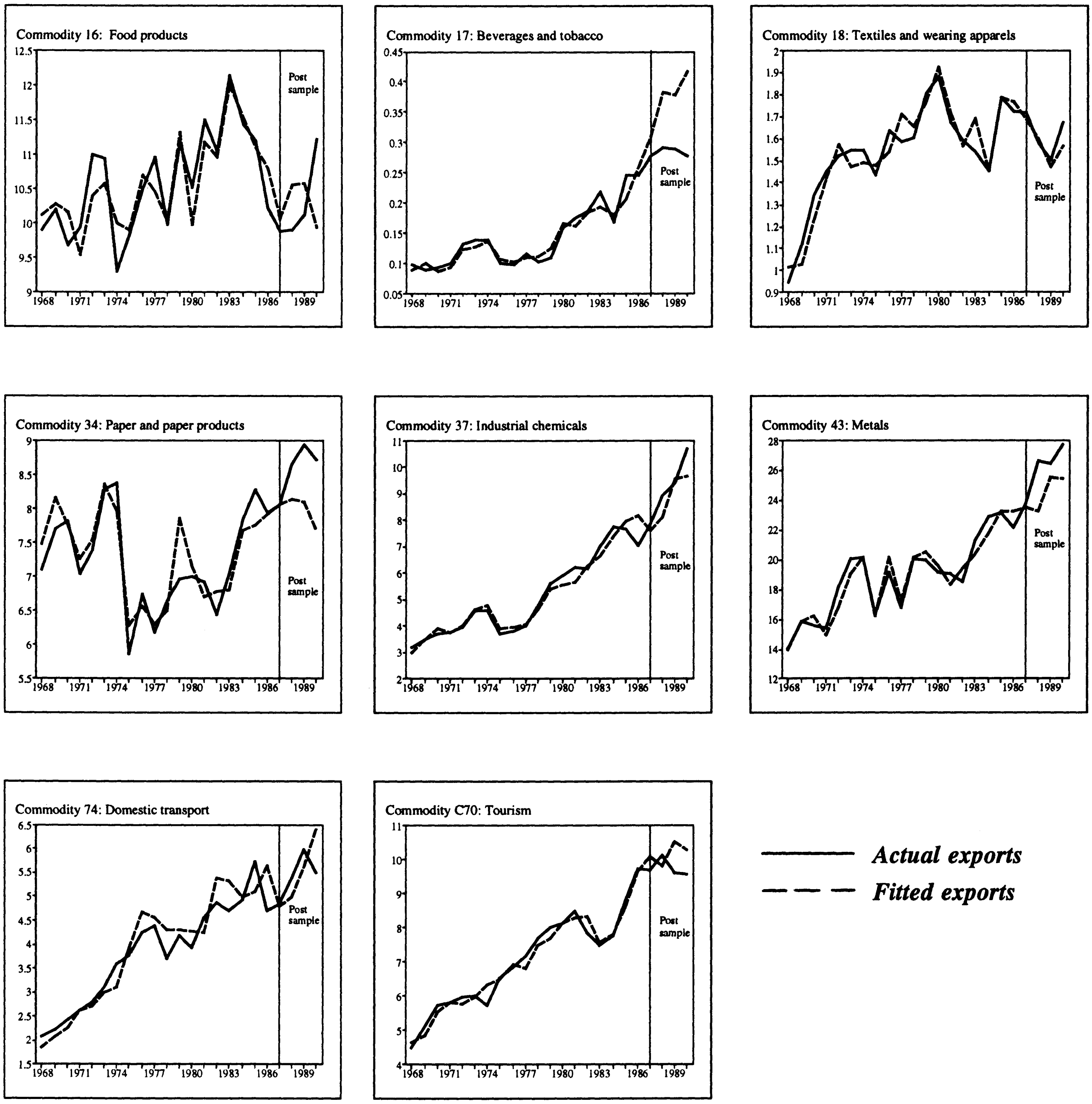


Figure 4.3. Actual and fitted exports for the export demand equations in table 4.5. Ex post forecasts for 1988-1990. Billion Nkr



As shown by figure 4.3, the results for the equations presented in table 4.5 (chapter 4.3) are particularly poor for commodity 17, 34 and 43. The prediction errors are relatively large for commodity 16, 74 and C70 as well. The equations for commodity 25 and 46 are not tested, because we find theory inconsistent long-run price elasticities for these commodities. For commodity 16 we see that the predicted level of exports is above actual exports in 1988 and 1989 and below actual exports in 1990. Regarding commodity 17, the predicted level of exports is well above actual exports. The opposite is true for commodity 34 and 43. Again we find that the predicted level of exports is above actual exports for commodity 74 in 1990 and for commodity C70 in both 1989 and 1990. From figure 4.4 we see that the predicted level of aggregate exports, which in this case is commodity 16-C70 exclusive commodity 25 and 46, is below actual exports. Furthermore, compared with the aggregate result in figure 4.2, which also includes commodity 25 and 46, figure 4.4 shows larger prediction errors.

Figure 4.4. Actual and fitted exports at the aggregate level: Commodity 16-C70 excl. commodity 25 and 46. The export demand equations in table 4.5. Ex post forecasts for 1988-1990. Billion Nkr

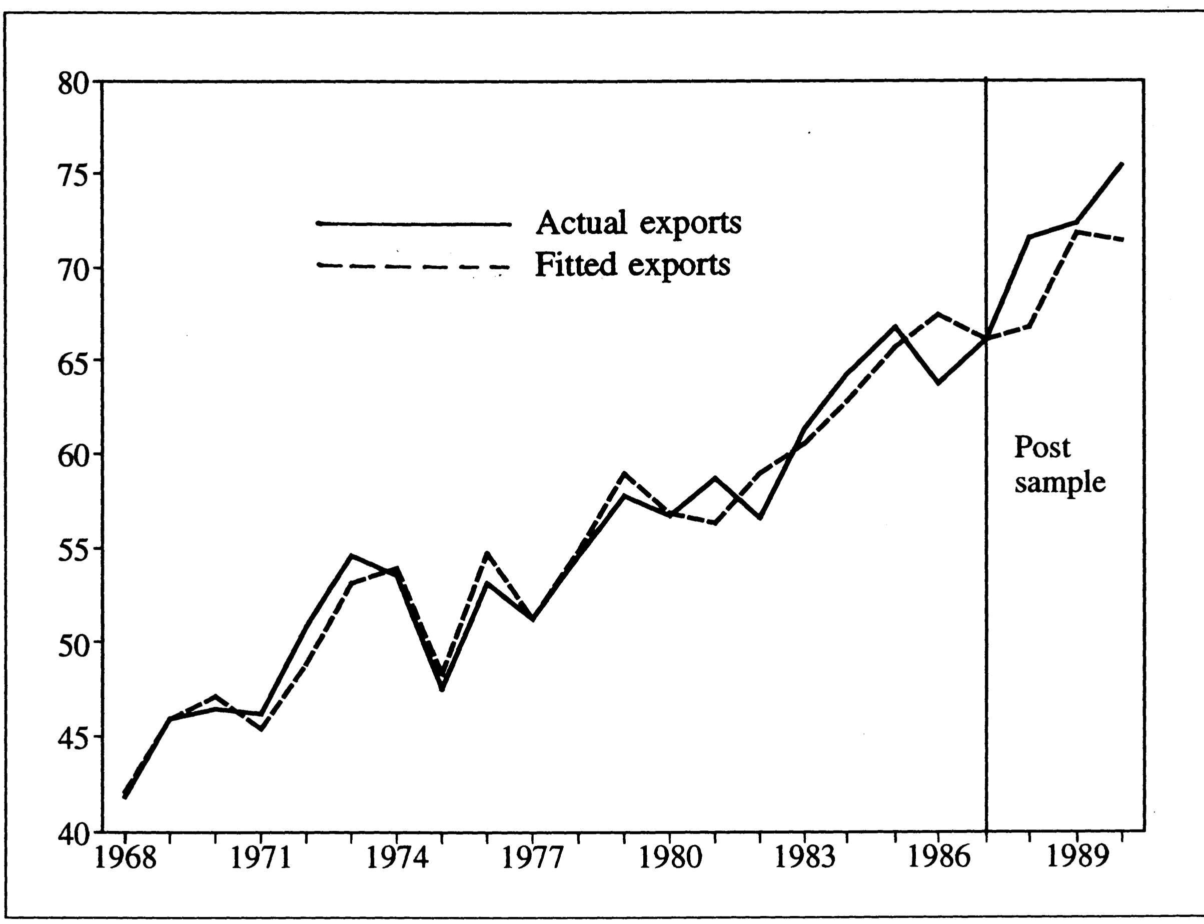


Figure 4.5. Actual and fitted exports for commodity 43: Metals. The export supply equation in table 4.8. Ex post forecasts for 1988-1990. Billion NOK

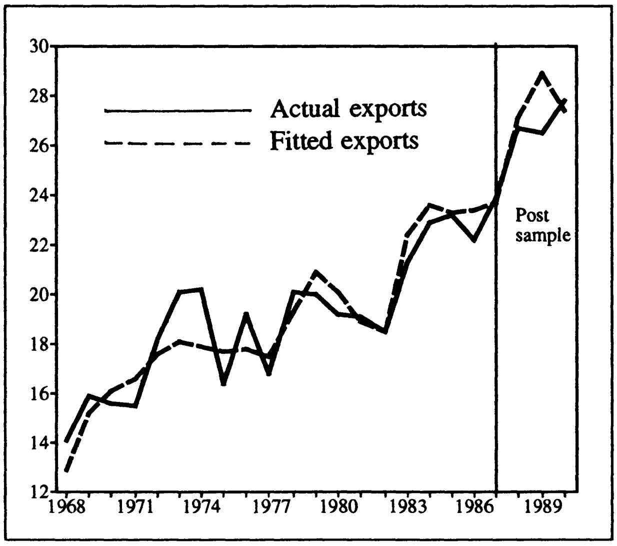
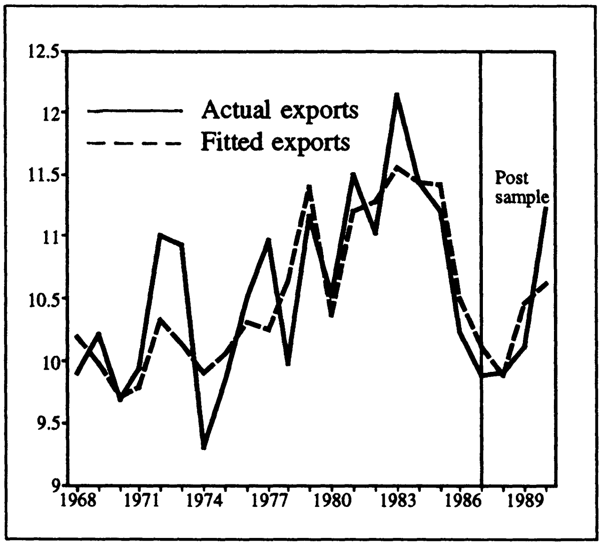
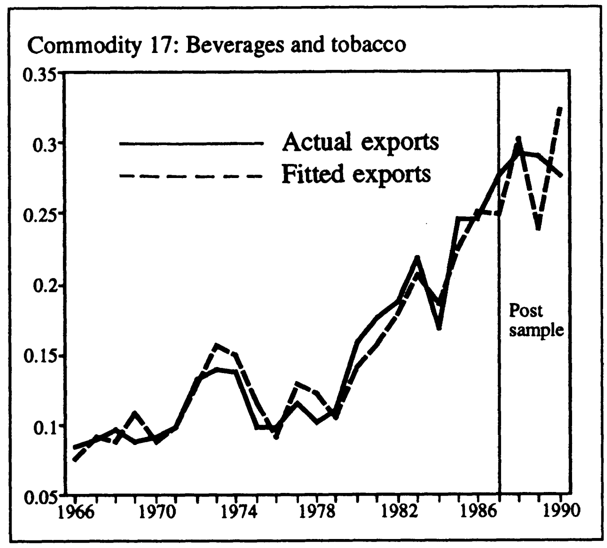


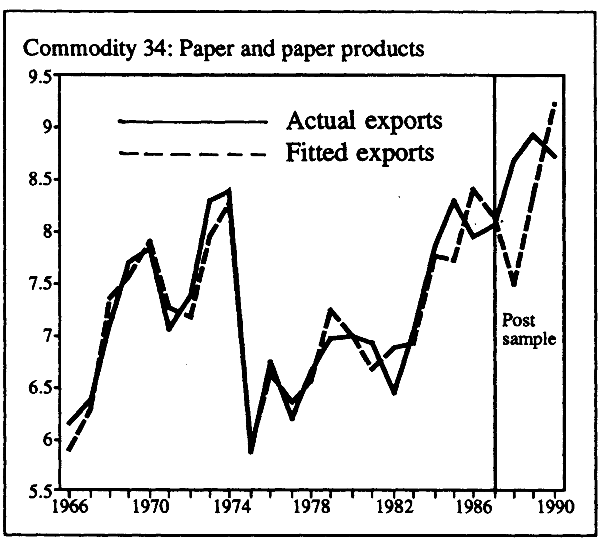
Figure 4.5 gives the result when simulating the export supply equation for commodity 43: Metals, in table 4.9 (chapter 4.4). The predicted level of exports is well above actual exports in 1989, and by comparing figure 4.5 with the export demand equation for this commodity in figure 4.1, we see that this export demand equation has better ex post forecast properties.

Due to the poor ex post forecast properties of the export demand equations for commodity 16: Food products, 17: Beverages and tobacco and commodity 34: Paper and paper products, we present the results from an alternative equation for these commodities (see appendix 3). The same variables for world demand and competitors' prices as in figure 4.1 above are used. Regarding commodity 16, the dynamic structure is simpler compared with the equation in figure 4.1, and this alternative equation includes short-run effects of variable unit costs in the domestic food processing industry as well as output in the domestic fishing sector. The fishing sector delivers raw materials to the food processing industry. In the alternative model for commodity 17, we exclude the trend variable which has a relatively large positive coefficient in the equation in figure 4.1. The result is larger long-run effects of changes in both world demand and relative prices, but this equation fails to pass the restriction of long-run price homogeneity. The alternative model for commodity 34 excludes import prices of other commodities abroad. The result is a larger long-run effect from changes in world demand, but smaller long-run price effects.

Figure 4.6. Actual and fitted exports for some commodities. The export demand equations in appendix 3. Ex post forecasts for 1988-1990. Billion Nkr







From figure 4.6 we see that the alternative equation for commodity 16 predicts the development in exports after 1987 much better than the equations in figure 4.1 and 4.3. The in sample properties are better for the equation in figure 4.1 though. The alternative equation for commodity 17 predicts exports better than the equation in figure 4.1, this is particularly true for 1988 and 1990. Again the in sample properties are poorer. For commodity 34 the in sample properties of the alternative equation and the equation in figure 4.1 are relatively similar, but the ex post forecast properties are better for the alternative equation.

On the basis of the *in sample* properties, we have concluded that we prefer the equation in figure 4.1 to that in figure 4.3 for all commodities. And furthermore, for commodity 43 we prefer the export supply equation in figure 4.5 to the export demand equation. The choice for commodity 18 is not obvious though, and one may choose the equation in figure 4.3 for this commodity. The *ex post* forecast results confirm our choice for most commodities. The exceptions are, as we have seen, commodity 16, 17, 18 and 34. For commodity 16 we suggest a variant of the equation in figure 4.6 rather than that in figure 4.1 or 4.3 due to the ex post forecast properties. The same is true for commodity 17 and 34. Regarding commodity 18, the ex post forecast properties make us prefer the equation in figure 4.3. The choice for commodity 43 is difficult though, and one may argue that the ex post forecast properties suggest that the export demand equation in figure 4.1 should be preferred to the export supply equation in figure 4.5 for this commodity.

Our conclusion based on both in sample and ex post forecast properties is that we prefer the equation in figure 4.1 for most commodities. The exceptions are commodity 16, 17 and 34 for which we prefer the equation in figure 4.6, and commodity 18 for which we prefer the equation in figure 4.3.

5. SUMMARY AND CONCLUSIONS

Using annual observations and error correction models, export equations for eight manufactured goods, one service and one consumption category are estimated. We estimate both export demand equations, i.e. the Armington approach assuming differentiated products and monopolistic competition, and export supply equations consistent with price taking behaviour (the small open economy model). The conclusion is that the Armington equation is to be preferred to the export supply model for most commodities. The in sample conclusion for commodity 43: Metals, is that we prefer the export supply model for this commodity, but the ex post forecast properties do not support this conclusion. For most other commodities, the data gives a clear rejection of the export supply model. The ex post forecast properties for commodity 16: Food products, suggest an export demand model with short-run effects of supply side variables though. We also suggest, on the basis of encompassing tests, a modelling strategy where both demand and supply side variables have short-run effects on exports of commodity 43: Metals and commodity 74: Domestic transport. This strategy may prove fruitful for other commodities as well though.

Due to the lack of ideal measures of the theory variables describing foreign markets in the Armington model, i.e. world demand and competitors' prices, the merits of alternative ways of measuring these variables are investigated. This report compares three empirical proxies for "world demand" and two empirical proxies for "competitors' prices" and shows that care must be taken when choosing observational counterparts of theory variables. The conclusion is that the measures for world demand based on total imports of goods by our principal trading partners and competitors' prices proxied by Norwegian import prices (Alternative I) give the best result for most commodities. Our interpretation of the relatively favourable results when using Norwegian import prices is that the commodity specific information incorporated in these prices is of major importance. The alternative measures for competitors' prices are based on more aggregate data than our commodities. We recognize that using Norwegian import prices as proxies for foreign import prices may involve a problem with measurement error. Still, at the aggregate level the ADF-statistic supports the hypothesis that these errors are integrated of order 0, and in that case, the estimated long-run elasticities are not biased. But, for commodity 18: Textiles and wearing apparels, we conclude that the empirical proxies for world demand and competitors' prices based on imports of four groups of SITC-commodities by our principal trading partners (Alternative II) are preferred.

The choice of empirical proxies for world demand and competitors' prices also prove to be important for our understanding of the competitiveness in domestic industries. The development in market shares and relative prices are assumed to picture the development in "overall" competitiveness and price competitiveness respectively. Estimated market elasticities and trend coefficients are assumed to capture the development in non-price competitiveness. The econometric results when using the empirical variables denoted Alternative I suggest a modest gain in non-price competitiveness for manufactured goods (i.e. commodity 16-46 in table 4.1), while the development in the aggregate relative price variable implies a loss of price competitiveness. A fall in the market share in this case implies a loss of overall competitiveness, and hence the loss of price competitiveness dominates the gain in non-price competitiveness according to these variables. According to Alternative II, manufacturing firms have experienced a significant loss of non-price competitiveness. This alternative also shows a loss of price competitiveness. Consistently, the development in the market share for manufactured goods implies a loss of overall competitiveness. In the "old" export model in MODAG, the measures for world demand were based on private consumption and investments by our principal trading partners, while Norwegian import prices were used as proxies for competitors' prices (Alternative III). According to the "old" export model, which were Armington equations with a simple partial adjustment mechanism, Norwegian firms producing manufactured goods have gained non-price competitiveness over time. The market share has increased according to this alternative, and hence the gain in non-price competitiveness dominates a loss of price competitiveness as predicted by the relative price. We conclude that the "old" world demand variables are biased downwards. As a result, Alternative III shows a too optimistic development in market shares.

From the comparison of the "new" export equations with those in the "old" MODAG, we conclude that the new equations encompass the old, while the opposite is not true. The SER is smaller for all the new equations. Despite the qualms one may have about the new equations, cf. earlier chapters, the "new" equations encompass the "old" and thus increase our knowledge about Norwegian export behaviour. By comparing the long-run elasticities in the new and the old export model, we see that the market elasticities are smaller while the price elasticities are somewhat larger (in absolute value). We separate the effects on the long-run elasticities of new variables, more flexible dynamics where we allow short-run price non-homogeneity and new observations. Our conclusion is that new import based world demand variables decrease both the estimated long-run market elasticities and the long-run price elasticities significantly (in absolute value). More flexible dynamics and short-run price non-homogeneity increases the estimated long-run price elasticities (in absolute value) though, and the overall effect is somewhat larger price effects. We conclude that the "old" long-run market elasticities are biased upwards, while the "old" long-run price elasticities are biased towards zero.

Our results confirm that there are important differences across commodities in both long-run price and market elasticities, and reveals that the same is true with respect to the dynamics. This provide strong support for employing a disaggregated rather than an aggregate analysis, since the latter cannot capture the differences that exist. A more aggregate approach clearly involves a loss of information, which may be of major importance in policy decisions, and in addition an aggregate analysis would face the problem with non-constancy in the parameters due to changing commodity composition. Furthermore, even if we are primarily interested in predicting or forecasting aggregate exports of manufactured goods, it may be that the disaggregated approach out performs an aggregate export equation. This is clearly of interest to test, but is beyond the scope of this report. We recognise that our commodities are also aggregates of goods rather than single goods, but goods grouped together have important features in common and are assumed to face similar market structures.

APPENDIX 1

Definitions of theoretical and empirical variables

The relationship between theoretical and empirical variables are given in the table below. If the definition of a theoretical variable differs from that of the corresponding empirical variable, the theoretical definition is given in brackets.

The relationship between the theoretical and empirical variables

Theoretical variable	Empirical variable	Definition. If the definition of the theoretical and empirical variable differ, the theoretical definition is given in brackets
XA_i	XA_i	Norwegian exports of commodity i in constant prices
PA_i	PA_i	The Norwegian export price of commodity i
PH_i	BH_i	The price of domestic sales of commodity i
PV_j	PV_j	Variable unit costs in domestic industry j (Domestic factor prices faced by industry j)
K_j	K_j	Capital stock of domestic industry j
X13	X13	Output in the Norwegian fishing sector in constant prices
Q	Q99	Real gross domestic product (GDP) (Total domestic income in nominal values)
P_i^*	PQ99	GDP deflator (The price of other commodities in the domestic market than PH_i and PW_i)
PW_i	PI_i	The Norwegian import price of commodity i (Competitors' prices in the export market of commodity i)
	PW_i	Competitors' prices in the export market of commodity i
M_i	M_i	World demand for commodity i in constant prices
PK_i	PK_i	Import prices abroad of other commodities than commodity i

Variables above the dotted line are Norwegian national account data. All variables are measured in Norwegian kroner.

APPENDIX 2

Instrumental variable results

In this appendix we report the results from using instrumental variables (IV) for the export price when estimating export equations to correct for simultaneity between quantities and prices and/or errors-in-variables. As already discussed in chapter 2.1, we may have errors-in-variables and correlation between an explanatory variable and the residual if we for example use improper price indices to deflate error free export values. In this particular case, the estimated price elasticities will be biased towards minus one, cf. Kemp (1962) and Magee (1975). Price elasticities in trade equations may also be biased as a consequence of simultaneity as demonstrated by Orcutt (1950) and Prais (1962) among others. The results in both Magee (1970) and Richardson (1972) suggest that the single-equation estimates of the price elasticities in this case can be biased towards zero.

Equation D1 and D2 are equivalent to the export demand model in table 4.1 and 4.3 respectively, while S represents the export supply model in table 4.6. We do not report D2 and S for all commodities. In general, the IV regressions are not tested as thoroughly as the OLS regressions. The instruments used for the export price is total variable unit costs (PV), capacity utilization (KAP) and the Norwegian import price of similar goods (PI) or the competitors' prices on foreign markets (PW). Both PV and KAP refer to the domestic industry producing the commodity. We also use the notation:

$$PVI_t = PV_t/PI_t$$
$$PKI_t = PK_t/PI_t$$
$$P_t = PA_t/PI_t \quad \text{in equation D1}$$
$$P_t = PA_t/PW_t \quad \text{in equation D2.}$$

t-values are given in brackets. The specification (SPEC) Chi-square test, tests for the validity of the choice of the instrumental variables, i.e. it tests for the independence between the residuals and the instruments, as discussed by Sargan (1964). It can also be interpreted as a specification test. The tables containing the estimation results presented in previous chapters include the Hausman-Wu test. Our conclusion is that the assumption of weak exogeneity of the export price in the export volume equations is valid, although we recognize that there may be a problem with low power of these tests, cf. Urbain (1992). Thus we conclude that the export price is not seriously correlated with the residual. The simple OLS estimates for the price elasticities are also larger (in absolute value) than those obtained when using the IV-method in most cases. One important exception is commodity 46.

Commodity 16: Food products

$$\text{(D1)}\ \Delta xa_t = \underset{(5.6)}{7.11} + \underset{(3.1)}{0.38}\,\Delta xa_{t-2} - \underset{(-4.3)}{0.92}\,\Delta pa_t + \underset{(2.7)}{0.82}\,\Delta pi_t + \underset{(6.7)}{1.87}\,\Delta p_{t-1} + \underset{(5.5)}{1.29}\,\Delta p_{t-2}$$

$$+ \underset{(7.2)}{0.90}\,\Delta pa_{t-3} - \underset{(-5.7)}{0.67}\,(xa_{t-1} - m_{t-2}) - \underset{(-6.3)}{2.83}\,p_{t-1}$$

Long-run elasticities: Relative price = -4.20
World demand = 1.00 *

Additional instruments: Δxa_{t-1} Δpi_t, Δkap_{t-1}, Δpvi_t, Δpvi_{t-1}, p_{t-1}, kap_{t-2}, pvi_{t-1}

Estimation period: 1966-1987 SER = 0.040 DW = 1.99

Reduced form SER = 0.068 SPEC Chi-square(6) = 9.96

Commodity 17: Beverages and tobacco

$$\text{(D1)}\ \Delta xa_t = \underset{(6.0)}{5.73} - \underset{(-4.7)}{0.76}\,\Delta pa_t + \underset{(4.4)}{0.82}\,\Delta pa_{t-1} + \underset{(5.9)}{3.42}\,(\Delta pi_t - 0.5\,\Delta pi_{t-1}) + \underset{(1.6)}{0.54}\,\Delta m_t - \underset{(-6.2)}{0.96}\,xa_{t-1} - \underset{(-6.6)}{1.57}\,p_{t-1} + \underset{(0.9)}{0.17}\,m_{t-1}$$

Long-run elasticities: Relative price = -1.63
World demand = 0.18

Additional instruments: Δpa_{t-2}, pi_{t-1}, kap_{t-2}, pv_{t-1}

Estimation period: 1965-1987 SER = 0.070 DW = 2.34

Reduced form SER = 0.112 SPEC Chi-square(3) = 2.37

$$\text{(D2)}\ \Delta xa_t = \underset{(2.8)}{1.29} - \underset{(-1.9)}{0.47}\,\Delta xa_{t-1} - \underset{(-2.5)}{1.26}\,\Delta pa_t - \underset{(-3.4)}{2.44}\,\Delta pw_{t-1} - \underset{(-1.7)}{1.62}\,\Delta m_t$$

$$- \underset{(-3.0)}{0.61}\,(xa_{t-1} - m_{t-1}) - \underset{(-3.1)}{1.35}\,p_{t-1}$$

Long-run elasticities: Relative price = -2.20
World demand = 1.00 *

Additional instruments: Δkap_{t-1}, Δpv_t, Δpw_t, p_{t-1}, kap_{t-2}, $(pv_{t-1} - pw_{t-1})$

Estimation period: 1967-1987 SER = 0.115 DW = 2.26

Reduced form SER = 0.157 SPEC Chi-square(4) = 3.50

Commodity 18: Textiles and wearing apparels

$$\text{(D1)}\ xa_t = \underset{(4.6)}{5.53} + \underset{(4.0)}{0.50}\ xa_{t-1} - \underset{(-1.0)}{0.67}\ p_t + \underset{(4.1)}{0.86}\ m_t - \underset{(-4.3)}{0.03}\ TREND$$

Long-run elasticities: Relative price = -2.97

World demand = 1.34

Additional instruments: pi_t, pa_{t-1}, kap_{t-1}, kap_{t-2}, kap_{t-3}, kap_{t-4}, pvi_{t-1}

Estimation period: 1966-1987 SER = 0.048 DW = 2.32

Reduced form SER = 0.062 SPEC Chi-square(6) = 7.14

$$\text{(D2)}\ \Delta xa_t = \underset{(0.1)}{0.01} + \underset{(1.9)}{0.38}\ xa_{t-1} - \underset{(-2.7)}{2.24}\ \Delta pa_t + \underset{(3.1)}{2.17}\ \Delta pw_t + \underset{(2.1)}{1.27}\ \Delta p_{t-1} - \underset{(-3.6)}{2.21}\ \Delta p_{t-2}$$

$$- \underset{(-2.4)}{0.31}\ ECM_{t-1}$$

$$ECM_t = xa_t - 6.35 + 5.63\ p_t - 0.70\ m_t$$

Additional instruments: Δkap_t, pv_t, kap_{t-1}, pw_{t-1}

Estimation period: 1968-1987 SER = 0.074 DW = 2.30

Reduced form SER = 0.044 SPEC Chi-square(4) = 6.20

Commodity 25: Miscellaneous industrial products

$$\text{(D1)}\ \Delta xa_t = \underset{(3.1)}{7.82} + \underset{(2.0)}{0.37}\ \Delta xa_{t-1} - \underset{(-2.5)}{0.63}\ \Delta pa_t + \underset{(1.3)}{0.43}\ \Delta pi_t + \underset{(2.4)}{0.61}\ \Delta p_{t-1} + \underset{(5.7)}{1.15}\ \Delta m_t$$

$$- \underset{(-2.3)}{0.70}\ \Delta m_{t-1} - \underset{(-3.0)}{0.69}\ a_{t-1} - \underset{(-4.0)}{1.04}\ p_{t-1} + \underset{(3.2)}{0.86}\ m_{t-1}$$

Long-run elasticities: Relative price = -1.51

World demand = 1.25

Additional instruments: Δkap_{t-1}, Δpvi_t, Δpvi_{t-1}, p_{t-1}, kap_{t-2}, pvi_{t-1}

Estimation period: 1966-1987 SER = 0.028 DW = 2.40

Reduced form SER = 0.038 SPEC Chi-square(5) = 5.60

Commodity 34: Paper and paper products

$$\text{(D1)}\ \Delta xa_t = \underset{(1.0)}{2.01} - \underset{(-5.2)}{1.77}\,\Delta pa_t + \underset{(4.7)}{1.36}\,\Delta pi_t + \underset{(4.4)}{1.27}\,\Delta pk_t + \underset{(7.3)}{1.25}\,(\Delta m_t - 0.5\,\Delta m_{t-1})$$

$$- \underset{(-1.0)}{0.19}\,xa_{t-1} + \underset{(1.6)}{0.15}\,m_{t-1} - \underset{(-5.4)}{1.17}\,p_{t-1} + \underset{(3.2)}{0.40}\,pki_{t-1}$$

Long-run elasticities: Own price = -6.11
Competitors' prices = 4.00 *
Other import prices = 2.11
World demand = 0.79

Additional instruments: Δpa_{t-1}, Δpv_t, pa_{t-1}, pi_{t-2}, kap_{t-2}, pvi_{t-1}

Estimation period: 1965-1987 SER = 0.034 DW = 1.92

Reduced form SER = 0.036 SPEC Chi-square(5) = 5.50

Commodity 37: Industrial chemicals

$$\text{(D1)}\ \Delta xa_t = \underset{(3.8)}{2.76} - \underset{(-6.1)}{1.17}\,\Delta pa_t + \underset{(6.3)}{1.08}\,\Delta pi_t - \underset{(-6.3)}{0.68}\,\Delta pa_{t-2} + \underset{(5.2)}{0.95}\,\Delta m_t - \underset{(-3.7)}{0.25}\,(xa_{t-1} + p_{t-1}) + \underset{(5.1)}{0.38}\,m_{t-3}$$

Long-run elasticities: Relative price = -1.00 *
World demand = 1.55

Additional instruments: Δpa_{t-1}, Δkap_{t-2}, Δpvi_t, Δpvi_{t-1}, pa_{t-1}, kap_{t-2}, pvi_t

Estimation period: 1966-1987 SER = 0.036 DW = 1.91

Reduced form SER = 0.049 SPEC Chi-square(6) = 5.94

Commodity 43: Metals

$$\text{(S)}\ \Delta xa_t = \underset{(-0.2)}{-0.01} + \underset{(3.8)}{1.16}\,\Delta pa_t - \underset{(-4.4)}{1.72}\Delta pv_t - \underset{(-4.2)}{1.14}\,(xa_{t-1} - k_{t-2}) + \underset{(3.7)}{1.25}\,(pa_{t-1} - pv_{t-1})$$

Long-run elasticities: Price-cost = 1.10
Capital = 1.00

Additional instruments: Δpa_{t-1}, Δpa_{t-2}, Δm_t, a_{t-1}, pa_{t-1}, pi_{t-1}, m_{t-1}

Estimation period: 1965-1987 SER = 0.065 DW = 1.85

Reduced form SER = 0.051 SPEC: Chi-square(6) = 9.24

Commodity 46: Machinery and metal products (excl. ships)

$$\text{(D1)}\ \Delta xa_t = \underset{(2.5)}{4.11} - \underset{(-2.2)}{0.47}\ \Delta pa_t + \underset{(2.4)}{0.45}\ \Delta p_{t-1} + \underset{(2.1)}{0.46}\ \Delta m_t + \underset{(6.4)}{1.02}\ m_{t-1} - \underset{(-2.5)}{0.35}\ xa_{t-2} - \underset{(-2.4)}{0.38}\ p_{t-2}$$

$$+ \underset{(2.7)}{0.52}\ m_{t-2}$$

Long-run elasticities: Relative price = -1.07

World demand = 1.46

Additional instruments: Δkap_{t-1}, p_{t-1}, kap_{t-2}, pvi_{t-1}

Estimation period: 1965-1987 SER = 0.025 DW = 2.57

Reduced form SER = 0.032 SPEC Chi-square(3) = 0.96

Commodity 74: Domestic transport

$$\text{(D1)}\ \Delta xa_t = \underset{(3.1)}{7.56} - \underset{(-0.1)}{0.07}\ \Delta pa_t + \underset{(1.4)}{0.34}\ \Delta pi_t - \underset{(-3.1)}{0.71}\ (xa_{t-1} - m_{t-1}) - \underset{(-1.6)}{0.39}\ p_{t-1}$$

Long-run elasticities: Relative price = -0.55

World demand = 1.00 *

Additional instruments: Δpa_{t-1}, Δkap_{t-2}, Δpvi_t, Δpvi_{t-2}, p_{t-1}, kap_{t-2}, pvi_{t-1}

Estimation period: 1966-1987 SER = 0.081 DW = 2.06

Reduced form SER = 0.080 SPEC Chi-square(6) = 7.98

Commodity C70: Tourism

$$\text{(D1)}\ \Delta xa_t = \underset{(5.7)}{8.00} - \underset{(-2.3)}{0.70}\ \Delta pa_t + \underset{(1.9)}{0.61}\ \Delta pi_t - \underset{(-4.0)}{0.51}\ \Delta pk_t + \underset{(1.6)}{0.33}\ \Delta m_t$$

$$- \underset{(-5.7)}{0.71}\ (xa_{t-1} - m_{t-1}) - \underset{(-5.1)}{0.84}\ p_{t-1} + \underset{(2.0)}{0.23}\ pki_{t-1}$$

Long-run elasticities: Own price = -1.17

Competitors' prices = 0.85 *

Other import prices = 0.32

World demand = 1.00 *

Additional instruments: Δxa_{t-1}, Δpa_{t-1}, Δpi_{t-1}, Δpk_{t-1}

Estimation period: 1965-1987 SER = 0.031 DW = 2.00

Reduced form SER = 0.031 SPEC Chi-square(4) = 6.56

APPENDIX 3

Alternative export equations for some commodities

In this appendix we present alternative export demand equations for commodity 16, 17 and 34 due to poor ex post forecast properties of the equations presented in table 4.1 (chapter 4.1). The alternative equations have more favourable ex post forecast properties but poorer in sample properties. For commodity 34 the in sample properties are not very different though. The same measures for world demand and competitors' prices as in chapter 4.1 are used. I.e., world demand is based on total imports of goods abroad, while competitors' prices are proxied by Norwegian import prices.

The alternative export demand model for **commodity 16:** Food products, includes supply side variables in the short-run. Compared with the equation for commodity 16 in table 4.1, the alternative model has a simpler dynamic structure but includes short-run effects of variable unit costs in the domestic food processing industry as well as output in the Norwegian fishing sector. A large share of exports of Food products is manufactured fish. The effect of output in the Norwegian fishing sector indicates that the domestic food processing industry is rationed in the short run in its access to raw materials.

$$
\begin{aligned}
(16)\quad \Delta xa_t = {} & \underset{(2.9)}{5.60} + \underset{(1.9)}{0.29}\, \Delta xa_{t-2} - \underset{(-1.7)}{0.41}\, \Delta p_t - \underset{(-1.4)}{0.39}\, \Delta m_{t-1} - \underset{(-2.7)}{1.15}\, \Delta pv_t + \underset{(3.2)}{0.41}\, \Delta x13_t \\
& - \underset{(-2.9)}{0.46}\, (xa_{t-1} - m_{t-1}) - \underset{(-1.5)}{0.47}\, p_{t-1} - \underset{(-2.9)}{0.01}\, TREND
\end{aligned}
$$

Long-run elasticities: Relative price = -1.03 (-1.6)
World demand = 1.00 *

Estimation period: 1965-1987 SER = 0.052 DW = 1.99 AR(2) = 0.87
ARCH(2) = 3.31 NORM = 0.71 ADF = -3.97 (s) Restr. m = 2.86 (s)
Restr. p = -3.38 (s)

Long-run price homogeneity is clearly rejected. And furthermore, the level of exports does not enter significantly in this equation. The restriction of a long-run market elasticity equal to unity is not supported by the data, but due to the problem with the significance of the export level, we choose to imply this restriction in accordance with the results in table 4.1. This alternative equation passes all other tests applied at the five per cent significance level and it is stable according to the Chow-tests. Regarding cointegration, the ADF-test is significant, the same is true for the t_{ECM}-test if we use the Gaussian-critical values. But, because the level of exports does not enter significantly on its own, it is difficult to conclude that these variables cointegrate. This may indicate that we should add relative import prices between different commodities abroad as explanatory variables, or that a modelling strategy where we include both demand and supply side variables also in the long-run may give more satisfactory results. Still, in chapter 4.6 we show that this equation has relatively favourable ex post forecast properties.

The predicted level of exports is well above actual exports for **commodity 17:** Beverages and tobacco, when using the equation in table 4.1. This equation includes a relatively large positive trend coefficient. In the alternative equation for this commodity we exclude the trend variable.

$$(17)\quad \underset{}{\Delta xa_t} = \underset{(1.8)}{1.87} - \underset{(-2.9)}{0.64\,\Delta pa_t} + \underset{(3.9)}{4.47\,\Delta pi_t} + \underset{(1.4)}{0.79\,\Delta m_t} - \underset{(-1.9)}{0.27\,xa_{t-1}} + \underset{(2.3)}{0.53\,m_{t-1}}$$

$$- \underset{(-3.0)}{0.86\,p_{t-2}}$$

Long-run elasticities: Relative price = -3.23 (-1.9)
World demand = 1.99 (3.0)

Estimation period: 1965-1987 SER = 0.119 DW = 1.91 AR(2) = 0.41
ARCH(2) = 0.70 NORM = 0.37 Hausman = 0.90 DF = -4.48 (s)
Restr. p = 3.71 (s)

SER increases significantly when excluding the trend variable, and in addition the long-run elasticities with respect to both world demand and relative prices increases. The large long-run market elasticity is due to the restriction of long-run price homogeneity, which is not supported by the data. Estimating without this restriction reduces the long-run market elasticity from 2 to 1. No cointegration is only rejected by the t_{ECM}-test if we use the Gaussian-critical values in this case. The DF-test supports cointegration though.

The alternative model for **commodity 34:** Paper and paper products satisfies the theoretical restriction of long-run price homogeneity, and in addition we find a long-run market elasticity equal to unity. A deterministic trend variable enters significantly with a negative coefficient. This equation passes most tests applied and it is stable. The t_{ECM}-test is significant if we use the Gaussian-critical values but not if we use the DF-critical values. The significant ADF-test supports cointegration though. Compared with the equation in table 4.1, the alternative equation implies larger long-run effects of changes in world demand but smaller long-run effects of changes in the relative export price.

(34) $\Delta xa_t = 5.12 - 1.09\ \Delta pa_t - 0.73\ \Delta pa_{t-1} + 1.39\ \Delta pi_t + 0.84\ (\Delta m_t - \Delta m_{t-1})$

(2.2) (-4.0) (-6.7) (1.4) (4.8)

$- 0.43\ (xa_{t-3} - m_{t-3}) - 0.75\ p_{t-3} - 0.01\ TREND$

(-3.4) (-1.8) (-2.1)

Long-run elasticities: Relative price = -1.72 (-3.5)

World demand = 1.00 *

Estimation period: 1965-1987 SER = 0.042 DW = 2.62 AR(2) = 2.71
ARCH(2) = 0.93 NORM = 0.39 ADF = -3.37 (s) Restr. m = 0.05
Restr. p = -0.86

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