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Abstract:
The Norwegian export price for an aggregated commodity is modelled assuming price-setting behaviour. The focus is on the choice between backward- and forward looking models. The dynamics is modelled according to three different approaches; a backward looking error correction model and two forward looking models where rational expectations are assumed. The first forward looking model is derived from a multiperiod quadratic loss function imposing backward-forward restrictions on the parameters. The results from this specification are not encouraging. We then allow data to choose the lead structure, resulting in a less restrictive forward looking model. The backward- and forward looking models are compared to an estimated cointegrating vector for the long-run solution. An encompassing test on the backward- and forward looking model indicates that further research should look for a model that encompasses both of them.

Keywords: Export prices, Imperfect competition, Multiperiod loss function, Rational expectations, Error correction models

JEL classification: C22, D84, F12

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"The only real test, however, is whether theories involving rationality explain observed phenomena any better than alternative theories (p. 330)." Muth, J. F. (1961): Rational Expectations and the Theory of Price Movements, Econometrica 29, 313-335.

1. Introduction[1]

In this paper we present empirical results from three different approaches for modelling Norwegian export prices. The focus is on the choice between backward- and forward looking models. A long-run equilibrium path for export prices is derived assuming Norwegian producers to be price setters. The dynamics are modelled following three different strategies, one which include only current and lagged values of the variables and two which includes leaded variables. The first of them represent the backward looking alternative in the present context while the two others are forward looking models.

Theoretical and empirical studies of export markets have traditionally focused on the choice between "price taker" behaviour and "price setter" behaviour. The prices on a single country's export products will equal the prices set on the world market if we assume perfect competition and homogeneous products in atomistic markets. The firms act as price takers and export volumes will consequently be modelled by supply equations. Against this stands the framework of imperfect competition with differentiated products. Producers will, according to this approach, face a downward sloping demand curve on export markets and they may act as price setters. Consumers are able to distinguish between products delivered by say Norwegian producers and those delivered by others. Several arguments can justify the assumption of differentiated products in trade between countries. There may be country specific differences in quality and/or degree of processing. In empirical economics, we are mainly working with aggregates of products. The composition of these aggregates may differ across countries in such a way that these aggregated commodities can be treated as differentiated products. One may argue for price setting behaviour even when homogenous products are traded on international markets, if the domestic producers have a certain market power through their share of the world market for the actual product. This may be the case even for Norwegian producers of semi-manufactured goods.

The backward looking error correction model (ECM), models the dynamics around the long-run equilibrium path in terms of lagged values of the endogenous variable and current and lagged values of explanatory variables. Neither do we make any specific assumptions concerning expectations. No a priori cross restrictions on the lag structure are imposed but the one that fits the data best is chosen.

Our forward looking models have the structure of the long-run equilibrium path in common with the backward looking ECM. Their dynamic part is however represented by expected changes in future costs and competing prices unlike the backward looking ECM in which expectations are not explicitly modeled. The first forward looking model is derived from the minimization of a multiperiod quadratic loss function and the assumption of rational expectations. The movements around the optimal path depend on the loss of being away from it and the loss associated with changing the price. The solution of the minimization problem imposes a set of cross restrictions on both long and short-run parameters known as the backward-forward restrictions. The model is first estimated without imposing the cross restrictions and the restrictions are successively tested on these freely estimated parameters. The model is then estimated subject to the restrictions. The results are not encouraging. The next step is then to allow for a less restrictive structure on an empirical rational expectations model, in that the data are allowed to choose the lead structure. This is our third model.

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[1] A shortened version of this paper was presented at the Nordic workshop «Topics in Empirical Macroeconomics», Ebeltoft 1995, and is to be presented at the Econometric Society 7th World Congress, Tokyo 1995.

Cuthbertson (1986, 1990) finds support for the forward looking model, estimated subject to the backward-forward restrictions, in modelling U.K. export prices. The forward looking models perform well compared with their backward looking error correction counterparts. He finds that both ways of modelling the dynamics result in stable parameters. But he also concludes that no major regime changes have taken place over the sample period, according to the parameter stability observed in the estimated processes behind the explanatory variables. Price (1992) finds that "data for UK manufacturing output prices are consistent with the view that prices are set by rational, forward looking agents". He tests the forward looking model against a backward looking error correction model. Price (1992) argues that the backward looking ECM is a reduced form of the structural forward looking model and the VAR process generating the expectational process. The approach of multiperiod quadratic loss functions and rational expectations have been widely applied in various applied economic models as demand for money (Cuthbertson (1988), Muscatelli (1989), Cuthbertson and Taylor (1992)), demand for labour (Sargent (1978), Nickell (1984), Burgess (1992), Price (1994)) and firms' inventory behaviour (Callen et. al (1990)).

The paper is organized as follows. Our price setting model is presented in section 2, while the dynamic models are derived in section 3. We take a closer look at the data in section 4. This section also includes results from the estimation of a cointegrating vector among the three variables; the export price, unit costs and the competing price. In section 5-7 we present the results from estimating the dynamic models, while conclusions are drawn in the final section. We are left with two competing models for Norwegian export prices, one including leads (without imposing backward-forward restrictions) and another including lags of the explanatory variables. None of them outclasses the other one and further investigations are needed in the search for a model that encompasses them both.

2. Price-setting under imperfect competition

The theoretical framework in this paper is that of imperfect competition, as we assume Norwegian firms act as price setters in domestic as well as in foreign markets. We also assume the possibility for price discrimination. The price setting model which we present in this section will serve as the long-run solution in both the backward and forward looking models to be presented in the following sections.

Let A denote the demand for the produced good in foreign markets and H denote the demand in domestic markets while X=A+H is the total produced quantity. PA is the export price and PK the price on competing goods in foreign markets. We assume imperfect competition due to differentiated products, and we let the demand for the good in foreign markets be a function of the price ratio, PA/PK and the level of total demand in the actual market, Y^A; $A=f(PA/PK, Y^A)$.

The standard assumption of profit maximisation lead to the well-known result that marginal revenue equals marginal costs in all markets. This condition implicitly defines the export price, PA, as a function of the price on competing products, the level of total demand in both markets, the price on variable production factors, the produced quantity, and the stock of capital. The exported quantity, A, follows from the demand function.

Assumptions on the form of the demand and production functions may give us a simplified price function. The first simplifying step is to assume constant return to scale for variable factors which implies equality between variable costs per unit (PV) and marginal costs. The optimal price, PA, can thus be expressed as a function of costs per unit and a mark-up depending on the structure of demand.

$$(1) \qquad PA = m(PK, PA, Y^A) \cdot PV \text{ where } m(PK, PA, Y^A) = \frac{\varepsilon_A}{1 + \varepsilon_A} \text{ and } \varepsilon_A = \frac{\partial f(\cdot)}{\partial PA}\frac{PA}{A}$$

A further simplification can be made if we assume the demand function to be derived from a CES (Constant Elasticity of Substitution) utility function. If the consumers' choice between the good delivered from Norwegian or foreign producers can be described according to a CES-function, the decision will depend solely on the price ratio between the two of them. The mark-up takes then the following form:

$$(2) \qquad m(PK, PA, Y^A) = m_0\left(\frac{PK}{PA}\right)^{m_1}, \quad m_0 = g(\sigma, \rho) \geq 0 \text{ and } m_1 = \sigma - 1 > 0$$

σ is the elasticity of substitution between the product delivered from Norwegian producers and the product delivered from foreign producers while ρ is a distribution parameter. We combine (1) and (2), make the relation linear in the parameters through a logarithmic transformation and arrive at a simplified equation describing the price set by Norwegian producers as a function of the price on competing products and variable unit costs. We denote the export price derived from this equation by lpa*, to indicate that the equation defines the long-run equilibrium path.

$$(3) \qquad lpa^* = \beta_0 + \beta_1 lpv + \beta_2 lpk, \quad \beta_1 + \beta_2 = 1, \quad \beta_1 \geq 0, \quad \beta_2 \geq 0$$

where lpa=log(PA), lpk=log(PK) and lpv=log(PV). $\beta_1=1/(1+m_1)$ and $\beta_2=m_1/(1+m_1)$.

We note that the elasticity of export prices with respect to unit costs is given by β_1 and the elasticity with respect to competing prices by β_2. It follows from our assumptions that the price PA should be homogenous of degree one (static homogeneity) in competing prices (PK) and unit costs (PV) which is implied by the restriction on the sum of β_1 and β_2.

If the elasticity of substitution (σ) approaches one, it follows that a 1% increase in the price ratio, PK/PA, will lead to a 1% change in the ratio between the quantities purchased from the two groups of producers. The price , PA, can then be described solely as a function of unit costs (β_2 approaches zero). If σ approaches ∞, the products are identical (homogenous) and we are back to the theory of competitive markets (β_1 approaches zero). Norwegian producers will have no explicit market power in this situation, and consequently PA will approach PK.

Previous studies on Norwegian export data support the assumption of imperfect competition. Disaggregated export price equations for Norwegian sectors, are estimated in Bowitz and Cappelen (1994), assuming imperfect competition. Unit costs are represented in the long-run solution with a unit elasticity on export prices for five commodities which represent about 50% of Norwegian export exclusive of petroleum and shipping, while a proxy for world market prices gets a unit elasticity for only one of the commodities (refined oil products). The two variables get equal weights in the long-run solution for two of the commodities (consumption goods, and machinery and metals products (excl.ships)). Lindquist (1993) studies Norwegian exports of eight tradeable goods. Two alternative models for Norwegian export are estimated and compared; a supply equation which is consistent with price taking behaviour and a demand equation which is consistent with price setting behaviour. The export demand equation is preferred for most commodities. The only exception is export of metals, for which the supply equation gets support. Naug (1994) estimates a general model which encompasses both an export demand equation and a supply equation, for an aggregate of wood products, industrial chemicals and metals on Norwegian data. Both sets of variables have significant effects in the resulting equation. This is taken as a support for a hypothesis that even most Norwegian export of raw materials is traded in markets characterised by imperfect competition among differentiated products, but that a smaller amount of the export is close substitutes to foreign products.

3. Specification of the dynamics

Equation (3) is often looked upon as a long-run equilibrium path, or a moving target that firms try to catch up with. The short-run movements, or the dynamics, around this target may be modelled in several different ways, out of which two are discussed in this section.

3.1 The forward looking ECM

The forward looking model is derived from a multiperiod quadratic loss function (Q), which imposes quite strict restrictions on the dynamics. In the short run, firms try to catch up with the long-run path (lpa^*_{t+s}) defined in (3), but are faced with costs related to changing the price. The actual price (lpa_{t+s}) is a result of minimizing the multiperiod quadratic loss function, with costs related both to discrepancies from the long-run equilibrium path and to changes in the actual price.

$$(4) \qquad Q = E_{t-1}\left[\sum_{s=0}^{\infty}\delta^s\left(\mu\left(lpa_{t+s} - lpa^*_{t+s}\right)^2 + \left(lpa_{t+s} - lpa_{t+s-1}\right)^2\right) \mid \Omega_{t-1}\right]$$

E_{t-1} is the expectations operator. We assume rational expectations, so that agents' beliefs concerning future prices and costs can be expressed as the mathematical expectation of the actual variable, conditional upon information available at time t-1, Ω_{t-1} .The information set may include lagged observations of lpa, knowledge about processes generating variables of importance for the choice of lpa, i.e. costs of production and competing prices. δ is the discount factor, defined over the range $\langle 0,1 \rangle$. A discount factor close to zero, implies that most weight is placed upon the near future, while a high rate implies that the more distant future also is taken into account. The parameter[2], μ, is the weight given to the discrepancy from the long-run path relative to the weight attached to changes in actual price. The solution to the optimization problem, derived by use of the forward convolution method (Sargent (1987)), is

$$(5) \qquad lpa_t = \lambda\, lpa_{t-1} + (1-\lambda)(1-\lambda\delta)\sum_{s=0}^{\infty}(\lambda\delta)^s E_{t-1}\left(lpa^*_{t+s} \mid \Omega_{t-1}\right)$$

λ is the stable root in the difference equation calculated from the first order condition to the above minimization problem[3].

We replace lpa^* by our assumed relation for the long-run equilibrium path (equation (3)).

$$(6) \qquad E_{t-1}\left(lpa^*_{t+s} \mid \Omega_{t-1}\right) = \beta_0 + \beta_1 E_{t-1}\left(lpv_{t+s} \mid \Omega_{t-1}\right) + \beta_2 E_{t-1}\left(lpk_{t+s} \mid \Omega_{t-1}\right)$$

Let $lpv^e_{t+s} = E_{t-1}(lpv_{t+s} \mid \Omega_{t-1})$ and $lpk^e_{t+s} = E_{t-1}(lpk_{t+s} \mid \Omega_{t-1})$.

Combining (5) and (6) gives us

$$(7) \qquad lpa_t = \alpha + \lambda\, lpa_{t-1} + (1-\lambda)(1-\lambda\delta)\sum_{s=0}^{\infty}(\lambda\delta)^s[\beta_1 lpv^e_{t+s} + \beta_2 lpk^e_{t+s}]$$

[2] The weights attached to the two parts of the cost-function are normalized so that the second part's weight equals one.

[3] One may show that $\lambda\mu=(1-\lambda)(1-\delta\lambda)$.

α equals $(1-\lambda)\beta_0$. Static homogeneity implies $\beta_1 + \beta_2 = 1$.

We reparameterise (7) in order to get to an error correction model with forward looking expectations. The model is augmented with dummies[4] for seasonal factors (dk, k=1,2,3) and for structural change in these movements in 1978 (dkvb). The lead length is truncated and we add an error term, w_t, assumed to be white noise. We arrive at the following regression model which we will refer to as the forward looking ECM:

(8)
$$\Delta lpa_t = \alpha + (1-\lambda)\sum_{s=0}^{n}(\lambda\delta)^s\left[\beta_1 \Delta lpv^e_{t+s} + \beta_2 \Delta lpk^e_{t+s}\right] + (\lambda - 1)\left[lpa - \beta_1\, lpv\, \beta_2\, lpk\right]_{t-1} + \sum_{k=1}^{3}(d_k + db_k dkvb_t)dk_t + w_t$$

A similar reparameterisation of a more general multiperiod quadratic loss function is shown in Callen et al. (1990). Their loss function also includes costs related to changes in the speed of adjustment, and their general ECM is augmented with a term that includes Δlpa_{t-1} (a discussion of this function is found in Pesaran (1991)). The cross-restrictions on the parameters imposed both by the minimization problem and the reparameterisation are however quite similar for the forward looking ECM in (8) and the one in Callen et al. (1990). Price (1992, 1994) assume the same loss function as Callen et al. while Cuthbertson (1986,1988,1990), Cuthbertson and Taylor (1992), Muscatelli (1989) assume the less general version in (4).

When the forward looking model is formulated as a forward looking ECM, the restrictions on the parameters may be divided into two different groups (see appendix 1). The theoretical framework leading to the forward looking model, restricts the parameters on the lead variables to decline geometrically with weights that are related to the backward looking parameter (λ). These restrictions on the dynamic structure are known as the backward-forward restrictions. A last set of restrictions arises from the reparameterisation of our original model into a forward looking ECM (Part (ii) in (6), appendix 1). The parameters in front of the lagged regressors equal the parameters in front of their respective current first order difference. These last restrictions are in fact zero-restrictions on the parameters on lagged exogenous variables.

Expectations are formed at the end of period t-1 or beginning of period t. Ω_{t-1} is the amount of information available to the agents when they form their expectations. We assume that firms set prices for period t at the beginning of the period or at the end of the previous, i.e. period t-1. It is then reasonable to treat the variables, lpv_t and lpk_t as unknown to the firms when prices are set and that the expectations are functions of the firms' information up to the end of period t-1. It is, however, not obvious that firms are unaware about wages, lpv_t and competing prices, lpk_t, in period t when they make their decisions on own prices, lpa_t. Our periods stretch out in time, being three months long. During this period, changes may appear in competing prices, say through changes in exchange rates, or in wages, followed by a change in Norwegian firms' export prices, lpa_t, before the end of the quarter. On the other hand, there are costs attached to changing prices and some prices are negotiated in advance. Firms may also have problems in processing the current flow of information, for instance to sort out significant changes from stochastic noise.

3.2 The backward looking ECM

The equation used in the estimation of a backward looking ECM is quite general.

[4] Variable definitions are given in appendix 2.

$$\Delta lpa_t = \gamma_0 + \tau_0 lpa_{t-1} + \tau_1 lpv_{t-1} + \tau_2 lpk_{t-1} + \sum_{r=1}^{R} \gamma_{1r} \Delta lpa_{t-r} + \sum_{l=0}^{L} \gamma_{2l} \Delta lpv_{t-l}$$

(9)

$$+ \sum_{m=0}^{M} \gamma_{3m} \Delta lpk_{t-m} + \sum_{k=1}^{3} (d_k + db_k\, dkvb_t) dk_t + u_t$$

where $-\tau_1/\tau_0 = \beta_1$, $-\tau_2/\tau_0 = \beta_2$ and u_t is assumed to be a white noise error term.

τ_0 is known as the error correction term and should lie between -1 and 0 in order to give reasonable results. The speed of adjustment towards the long-run equilibrium path, when away from it, increases when τ_0 goes from 0 to -1.

With the exception of some differences in the use of symbols, we recognize that the long-run equilibrium path in equation (9) is the same as in the forward looking ECM. Both equations are balanced if the level terms cointegrate and the rest of the variables are I(0). The difference between the two models lies in our assumptions concerning (a) expectations and (b) the cross-restrictions imposed on the parameters in the forward looking model, but also in the estimation strategy.

Starting out with equation (9), we search for a parsimonious representation by successively imposing zero restrictions on insignificant parameters in the dynamic part of the equation. The remaining coefficients have to satisfy fundamental restrictions proposed by economic theory and the estimated regression has to pass different tests for misspecification. This estimation strategy is known as the general-to-specific approach advocated by Davidson et al. (1978). As a contrast, the dynamic part of the forward looking model in equation (8) is based solely on theoretical assumptions. The export price equation is required to satisfy the following restrictions independent of whether the dynamic part is forward- or backward looking: the long-run elasticities are non-negative ($\beta_1, \beta_2 \geq 0$) while τ_0 or (λ-1) are negative, the static homogeneity restriction ($\beta_1+\beta_2=1$) is not rejected and short run dynamics give a positive effect on changes in the export price from increased costs and competing prices.

We do refer to equation (9) as a backward looking ECM. This is, however, somewhat unprecisely as far as no specified assumptions are made concerning expectations. In fact, equation (9) encompasses a number of models based on different sets of assumptions. Equation (9) may be the reduced form of a structural forward looking model with rational expectations and an autoregressive (or vector autoregressive) process generating the expectational terms (see Nickell (1985)). The error correction specification will, if this is the case, be subject to the Lucas critique which states that the reduced form equation will not exhibit invariance if the process generating the expectations changes[5]. The resulting reduced form equation derived from a multiperiod quadratic loss function can also be formulated as a ECM in current and lagged variables if the assumption of rational expectations is replaced by the assumption of extrapolative expectations, for instance adaptive expectations. Analysis on Norwegian microeconomic data on how firms form their expectations, conclude that expectations are formed according to an extrapolative scheme (Svendsen (1993, 1994)). We may also arrive at an equation like equation (9) if the multiperiod quadratic loss function is replaced by a loss function related to one single period. The forward looking part of the equation (i.e. the expectational variables) will in this case disappear.

[5] The Lucas critique is a special case of Haavelmo's discussion of autonomous relations (Haavelmo (1944)).

4. The Data

Estimations are carried out on quarterly seasonal unadjusted data. Variable definitions and data sources are given in appendix 2.

We study the export price of a commodity which is an aggregate of all goods and services produced in the Norwegian economy excluding commodities from oil production, shipping and government services, i.e. private mainland economy. The level of aggregation may create problems in our analysis, because it may cover sectors with different strategic position in their respective markets and with different production structure. If the composition of the aggregate has changed during the estimation period, the differences between the sectors may lead to instability in our estimated parameters.

As a proxy for competing prices (PK), we have chosen a weighted average of import prices, measured in Norwegian currency (NOK), in the main foreign markets for Norwegian producers. Our proxy does not incorporate the prices on competing products delivered by domestic producers in the export markets. Two other proxies were considered; the Norwegian import price index for our aggregated commodity, and a weighted average of export prices (in NOK) in the main foreign markets. The use of these proxies gave unsatisfactory results.

Costs (PV) are represented by variable unit costs (labour costs per unit) inclusive of net sector taxes for the sector we are studying. Because our sector includes most of private production activity for the mainland economy, intermediate deliveries from other sectors are mainly imported. These costs are proxied by the index of competing prices (PK). If the composition of Norwegian imports of intermediate goods differ substantially from the composition of our trading partners import, the full effect of costs related to intermediate deliveries will not be captured by our equation.

4.1 A closer look at the data

Table 1 shows the percentage growth in the three variables PA, PV and PK and in the ratios PA/PV and PA/PK for the whole period and for three subperiods.

Table 1: Percentage increase in prices and costs

Variable	71:1-78:4	78:4-85:4	85:4-91:4	71:1-91:4
PA......................................	75	50	31	245
PV......................................	85	59	33	291
PK......................................	87	82	7	267
PA/PV	-5	-6	-1	-12
PA/PK	-7	-17	22	-7

We first note that Norwegian export prices (PA) have increased less than both unit costs (PV) and competing prices (PK). The ratio between export prices and costs (PA/PV) has decreased more than the ratio between export prices and competing prices (PA/PK). The movements in the ratios throughout the period give a more complex picture. This is also displayed in figure 1, showing PA, PV and PK together, and in figure 2 and 3 which show the two ratios. Both the table and the figures show that Norwegian export prices follow the movements in competing prices and costs, quite close in the first subperiod. From figure 1, we observe that Norwegian export prices took part in the international price increase that succeeded OPEC I. Exports of energy intensive goods make up a substantial part of our aggregate. Norwegian producers were less affected by increased petroleum prices due to cheap hydroelectric power in Norway. However they were affected as a large part of their intermediates is imported goods. The most dramatic change in the ratio between Norwegian export prices and competing prices, takes place in the 1980s. While Norwegian export prices decreased 17 percent relative to competing prices from 78:4 to 85:4, the same prices increase with 22 percent relative to competing prices in the following period. The differing paths through the 1980s may be due to both a different economic situation in Norway than in our foreign markets, and to the two price indices, PA and PK, representing different aggregates of goods and services.

Figure 1: Norwegian export price (PA), competing price in foreign markets (PK) and variable unit costs (PU). 1971:1 to 1991:4.

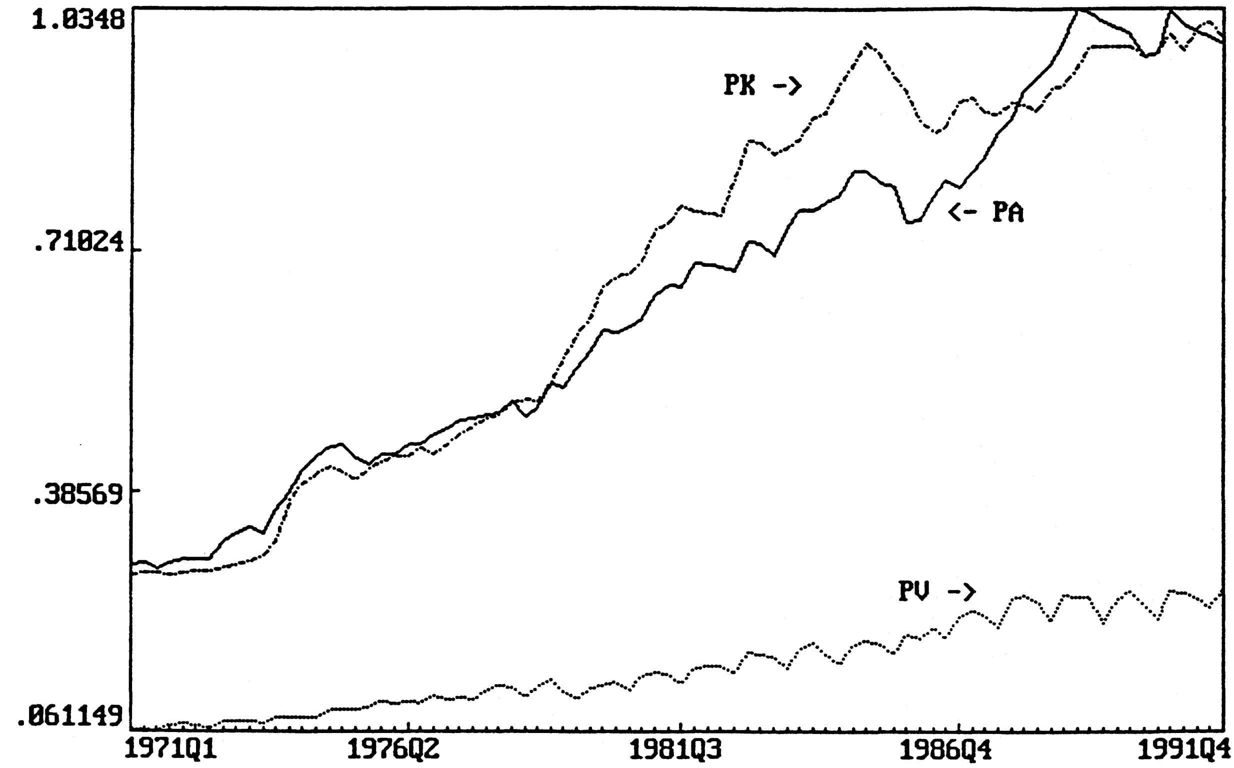


Figure 2: The ratio of export prices on variable unit costs (PA/PV). 1971:1-1991:4.

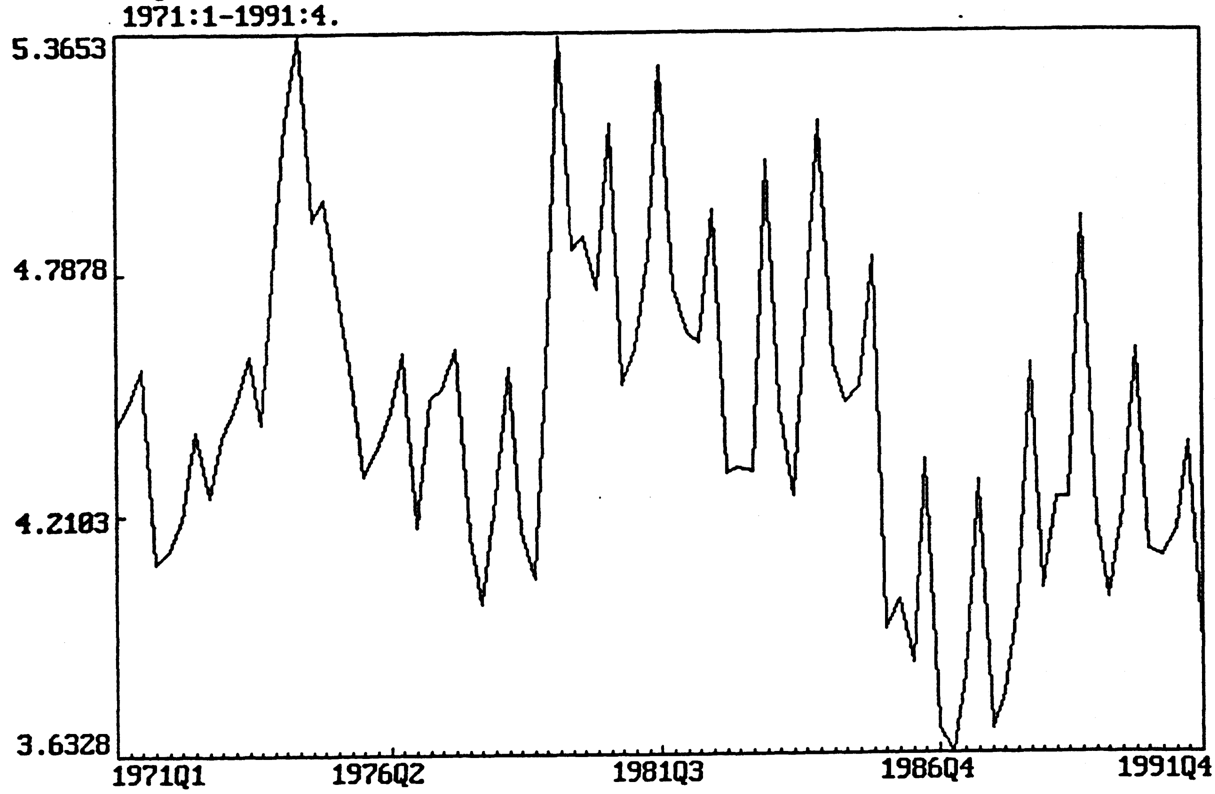
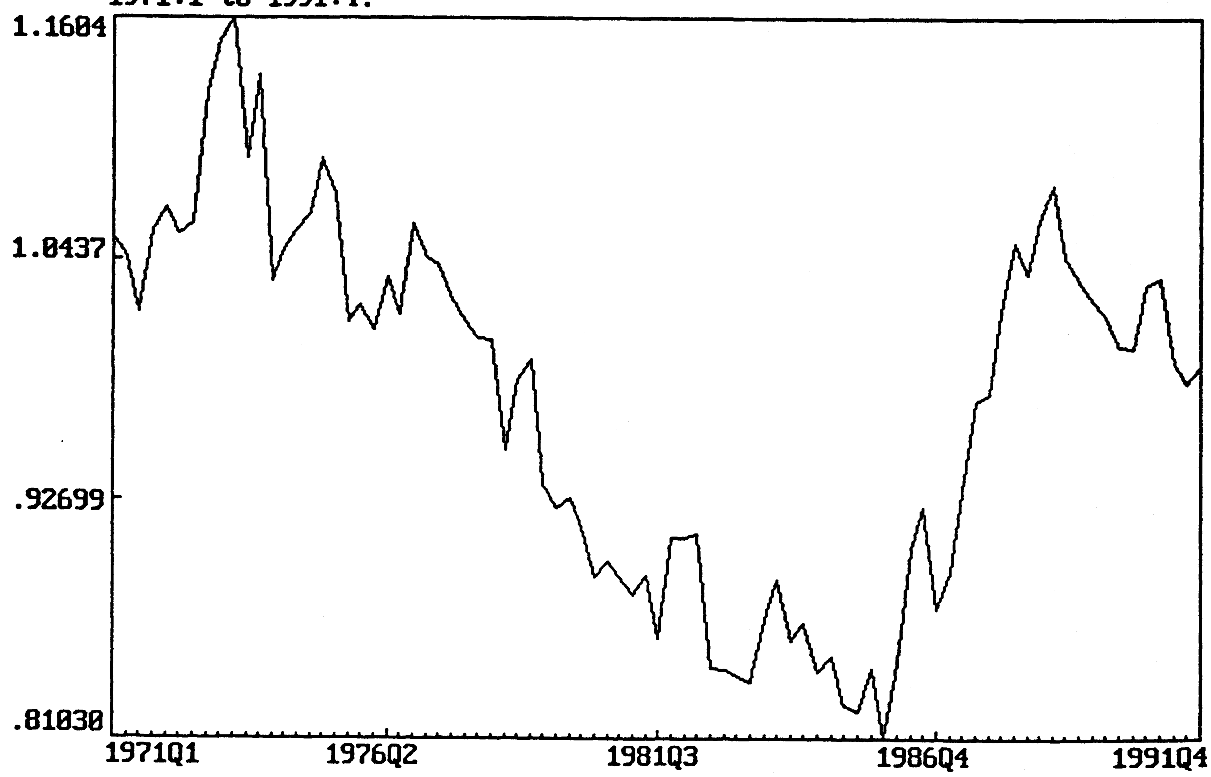


Figure 3: The ratio of export price on competing price (PA/PK). 1971:1 to 1991:4.



4.2 Time series properties and cointegrating vectors

An important requirement to be met by our two models (equations (8) and (9)) in order to get valid inference, is that the equations are balanced. This requirement is met if the equation is made up of stationary variables, i.e. I(0)-variables, and/or cointegrating vectors of non-stationary variables. The time series properties of the variables included in our models are tested by use of Dickey-Fueller and Augmented Dickey-Fueller tests. The results are reported in table 2 and we cannot reject the hypothesis that the variables lpa, lpv, lpk are I(1)-variables and consequently neither reject the hypothesis that Δlpa, Δlpv and Δlpk are I(0).

Table 2: Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests for Unit roots. Sample 1971:1 - 1991:4

Variable	Test	"T-value"[6]	Variable	Test	"T-value"[6]
lpa	DF	-1.99	Δlpa	DF	-7.78
lpv	ADF(7)	-1.78	Δlpv	ADF(6)	-3.82
lpk	ADF(1)	-1.91	Δlpk	DF-T	-6.07

We have used tests[7] developed by Johansen (1988) to test the number of cointegrating relations among the I(1)-variables included in the vector (lpa,lpv,lpk). The results when a VAR-model of order 5 is chosen, reported in table 3, lead us to conclude that there is one cointegrating vector (r=1). The model is augmented with centered seasonal dummies. Critical values are calculated according to Osterwald-Lenum (1992).

Table 3: Johansen maximum likelihood procedure. Cointegration LR test.
N=83 (71:2 to 91:4). VAR (5)-model for lpa, lpv, lpk. Additional I(0) variables included in the VAR: centered seasonal dummies. Eigenvalues: .277, .091, .034

Max eigenvalue test				Eigenvalue trace test			
H_0	H_1	Statistic	95% Critical Value	H_0	H_1	Statistic	95% Critical Value
$r = 0$	$r = 1$	26.94	21.07	$r = 0$	$r > 1$	37.67	31.53
$r \leq 1$	$r = 2$	7.88	14.90	$r \leq 1$	$r > 2$	10.73	17.95
$r \leq 2$	$r = 3$	2.85	8.18	$r \leq 2$	$r > 3$	2.85	8.18

The cointegrating vector corresponding to the highest eigenvalue is calculated by use of the Johansen maximum likelihood procedure. The results is shown in table 4. The hypothesis of homogeneity of degree one in costs and competing prices on the parameters in column (a) is tested by use of a LR-Test and is not rejected, with a significance probability of 0.173. The coefficients corresponding to this restriction are reported in column (b) in table 4.

The VAR model has been estimated with different number of lags. The results indicate cointegrating vectors with relatively stable parameter estimates independent of the order of the VAR. The results indicate that unit costs have a greater impact on export prices than have competing prices and are consequently not in favour of an assumption of price-taking behaviour.

[6] The 95 per cent critical values are -2.90 for the ADF- or DF-test without a time trend, and -3.46 for the ADF- or DF-test (ADF-T and DF-T) with a time trend. The critical values are given in MacKinnon (1990).

[7] All estimations and statistical tests have been carried out by use of the econometric package MICROFIT 3.21 (Pesaran and Pesaran (1991)).

Table 4: Estimated cointegrated vector using the Johansen procedure, normalized on export prices (lpa)

Variable	(a)	(b)
lpv	.76**	.86[1)]
lpk	.20*	.14[1)]

* (**): significant at a 5% (1%) significance level.
[1)] Estimated subject to the restriction of static homogeneity. Significance probabilities are not available in Microfit 3.21 when the vector is estimated subject to a restriction.

5. An error correction model with backward looking expectations

The starting point for the estimations is equation (9), presented in section 3.2. The long-run equilibrium part of the equation and the short-run dynamics are estimated simultaneously. Lagged endogenous variables (one to four lags) have been included in preliminary estimations, but were far from being significant, and these results are not reported.

Equation (9) is a conditional econometric model, where we condition on the current variables Δlpv_t and Δlpk_t . The estimated cointegrating vector in section 4.2 were derived from the estimation of a VAR-model with the three variables, lpa, lpv and lpk, being treated as endogenous. The single-equation approach behind the estimation of a conditional econometric model, leads to valid inference only if we cannot reject the hypothesis that the conditioning variables are weakly exogenous for the parameters of interest (Engle et al. (1983)). If weak exogeneity is rejected for some of the variables on the right hand side of equation (9), useful information is lost when we condition on these variables. The coefficients may not be independent of changes in the process generating these variables.

We apply an orthogonality test, the Wu-Hausman test (Wu (1973)), to check for weak exogeneity of Δlpv_t and Δlpk_t in equation (9). This is a test for independence between the residual in equation (9) and the conditioning variables. Reduced form equations are estimated for Δlpv_t and Δlpk_t. Next, we test the significance of the residuals from these two equations in our preferred equation for Δlpa_t (equation (d) in table 5) estimated by use of ordinary least squares (OLS). The observed F-statistics of the variable addition test, which equals the Wu-Hausman statistics, is 0.06 and follows a F(2,72)-distribution. So, we cannot reject that both Δlpv_t and Δlpk_t are weakly exogenous for the parameters of interest. Urbain (1992) proposes the use of another sort of exogeneity tests, in which one tests for weak exogeneity of the conditioning variables for the cointegrating vectors. Δlpv_t and Δlpk_t can be treated as weakly exogenous in this sense if their marginal processes do not display error correcting behaviour. We have not been able to establish reasonable error correction models which include the cointegrating vector for the two conditioning variables. The long-run parameters were either insignificant or had the wrong sign. We interpret these results as evidence for Δlpv_t and Δlpk_t being weakly exogenous for the long-run parameters. The OLS estimates of the long-run parameters will equal the estimates derived by Johansen's maximum likelihood method if weak exogeneity is imposed in the latter, and the same order of the VAR is assumed. The OLS estimates are however more efficient. Both short- and long-run coefficients in equation (9) are consequently estimated by use of OLS[8].

The results from estimations of equation (9) are presented in table 5. Equation (d) is our preferred backward looking ECM and is estimated subject to the restriction of static homogeneity ($\beta_1 + \beta_2 = 1$). The unrestricted version is reported in column (c). The homogeneity restriction is not rejected by the data according to a Wald test with a significance probability of 0.095. We thus focus on the restricted version in (d).

The equation passes all diagnostic tests for functional form misspecification. $\chi^2_{RESET}(1)$ is the RESET-test (Ramsey (1969)). $\chi^2_N(2)$ is the Jarque-Bera's test statistic of the normality of regression residuals (Jarque and Bera (1980)). $\chi^2_{SC}(4)$ is Godfrey's test of residual serial correlation (Breusch and Godfrey

[8] One may, on theoretical grounds, suspect Δlpv_t and Δlpa_t to be determined simultaneously in a more general system of equations and that Δlpv_t is not weakly exogenous for our parameters of interest. In addition we know that the Wu-Hausman statistic is sensitive for the choice of regression used to model the conditioning variables. We have, for these reasons, also estimated the equation by use of 2SLS (two-stage least squares) with instruments for Δlpv_t. The results were very close to the ones obtained by the OLS-method.

(1981), App.B). $\chi^2_{HET}(4)$ is the test of heteroscedasticity based on the regression of squared fitted values on squared residuals (Koenker (1981)). $\chi^2_{CHOW}(3)$ is the test of adequacy of predictions, known as Chow's second test (Chow (1960)).

Table 5: Backward looking ECMs for Δlpa. N=83 (71:2-91:4). OLS. Standard errors in parentheses

Regressor	(a)		(b)		(c)		(d)	
	Coeff.	(S.E.)	Coeff.	(S.E.)	Coeff.	(S.E.)	Coeff.	(S.E.)
Constant	.31**	(.08)	.25**	(.08)	.16**	(.05)	.14**	(.05)
lpa_{t-1}	-.29**	(.08)	-.19**	(.06)	-.16**	(.06)	-.11*	(.05)
lpv_{t-1}	.21**	(.05)	.17**	(.05)[1)]	.11**	(.04)	.10**	(.04)[1)]
lpk_{t-1}	.06*	(.03)	.02	(.03)[1)]	.04	(.03)	.01	(.03)[1)]
Δlpv_t	.28**	(.09)	.31**	(.09)	.21**	(.05)	.22**	(.05)
Δlpv_{t-1}	-.21*	(.09)	-.16	(.09)				
Δlpv_{t-2}	-.27**	(.09)	-.20**	(.08)	-.07	(.04)	-.07	(.04)
Δlpv_{t-3}	.06	(.09)	.14	(.08)	.14**	(.05)	.15**	(.05)
Δlpv_{t-4}	.08	(.08)	.13	(.08)				
Δlpk_t	.37**	(.10)	.38**	(.10)	.37**	(.09)	.38**	(.10)
Δlpk_{t-1}	.27**	(.10)	.29**	(.11)	.25*	(.10)	.26*	(.10)
Δlpk_{t-2}	.19	(.11)	.18	(.11)				
Δlpk_{t-3}	.00	(.11)	-.02	(.11)				
Δlpk_{t-4}	.19	(.11)	.18	(.11)				
d1	-.01	(.01)	-.002	(.02)				
d2	.05**	(.01)	.05**	(.01)	.02*	(.01)	.02*	(.01)
d3	.02	(.02)	.02	(.02)				
dkvb*d1	.02	(.01)	.02	(.01)				
dkvb*d2	-.02	(.01)	-.02	(.01)				
dkvb*d3	-.04**	(.01)	-.04**	(.01)	-.03**	(.01)	-.03**	(.01)
$\hat{\beta}_1$	.73**	(.08)	.89**	(.12)[1)]	.68**	(.15)	.88**	(.21)[1)]
$\hat{\beta}_2$	.21**	(.08)	.11[1)]		.24	(.14)	.12[1)]	
R^2		.625		.594		.518		.500
SER		.0202		.0208		.0213		.0215
DW		1.85		1.91		1.99		2.02
$\chi^2_{SC}(4)$[2)]		2.29		1.54		.88		.83
$\chi^2_{RESET}(1)$		.01		.26		.02		.01
$\chi^2_N(2)$		6.08*		2.91		1.46		1.26
$\chi^2_{HET}(1)$		.55		.36		.32		.22
$\chi^2_{CHOW}(3)$		2.56		2.70		2.61		3.06

* (**): Significant at a 5% (1%) level.

1) Estimated subject to the restriction of static homogeneity.

2) Critical values: $\chi^2_{0.05}(1)=3.84$, $\chi^2_{0.05}(2)=5.99$, $\chi^2_{0.05}(3)=7.81$, $\chi^2_{0.05}(4)=9.49$.

The equation has reasonable stable parameters according to recursive estimations. The long-run effects of unit costs and competing prices, β_1 and β_2, are reasonable and nearly identical to the cointegrating vector estimated by Johansen's maximum likelihood procedure subject to the restriction of static homogeneity. The most striking effect of imposing the restriction of static homogeneity, is the increased weight on unit costs in the long-run solution. The elasticity of unit costs (β_1) increases from 0.68 to 0.88, while the elasticity of competing prices (β_2) decreases from 0.24 to 0.12. The latter is insignificant. We cannot reject the hypothesis of dynamic homogeneity[9] (at a significance probability of 0.749).

We have included one insignificant lag on unit costs (Δlpv_{t-2}) in the dynamics. The t-value of this parameter is -1.63. If Δlpv_{t-2} is excluded, one of the remaining seasonal dummies, d2, becomes insignificant. The estimated equation resulting from the exclusion of both Δlpv_{t-2} and d2 (not reported) performs worse than the one reported in column (d) according to standard errors from recursive estimations. The static homogeneity restriction is rejected at a 5% level (but not at a 1% level) and the dynamic homogeneity restriction is rejected as well.

The table also includes the results from the estimation of the general unrestricted backward looking specification before zero restrictions are imposed on the short-run coefficients (a). The equation passes all diagnostic tests with the exclusion of the test for normality. We note that the estimated long-run elasticities in equation (a) are quite close to the unrestricted cointegrating vector. The restriction of static homogeneity is rejected at a 5% level of significance (the significance probability is 0.023). The general backward looking specification estimated subject to the static homogeneity restriction is reported as equation (b).

The speed of adjustment towards the long-run equilibrium path is given by the error correction term, τ_0. τ_0 falls from 0.29 in (a) to 0.11 in (d). The reduced speed of adjustment is both due to the imposed zero restrictions on the short-run coefficients and to the restriction of static homogeneity.

[9] Dynamic homogeneity is defined as $\sum_{l=0}^{l=4}\gamma_{2l} + \sum_{m=0}^{m=4}\gamma_{3m} = 1$. The long-run equilibrium solution will thus be unaffected by the steady states growth rate.

6. The forward looking model

We start out this section with recalling some estimation problems that arise when we introduce rational expectations into regression models. The problems should be well known from the literature (see for example the surveys by Pesaran (1987) and Cuthbertson, Hall and Taylor (1992) or Nelson (1975), McCallum (1976a, 1976b), Wickens (1982) and Pagan (1984) for early contributions).

The expectations variables, Δlpv^e_{t+s} and Δlpk^e_{t+s}, in equation (8) are unobservable but assumed to be formed according to the hypothesis of rational expectations. Alternatively, one may assume an extrapolative expectation mechanism as the adaptive expectation model and/or include learning rules. Another way of dealing with unobservable expectations variables is the use of proxies calculated on basis of survey data. The advantage of such a strategy is that no assumptions have to be made on behalf of how the expectations are formed. However, the use of survey data often implies practical problems partly because such data often are categorical. This is the case for data available on Norwegian firms' expectations (see Svendsen (1993, 1994)).

Different properties can be deduced from the hypothesis of rational expectations. One of them, the unbiasedness property (equation (10)), has proved to be quite useful in order to derive proxies for the unobserved expectations terms when rational expectations are assumed.

$$(10)\qquad \begin{aligned} \Delta lpv_{t+s} &= \Delta lpv^e_{t+s} + \omega_{1,t+s} \\ \Delta lpk_{t+s} &= \Delta lpk^e_{t+s} + \omega_{2,t+s} \end{aligned}$$

$\omega_{1,t+s}$ and $\omega_{2,t+s}$ are prediction errors with assumed white noise properties under the hypothesis of rational expectations. The realized values, Δlpv_{t+s} and Δlpk_{t+s}, appear as obvious candidates as proxies for the unobserved expectations variables in equation (8), Δlpv^e_{t+s} and Δlpk^e_{t+s}.

We insert (10) in (8) and obtain the following equation:

$$(11)\qquad \begin{aligned} \Delta lpa_t &= \alpha + (1-\lambda)\sum_{s=0}^{n}(\lambda\delta)^s[\beta_1\Delta lpv_{t+s} + \beta_2\Delta lpk_{t+s}] \\ &\quad + (\lambda - 1)[lpa - \beta_1 lpv - \beta_2 lpk]_{t-1} + \sum_{k=1}^{3}(d_k + db_k dkvb_t)dk_t + e_t \\ e_t &= w_t - (1-\lambda)\sum_{s=0}^{n}(\lambda\delta)^s[\beta_1\omega_{1,t+s} + \beta_2\omega_{2,t+s}] \end{aligned}$$

An inspection of the residual structure in (11) reveals that the regressors Δlpv_{t+s} and Δlpk_{t+s} will be correlated with the residual, e_t, through the prediction errors, and are consequently not exogenous. The estimators for the short-run parameters in the regression model will thus be inconsistent. The choice of an errors-in-variable-method is therefore natural. Here the linear and non-linear two-stage least squares (2SLS and NL-2SLS) estimation techniques are applied. Instruments for Δlpv_{t+s} and Δlpk_{t+s} are to be found as part of the agents' information set Ω_{t-1}. The estimators are consistent even if not the entire information set is applied, but only a subset of it[10]. The chosen additional instruments are lagged values of Δlpv and Δlpk, the unemployment rate, consumer price index, the average tax rate for households, the exchange rate for NOK and a dummy (d74q1) for a one period shock in the

[10] A bias is introduced if the chosen instruments not form part of the agents' information set. So, our results concerning the joint hypothesis of imperfect competition, multiperiod quadratic loss function and rational expectations, depend upon our instruments.

rate of change in import prices caused by OPEC [11]. The other regressors in (11) serve as instruments for themselves. Variables to be included in the instrument matrix are taken from a larger set of variables. When selecting the instruments, we have to take under consideration that the matrix will serve as instruments for seven endogenous regressors, that an eventual multicollinearity may arise between potential instruments and finally, that restrictions on the number of variables to be included often are set by the applied software.

Looking at the error term, e_t, we note that serial correlation in the residual is likely to occur in the estimated relation. This is due to the theoretical assumptions made in deriving (11). If we find that autocorrelation is present in the estimated regression, the standard formulas for standard errors of the estimated parameters will be incorrect. Consistent standard errors may however be derived by calculating the Newey and West (1987) heteroscedasticity and autocorrelation consistent variance-covariance matrix.

An alternative estimation method to the 2SLS (see for instance Cuthbertson (1986, 1988), Muscatelli (1989)), is the so-called two-step least squares or "the substitution method". Forecasting equations (often AR-models) are estimated and proxies for the expectational terms are obtained from the predictions of these equations. A main problem related to this procedure is the possibility for correlation between predetermined variables in the final regression, which are not included in the forecasting model, and the residuals (Nelson (1975)). Another point of criticism, is that one implicitly assumes the parameters in the forecasting equations are stable and known by the agents at the beginning of the sample period. The first problem is met by the errors-in-variable-method. Part of the second point is also met, in that we do not assume particular expectations generating equations with fixed parameters when 2SLS is applied. One may also avoid the first problem in a joint estimation of equation (8) and the forecasting equations (Cuthbertson (1990)). A solution to the second point of criticism is the use of a "rolling VAR" regression as forecasting equation or applying other learning mechanisms (Cuthbertson et al. (1992) and Cuthbertson and Taylor (1992)).

Equation (11) is first estimated without imposing the cross-restrictions on the parameters in order to test whether these restrictions are valid. The number of leads was initially set to four for both variables. The whole set of backward-forward restrictions (part (i) and (ii) in (6), appendix 1) was rejected by the data. We then reduced the number of leads, and ended up by setting the number of leads equal to two for unit costs and equal to three for competing prices. The results from the estimation of the unconstrained version of equation (11), subject to these limitations on the lead structures, are reported in table 6.

The results from four regressions are reported. The two first ones ((a) and (b)) are estimated without imposing the restriction of static homogeneity. (b) differ from (a) in that insignificant seasonal dummies are excluded. The static homogeneity restriction is tested by use of a Wald-test on the estimated parameters in (a) and (b) and is rejected in neither of them (the significance levels are 0.425 (a) and 0.367 (b)). The dynamic homogeneity restriction is rejected in neither of the equations (the significance level varies from 0.419 to 0.924). The results when the regression is estimated with static homogeneity imposed a priori, are reported in the two last columns, named (c) (without zero restrictions on seasonal dummies) and (d) (insignificant dummies excluded). We note that the standard error of regression (SER) decreases when the dummies are excluded, but increases when the homogeneity restriction is imposed.

[11] Instruments for Δlpv_{t+s} and Δlpk_{t+s} : lpk_{t-1} Δlpk_{t-1} Δlpk_{t-3} Δlpk_{t-4} Δlpk_{t-6} lpv_{t-4} Δlpv_{t-1} Δlpv_{t-4} U_{t-1} ΔU_{t-1} ΔU_{t-4} $lkpi_{t-1}$ $lkpi_{t-3}$ $\Delta lkpi_{t-1}$ $\Delta lkpi_{t-4}$ ltr_{t-1} ltr_{t-2} Δltr_{t-4} lv_{t-1} Δlv_{t-4} Δlv_{t-5} Δlv_{t-6} Δlv_{t-7} Δlv_{t-8} d74q1. The seasonal dummies, d1, d2, d3, and dkvb are used as instruments when excluded from the structural equation.

The two long-run elasticities ($\hat{\beta}_1$ and $\hat{\beta}_2$) differ (with one exception) significantly from zero and all four regressions pass the diagnostic tests. All reported statistics are based on the IV-residuals. In addition to the tests already considered, we report the observed value for $\chi^2_{SM}(p)$, which is Sargan's statistic for a general test of misspesification of the model and the validity of the instruments (Sargan (1964)). The null hypothesis is formulated as the regression is correctly specified and the instrumental variables are valid instruments. The Chow-test is not applicable when 2SLS is applied due to endogenous regressors.

Table 6: Forward looking models for export prices without backward-forward restrictions imposed. Dependent variable: Δlpa_t. 2SLS. N=83 (71:2-91:4)

Regressor	(a)		(b)		(c)		(d)	
	Coeff.	(s.e.)	Coeff.	(s.e.)	Coeff.	(s.e.)	Coeff.	(s.e.)
Constant	.13*	(.06)	.13*	(.06)	.13*	(.06)	.12*	(.06)
lpa_{t-1}	-.17*	(.07)	-.17**	(.06)	-.14*	(.06)	-.14*	(.06)
lpv_{t-1}	.09*	(.05)	.09*	(.04)	.09*	(.05)[1]	.09*	(.04)[1]
lpk_{t-1}	.07	(.04)	.07	(.03)	.05	(.03)[1]	.06	(.03)[1]
Δlpv_t	.22	(.14)	.12*	(.06)	.22	(.14)	.12*	(.06)
Δlpv_{t+1}	.05	(.22)	.05	(.04)	.12	(.20)	.05	(.05)
Δlpv_{t+2}	-.07	(.22)	-.00	(.05)	.01	(.19)	.00	(.05)
Δlpk_t	.43*	(.17)	.43**	(.15)	.43*	(.17)	.44**	(.15)
Δlpk_{t+1}	.19	(.21)	.19	(.18)	.20	(.21)	.20	(.18)
Δlpk_{t+2}	.24	(.25)	.19	(.22)	.20	(.25)	.20	(.22)
Δlpk_{t+3}	-.02	(.27)	.05	(.23)	.08	(.24)	.12	(.22)
d1	-.01	(.03)			.00	(.02)		
d2	.01	(.03)			.01	(.03)		
d3	.01	(.04)			.00	(.03)		
dkvb*d1	.01	(.02)			.00	(.02)		
dkvb*d2	.00	(.02)			-.00	(.02)		
dkvb*d3	-.03	(.02)	-.02*	(.01)	-.02	(.02)	-.02*	(.01)
$\hat{\beta}_1$	.56**	(.18)	.56**	(.15)	.65**	(.19)[1]	.60**	(.17)[1]
$\hat{\beta}_2$	.39*	(.16)	.39**	(.14)	.35 [1]		.40*	[1]
$\hat{\lambda}$	.83**	(.07)	.83**	(.06)	.86**	(.06)	.86**	(.06)
R^2	.43		.41		.42		.38	
SER	.0243		.0238		.0243		.0242	
IV-minimand	.0120		.0126		.0123		.0131	
DW	1.88		1.90		1.90		1.88	
$\chi^2_{SM}(p)$ [2]	2.35(p=17)		22.34(p=22)		2.91(p=18)		22.41(p=23)	
$\chi^2_{SC}(4)$	5.62		3.51		5.53		3.96	
$\chi^2_{RESET-IV}(1)$	.69		.96		.62		.94	
$\chi^2_N(2)$	1.57		3.37		2.34		3.45	
$\chi^2_{HET}(1)$	.07		.04		.01		.01	
$\chi^2_{WALD}(7)$	11.09		13.95		1.72		16.17*	

*(**):significant at 1% (5%) level.

[1] Estimated subject to the homogeneity restriction.

[2] Critical values: $\chi^2_{0.05}(1)=3.84$, $\chi^2_{0.05}(2)=5.99$, $\chi^2_{0.05}(4)=9.49$, $\chi^2_{0.05}(7)=14.07$, $\chi^2_{0.05}(17)=27.59$, $\chi^2_{0.05}(18)=28.87$, $\chi^2_{0.05}(22)=33.92$, $\chi^2_{0.05}(23)=35.17$.

The values of the backward looking parameter, λ, are derived from the coefficient for lpa_{t-1} and lie between 0.85 and 0.87. This indicates that the backward looking part of the decision rule described in (5) is rather influential compared with the forward looking part. The regressions contain many insignificant parameters in the lead structure, possibly due to overparameterisation, but also consistent with the relative high estimates on λ. The only significant terms are the parameters for expected current values of costs and competing prices. However, a rough inspection of the lead structures, shows a picture that may be consistent with geometrically declining weights.

We apply a Wald-test to test for the validity of the cross-restrictions in equation (11) on the estimated parameters in table 6. There is a total of seven restrictions involved and the observed Wald-statistics thus follow a $\chi^2(7)$-distribution. We need an estimate of the discount rate, δ, in order to carry out the test. Five different estimates on δ can be calculated from each equation in table 6. The different estimates are, however, not precisely estimated and several of them lie outside the interval over which δ is defined ($0<\delta<1$), as the estimates lie in the interval $\langle -0.27, 1.88 \rangle$. We have therefore chosen to fix it at the value 0.99 in the test. It is quite usual in the literature to chose a value close to one when working with quarterly data, and the value 0.99 is often used (see for instance Cuthbertson (1988) and Muscatelli (1989)).

The results from testing the backward-forward restrictions are reported as the $\chi^2_{WALD}(7)$-statistics in table 6 which show the restrictions to be valid for equations (a)-(c). The restrictions are, however, rejected at a 5% level of significance in equation (d), the one which is estimated subject to the static homogeneity restriction and valid zero restrictions on some of the seasonal dummies. The restrictions are however not rejected at a 1% level. Wald-tests have also been run to different combinations of the total of seven restrictions. The results (not reported) indicate that the problematic part of the restrictions, is the link between the lagged level and first order difference of respectively unit costs and competing prices. The other restrictions are not rejected.

The results when the four regressions in table 6 are estimated subject to the backward-forward restrictions (equation (11)), are reported in table 7. The number of freely estimated parameters is reduced by seven due to the imposed cross-restrictions. The regression model is non-linear in the remaining parameters λ, δ, β_1 ,β_2 , d_k and db_k (k=1,2,3) and the non-linear 2SLS (NL-2SLS) estimation technique is applied. Initial estimates are set for the unknown parameters. The discount rate, δ, is fixed in order to get the method to converge. Again the value δ=0.99 is chosen. The estimated parameters remain invariant to different choice of the value of δ and also to different sets of initial estimates.

The SER is increased in all equations when the backward-forward restrictions are imposed, but the increase is not disquieting. The Durbin-Watson statistics have fallen, and the observed $\chi^2_{SC}(4)$-statistics have increased and leads to rejection of the null hypothesis of no residual serial correlation in regression (c). The reported standard errors of the parameters in this specific regression are derived from the Newey-West heteroscedasticity and autocorrelation consistent variance-covariance matrix (N-W s.e.). It is important to note that our findings concerning autocorrelation in the regressions reported in table 7, may be a consequence of the assumed theoretical framework and cannot be taken as an indication of misspecification without reservation.

Our results do not give much support to the theoretical framework leading to equation (11), even though the backward-forward restrictions could not be rejected in the first step. The most critical result is the rejection of the static homogeneity restriction when regression (a) and regression (b) are estimated subject to backward-forward restrictions. The reported tests statistics, $\chi^2_{WALD}(1)$, are significant at a 1% level. A consequence of rejecting the homogeneity restriction in (a) and (b), is that (c) and (d) are estimated subject to an invalid restriction. For regression (d) we also bear in mind from table 6, that the backward-forward restrictions were rejected at a 5% level. Three of the equations do not pass the RESET test of functional misspecification.

The estimated values for the two long-run elasticities move even further away from those estimated within the backward looking framework (table 5) and the estimated cointegrating vector (table 4) when the forward looking model is estimated subject to the backward-forward restrictions. The strongest impact is now coming from competing prices and, in fact, $\hat{\beta}_1$ becomes insignificant when valid zero-restrictions on seasonal dummies are implemented. The big differences in estimated long-run elasticities, when going from the backward looking model to the constrained forward looking model via the unconstrained forward looking model, may be due both to the inclusion of insignificant leads and to the rather heavy cross restrictions that are imposed upon the parameters.

Table 7: Forward looking model for export prices. δ=.99. Dependent variable: Δlpa. NL-2SLS. N=83 (71:2 - 91:4)

Parameter	(a)		(b)		(c)		(d)	
	Estimate	(s.e.)	Estimate	(s.e.)	Estimate	(N-W s.e.)	Estimate	(s.e.)
α_0	.09	(.06)	.07	(.06)	.07	(.05)	.03	(.06)
$\hat{\lambda}$	.82**	(.07)	.83**	(.06)	.89**	(.05)	.92**	(.06)
$\hat{\beta}_1$	.37*	(.16)	.30	(.17)	.40*	(.22)[1)]	.20	(.37)[1)]
$\hat{\beta}_2$	.52**	(.15)	.58**	(.15)	.60**	(.22)[1)]	.80*	(.37)[1)]
d1	.01	(.01)			.01	(.01)		
d2	-.01	(.006)			-.01*	(.01)		
d3	-.00	(.006)			-.00	(.01)		
db1	.00	(.011)			-.00	(.01)		
db2	.00	(.01)			.01	(.01)		
db3	-.02	(.01)	-.02**	(.01)	-.02	(.01)	-.02**	(.01)
R^2	.29		.24		.21		.17	
SER	.0258		.0257		.0270		.0268	
IV-minimand	.0218		.0248		.0219		.0247	
DW	1.58		1.61		1.53		1.57	
$\chi^2_{SM}(p)$[2)]	32.80(p=23)		37.45(p=28)		30.06(p=23)		34.34(p=28)	
$\chi^2_{SC}(4)$	9.24		8.15		10.38*		8.25	
$\chi^2_{RESET}(1)$	4.95*		3.22		7.81**		4.33*	
$\chi^2_{N}(2)$	3.42		.86		2.66		.15	
$\chi^2_{HET}(1)$	.05		.01		1.45		.34	
$\chi^2_{WALD}(1)$	6.90**		6.81**					

* (**): Significant at a 5% (1%) level.

1) Estimated subject to the homogeneity restriction.

2) Critical values: $\chi^2_{0.05}(1)=3.84$, $\chi^2_{0.05}(2)=5.99$, $\chi^2_{0.05}(4)=9.49$, $\chi^2_{0.05}(23)=35.17$, $\chi^2_{0.05}(28)=41.34$.

The estimated values on λ are high, especially when the homogeneity restriction is imposed. As the value on λ approaches one, the impact of the discrepancy from the long-run path approaches zero. The weight placed upon the leads in our constrained forward looking model will consequently be reduced as λ approaches one. High estimates on λ are often reported in the empirical literature on forward looking models derived from quadratic loss functions, and may be interpreted as throwing doubt on this particular theoretical framework. The constrained versions have also been estimated with different a priori fixed values of the discount rate, showing the estimated parameters to be rather insensitive to the choice of δ, a result that supports the view that the forward looking part of the model has a rather low impact on Δlpa_t.

Different restrictions on the lead length have been tried. The reported results originate from the only combination of lengths on the two leads, that does not reject the backward-forward restrictions. In other words, it was the specification that had the best chance to succeed. More elaborated multiperiod quadratic loss functions have also been investigated, but the results were not encouraging.

7. A less restrictive forward looking model

As already stated, the results in our preceding section throw serious doubt on the assumptions that lie behind the restrictive forward looking model deduced from the assumptions of imperfect competition, a multiperiod quadratic loss function and the hypothesis of rational expectations. Not all these assumptions need to be fallacious. In this section we allow for a more flexible lead structure, leaving the framework of a multiperiod quadratic loss function (equation (4)) behind us. We stick to the assumptions of imperfect competition and rational expectations, but choose the lead-structure that fits the data best and do not impose the backward-forward restrictions (see (6) in appendix 1). Some aspects of the multiperiod framework, as the declining weights, may serve as benchmark to evaluate the resulting regression against. It does not seem plausible that Δlpv^{e}_{t+s} should have greater impact than Δlpv^{e}_{t+s-j} (j, s > 0 and j < s) on Δlpa_t.

We started out with allowing for up to four leads in the explanatory variables. We then successively removed the insignificant leads, starting with the highest ones (i.e. Δlpv_{t+4} and Δlpk_{t+4}). The estimated parameters for the leads Δlpv_{t+s} and Δlpk_{t+s} ($s \geq 2$) were never significant and the results for the regressions including these are not reported.

Equation (c) in table 8 is our preferred forward looking ECM. It passes all the diagnostic tests for misspecification, neither static nor dynamic homogeneity is rejected (with a significance probability of 0.103 (static) and 0.222 (dynamic)) and both long-run elasticities are significant, according to one-sided tests. The forward looking ECM gives less impact on costs than what is the case in the backward looking ECM, but not as little as in the forward looking model estimated subject to the backward-forward restrictions.

The lead structure in equation (c) is heavily reduced when compared with our starting point in this paper. Expected costs are just present with one term while two terms are included for expected competing prices. When an additional lead for costs is included, the coefficient for this lead is both insignificant and negative. The number of lead parameters are too few to test whether the weights are declining geometrically, but we note that the impact of Δlpk^{e}_{t+1} on changes in export prices is less than the impact of Δlpk^{e}_{t}. The implicit weight in the equation is also consistent with the excluded leads in competing prices being insignificant.

The estimation results before imposing the restriction of static homogeneity and zero restrictions on parameters are also reported in the table. The homogeneity restriction is tested within equation (a) by use of a Wald test and is not rejected with a significance probability of 0.102. The homogeneity restriction is thus imposed (equations (b) and (c)) in the continuing search for the best parsimonious equation and leads the competing prices elasticity (β_2) to decrease and the unit costs elasticity (β_1) to increase.

Table 8. Forward looking ECM for Δlpa. N=83 (71:2-91:4). 2SLS[3]. Standard errors in parentheses

Regressor	(a)		(b)		(c)	
	Coeff.	(s.e.)	Coeff.	(s.e.)	Coeff.	(s.e.)
Constant	.12	(.06)	.11	(.06)	.11*	(.05)
lpa_{t-1}	-.17*	(.07)	-.11*	(.06)	-.11*	(.05)
lpv_{t-1}	.09	(.05)	.07	(.04)[1)]	.07*	(.04)[1)]
lpk_{t-1}	.07	(.04)	.04	(.03)[1)]	.04	(.03)[1)]
Δlpv_t	.26	(.14)	.29*	(.14)	.10**	(.04)
Δlpv_{t+1}	-.30	(.24)	-.17	(.22)		
Δlpk_t	.36*	(.17)	.36*	(.17)	.43**	(.14)
Δlpk_{t+1}	.32	(.20)	.35*	(.19)	.29	(.15)
d1	-.01	(.01)	-.01	(.01)		
d2	-.03	(.03)	-.02	(.02)		
d3	.06	(.04)	.05	(.04)		
dkvb*d1	.02	(.01)	.01	(.01)		
dkvb*d2	.02	(.02)	.01	(.02)		
dkvb*d3	-.04*	(.02)	-.04*	(.02)	-.01*	(.01)
$\hat{\beta}_1$	.50**	(.16)	.65**	(.22)[1)]	.65**	(.19)[1)]
$\hat{\beta}_2$	.41**	(.15)	.35	[1)]	.35	[1)]
R^2	.360		.403		.414	
SER	.0252		.0241		.0229	
DW	2.02		1.98		1.99	
$\chi^2_{SM}(p)$[2)]	23.10 (p=19)		28.06 (p=20)		35.71 (p=26)	
$\chi^2_{SC}(4)$	3.57		3.99		2.36	
$\chi^2_{RESET\text{-}IV}(1)$	1.62		.97		.45	
$\chi^2_N(2)$	1.15		.52		.89	
$\chi^2_{HET}(1)$	.001		.26		.07	

* (**): Significant at a 5% (1%) level.

1) These are estimated subject to the restriction of static homogeneity.

2) Critical values: $\chi^2_{0.05}(1)=3.84$, $\chi^2_{0.05}(2)=5.99$, $\chi^2_{0.05}(4)=9.49$, $\chi^2_{0.05}(19)=30.14$, $\chi^2_{0.05}(20)=31.41$, $\chi^2_{0.05}(26)=38.89$.

3) Additional instruments: lpv_{t-4}, Δlpv_{t-1}, Δlpv_{t-3} Δlpv_{t-4}, $lkpi_{t-1}$, $\Delta lkpi_{t-1}$, $\Delta lkpi_{t-2}$, $\Delta lkpi_{t-4}$, U_{t-1}, ΔU_{t-1}, ΔU_{t-2}, ΔU_{t-4}, lpk_{t-1}, Δlpk_{t-1}, Δlpk_{t-3} , Δlpk_{t-4}, lv_{t-1}, Δlv_{t-1}, Δlv_{t-2}, Δlv_{t-4}, ltr_{t-1}, ltr_{t-2}, Δltr_{t-4}, d74q1 and (d1, d2, d3 and dkvb).

8. Is the export price equation forward- or backward looking?

The main estimation results of important parameters are summarized in table 9. The table includes results for the long-run equation estimated by Johansen's method subject to the static homogeneity restriction, the preferred backward looking regression, M_{BL} (equation (d) in table 5) and the forward looking model estimated without imposing the backward-forward restrictions, M_{FL} (equation (c) in table 8). The results presented in section 6 for the forward looking equation estimated subject to the backward-forward restrictions, showed that the restriction of static homogeneity is strongly rejected within that particular framework. The estimated elasticities in section 6 did also differ greatly from other results presented in this paper, independent of whether static homogeneity is imposed or not. We therefore concentrate on M_{BL} and M_{FL} in the following, leaving behind us the forward looking model estimated subject to the backward-forward restrictions.

Table 9: Estimated long-run parameters for Norwegian export prices

	Johansen's ML[2]	Backward looking M_{BL}	Forward looking M_{FL}
$\hat{\beta}_1$ [1]	.86	.88**	.65**
$\hat{\beta}_2$ [1]	.14	.12	.35
Error correction coefficient		-.11*	-.11*
SER		.0215	.0229

* (**): Significant at a 5% (1%) level.
[1] Static homogeneity imposed.
[2] The parameters' standard errors are not available in Microfit 3.21 when restrictions are imposed.

Both regressions (M_{BL} and M_{FL}) pass the misspecification tests, and the imposed static homogeneity restriction on the long-run solution is valid for both. The dynamic homogeneity restriction can neither be rejected. The estimated error correction coefficients are identical, in contrast to the marked difference in the estimated long-run elasticities. The long-run elasticity of competing prices (β_2) derived from the backward looking model is rather low and insignificant, mirrored by a high and significant elasticity of unit costs (β_1). β_2 is insignificant also before the homogeneity restriction is imposed, albeit the coefficient is higher and more precisely estimated. The backward looking model does, however, give a long-run solution which is very close to the long-run relationship estimated by the Johansen method. The long-run elasticities in the forward looking model are both significant according to one-sided tests, and more weight is given to competing prices than in the backward looking model. On a mere intuitive ground, one may find the estimated long-run elasticities in the forward looking model more reasonable as the backward looking results indicate a very high degree of market power in foreign markets for Norwegian producers. It is on the other side important to bear in mind that our findings may originate from omitted variables[12] or be a result of our high level of aggregation.

The standard error of regression (SER) is lower for the backward looking model, showing this model to be more accurate. The difference is, however, not big. Plotting the standard errors of recursive regressions for both regressions together in figure 4 reveals that the backward looking model fits better over the entire period. It is interesting to note that the two curves in the figure follow the same

[12] Omitted variables may be production costs not included in our information set. Our proxy for competing prices may fail to represent the movements in the prices of the products in foreign markets that compete with Norwegian products.

pattern. The standard errors of both regressions increase from the mid-1980s, showing that none of them succeed in explaining the decrease in export prices caused by the fall in petroleum prices and other raw material prices. They do both also have problems in 1982/83. The two problematic periods, are also displayed in recursive plots of the individual parameters (not reported) for both equations. As shown in the recursive plots of the two long-run elasticities (figure 5 and 6), the instability in these is large in 82/83 and about the same for the two models.

Figure 7 shows the observed time series for the export prices (lpa) together with static simulations of the backward- and forward looking models. Both models track the observed prices quite well but seem to lag the changes in prices at several occasions, for instance in connection with the drop in export prices in the mid-1980s and the levelling out into the 1990s due to the increased competition from the Eastern Europe. This is due to the pronounced effect of the long-run terms in both equations.

If the hypothesis of rational expectations is true, the regressors Δlpv_t and Δlpk_t are not weakly exogenous in our regressions. In the backward looking model we cannot, however, reject that Δlpv_t and Δlpk_t are weakly exogenous according to a Wu-Hausman test. This finding may be interpreted as (a) the hypothesis of rational expectations is not true, or (b) the hypothesis of rational expectations still remain, but Δlpv_t and Δlpk_t are included in the information set when the agents make their decision concerning Δlpa_t and the expectations are consequently related to Δlpv_{t+s} and Δlpk_{t+s} (s>0). It is worth mentioning that the Wu-Hausman test is sensitive for the choice of regression used to model the conditioning variables.

Hendry (1988) shows that if the expectations generating mechanisms are sufficiently unstable then, if the rational expectations hypothesis is true, a (misspecified) backward looking model should also be unstable. If, on the other hand, the backward looking model is found to be stable, evidence is found against the rational expectations hypothesis. Inspection of recursive OLS-estimates and the regression standard errors from the recursive regressions of Δlpv_t and Δlpk_t on the whole set of instruments, reveals some instability in the process behind the variables in the period around 1986. This is the same instability as we have revealed in both our backward- and forward looking regressions. So, our results cannot, according to Hendry's proposed test of rational expectations, be taken as evidence against the hypothesis of rational (or forward looking) expectations.

Table 10: Encompassing tests of backward (M_{BL}) vs. forward looking model (M_{FL}) and vice versa

The combined model: $\hat{\beta}_1$ = .76**(.16), $\hat{\beta}_2$ = .24 (.16), ec-term = -.13**(.05). R^2=0.53, SER=.0210, DW=2.03, $\chi^2_{SM}(22)$=24.18, $\chi^2_{SC}(4)$=2.36, $\chi^2_{RESET}(1)$=.71, $\chi^2_{N}(2)$=.62, $\chi^2_{HET}(1)$=.52.	
H_0^a: M_{BL} vs M_{FL}	H_0^a: M_{FL} vs M_{BL}
$\chi^2_{WALD}(1)$=6.26 [.012]	$\chi^2_{WALD}(4)$=18.40 [.001]

Our two competing models are tested against each other by use of encompassing tests. We estimate (2SLS) the combined regression of the backward- and forward looking regressions. We test the backward looking model against the forward looking model by use of a Wald-test of the zero restrictions on the parameters related to the variables not included in the backward looking model and vice versa. As the results in table 10 indicate, none of the models encompasses the other. It is interesting to note that both lagged and leaded variables are significant in the combined model. The estimation results for the combined model are reported in appendix 3.

The results presented in this paper indicate that the theoretical framework based on the minimization of a multiperiod quadratic loss function is too restrictive, but that forward looking behaviour still may be present. Our "freely" estimated forward looking model (M_{FL}) does however not outclass the backward looking model (M_{BL}). Further investigations are needed in the search for a model that encompasses them both. It is desirable that such a model also has a somewhat better performance during the mid-1980s. One strategy would be to include a learning process, by which the agents gradually learn about the data generating processes. Other specifications of the long-run solution also remain to be tried, for instance time dependent elasticities. But, one should also bear in mind, that our findings may be the result of our high level of aggregation - a level of aggregation that includes sectors which may follow different decision rules and for which competing prices have shown different tendencies during the estimation period.

Figure 4: Standard errors of recursive regressions. Backward looking (M_{BL}) and forward looking (M_{FL}) models.

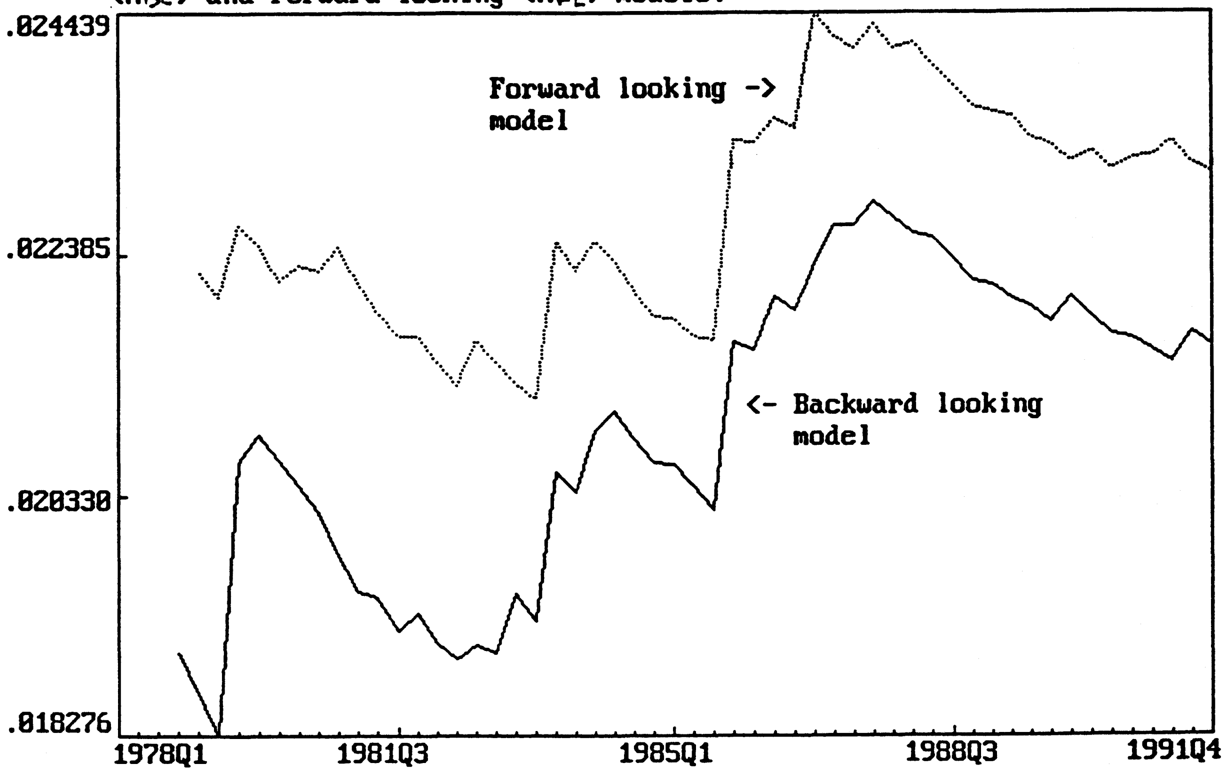


Figure 5: Recursive estimates of the elasticity of PV on PA. Backward looking (M_{BL}) and forward looking (M_{FL}) models.

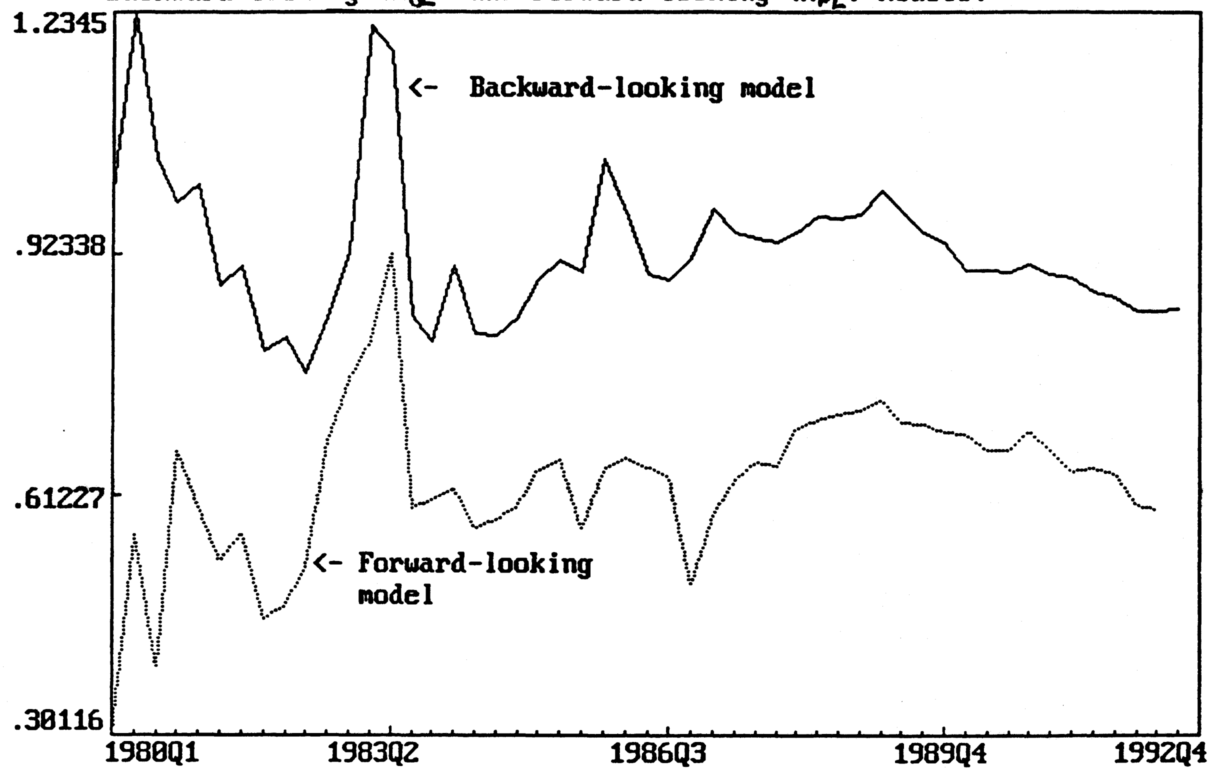


Figure 6: Recursive estimates of the elasticity of PK on PA. Backward looking (M_{BL}) and forward looking (M_{FL}) models.

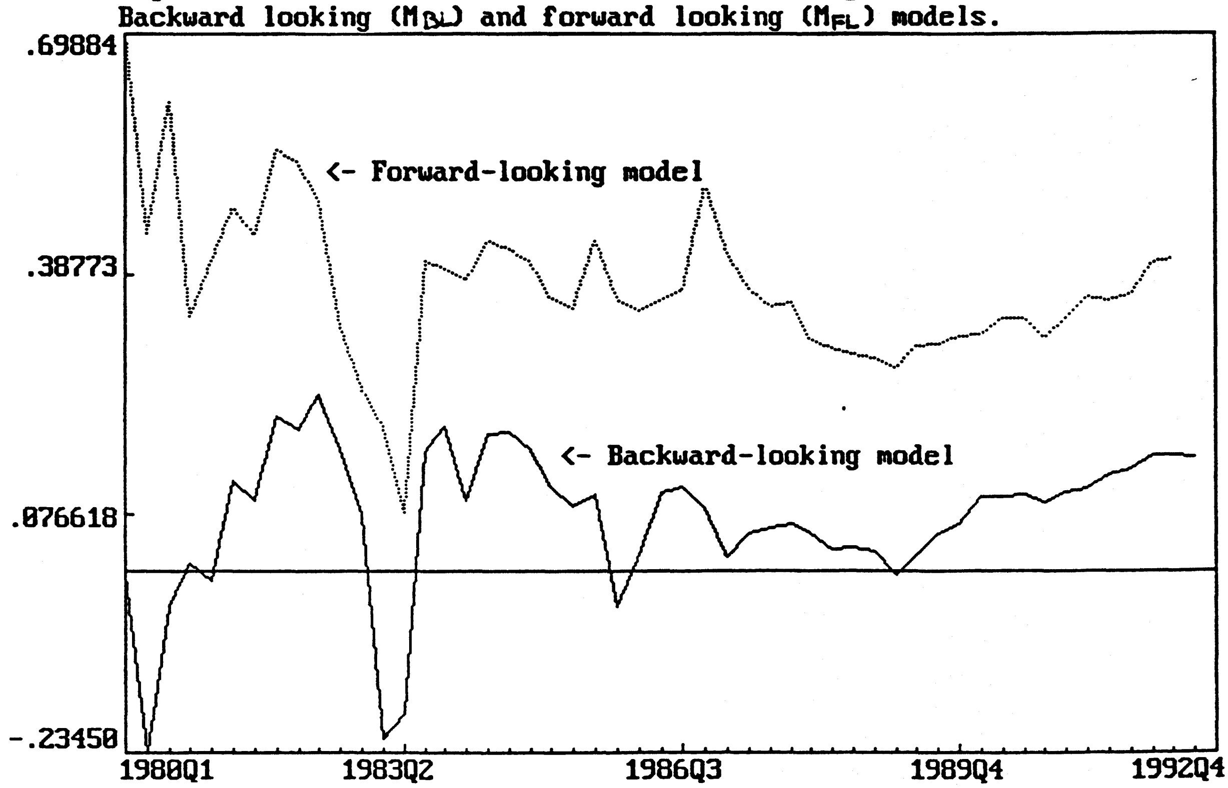
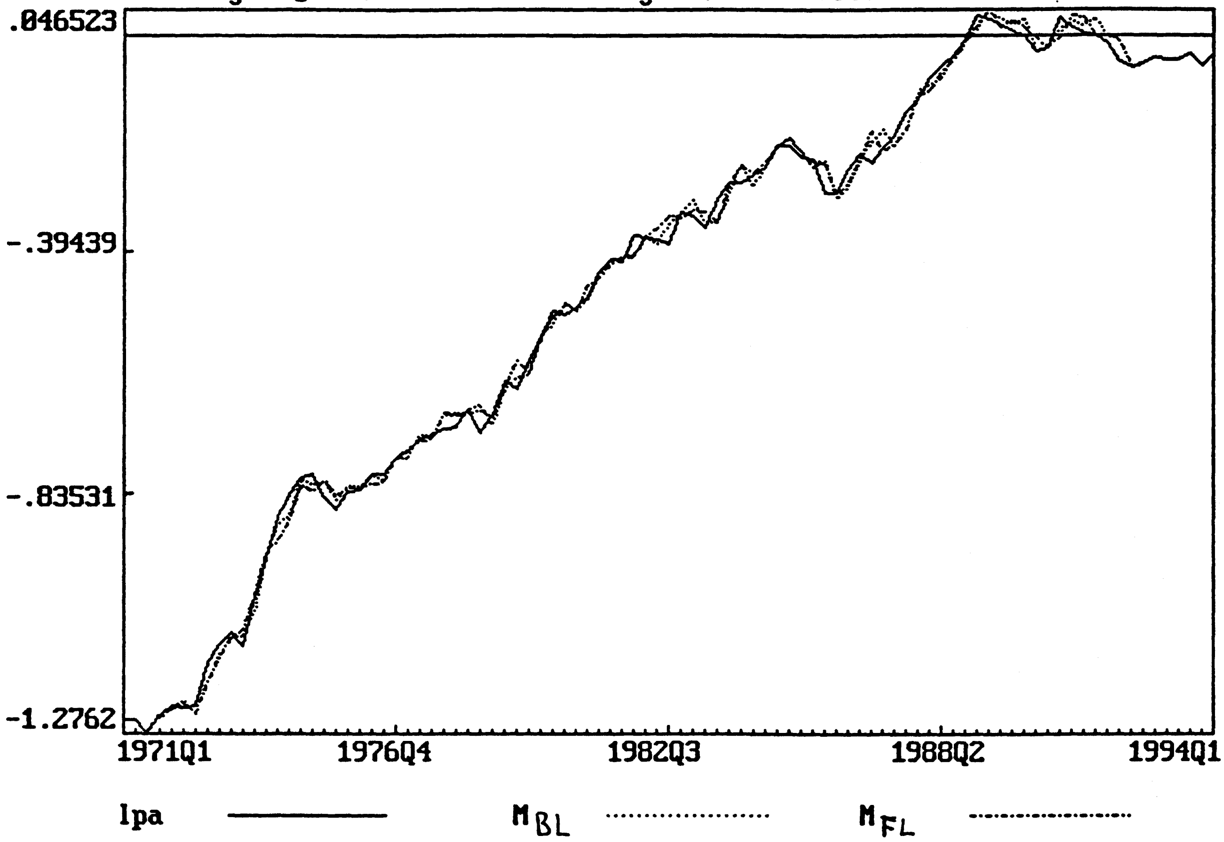


Figure 7: Static simulations of the export price (lpa). Backward looking (M_{BL}) and forward looking (M_{FL}) models.



References

Bowitz, E. and Å. Cappelen (1994): *Prices and Demand for Factors of Production in Norwegian Sectors* (in Norwegian), Social and Economic Studies 85, Statistics Norway.

Breusch, T. S. and L. G. Godfrey (1981): "A Review of Recent Work on Testing for Autocorrelation in Dynamic Simultaneous Models" in *D. Currie, R. Nobay and D. Peel (eds): Macroeconomic Analysis: Essays in Macroeconomics and Econometrics,* London: Croom Helm.

Burgess, S. M. (1992): Nonlinear Dynamics in a Structural Model of Employment, *Journal of Applied Econometrics* **7**, S101-S118.

Callen, T. S., S. G. Hall and S. G. B. Henry (1990): Manufacturing Stocks: Expectations, Risk and Co-integration, *The Economic Journal **100**,* September 1990, 756-772.

Chow, G. C. (1960): Tests of Equality between Sets of Coefficients in Two Linear Regressions, *Econometrica* **28**, 591-605.

Cuthbertson, K. (1986): The Behaviour of U.K. Export Prices of Manufactured Goods 1970-1983, *Journal of Applied Econometrics **1**,* 255-275.

Cuthbertson, K. (1988): The Demand for M1: A Forward Looking Buffer Stock Model, *Oxford Economic Papers* **40**, 1, 110-131.

Cuthbertson, K. (1990): Rational Expectations and Export Price Movements in the UK, *European Economic Review* **34**, 953-969.

Cuthbertson, K., S. G. Hall and M. P. Taylor (1992): *Applied Econometric Techniques*, Hempel Hempstead: Harvester Wheatsheaf.

Cuthbertson, K. and M. P. Taylor (1992): A Comparison of The Rational Expectations and The General-to-Specific Approaches to Modelling The Demand for M1, *The Manchester School* **LX 1,** March 1992, 1-22.

Davidson, J. E. H., D. F. Hendry, F. Srba and S. Yeo (1978): Econometric Modelling of the Aggregate Time-Series Relationships Between Consumers' Expenditure and Income in the United Kingdom, *The Economic Journal* **88**, 661-692.

Engle, R. F., D. F. Hendry and J.-F. Richard (1983): Exogeneity, *Econometrica* **51**, 277-304.

Haavelmo, T. (1944): The Probability Approach in Econometrics, *Econometrica* **12** (supplement), 1-118.

Hendry, D. F. (1988): The Encompassing Implications of Feedback versus Feedforward Mechanisms in Econometrics, *Oxford Economic Papers **40**,* 132-139.

Jarque, C. M. and A. K. Bera (1980): Efficient tests for Normality, Homoscedasticity and Serial Independence of Regression Residuals, *Economic Letters* **6**, 255-259.

Johansen, S. (1988): Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control* **12**, 231-254.

Lindquist, K.-G. (1993): *Empirical Modelling of Exports of Manufactures: Norway 1962-1987*, Reports 93/12, Statistics Norway.

Koenker, R. (1981): A Note on Studentizing a Test for Heteroskedasticity, *Journal of Econometrics* **17**, 107-112.

MacKinnon, J. G. (1990): Critical Values for Cointegration Tests, UC San Diego Discussion Paper 90-4.

McCallum, B. T. (1976a): Rational Expectations and the Natural Rate Hypothesis: Some Consistent Estimates, *Econometrica* **44**, No.1, 43-52.

McCallum, B. T. (1976b): Rational Expectations and the Estimation of Econometric Models: An Alternative Procedure, *International Economic Review* **17**, 484-490.

Muscatelli, V. A. (1989): A Comparison of the Rational Expectations And «General-to-Specific» Approaches to Modelling the Demand for M1, *Oxford Bulletin of Economics and Statistics* **51**, 4, 353-375.

Naug, B. E. (1994): *An Econometric Model for Norwegian Export of Raw Materials* (in Norwegian), Reports 95/2, Statistics Norway.

Nelson, C. R. (1975): Rational Expectations and the Estimation of Econometric Models, *International Economic Review* **16**, 555-561.

Newey, W. K. and K. D. West (1987): A Simple, Positive Semi-definite, Heteroscedasticity and Autocorrelation Consistent Covariance Matrix, *Econometrica* **55**, 703-708.

Nickell, S. J. (1984): An Investigation of the Determinants of Manufacturing Employment in the United Kingdom, *Review of Economic Studies* **LI**, 529-557.

Nickell, S. J. (1985): Error Correction, Partial Adjustment and All That: An Expository Note, *Oxford Bulletin of Economics and Statistics* **47**, 119-129.

Osterwald-Lenum, M. (1992): A Note with Quantiles of the Asymptotic Distribution of the Maximum Likelihood Cointegration Rank Test Statistics, *BULLETIN* **54**, 461-471.

Pagan, A. (1984): Econometric Issues in the Analysis of Regressions with Generated Regressors, *International Economic Review* **25**, 221-247.

Pesaran, M. H. (1987): *The Limits to Rational Expectations*, Oxford: Basil Blackwell.

Pesaran, M. H. (1991): Costly Adjustment under Rational Expectations: A Generalization, *The Review of Economics and Statistics* **74**, 353-358.

Pesaran, M. H. and B. Pesaran (1991): *Microfit 3.0 - Users Manual*, Oxford: Oxford University Press.

Price, S. (1992): Forward Looking Price Setting in UK Manufacturing, *The Economic Journal* **102**, *May 1992,* 497-505.

Price, S. (1994): Aggregate Uncertainty, Forward Looking Behaviour and the Demand for Manufacturing Labour in the UK, *Oxford Bulletin of Economics and Statistics* **56**, 3, 267-283.

Ramsey, J. B. (1969): Tests for Specification Errors in Classical Linear Least Squares Regression Analysis, *Journal of the Royal Statistical Society* **B 31**, 350-371.

Sargan, J. D. (1964): "Wages and Prices in the United Kingdom: A Study in Econometric Methodology" in P. E. Hart, G. Mills, and J. K. Whitaker *(eds.): Econometrics Analysis for National Economic Planning,* London: Butterworths.

Sargent, T. J. (1978): Estimation of Dynamic Labor Demand Schedules Under Rational Expectations, *Journal of Political Economy* **86**, 1009-1044.

Sargent, T. J. (1987): *Macroeconomic Theory - second edition*, San Diego-California: Academic Press.

Svendsen, I. (1993): Testing the Rational Expectations Hypothesis - Using Norwegian Microeconomic Data, Discussion Papers 90, Statistics Norway.

Svendsen, I. (1994): Do Norwegian Firms Form Extrapolative Expectations ? Discussion Papers 126, Statistics Norway.

Urbain, J.-P. (1992): On Weak Exogeneity in Error Correction Models, *Oxford Bulletin of Economics and Statistics* **54**, 2, 187-207.

Wickens, M. R. (1982): The Efficient Estimation of Econometric Models with Rational Expectations, *Review of Economic Studies* **XLIX**, 55-67.

Wu, D.-M. (1973): Alternative Tests of Independence between Stochastic Regressors and Disturbances, *Econometrica* **41**, 733-50.

Appendix 1. Cross-restrictions in the forward looking model

(a) lpa as the dependent variable
The forward looking model with the backward-forward restrictions imposed and the number of leads truncated at four, is as follows:

$$
\begin{aligned}
(1)\qquad lpa_t = {} & \alpha + (1-\lambda)(1-\lambda\delta)\beta_1 lpv^e_t + (1-\lambda)(1-\lambda\delta)(\lambda\delta)\beta_1 lpv^e_{t+1} \\
& + (1-\lambda)(1-\lambda\delta)(\lambda\delta)^2\beta_1 lpv^e_{t+2} + (1-\lambda)(1-\lambda\delta)(\lambda\delta)^3\beta_1 lpv^e_{t+3} \\
& + (1-\lambda)(1-\lambda\delta)(\lambda\delta)^4\beta_1 lpv^e_{t+4} + (1-\lambda)(1-\lambda\delta)\beta_2 lpk^e_t \\
& + (1-\lambda)(1-\lambda\delta)(\lambda\delta)\beta_2 lpk^e_{t+1} + (1-\lambda)(1-\lambda\delta)(\lambda\delta)^2\beta_2 lpk^e_{t+2} \\
& + (1-\lambda)(1-\lambda\delta)(\lambda\delta)^3\beta_2 lpk^e_{t+3} + (1-\lambda)(1-\lambda\delta)(\lambda\delta)^4\beta_2 lpk^e_{t+4} \\
& + \lambda\, lpa^*_{t-1} + dummies + v_t
\end{aligned}
$$

The next equation is the unconstrained version of equation (1).

$$
\begin{aligned}
(2)\qquad lpa_t = {} & \alpha + \phi_{10}\, lpv^e_t + \phi_{11}\, lpv^e_{t+1} + \phi_{12}\, lpv^e_{t+2} + \phi_{13}\, lpv^e_{t+3} + \phi_{14}\, lpv^e_{t+4} \\
& + \phi_{20}\, lpk^e_t + \phi_{21}\, lpk^e_{t+1} + \phi_{22}\, lpk^e_{t+2} + \phi_{23}\, lpk^e_{t+3} + \phi_{24}\, lpk^e_{t+4} \\
& + \lambda\, lpa^*_{t+1} + dummies + v_t
\end{aligned}
$$

The backward-forward restrictions can now be expressed as the following set of restrictions on the parameters in the unconstrained equation. The eight independent restrictions (or subsets of these) can be tested by a Wald-test.

$$
(3)\qquad \frac{\phi_{11}}{\phi_{10}} = \frac{\phi_{12}}{\phi_{11}} = \frac{\phi_{13}}{\phi_{12}} = \frac{\phi_{14}}{\phi_{13}} = \frac{\phi_{21}}{\phi_{20}} = \frac{\phi_{22}}{\phi_{21}} = \frac{\phi_{23}}{\phi_{22}} = \frac{\phi_{24}}{\phi_{23}} = \lambda\delta
$$

The first seven equalities in (2) imply geometrically declining weights on the leads in the two explanatory variables and also that the implicit weights are equal for both variables. The implicit weight is according to the last equality, linked to the backward looking part of the equation.

(b) Δlpa as the dependent variable
The forward looking model on differentiated form, with the backward-forward restrictions imposed may be written in the following way:

$$
\begin{aligned}
(4)\qquad \Delta lpa_t = {} & \alpha + (1-\lambda)\beta_1\, \Delta lpv^e_t + (1-\lambda)(\lambda\delta)\beta_1\, \Delta lpv^e_{t+1} + (1-\lambda)(\lambda\delta)^2\beta_1\, \Delta lpv^e_{t+2} \\
& + (1-\lambda)(\lambda\delta)^3\beta_1\, \Delta lpv^e_{t+3} + (1-\lambda)(\lambda\delta)^4\beta_1\, \Delta lpv^e_{t+4} + (1-\lambda)\beta_2\, \Delta lpk^e_t \\
& + (1-\lambda)(\lambda\delta)\beta_2\, \Delta lpk^e_{t+1} + (1-\lambda)(\lambda\delta)^2\beta_2\, \Delta lpk^e_{t+2} + (1-\lambda)(\lambda\delta)^3\beta_2\, \Delta lpk^e_{t+3} \\
& + (1-\lambda)(\lambda\delta)^4\beta_2\, \Delta lpk^e_{t+4} - (1-\lambda)\, lpa_{t-1} + (1-\lambda)\beta_1\, lpv_{t-1} + (1-\lambda)\beta_2\, lpk_{t-1} \\
& + dummies + v_t
\end{aligned}
$$

In the next equation, we present the econometric equation with no cross-restrictions imposed on parameters. The parameters are linear in the variables.

$$
\begin{aligned}
\Delta lpa_t \;&=\; \alpha + \pi_{10}\Delta lpv^e_t + \pi_{11}\Delta lpv^e_{t+1} + \pi_{12}\Delta lpv^e_{t+2} + \pi_{13}\Delta lpv^e_{t+3} + \pi_{14}\Delta lpv^e_{t+4} \\
&\quad + \pi_{20}\Delta lpk^e_t + \pi_{21}\Delta lpk^e_{t+1} + \pi_{22}\Delta lpk^e_{t+2} + \pi_{23}\Delta lpk^e_{t+3} + \pi_{24}\Delta lpk^e_{t+4} \qquad (5) \\
&\quad - \psi_0 lpa_{t-1} + \psi_1 lpv_{t-1} + \psi_2 lpk_{t-1} + dummies + v_t
\end{aligned}
$$

We get from equation (5) to equation (4) by imposing the following cross-restrictions on the parameters in equation (5):

$$
(6) \qquad
\begin{aligned}
&(i) \quad \frac{\pi_{11}}{\pi_{10}} = \frac{\pi_{12}}{\pi_{11}} = \frac{\pi_{13}}{\pi_{12}} = \frac{\pi_{14}}{\pi_{13}} = \frac{\pi_{21}}{\pi_{20}} = \frac{\pi_{22}}{\pi_{21}} = \frac{\pi_{23}}{\pi_{22}} = \frac{\pi_{24}}{\pi_{23}} = (1+\psi_0)\delta \\
&(ii) \quad a)\ \pi_{10} = \psi_1 \quad b)\ \pi_{20} = \psi_2
\end{aligned}
$$

This makes up a total of ten independent restrictions which can be tested empirically by one or several Wald-tests. The first part of (6), (i), includes the eight restrictions normally associated with backward-forward restrictions and are the parallel to the restrictions in equation (2). The second part is a result of our transformation of the equation over to differentiated form.

Appendix 2: Data and definition of variables

PA_t	Export price index of the commodity produced by Private mainland economy
PK_t	Price index in competing markets, calculated from import prices in foreign markets
PV_t	Labour unit costs inclusive of net sector taxes for Private mainland economy
U_t	Unemployment rate, according to Labour Force Sample Surveys (LFSS).
KPI_t	The Consumer price index
TR_t	Average tax rate of households
V_t	Exchange rate expressed as NOK per unit of foreign currency
Dk_t (k=1,2,3)	Seasonal dummies. Dk = 1 if quarter = k, Dk = -1 if quarter = 4, 0 otherwise.
$DKVB_t$	Dummy for structural change in seasonal movements. DKVB = 1 if t ≤ 77:4, 0 otherwise.
$D74Q1_t$	Dummy. D74Q1 = 1 if t = 74:1, 0 otherwise.

Data are taken from the Quarterly National Account, published by Statistics Norway. The proxy for competing prices (PK) is calculated by use of data from IMF's International Financial Statistics and the Bank of Norway. PK is calculated as a weighted average of import prices (in NOK) in the main foreign markets for Norwegian producers. We have used the weights previously (until october 1990) used by the Bank of Norway in fixing the exchange rate for NOK.

All prices are given in Norwegian currency (NOK). All price indices equal 1 in 1991. The letter l in front of a variable denotes the natural logarithm of the variable (lpa = ln(PA), etc.). The symbol Δ denotes a differentiated variable.

Appendix 3: Encompassing equation for export prices

Table A3.1: Encompassing ECM for Δlpa. N=83 (71:2-91:4). 2SLS[3]. Standard errors in parentheses

Regressor	Coeff.	(s.e.)
Constant	.14**	(.05)
lpa_{t-1}	-.13**	(.05)
lpv_{t-1}	.10**	(.04)[1]
lpk_{t-1}	.03	(.03)[1]
Δlpv_t	.19**	(.06)
Δlpv_{t-2}	-.09*	(.04)
Δlpv_{t-3}	.13**	(.05)
Δlpk_t	.17	(.16)
Δlpk_{t+1}	.39*	(.16)
Δlpk_{t-1}	.29**	(.10)
d2	.02*	(.01)
dkvb*d3	-.02**	(.01)
$\hat{\beta}_1$	.76**	(.16)[1]
$\hat{\beta}_2$	.24	[1]
R^2	.53	
SER	.0210	
DW	1.03	
$\chi^2_{SM}(22)$	24.18	
$\chi^2_{SC}(4)$[2]	2.36	
$\chi^2_{RESET\text{-}IV}(1)$	.71	
$\chi^2_{N}(2)$	.62	
$\chi^2_{HET}(1)$	.52	

* (**): Significant at a 5% (1%) level.

[1] These are estimated subject to the restriction of static homogeneity.

[2] Critical values: $\chi^2_{0.05}(1)=3.84$, $\chi^2_{0.05}(2)=5.99$, $\chi^2_{0.05}(4)=9.49$, $\chi^2_{0.05}(22)=33.92$.

[3] Additional instruments: lpv_{t-4}, Δlpv_{t-1}, Δlpv_{t-4}, $lkpi_{t-1}$, $\Delta lkpi_{t-1}$, $\Delta lkpi_{t-2}$, $\Delta lkpi_{t-4}$, U_{t-1}, ΔU_{t-1}, ΔU_{t-2}, ΔU_{t-4}, lpk_{t-1}, Δlpk_{t-3}, Δlpk_{t-4}, lv_{t-1}, Δlv_{t-1}, Δlv_{t-2}, Δlv_{t-4}, ltr_{t-1}, ltr_{t-2}, Δltr_{t-4}, d74q1, d1, d2, d3 and dkvb.

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