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Empirical Modelling of Norwegian Exports: A Disaggregated Approach

by

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Abstract

Using annual observations, export equations for ten commodities are estimated, of which eight are manufactured goods. Important differences across commodities regarding both long-run elasticities and dynamics are revealed. Both Armington equations, assuming differentiated products and monopolistic competition, and equations consistent with price taking behaviour (the small open economy case) are estimated. The small open economy approach is assumed particularly promising for raw materials and intermediate goods, but the data supports the price taking hypothesis only for metals. The merits of using alternative empirical proxies for world demand and competitors' prices in the Armington model are also investigated. The paper concludes that both careful modelling of the dynamics and the choice of explanatory variables are important for the encompassing properties and the estimated long-run elasticities. In addition, inference about competitiveness in trading industries depends critically on the choice of variables describing foreign markets.

Keywords: Export modelling, Disaggregated approach, Competitiveness

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CONTENTS

1. INTRODUCTION

In this paper, two alternative hypotheses on Norwegian export determination are tested on ten commodity groups; The small open economy model assuming homogeneous goods and price taking behaviour and the Armington model assuming differentiated products and monopolistic competition. The price taking hypothesis is assumed particularly relevant for raw materials and intermediate goods. The Armington model, where exports are determined by foreign demand, predicts intra-industry trade between countries. This is supported by trade statistics for Norway, which show prevalent two-way exchanges of similar goods with other OECD-countries. The paper concludes that the Armington model clearly encompasses the small open economy model for most commodities, the only exception being Metals.

Our results support earlier analyses on Norwegian export price determination, which suggest price setting rather than price taking behaviour, but also show that further research may be necessary for raw materials and intermediate goods. Bowitz and Eika (1989) and Cappelen (1992) find that Norwegian export prices of manufactured goods are influenced by domestic costs and capacity utilization as well as by international prices.

The econometric methodology in this paper uses error correction models and annual data for the period 1962-1991. The results show important variation across commodities regarding long-run elasticities and dynamics, which would not have been revealed in a more aggregate approach.

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 theory variables "world demand" and "competitors' prices" in the Armington model, and one has to choose among empirical proxies with different weaknesses and merits which are difficult to choose between on pure theoretical grounds. This issue is also raised by Goldstein and Khan (1985, pp. 1056-1063). In this paper, alternative measures for these variables are compared and used as regressors. The exact definition of these variables prove to be very important for the estimated coefficients and statistical properties such as fit and stability in addition to inference about competitiveness in trading industries.

In the next chapter we present two alternative models of export determination. In chapter 3 we compare different empirical proxies for the theory variables in the Armington model. The econometric results are given in chapter 4, where we also compare our results with an earlier export analysis on Norwegian data. The main conclusions are summarized in the final chapter.

2. TWO ALTERNATIVE MODELS OF EXPORT DETERMINATION

2.1 The Armington (export demand) model

In the article by Armington (1969), a theory of demand for products distinguished by place of production is put forward. The main assumption is that firms within a geographical area or country produce identical products of commodities, while products of the same commodity produced in different countries are heterogeneous. To obtain a manageable specification of foreign demand for Norwegian products, we follow Armington and assume separability in demand for different commodities. We do not restrict the market elasticities to unity a priori however, but we assume constant elasticities of substitution between products of the same commodity and long-run price homogeneity. By treating foreign markets as one aggregate market and using a log-linear error correction specification, foreign demand for Norwegian exports can be defined as in equation (2.1). The long-run solution of the model is given in (2.2). 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.

$$\Delta xa_{it} = \Sigma_j[\alpha_{ij}\ \Delta pa_{i,t-j} + \beta_{ij}\ \Delta pw_{i,t-j} + \gamma_{ij}\ \Delta pk_{i,t-j} + \mu_{ij}\ \Delta m_{i,t-j} + \eta_{ij}\ \Delta xa_{i,t-j-1}] \quad (2.1)$$
$$+ \tau_i\ xa_{i,t-k} + \tau_{i0} + \tau_{i1}\ (pa_{i,t-l} - pw_{i,t-m}) + \tau_{i2}\ (pk_{i,t-n} - pw_{i,t-o}) + \tau_{i3}\ m_{i,t-p}$$

$$xa_i = \alpha_{i0} + \alpha_i\ (pa_i - pw_i) + \beta_i\ (pk_i - pw_i) + \gamma_i\ m_i \quad (2.2)$$

where $\alpha_{i0} = -\tau_{i0}/\tau_i$, $\alpha_i = -\tau_{i1}/\tau_i$, $\beta_i = -\tau_{i2}/\tau_i$, $\gamma_i = -\tau_{i3}/\tau_i$, i=1,..,n commodities, j=1,..,J and k,..,p describe the lag structure. XA_i is Norwegian exports of commodity i in constant prices, PA_i is the Norwegian export price of commodity i, PW_i is competitors' prices in the world market of commodity i, PK_i is the price of other commodities abroad, M_i is world demand for commodity i in constant prices. All variables are measured in Norwegian kroner (Nkr). The data for XA_i and PA_i are from the Norwegian national accounts. Empirical proxies for M_i and PW_i are presented in chapter 3, in addition to the measure for PK_i. The inclusion of the relative price term between PK_i and PW_i, is because we use world demand variables based on more aggregate data than the measures for competitors' prices in some equations and need to take into account substitution effects between commodities. τ_{i2}, and hence β_i, are restricted to zero otherwise. The α_{ij}'s, β_{ij}'s, γ_{ij}'s, μ_{ij}'s and η_{ij}'s are short-run coefficients, while the τ's represent the long-run structure. τ_i is the error correction coefficient. α_i, β_i and γ_i are the long-run elasticity of the own price, other import prices abroad and world demand respectively. The long-run elasticity of competitors' prices equals $-(\alpha_i-\beta_i)$. τ_{i0} and α_{i0} are intercepts.

The theoretical predictions are that $\alpha_i < 0$, $\beta_i > 0$ and $\gamma_i > 0$. In the monopolistic competition case with differentiated products, an optimum does not exist if demand is inelastic and $\alpha_i >-1$. However, if the assumption of "homogeneous products of a commodity within a country" is violated and Norwegian firms produce differentiated products, we may well find small price elasticities for Norwegian commodities, even if firms at the micro level face price elasticities well below minus one. This is due to the substitution effect between Norwegian products.

If the market elasticity γ_i equals one, this implies constant market share at constant relative prices. "Market share" is defined as the ratio of exports of a commodity to world demand. Changes in market shares are assumed to reflect the development in "total" competitiveness of trading industries, and includes changes in both price and non-price competitiveness. The development in relative export prices, i.e. the ratios of the Norwegian export price to competitors' prices, picture the development in price competitiveness. Estimated market elasticities are 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, trade barriers, product quality, marketing and advertising, delivery reliability, after sales service, etc. Because the export prices applied are unit value indices, our data for export volumes and prices include quality changes. Most variables influencing firms' non-price competitiveness are difficult to observe or express in quantitative terms. For this reason, empirical analyses tend to either neglect most of these factors, in which case the market elasticity should be 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, cf. 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 estimated long-run market elasticity in the Armington model deviates from unity, we test whether this can be explained by a deterministic trend variable.

2.2. The small open economy (SOE) model

The main assumption in the SOE model is that the small economy faces perfectly elastic foreign supply and demand and have no influence on international prices, cf. Hansen (1955) and Rødseth (1979). It is implicitly assumed that commodities produced at home and abroad are homogeneous. For simplicity, we ignore border trade due to domestic transportation costs, and commodities are either exported or imported. In this case, exports equal domestic output minus domestic demand, and this "excess" or reduced form export function depends on the variables determining both domestic output and demand. If there are no barriers to trade, the prices of exports, imports and domestic sales will equal world market prices. In situations with barriers to trade where the price of imports exceeds the price of exports, a domestic monopolist or oligopolists may exploit their market power and charge a price in the domestic market above the export price. With barriers to trade and many small domestic firms or an unstable monopoly or oligopoly, we expect the price of domestic sales to equal the export price but differ from the import price. A difference in the price of domestic sales and exports in this case, is assumed to trigger a redistribution of sales between domestic and foreign markets.

We estimate a general SOE model, which encompasses both the excess export supply function and the case when commodities produced for exports and domestic sales by Norwegian firms are heterogeneous rather than homogeneous goods. We maintain the assumptions of price taking behaviour on the export markets and that domestic firms may have market power at home. Firms' short run decision is how much of their total production capacity to use in producing commodities for the export and domestic market respectively. I.e., profits are maximized with respect to both exports and domestic sales, see f.ex. Dinenis and Holly (1991) who use the multi product firm approach for a large open economy. The general SOE model is given in (2.3), with the long-run solution in (2.4).

$$\begin{aligned}\Delta xa_{it} = {} & \Sigma_j[\alpha_{ij}\,\Delta pa_{i,t-j} + \beta_{ij}\,\Delta pv_{i,t-j} + \gamma_{ij}\,\Delta ph_{i,t-j} + \delta_{ij}\,\Delta p^*_{i,t-j} + \zeta_{ij}\,\Delta q_{t-j} \\ & + \mu_{ij}\,\Delta k_{i,t-j} + \eta_{ij}\,\Delta xa_{i,t-j-1}] + \tau_i\, xa_{i,t-k} + \tau_{i0} + \tau_{i1}\,(pa_{i,t-l} - pv_{i,t-m}) \\ & + \tau_{i2}\,(ph_{i,t-n} - pv_{i,t-o}) + \tau_{i3}\,(ph_{i,t-n} - p^*_{i,t-p}) + \tau_{i4}\, q_{i,t-q} + \tau_{i5}\, k_{i,t-r}\end{aligned} \tag{2.3}$$

$$xa_i = \alpha_{i0} + \alpha_i\,(pa_i - pv_i) + \beta_i\,(ph_i - pv_i) + \gamma_i\,(ph_i - p^*_i) + \zeta_i\, q_i + \mu_i\, k_i \tag{2.4}$$

where $\alpha_{i0} = -\tau_{i0}/\tau_i$, $\alpha_i = -\tau_{i1}/\tau_i$, $\beta_i = -\tau_{i2}/\tau_i$, $\gamma_i = -\tau_{i3}/\tau_i$, $\zeta_i = -\tau_{i4}/\tau_i$, $\mu_i = -\tau_{i5}/\tau_i$. PV_i is variable unit costs in the domestic industry producing commodity i, PH_i is the price of domestic sales of commodity i, Q is real gross domestic product (GDP), P_i^* is the GDP deflator, K_i is the capital stock of the industry producing commodity i. All variables are Norwegian national accounts data. α_i and β_i are the long-run price-cost elasticities in domestic supply, $-\gamma_i$ is the long-run price elasticity and $-\zeta_i$ is the long-run income elasticity in domestic demand, while μ_i is the long-run capital elasticity in supply. τ_{i0} and α_{i0} are intercepts.

The theoretical predictions are that $\alpha_i > 0$, $\beta_i < 0$, $\gamma_i > 0$, $\zeta_i < 0$ and $\mu_i > 0$. If $\tau_{i2} = 0$, i.e. $\beta_i = 0$, equation (2.3) is reduced to an excess export supply function. To discriminate between different market situations in this case, we may compare the export and the import price faced by domestic agents and the price of domestic sales, as explained above. If $\tau_{i2} = \tau_{i3} = \tau_{i4} = 0$, i.e. $\beta_i = \gamma_i = \zeta_i = 0$, the export equation is interpreted as a simple Cobb-Douglas production or export supply function, where only the ratio of the export price to variable costs and the capital stock have long-run effects on exports. $\mu_i = 1$ implies a constant return to scale technology. If τ_{i2} is significant, this supports the hypothesis that commodities produced for domestic sales differ from those exported. Both in this case and if we find that τ_{i3} is significant, we should test for simultaneity bias in the export equations and instrument PH_i.

3. EMPIRICAL PROXIES FOR WORLD DEMAND AND COMPETITORS' PRICES IN THE ARMINGTON MODEL

The Armington model in (2.1) assumes separability in demand across commodities, and the *ideal* world demand variables are foreign demand for each commodity. Competitors' prices should 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 for these variables, and we are left to choose between proxies with different qualities and merits. When constructing empirical proxies for these theory variables, the number of countries included have been limited to Norways principal trading partners, which are Denmark, France, Italy, Japan, Netherlands, Sweden, UK, USA and West-Germany. When aggregating country specific demand and competitors' prices, we use constant weights which reflect each countries' importance for Norwegian exports of different commodities.

This paper presents three alternative proxies for world demand and two alternative proxies for competitors' prices. World demand according to Alternative I is based on total imports of goods by our principal trading partners, while competitors' prices, i.e. import prices abroad, are proxied by Norwegian import prices. In Alternative II we use imports of four groups of SITC[2]-commodities by Norways principal trading partners as a basis for world demand as well as for competitors' prices. Both alternative I and II imply an assumption of separability between imports and domestic commodities. Tveitereid and Lædre (1981) present world demand variables based on private consumption and capital formation for the principal trading partners, which aim to measure domestic demand abroad. These variables are denoted Alternative III. Competitors' prices, which in this case should reflect the development in domestic as well as import prices abroad, are proxied by Norwegian import prices. Figure 3.1 gives the development in the market share and the relative export price for manufactured goods as predicted by these alternative measures for world demand and competitors' prices.[3]

Alternative III implies gains in competitiveness for important commodities, while the opposite is true according to the other two alternatives for world demand. An increase (decrease) in the market share is defined as a gain in (loss of) competitiveness. The two import based alternatives are relatively similar, but Alternative I shows a more favourable development in the market share during the eighties than Alternative II. One interpretation of the difference between Alternative III on one hand and Alternative I and II on the other, is that Norwegian firms have increased their share in domestic demand by our principal trading partners but not managed to keep up with the relatively rapid growth in foreign trade in the OECD-area over the last decades. On the other hand, the world demand variables denoted Alternative III are downwards biased because of the simplification to exclude exports in addition to government demand when calculating these measures. 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. This is largely supported by the development in the market share according to both Alternative I and II and also by the measure of export performance for the manufacturing sector in Norway published by the OECD, cf. Durand et al. (1992).

The relative export price according to both Alternative I (III) and II shows a loss of price competitiveness for Norwegian manufactures. An increase (decrease) in the relative export price implies a loss of (gain in) price competitiveness. OECD's measure of export competitiveness for the manufacturing sector in Norway cf. Durand et al. (1992), performs very similar to our Alternative II.

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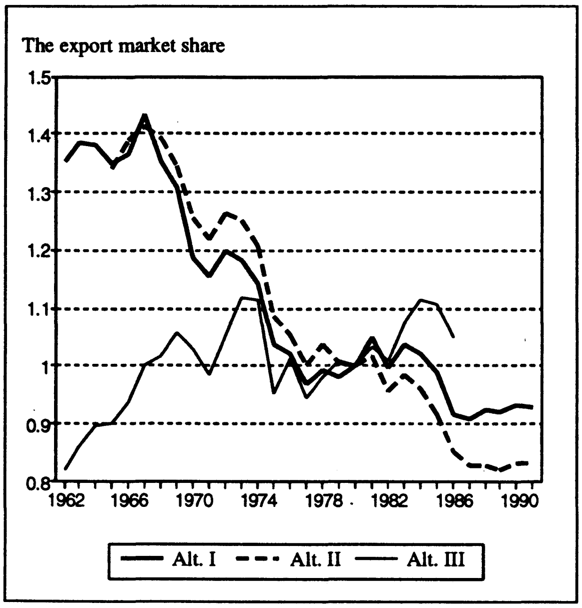
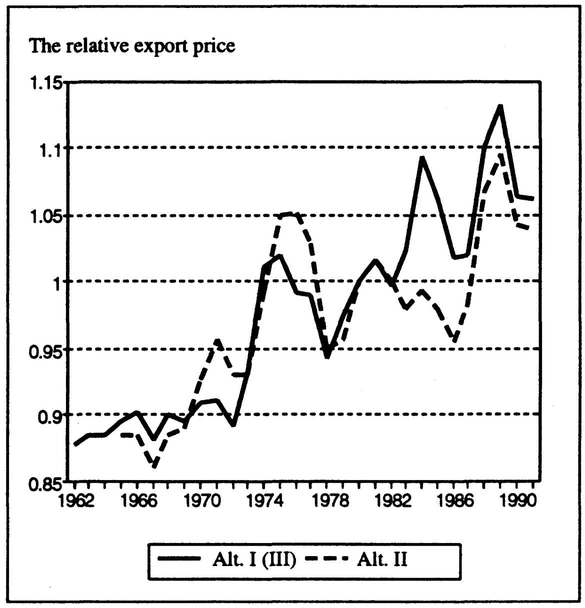
[2] The UN Standard International Trade Classification.

[3] For this presentation, we decided to aggregate across manufactured goods. Lindquist (1993) gives a more detailed presentation.

Figure 3.1. The export market share and the relative price for manufactured goods, 1980=1. Alt. I: World demand is based on total imports of goods abroad, competitors' prices are proxied by Norwegian import prices; Alt. II: Both world demand and competitors' prices are based on imports of four groups of SITC-commodities abroad; Alt. III: World demand is based on private consumption and investments abroad, competitors' prices are proxied by Norwegian import prices





The strategy to use Norwegian import prices as proxies for competitors' prices is likely to involve measurement error in these variables and bias the price elasticities towards 0. However, the long-run elasticities obtained from cointegrating error correction models are consistent if the measurement error is integrated of order 0 and thus has a finite variance, cf. Engle and Granger (1987). With respect to Alternative I, figure 3.1 indicates that Norwegian import prices follow the same trend as import prices by our principal trading partners, even if there are important short-run discrepancies. The ADF-statistic on the difference of the log of the two aggregate relative prices for manufactured goods is -2.86. We include a constant term. The critical value at the five per cent significance level is -2.98, we use the method suggested in MacKinnon (1991) to calculate the critical value with 25 observations. Although not formally supported at the five per cent level, we accept integration of order 0 as a plausible hypothesis in this case. Naug and Nymoen (1993) conclude that Norwegian import prices are cointegrated with domestic labour costs in addition to foreign prices. Their data set differs from ours though, and integration properties are known to vary between data sets. Furthermore, because our applications of the Armington model are for disaggregated commodities, the Norwegian import price of each commodity may be a "better choice" than Alternative II, which is based on more aggregate data. Norwegian import prices may capture important commodity specific information which is lost in Alternative II, and hence be closer to the "true" variables.

It is difficult to find economic and statistically satisfactory selection criteria to help us choose between the alternative empirical proxies for world demand and competitors' prices. We reject Alternative III for reasons explained earlier however, and hence the choice is between Alternative I and II. 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. 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 is preferable to an à priori "blind" choice of empirical variables.

4. EMPIRICAL RESULTS

In this chapter, we present the results from estimating export equations for the commodities listed in table 4.1. The classification of the commodities follows that in MODAG[4].

Table 4.1. Commodities included in this analysis

Commodity	Share of total exports in per cent, 1991
Food products	4.3
Beverages and tobacco	0.1
Textiles and wearing apparels	0.6
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
Paper and paper products	3.0
Industrial chemicals	3.2
Metals	7.8
Machinery and metal products (excl. ships)	6.8
Domestic transport	1.7
Tourism	3.8
Share of the commodities above	36.7
Total exports, billion Nkr	307.5

Source: Statistics Norway.

[4] MODAG is an annual large scale macromodel for Norway developed by Statistics Norway, cf. Cappelen (1992),

Except for Domestic transport and Tourism, the commodities analysed are manufactured goods. Paper and paper products, Industrial chemicals and Metals are basically industrial raw materials and intermediate goods. Important commodities for Norway such as Crude oil and gas and Shipping services (with 31.4 and 16.5 per cent of total exports in 1991 respectively) are not included in this analysis.

The econometric package PC-GIVE Version 6.1 is applied, cf. Hendry (1989). We use ordinary least squares (OLS). Except for some variables which start in 1965, our data cover 1962-1991. The 1988-1991 observations are not included when designing the models but used for ex post forecast comparisons. Asymptotic t-values of the long-run elasticities are calculated by the method suggested in Kmenta (1971), see Bårdsen (1989). AR(j) and ARCH(j) are F-form tests of the LM-test of j'th order autocorrelation (Harvey (1981)) and heteroscedasticity (Engle (1982)) respectively. NORM is the χ^2-test of normal residuals with two degrees of freedom (Jarque and Bera (1980)). The Hausman-Wu test (Godfrey (1988)) is applied to test for weakly exogenous export prices, and the validity of the instruments used is tested by the specification χ^2-test with j degrees of freedom denoted SPEC(j) (Sargan (1964)). To test for cointegration, we use the test suggested in Kremers et al. (1992) 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 critical values of the Dickey-Fuller test. We also report the Dickey-Fuller (DF) and the Augmented Dickey-Fuller (ADF) test of cointegration (Engle and Granger (1987)). According to Kremers et al., these tests have lower power compared with the t_{ECM}-test. Restrictions on the coefficients are tested by simple t-tests of adding one of the variables with a restricted coefficient. We report the t-statistic from testing long-run price homogeneity (Restr. p) and a long-run market elasticity equal to unity (Restr. m). Encompassing properties are tested by the F-form of the "joint model" LM-test, which tests if each model encompasses the linear nesting model.

Empirical export demand and supply equations are presented in chapter 4.1 and 4.2 respectively. We compare our equations with an earlier export analysis in chapter 4.3.

4.1. Empirical Armington (export demand) equations

In this section we present the results from estimating Armington equations using alternative proxies for world demand and competitors' prices. The regressions in table 4.2 use the proxies denoted Alternative I in chapter 3, while the regressions in table 4.3 use Alternative II. Because the proxies for world demand are based on more aggregate data than the proxies for competitors' prices in Alternative I, we include import prices of other commodities abroad,

PK_i, in table 4.2. We find significant long-run effects of PK_i for only two commodities, which indicate that the world demand variables according to Alternative I reflect the development in foreign demand reasonably well for most commodities. The export equation for Food products in table 4.3 includes short run effects of output in the Norwegian fishing sector. Our interpretation of this is that the domestic food processing industry is rationed in the short-run in its access to raw materials. We do not find significant effects of this variable in table 4.2.

The most salient difference between the results in table 4.2 and 4.3 is perhaps that the Armington model is rejected for Miscellaneous industrial products and Machinery and metal products in table 4.3, while this is not the case in table 4.2. This may indicate that the empirical proxies for competitors' prices used in table 4.3 are based on too aggregate data and do not measure prices of close substitutes to our commodities. In that case, the elasticities reported in table 4.3 are biased. For the remaining commodities in table 4.3 and for all commodities in table 4.2, long-run price homogeneity is supported by the data, which is regarded as a test of the validity of the empirical variables applied just as much as of the theoretical model. Both tables show that à priori restrictions on the short-run price elasticities involve misspecification for important commodities.

The long-run relative price elasticity is below minus one for most commodities in table 4.2, while this is true for only a few commodities in table 4.3. The aggregate relative price elasticity for manufactured goods excl. Miscellaneous industrial products and Machinery and metal products is -0.94 in table 4.3. The corresponding aggregate elasticity with respect to the own price and competitors' prices in table 4.2 are -1.80 and 1.68 respectively. Export volumes in 1990 are used as weights when calculating aggregate elasticities. If we include all manufactured goods, we find an aggregate long-run own price elasticity equal to -1.67 and a long-run elasticity with respect to competitors' prices equal to 1.60 in table 4.2.

According to table 4.2, the price effects are relatively large for Food products and Textiles and wearing apparels, for which private consumption is the dominant end use, and also for Paper and paper products, which is mainly industrial raw materials and intermediate goods. This suggest the existence of relatively close substitutes to these commodities and weak consumer loyalty. The small price effects for Industrial chemicals and Metals, which also are basically industrial raw materials and intermediate goods, may indicate misspecification. Particularly for Metals, one may expect supply side factors such as output capacity to be important, because changes in capacity utilization or the capital stock involve high costs. On the other hand, small price elasticities may simply reflect that Norwegian products are close substitutes rather than homogeneous products as explained in chapter 3.

Table 4.2. Armington 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	Food products	Beverages and tobacco	Textiles and wearing app.[2]	Miscellan. industrial prod.	Paper and paper prod.
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)				
Δpw_t	1.01 *	3.48 (6.8)		0.52 *	1.37 *
Δpw_{t-1}	-1.91 *	-1.74 *		-0.78 *	
Δpw_{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)
pkw_{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)
$El_{PW} XA$	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[3]	-0.41	0.90	-1.29	-0.29	-1.38
SPEC(j)	9.96 (6)	2.37 (2)	7.16 (6)	5.60 (5)	5.50 (5)
t_{ECM}	(s)	(s)	..	(s)	
DF/(ADF)	(-3.79) (s)	-4.48 (s)	-2.54	(-3.91) (s)	(-3.39)
Restr. m	-0.53				
Restr. p	0.73	0.49	0.48	-1.20	-1.50

1) t-statistics in brackets.
2) Left hand side variable is xa_t.
3) The instrumental variables regressions are reported in Lindquist (1993).
* Restricted à priori, (s) Significant at the five per cent level.
$p_t = (pa_t - pw_t)$, $pkw_t = (pk_t - pw_t)$.

Table 4.2. Continues

Variable	Estimated coefficients[1] Industrial chemicals	Metals	Machinery & metal prod.	Domestic transport	Tourism
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)				
Δpw_t	1.10 *			0.38 *	0.62 *
Δpw_{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)
$El_{PW} XA$	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[2]	-0.09	..	-0.06	0.25	0.51
SPEC(j)	5.94 (6)	..	0.96 (3)	7.98 (6)	6.56 (4)
t_{ECM}	(s)	(s)		(s)	(s)
DF/(ADF)	(-2.22)	-4.04	-2.68	-3.75 (s)	(-4.45) (s)
Restr. m				-1.16	-0.37
Restr. p	1.24	-1.62	-1.11	-0.82	-0.41
Restr. $El_p XA=-1$	0.14				

1) t-statistics in brackets.
2) The instrumental variables regressions are reported in Lindquist (1993).
* Restricted à priori, (s) Significant at the five per cent level.
$p_t = (pa_t - pw_t)$, $pkw_t = (pk_t - pw_t)$.

Table 4.3. Armington equations with "world demand" and "competitors' prices" based on imports of four categories of SITC-commodities abroad. Alternative II

Variable	Estimated coefficients[1]				
	Food products	Beverages and tobacco	Textiles and wearing app.[2]	Miscellan. industrial prod.	Paper and paper prod.
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}[2]			-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[4]	-1.22	0.74	0.55		..
SPEC(j)	5.68 (4)	3.50 (4)	6.20 (4)		..
t_{ECM}					(s)
DF/(ADF)	-3.14	-3.08	(-2.31)		-3.39
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 (Engle and Granger (1987)). The error correction mechanism (ECM) is estimated in the first step and the dynamics are estimated in the second.
3) $x13_t$ is the volume of production in the Norwegian fishing sector.
4) The instrumental variables regressions are reported in Lindquist (1993).
* Restricted à priori, (s) Significant at the five per cent level, (nc) Not consistent with theory.
$p_t = (pa_t - pw_t)$.

Table 4.3. Continues

Variable	Estimated coefficients[1]				
	Industrial chemicals	Metals	Machinery & metal prod.	Domestic transport[2]	Tourism
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}[2]				-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[3]	1.00	-0.30		..	..
SPEC(j)	9.66 (6)	7.02 (6)		..	..
t_{ECM}					(s)
DF/(ADF)	(-3.40) (s)	-4.39 (s)		-2.52	(-3.96) (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 (Engle and Granger (1987)). The error correction mechanism (ECM) is estimated in the first step and the dynamics are estimated in the second.
3) The instrumental variables regressions are reported in Lindquist (1993).
* Restricted à priori, (s) Significant at the five per level, (nc) Not consistent with theory.
$p_t = (pa_t - pw_t)$.

The long-run market elasticity is smaller in table 4.3 than in table 4.2 for most commodities. The aggregate market elasticity for manufactured goods excl. Miscellaneous industrial products and Machinery and metal products is 0.51 according to table 4.3, and the aggregate trend coefficient is close to zero. Thus, table 4.3 implies a significant loss of non-price competitiveness for these commodities. The corresponding market elasticity in table 4.2 equals 0.91, which together with a small negative aggregate trend coefficient also indicates a loss of non-price competitiveness, but of much less magnitude. This shows that our understanding of competitiveness in trading industries depends on the explanatory variables chosen. If we also include Miscellaneous industrial products and Machinery and metal products, the aggregate market elasticity increases to 1.11 in table 4.2, suggesting gains in non-price competitiveness for manufacturing firms.

Table 4.4 compares the predictive power of the equations in table 4.2 and 4.3 and shows encompassing tests. For most commodities, the SER is smaller in table 4.2, but the encompassing tests are not very helpful when choosing between the equations. The equation in table 4.2 encompasses the equation in table 4.3 for Industrial chemicals, and the same is true for Food products and Paper and paper products if we allow an eight and a 10 per cent significance level respectively. We find that the equation in table 4.3 clearly encompasses that in table 4.2 for Domestic transport, and the same is true for Metals and Tourism at the 14 and 10 per cent significance level respectively.

Table 4.4. Encompassing tests. M_1 represents the equation in table 4.2, while M_2 represents the equation in table 4.3 [1]

Commodity	M_1 encom. M_2	M_2 encom. M_1	SER	
			M_1	M_2
Food products	F(5,8) = 1.33 (.342)	F(7,5)[2] = 3.91 (.076)	0.039	0.047
Beverages and tobacco	F(5,8) = 1.25 (.372)	F(5,8) = 1.04 (.456)	0.066	0.110
Textiles and wearing apparels	F(6,9) = 1.00 (.479)	F(2,12) = 0.62 (.555)	0.045	0.060
Paper and paper products	F(3,11) = 1.13 (.378)	F(6,10) = 2.49 (.097)	0.035	0.045
Industrial chemicals	F(4,12) = 1.24 (.345)	F(5,10) = 3.41 (.047)*	0.036	0.062
Metals	F(6,9) = 2.23 (.134)	F(4,9) = 0.78 (.567)	0.060	0.047
Domestic transport	F(4,2) = 4.59 (.018)*	F(3,13) = 1.56 (.246)	0.075	0.076
Tourism	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 observation to allow for this test.

The t_{ECM}-test rejects the hypothesis of no cointegration for all commodities except Paper and paper products and Machinery and metal products in table 4.2. (The equation for Textiles and wearing apparels in table 4.2 is not an error correction model and the t_{ECM}-statistic can not be calculated. The DF-test does not support cointegration though.) If we assume that the t_{ECM}-

statistic is normally distributed, we accept cointegration for Paper and paper products and Machinery and metal products as well. In table 4.3, cointegration is found for only three commodities. If the t_{ECM}-statistic is normally distributed, we accept cointegration for most commodities, and the only exception in this case is Industrial chemicals.

Kremers et al. (1992) question the power of the DF-/ADF-test, because these tests often do not support cointegration even if the t-statistic on the error correction coefficient is highly significant and suggests cointegration. In our case, the t_{ECM}-test rejects no cointegration more frequently than the DF-/ADF-test in table 4.2, even when we use the DF- rather than the Gaussian-critical values. The opposite is true in table 4.3 however. Still, for most commodities, we find that the conclusion from these two alternative test procedures are consistent.

When evaluating the alternative equations we also emphasize stability and the dynamics. Chow-tests show that the equation in table 4.2 is superior to the equation in table 4.3 for most commodities. The standardized interim multiplicator with respect to competitors' prices is negative at t+1 for Beverages and tobacco and Machinery and metal products in table 4.2. This may indicate that relative import prices between commodities abroad matter for these commodities, although such effects are not identified in this analysis. Thus, when competitors' prices increase, a negative effect on Norwegian exports due to 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. More difficult to interpret is the negative interim multiplicator with respect to competitors' prices at t+2 for Beverages and tobacco in table 4.3. We do not accept negative interim multiplicators with respect to an increase in world demand, this is found in table 4.3 for Beverages and tobacco, Tourism and Domestic transport.

We now subject our export equations to true ex post sample forecast test. For this purpose we use data for 1988-1991. We plot both actual exports and the 1-step predicted values at the aggregate level. Figure 4.1 shows that the equations in table 4.2 predict well aggregate exports, and the average percentage deviation in export levels is 1.1 percent over 1988-1991 and 1.5 percent over 1966-1987. This hides relatively poor ex post forecast properties for Food products, Beverages and tobacco and Paper and paper products though. The equations in table 4.3 underpredict the level of aggregate exports (excl. Miscellaneous industrial products and Machinery and metal products), and the average percentage deviation is 5.5 percent over 1988-1991 and 1.9 percent over 1968-1987. We find poor ex post forecast properties for the same commodities as in table 4.1.

Figure 4.1. Actual and fitted aggregate exports: The Armington equations in table 4.2

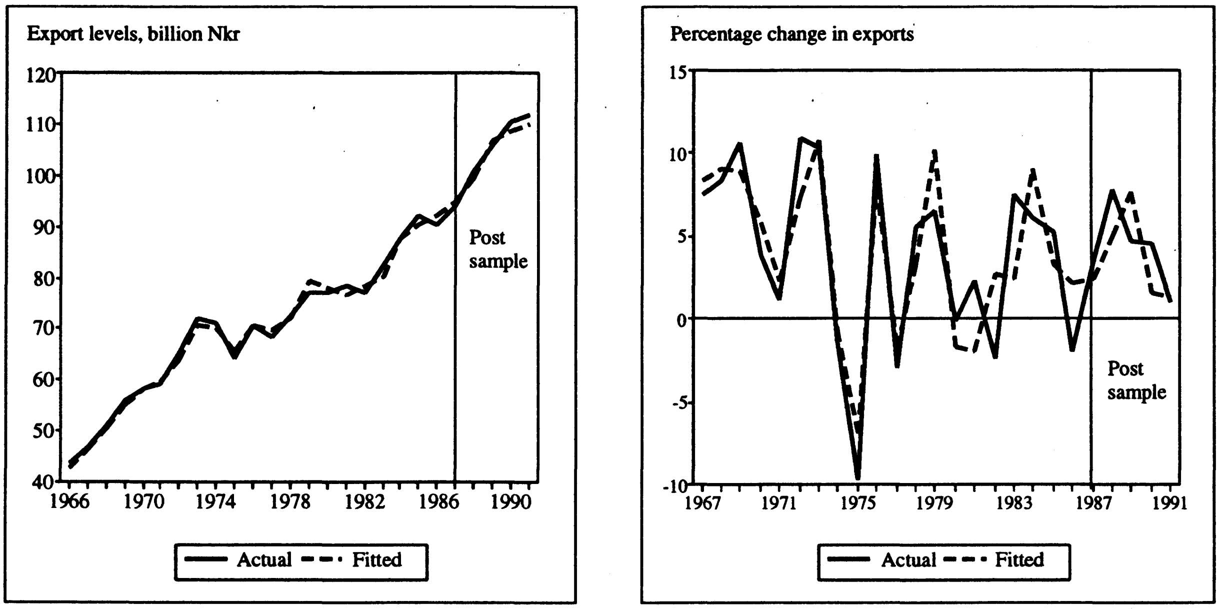
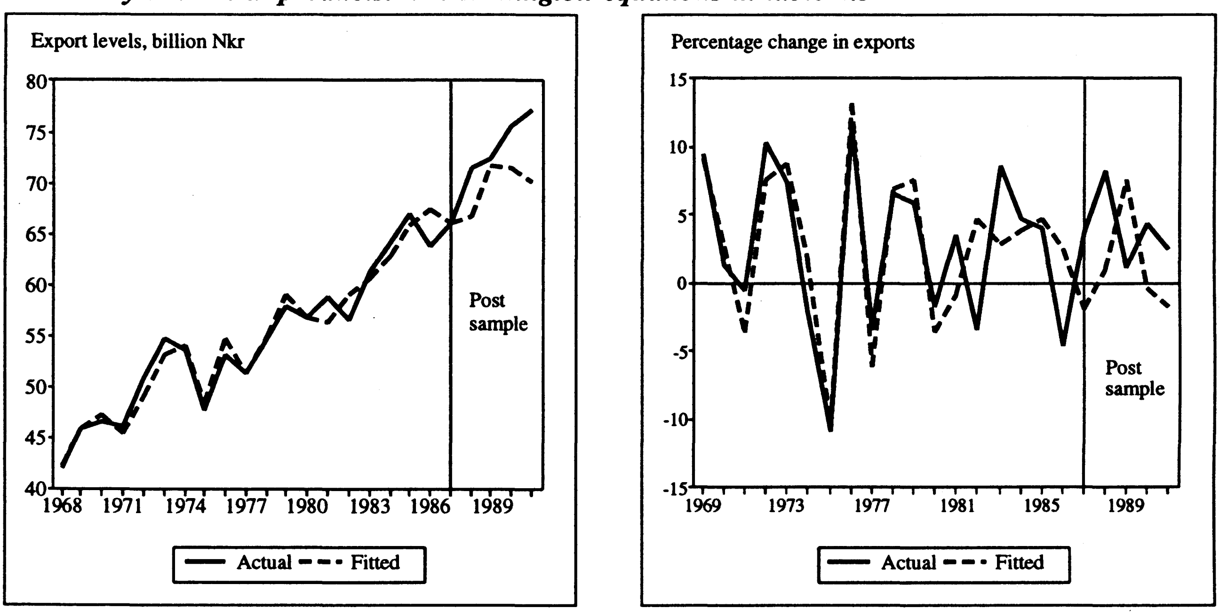


Figure 4.2. Actual and fitted aggregate exports excl. Miscellaneous industrial products and Machinery and metal products: The Armington equations in table 4.3



Our conclusion from comparing the in sample and the ex post forecast properties of the two alternative equations for each commodity is that we prefer the equation in table 4.2 for all commodities. Our choice for Textiles and wearing apparels is not obvious though due to better ex post forecast properties. Table 4.5 summarizes the arguments for our choices.

Table 4.5. Model choice based on in sample and ex post forecast properties. M_1 from table 4.2 versus M_2 from table 4.3.

Preferred model: M_1

Food products: 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. Ex post forecast properties are poor for both equations.

Beverages and tobacco: 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. Ex post forecast properties are poor for both equations.

Textiles and wearing apparels: Both equations are unstable in the first half of the eighties. The N-decreasing Chow-test is significant in 1984 for M_1, and recursive least squares reveals large variation in the elasticities over the sample for M_2. 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, but M_2 has better ex post forecast properties.

Miscellaneous industrial products: 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. The ex post forecast properties are good.

Paper and paper products: 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. Ex post forecast properties are poor for both equations.

Industrial chemicals: 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, and M_1 has better ex post forecast properties.

Metals: 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, but M_1 has better ex post forecast properties.

Machinery and metal products: 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, and the long-run price elasticity is not significant. Still, the equation is stable and the ex post forecast properties are good.

Domestic transport: 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. The ex post forecast properties are relatively similar.

Tourism: 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. The ex post forecast properties are relatively similar.

4.2. Empirical export supply equations (the small open economy case)

In this chapter we present the results from estimating the general small open economy model presented in chapter 2.2. We find theory consistent long-run elasticities and long-run price-cost homogeneity for Metals and Domestic transport only. Homogeneity is rejected for Metals at the nine per cent significance level though. For the remaining commodities, the long-run price and cost elasticities have the wrong sign or the equations are seriously unstable.

Table 4.6. Export supply equations

Estimated coefficients[1]		
Variable	Metals	Domestic transport
Δxa_{t-1}		-0.57 (-4.7)
Δk_t		7.99 (5.7)
Δk_{t-1}		-6.55 (-5.6)
Δpa_t	0.86 (3.6)	
Δpv_t	-1.44 (-4.2)	1.81 (5.2)
xa_{t-1}	-0.98 (-4.5)	-0.31 (-2.5)
k_{t-2}	0.98 *	0.31 *
pa_{t-1}	1.00 (3.8)	0.03 (0.2)
pv_{t-1}	-1.00 *	-0.03 *
Constant	0.01 (0.4)	-1.09 (-2.7)
$El_K XA$	1.00 *	1.00 *
$El_{PAV} XA$	1.02 (4.7)	0.11 (0.3)
Est.period	1964-1987	1965-1987
SER	0.062	0.042
DW	2.11	3.07
AR(2)	0.08	4.93 (s)
ARCH(2)	1.56	0.00
NORM	1.73	0.43
Hausman[2]	-1.72	
SPEC(j)	9.24 (6)	
t_{ECM}	(s)	
DF/(ADF)	-5.43 (s)	(-2.81)
Restr. K	-0.39	-0.58
Restr. PAV[3]	-1.84	-0.61

1) t-statistics in brackets.
2) The instrumental variables regressions are reported in Lindquist (1993).
3) Restriction $El_{PA}XA = -El_{PV}XA$.
* Restricted à priori.
(s) Significant at the five per cent level.

The export equation in table 4.6 for both Metals and Domestic transport are simple Cobb-Douglas production or export supply functions. The long-run capital elasticity equals unity for both commodities. We find no influence of domestic demand on exports as suggested by the residual export supply model. And furthermore, we find no direct effect of the price of domestic sales as predicted by the multi product firm model. This simple export supply model indicates that the domestic market has only minor effect on the export decition. We find this to be a plausible result for Metals, because Norwegian production of this commodity to a large degree is exported. We reject this export supply model for Domestic transport due to a very low t-value of the long-run price-cost elasticity and implausible dynamics though.

With respect to Metals, the t_{ECM}-test supports cointegration. The 1-step ahead Chow-test shows parameter non-constancy in 1977, but this is not confirmed by the N-decreasing Chow-test. The Hausman-Wu test supports the assumption of weakly exogenous export price at the five but not at the 10.4 per cent significance level for this commodity. A comparison of the OLS and the instrumental variable long-run price-cost elasticity for Metals reveals that OLS bias this elasticity only marginally downwards.

On the basis of in sample properties, it is difficult to choose between the export supply equation in table 4.6 and the export demand equation in table 4.2 for Metals. The variables in both equations cointegrate, and none of the equations can be said to encompass the other, see table 4.7. If we also take into consideration the ex post forecast properties, our conclusion is that we prefer the export demand equation, but our choice is not obvious.

Table 4.7. Encompassing tests. M_1 represents the export demand model in table 4.2 and M_2 the export supply model in table 4.6[1]

Com-modity	M_1 encom. M_2	M_2 encom. M_1	SER	
			M_1	M_2
Metals	F(4,14) = 1.21 (.352)	F(5,14) = 1.55 (.238)	0.060	0.062
1) Significance levels in brackets.				

4.3. A comparison with an earlier export analysis

Our export equations are implemented in MODAG, and it is of interest to compare our equations with those in earlier versions of this macroeconomic model for Norway[7]. The old export equations were Armington equations with a simple partial adjustment mechanism. Price homogeneity was imposed as a restriction in both the short- and the long-run, and world demand and competitors' prices were proxied by Alternative III, see chapter 3.

It is of major interest to check whether these "new" export equations encompass the old. Encompassing is a test of the "value added" from implementing alternative explanatory variables, looking at alternative models and a more careful modelling of the dynamic structure. The results are given in table 4.8, where M_1 represents the new model and M_2 represents the old model. We conclude that most of the new export equations encompass the "old" equations and thus increase our knowledge about Norwegian export behaviour. The SER of the new equations are lower for all commodities.

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

Table 4.8. 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.

Commodity	M_1 encom. M_2	M_2 encom. M_1	SER	
			M_1	M_2
Food products	F(2,12) = 0.77	F(6,11) = 5.70 (s)	0.039	0.067
Beverages and tobacco	F(2,13) = 0.06	F(6,13) = 7.89 (s)	0.066	0.130
Textiles and wearing apparels	F(1,16) = 0.17	F(2,16) = 11.13 (s)	0.045	0.067
	F(2,2) = 0.80[1]	F(6,10) = 2.47[1]	0.060	0.068
Miscellaneous industrial products	F(1,14) = 0.01	F(5,15) = 4.36 (s)	0.032	0.047
Paper and paper products	F(1,14) = 0.14	F(5,14) = 14.33 (s)	0.035	0.076
Industrial chemicals	F(2,14) = 0.02	F(5,13) = 5.35 (s)	0.036	0.066
Metals	F(2,16) = 0.53	F(4,16) = 4.00 (s)	0.060	0.078
	F(2,17) = 1.93[2]	F(4,17) = 6.83[2] (s)	0.057	0.078
Machinery and metal products	F(3,11) = 0.29	F(7,13) = 8.33 (s)	0.027	0.055
Domestic transport	F(2,19) = 0.70	F(2,19) = 1.68	0.075	0.079
Tourism	F(1,15) = 0.13	F(5,14) = 3.69 (s)	0.030	0.042

1) M_1 is the export demand model in table 4.3.
2) M_1 is the export supply model in table 4.6.

In addition to the encompassing properties, we are also interested in analysing the effect on the long-run elasticities in the Armington model of using new explanatory variables, re-specifying the dynamic structure, allowing price non-homogeneity in the short-run and new observations. By comparing the two first columns with the two last columns in table 4.9, we see that the long-run market elasticity is lower in the new model than in the old model for most commodities. (The new equation for commodity 18 includes a negative trend coefficient, and excluding the trend variable decreases the market elasticity.) In most cases the long-run price effects are larger in the new model than in the old.

By comparing the last two columns with column five and six, we find the effect of introducing new world demand variables. (The relative price terms are identical.) The effect is a smaller market elasticity for all commodities. 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 ratio of the "old" to the "new" aggregate market elasticity is 1.6, 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 1.6 is a reasonable figure. The effect on the long-run price elasticities of new explanatory variables is more obscure, but a comparison at the aggregate level shows that the result is significantly smaller price effects. I.e., new world demand variables influence the long-run price elasticities as well as the long-run market elasticities in important ways.

The impact of using error correction models where we allow short-run price non-homogeneity can be seen by comparing column three and four with column five and six. The aggregate long-run market elasticity is relatively robust, but the impact on the long-run price elasticities is significant. More flexible dynamics gives larger price effects. Extending the estimation period influences the aggregate long-run elasticities very little, as can be seen by comparing column one and two with column three and four. From this we conclude that new world demand variables tend to give smaller price effects, while an alternative dynamic specification and short-run price non-homogeneity tend to increase the price effects. The reduction of the long-run market elasticities is largely due to new measures of world demand.

Table 4.9. A comparison of the estimated long-run price (P) and market (M) elasticities with those in the "old" export model in MODAG

Commodity	New model[1]		New model[1] Short est. per.		Old model New expl.var.		Old model	
	P	M	P	M	P	M	P	M
Food products	-4.20	1.00	-4.33	1.00	-0.60	0.48	-0.39	0.89
Beverages and tobacco	-1.66	1.99	-1.78	0.13	-0.82	1.00	-0.92	2.29
Textiles and wearing appar.	-2.99	1.82	-4.06	4.46	-0.55	0.86	-1.50	1.08
Miscell. industrial products	-1.31	1.25	-1.34	1.21	-0.80	1.26	-0.95	2.58
Paper and paper products	-2.83 2.12	0.53	-3.32 2.62	0.79	-1.89	0.67	-1.86	1.41
Industrial chemicals	-1.00	1.53	-1.00	1.28	-1.28	0.94	-1.00	1.93
Metals	-0.64	0.73	-0.46	0.74	-0.40	1.12	-1.77	1.42
Machinery and metal prod.	-1.58	1.57	-1.50	1.57	-1.07	1.22	-1.90	2.06
Domestic transport	-0.50	1.00	-0.47	1.00	-0.66	1.01	-0.37	2.23
Tourism	-1.18 0.86	1.00	-1.02 0.53	1.00	-0.26	0.80	-0.16	1.62
Aggregate elasticities[2]	-1.56 1.47	1.10	-1.56 1.46	1.13	-0.81	1.00	-1.25	1.76

1) For Paper and paper products and Tourism, 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) Weighted averages of all commodities above. Export volumes in 1990 are used as weights. "New" model is the equations in table 4.2 for all commodities. We estimate the new export equations over the same "short" estimation period as the old equations, and end the regressions in 1981. Thirdly, the export equations in the old model are estimated over the short estimation period using the same explanatory variables as in the new model. The elasticities in the old export model are given in the last two columns, cf. Bergan and Olsen (1985).

5. SUMMARY AND CONCLUSIONS

Using error correction models and annual observations, we estimate export equations for ten commodities of which eight are manufactured goods. Two alternative hypothesis are tested; The small open economy model assuming price taking behaviour and the Armington model assuming differentiated products and monopolistic competition. The Armington model clearly encompasses the small open economy model for most commodities. The only exception is Metals, for which we find that the in sample properties favour the export supply model while the ex post forecast properties favour the Armington model.

The paper compares three ways of measuring "world demand" and two ways of measuring "competitors' prices" in the Armington model, and shows that care must be taken when choosing observational counterparts of these theory variables. The measures for world demand based on total imports of goods by our principal trading partners and competitors' prices set equal to Norwegian import prices give the best econometric results. Our interpretation of the latter is that the commodity specific information incorporated in Norwegian import prices is of major importance. The alternative proxies not chosen are based on more aggregate data. We recognize that using Norwegian import prices may involve a problem with measurement error. However, the ADF-statistic on aggregate data supports the hypothesis that these errors are integrated of order 0, and in that case, the estimated long-run elasticities are not biased. The preferred measures show that Norwegian manufacturing firms have lost competitiveness during the last decades due to a loss of price competitiveness, but that there has been a more favourable development since the late eighties. The results imply a modest gain in non-price competitiveness.

Our results show that there are important differences across commodities in both long-run elasticities and dynamics, which provide strong support for employing a disaggregated rather than an aggregate approach. Thus, even if we primarily are 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 analysis.

APPENDIX 1.

Definitions of empirical and theoretical 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 differs, 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 accounts data. All variables are measured in Norwegian kroner.

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