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Price adjustment for Finnish and Swedish papers under fixed and floating exchange rate regimes

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HELSINGIN TUTKIMUSKESKUS – HELSINKI RESEARCH CENTRE

METLA

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ABSTRACT

The study examines the effects of fixed and floating exchange rate regimes on Finnish and Swedish export price adjustment for newsprint and printing and writing papers using a two-period, non-competitive model. In the model, firms' second-period export demand is assumed to depend on their first-period market share, and thus, the first-period uncertainty about future exchange rates affects exporters' pricing behavior. The theoretical model was estimated using Johansen's cointegration method on monthly data from 1987-1997 on Finnish and Swedish paper export prices in Germany and the United Kingdom.

The results indicate that the fixed regime has not reduced Finnish and Swedish exporters' exchange rate uncertainty, and thus, the exchange rate regime itself does not seem to affect export pricing. Finnish and Swedish exporters' perception of exchange rates, however, has affected export pricing in the next period and the results imply that exchange rate pass-through has been incomplete. The results imply that Finnish exporters' future pricing behavior might change in the European single currency market as the exchange rate changes disappear.

Keywords: International trade, single currency, exchange rate regime, newsprint, printing and writing paper, Johansen's cointegration method, Finland, Sweden, Germany, United Kingdom

TIIVISTELMÄ

Tutkimuksessa selvitetään kiinteiden ja kelluvien valuuttakurssien vaikutusta Suomen ja Ruotsin sanomalehtipaperin ja paino- ja kirjoituspaperien vientihinnoitteluun Saksan ja Iso-Britannian markkinoilla. Empiirinen aineisto koostuu Suomen ja Ruotsin paperien kuukausittaisista viennin yksikköarvoista ko. ostajamaihin 1986-1997. Tutkimuksessa kiinteän järjestelmän jakso oli 1987-1991 ja kelluvan järjestelmän jakso 1992-1996 Suomessa ja 1992-1997 Ruotsissa. Tutkimuksen teoreettinen malli perustuu kahden periodin epätäydellisen kilpailun malliin. Mallissa oletetaan viejien luottavan valuuttakurssien vakauteen kiinteän järjestelmän vallitessa, kun taas kelluvan kurssin vallitessa viejät kokevat kurssimuutokset tilapäisiksi hinnoittelupäätöksiä tehdessään. Näin ollen tuleviin valuuttakursseihin sisältyvä epävarmuus vaikuttaa viejäyritysten hinnoittelukäyttäytymiseen eri tavalla valuuttakurssijärjestelmästä riippuen.

Tulokset osoittavat, että Suomen ja Ruotsin paperiteollisuuden tuotteiden hinnoittelussa kiinteät kurssit eivät vähentäneet viejien valuuttakurssimuutoksia kohtaan tuntemaa epävarmuutta. Tulos oli ennakko-oletuksen vastainen ja viittaisi siihen, että valuuttakurssijärjestelmällä itsessään ei olisi vaikutusta paperin vientihinnoitteluun. Tulosten mukaan valuuttakurssimuutokset ovat kuitenkin siirtyneet osittain valuuttamääräisiin vientihintoihin, jolloin viejillä on ollut mahdollisuus vaikuttaa markkinaosuuteensa vientihintaa muuttamalla valuuttakurssin muuttuessa. Euromarkkinoiden synnyttyä suomalaisten viejien hinnoittelustrategia euroalueelle muuttunee valuuttakurssipuskurin poistuessa.

Avainsanat: Kansainvälinen kauppa, yhden valuutan markkinat, valuuttakurssijärjestelmät, sanomalehtipaperi, paino- ja kirjoituspaperit, Johansenin yhteisintegroituvuusmenetelmä, Suomi, Ruotsi, Saksa, Iso-Britannia

1 INTRODUCTION

Exchange rates are an important determinant of competitiveness in export-driven market sectors, especially for companies in small open economies like those of Finland and Sweden. Exchange rates affect production costs, as well as export prices, the price effect being tempered by exchange rate pass-through. Firms' profits are also affected by exchange rate uncertainty, and, by extension, so are investment decisions and regional welfare. Exchange rate uncertainty has been increased by the failure of the Exchange Rate Mechanism (ERM) to stabilize European exchange rates and the new single European currency, the Euro, adopted in the beginning of January 1999, might initially only add to the uncertainty

The purpose of this study is to examine the impact of exchange rate regimes on forest industry export prices. The effects of exchange rate regimes on price adjustments for forest products are analyzed in a framework of a two-period model of a non-competitive industry. In order to specifically study the differences in price adjustment when the exchange rates are perceived to be either permanent or temporary, dynamics are build into the theoretical model by assuming that the second period demand depends on the first period demand so that the future "matters" to exporters. The theoretical model derived is estimated using Johansen's cointegration method for Finnish and Swedish forest industry export prices.

This paper's approach should reveal information about exporters' pricing behavior, i.e., how the exporters perceive the exchange rates under different regimes and what the degree of exchange rate pass-through is under these regimes. The empirical part of the study tests whether exporters' behavior is consistent with the theory, i.e., if under the fixed exchange rate regime they perceived exchange rates as permanent and, therefore, changed their prices more than they would have under a floating regime. If the exporters adjust their export prices according to the theory, this would indicate that the exporters could benefit from the reduced uncertainty in exchange rates under a fixed regime.

Additionally, the information about exporters' pricing behavior under different exchange rate regimes will give indications of their pricing strategies if they were to operate in a single currency market where a government cannot use exchange rate realignments to increase the competitiveness of that country's export industry. This is an important issue, especially in export income dependent countries such as Finland, who entered into the EMU as a member

of the first group in 1999, and Sweden, who is planning to join later, since the capability of the export-driven forest industries to adjust to a single currency will effect the economic outcome of the nation's EMU participation.

2 PURPOSE OF THE STUDY

That exchange rate regimes have an effect on the volume of international trade is widely recognized. Flexible exchange rates have been argued to reduce the volume of trade, mainly due to the risk the importers and exporters face because of unanticipated exchange rate fluctuations and government imposed trade barriers caused by volatile exchange rates (see, e.g., Brada and Mendez 1988). On the other hand, hedging under fixed rates to promote trade is not without its own costs.

The role of exchange rate regimes in import and export pricing is significant. Moreover, exporting firms are often concerned about their current and future competitiveness in the market, and do not want to lose their market share. It is, therefore, an important question whether the firms see possible changes in exchange rates as permanent or temporary and change their prices accordingly. Exchange rate regimes significantly affect exchange rate stability, and therefore the pricing decisions and behavior of export industries. For example, under a fixed exchange rate regime, the uncertainty of future changes in exchange rates is less than under a flexible exchange rate regime, and therefore the pass-through could be more complete.

This study seeks to answer the following questions:

1. Does the exchange rate regime have an effect on how the exchange rates are perceived ?
2. Does the exchange rate regime have an effect on exchange rate pass-through?
3. Do prices have an effect on exchange rates?

There are numerous industry-level exchange rate pass-through studies, however, only a very few have examined the role of exchange rate regimes. Understanding price adjustment under different exchange rate regimes would yield important information, not only about the past price adjustments, but also about price adjustments in a common currency market. This kind of information is essential, not only for industry level decision making, but also for government policy making.

The few existing empirical studies of the effect of exchange rate regimes on trade price adjustment have focused on aggregate trade between countries with different exchange rate regimes. This study chooses to concentrate on how different exchange rate regimes affect the pricing of specific products in a export driven industry in a specific small open economy. Johansen's cointegration method (Johansen 1988, 1995) is employed in this study in order to obtain dynamic industry level information about the pricing behavior of Finnish and Swedish forest industry in European markets. The advantage of this method is that it enables a simultaneous modeling of long- and short-run effects. Moreover, various linear restrictions relating to study's key questions can be tested in the cointegration space. This method has not been widely used for industry and commodity level studies, however, e.g., Sarker (1993), Menon (1993), Hänninen *et al.* (1997), Laaksonen *et al.* (1997) and Hänninen and Toppinen (1999) have used the method in their papers.

3 PREVIOUS STUDIES

3.1 International trade literature

The international trade literature on exchange rate pass-through on prices is a rich one. Krugman (1987) examined German-U.S. pricing-to-market under changing exchange rates using both static models with different types of imperfect competition, and dynamic models with both supply and demand side dynamics. He concluded that the pricing-to-market could be best explained in terms of dynamic imperfect competition, and that the phenomenon seemed to rise from both supply and demand dynamics.

Dornbusch (1987) studied several different types of models to explain exchange rate related price changes during the appreciation of the U.S. dollar in the early 1980's. Standard models, including the law of one price model, the fully specialized country model, the equilibrium pricing model, the Cournot model with homogeneous products, the Dixit-Stiglitz model with Chamberlinian imperfect competition, the Dixit-Stiglitz model with conjectural variation, and the competition on the circle model, all predicted that appreciation should lead to a decline in import prices.

Giovannini (1988) investigated the determination of domestic and export prices by a monopolisticly competitive firm, assuming that a risk-neutral firms maximizing the

expectation of the present value of future profits must commit to given prices, either in terms of domestic or foreign currency, at the beginning of each period. This assumption emphasizes the role of expectations and exchange rate uncertainty. The results indicated that an increase in exchange rate risk leaves both domestic and export prices unaffected when export prices are set in foreign currency, whereas, when the export prices are set in domestic currency, increasing exchange rate risk has ambiguous effects on domestic and foreign prices. Moreover, Giovannini concluded that increasing exchange rate risk lowers foreign currency export prices when both demand and cost functions are linear.

Knetter (1989) employed an industrial organization approach to investigate the impact of exchange rate fluctuations on pricing-to-market behavior by U.S. and German exporters. In his simple model, an exporter sells to several foreign countries, attempting to maximize its profits in each time period. Price in domestic currency was assumed to be a markup over marginal cost, with the size of the markup being determined by the elasticity of demand. Empirical testing with U.S. and German exports data indicates that U.S. export prices are fairly insensitive to exchange rate fluctuations while German export prices are. Moreover, U.S. export price adjustment has often amplified the effect of exchange rate changes on foreign currency prices, while German price adjustment tends to stabilize the effect of exchange rate changes on foreign currency prices.

Froot and Klemperer (1989) studied exchange rate pass-through and dynamic side effects using a two-period duopoly model in which the discounted value of own-currency profits from competition in a domestic market is maximized. In their model, a firm's future demand depends on current market share, so expected future exchange rates affect the value of current market share, and therefore, current pricing strategies. This can be seen by separating the price changes caused by exchange rate changes into cost effects and interest rate effects. Furthermore, they showed that this type of inter-temporal dependence indicates that the magnitude and the sign of the exchange rate pass-through depends on whether exchange rate changes are seen to be permanent or temporary. This implies that, to gain larger market share, foreign firms price more aggressively in the domestic market when the price of domestic currency is expected to stay permanently high than when the appreciation is viewed to be temporary.

Introducing supply side dynamics to his model, Kasa (1992) developed an adjustment cost model of pricing-to-market for a monopolist faced with adjustment costs and exogeneously specified constant elasticity demand curves for two foreign markets. The monopolist was assumed to maximize the expected present discounted value of profits. Assuming convex costs of adjusting supply to foreign markets, the model implies that firms use their profit margins to smooth out exchange rate fluctuations which are seen as temporary. U.S. and Canadian import prices of German goods were used in an empirical analysis of the model, which indicated that the prices of imported German goods rose in the U.S. relative to Canada in response to an innovation in the rate of appreciation of the dollar against the Deutschmark.

Turning to the literature on forest products trade, Uusivuori and Buongiorno (1990) studied the effects of the exchange rate pass-through behavior in the U.S., European, and Japanese markets. Investigating short- and long-run effects of changes in exchange rates on U.S. paper imports from Finland and Sweden, they used a time series model to describe the dynamic relationship existing between imported quantities and exchange rate. Short- and long-run measures of feedback were derived and the empirical results indicated that there is a short-run, but not a long-run, relationship between traded quantities and exchange rates. The same authors (1991) used Dornbusch's (1987) Cournot-Nash model of oligopolistic market for homogeneous products as the basis for a structural model including demand, supply and price equations. Data on U.S. forest products exports to seven European countries and Japan was used to empirically test this model. In general, their results showed that exchange rate pass-through was often incomplete, especially when the value of U.S. dollar depreciated.

Hänninen and Toppinen (1999), studied the long-run price effects of exchange rate changes in Finnish pulp and paper exports to the U.K. and Germany by examining the long-run exchange rate elasticities related to mark-up in pricing. The derived equations were estimated using Johansen's multivariate cointegration method. In the study, the pass-through elasticity estimates indicated that pass-through of exchange rates to export prices has been incomplete, and therefore, in accordance with previous studies.

3.2 International trade and exchange rate regimes

The effects of flexible exchange rate regimes on the volume of international trade were studied by Brada and Mendez (1988). Assuming that flexible exchange rate regimes are

characterized by unanticipated exchange rate fluctuations, and therefore by greater exchange rate risks than under fixed rate regimes, they hypothesized that firms might be less willing to trade internationally under a flexible exchange rate regime. Employing a gravity model of bilateral trade flows, they tested whether flexible exchange rates reduce the volume of international trade more than fixed exchange rates. The results implied that bilateral trade flows are higher among countries with floating exchange rates than among those with fixed exchange rates. Moreover, while exchange rate uncertainty reduced the volume of trade regardless of countries' exchange rate regime, this reduction was smaller than that caused by restrictive commercial policies often imposed by countries with fixed exchange rates.

Sapir and Sekkat (1995) considered the effect of exchange rate regimes on trade prices and on the process of trade adjustment. Following the convention of Froot and Klemperer (1989), that a firm's future demand depends on firm's current market share, they constructed a two-period duopoly model with consumer switching costs, consumers maximizing their inter-temporal utility and the firms maximizing their inter-temporal own-currency profits. An exporter's optimal pricing policy with switching costs was derived, showing that in the presence of switching costs, the effect of a change in present exchange rates on trade prices depended on whether the change in exchange rates was seen as a temporary or a permanent. Using bilateral trade prices between the members of the European Monetary Union (EMS) and between EMS members and non-EMS trading partners, their empirical results indicated that the EMS enhanced trade adjustment, but that smooth trade adjustment could also be achieved under flexible exchange rates.

Bourdet (1996) studied pass-through of exchange rates into import prices under different exchange rate regimes in Swedish car markets. Hedonic price indexes were estimated for exporting countries for both fixed and floating exchange rate periods. The empirical results showed that the exchange rate regime has an effect on price adjustment, with the pass-through seeming to be less complete under floating exchange rates. Moreover, price changes were slower under a floating, rather than under a fixed, exchange rate regime.

4 DYNAMIC PASS-THROUGH MODEL

4.1 Theoretical model

4.1.1 General

For this study, a two-period model of a non-competitive industry was employed. Two representative firms are assumed to be competing in a market which is foreign to one and domestic to the other. In order to study the pricing behavior of the industry, it is assumed that firms' second-period demand depends on first-period market share. A similar approach to this was used by Froot and Klemperer (1989) and Sapir and Sekkat (1995). A justification for this assumption, and an explanation for the relationship between first and second periods, can arise, for example, from switching costs faced by the customer. Switching costs typically originate from a consumer's desire for compatibility between current purchases and previous investments. This is a reasonable assumption to make for the forest industry, where customers often face significant costs if they decide to change supplier, even though the products of different suppliers are practically homogeneous. Particularly in the paper industry, customer's production lines are typically set for very specific paper grades, and contracts are often for long time periods.

It is further assumed that: (1) the domestic firm produces in domestic country, and exports all its production to the foreign country[1]; (2) the foreign firm produces in the foreign country and sells all of its production in the foreign country. Both firms are assumed to receive payment for their sales in foreign currency, but want to maximize their profits in their own currency. Thus, both firms seek to maximize the present value of their own-currency profits, where the second-period profits depend on first-period market share. This maximization problem can be solved by using backwards induction.

4.1.2 Second period

In the second period, customers are bound by their first period purchases. It is assumed that customers have a reservation price R_i, which determines their behavior with respect to changing suppliers. The reservation price depends on the price difference between suppliers i

[1] The model could also be constructed to allow the domestic firm to choose the place of production, i.e., divide its production between the domestic country and the foreign country. This approach would make it possible to examine the domestic firm's pricing behavior when the exchange rate changes affect the profits through both the price and the costs. According to the studies by, e.g., Aizenman (1991), Goldberg ans Kolstad (1995) and Gron and Swenson (1996) in the presence of the exchange rate uncertainty the firms do diversify their production geographically.

and j and the switching cost and can be expressed as:

(1) $R_i = (p_{2i} - p_{2j}) - sq_{1i}$

where p_{2i} and p_{2j} are the second period prices for each supplier, s is the marginal switching cost, and q_{1i} is the first period demand.

In duopoly cases, assuming constant and equal marginal costs for both supplier, the reservation price would be:

(2) $R_i = -sq_{1i}$

Since the second period demand depends on the first period demand, the linear forms of the inverse demands in the second period for domestic and foreign firms, respectively, are:

(3) $P_{21} = a - R_1 - q_{21} - q_{22}$

(4) $P_{22} = a - R_2 - q_{22} - q_{21}$

Thus, the own currency profit maximizing problem for both firms in the second period can be written in the form:

(5) $\max \pi_{21} = (e_E P_{21} - c_{21})q_{21} = (e_E(a + sq_{11} - q_{21} - q_{22}) - c_{21})q_{21}$

(6) $\max \pi_{22} = (P_{22} - c_{22})q_{22} = (a + sq_{12} - q_{22} - q_{21} - c_{22})q_{22}$

The second period exchange rate e_E is merely the expectation of the exchange rate in the second period:

(7) $e_E = E[e_2] = \Phi e_m + (1-\Phi)e_p = \Phi e_m + (1-\Phi)e_1$,

where, with probability *(1-Φ)*, the exchange rate is considered permanent, i.e., the exchange rate in the second period equals the exchange rate in the first period, e_1.

Both firms solve their maximization problems taking the other firm's decisions as given. Therefore, the optimal quantities for the domestic and the foreign firm are respectively:

(8) $q_{21}^* = \frac{a - 2c_{21}/e_E + c_{22}}{3} + s\frac{2q_{11} - q_{12}}{3}$

(9) $q_{22}^* = \frac{a - 2c_{22} + c_{21}/e_E}{3} + s\frac{2q_{12} - q_{11}}{3}$

where the second RHS term describes the effect of the switching costs. Using these optimal quantities the second period profits can be expressed:

(10) $\pi_{21}^{*} = e_E(q_{21}^{*})^2$

(11) $\pi_{22}^{*} = (q_{22}^{*})^2$

4.1.3 First period

In the first period customers can choose the supplier without any constraints, since they have not yet purchased products from either supplier. Therefore, the first period inverse demand functions for domestic and foreign firms are of the form:

(12) $P_{11} = a - q_{11} - q_{12}$

(13) $P_{12} = a - q_{12} - q_{11}$

In the first period both the domestic firm and the foreign firm maximize their intertemporal own-currency profits:

(14) $\max \pi_{11} = (e_1 P_{11} - c_{11})q_{11} + E[e_E(q_{21}^{*})^2]$

(15) $\max \pi_{12} = (P_{12} - c_{12})q_{12} + E[(q_{22}^{*})^2]$

Solving the intertemporal maximization problems for both the domestic and the foreign firm, the following optimal quantities are obtained:

(16) $q_{11}^{*} = \dfrac{9\sigma\varphi_{11} - \varphi_{12}\rho_e + \varphi_{22}\rho_e + 4\sigma\varphi_{21}}{\sigma\sigma_e - 81e_1 + 36s^2(e_1 - e_E) - 16e_E s^4}$

(17) $q_{12}^{*} = \dfrac{9\sigma_e\varphi_{12} - \varphi_{11}\rho + \varphi_{21}\rho + 4\sigma_e\varphi_{22}}{\sigma\sigma_e - 81e_1 + 36s^2(e_1 - e_E) - 16e_E s^4}$,

where:

$\varphi_{11} = (e_1 a - c_{11})$, $\varphi_{12} = (a - c_{12})$,

$\varphi_{21} = (e_E sa - 2sc_{21} - e_E sc_{22})$, $\varphi_{22} = (sa - 2sc_{22} - sc_{22}/e_E)$,

$\sigma = (18 - 8s^2)$, $\sigma_e = (18e_1 - 8e_E s^2)$,

$\rho = (81 + 36s^2)$ and $\rho_e = (81e_1 + 36e_E s^2)$

In order to study the pricing behavior of the domestic firm, the optimal quantities q_{11}^* and q_{12}^* are substituted to domestic firm's first period inverse demand function to obtain:

$$(18)\ P_{11}^* = a - \frac{9\sigma\varphi_{11} - \varphi_{12}\rho_e + \varphi_{22}\rho_e + 4\sigma\varphi_{21}}{\sigma\sigma_e - 81e_1 + 36s^2(e_1 - e_E) - 16e_E s^4} - \frac{9\sigma_e\varphi_{12} - \varphi_{11}\rho + \varphi_{21}\rho + 4\sigma_e\varphi_{22}}{\sigma\sigma_e - 81e_1 + 36s^2(e_1 - e_E) - 16e_E s^4}$$

Additionally, it can be theoretically shown that if exporters perceive the exchange rates permanent, they will change their prices more than if they perceive the exchange rate temporary. Derivation of this result is in Appendix 1.

4.2 Empirical model

To test the effects of exchange rate stability on export pricing, an estimable model is derived by totally differentiating the equation (18). The pricing equation is, thus:

$$(19)\quad dP_{11}^* = \frac{\partial P_{11}^*}{\partial c_{11}} dc_{11} + \frac{\partial P_{11}^*}{\partial c_{12}} dc_{12} + \frac{\partial P_{11}^*}{\partial e_1} de_1 + \frac{\partial P_{11}^*}{\partial e_E} de_E$$

Accordingly, trade prices are affected by both firms' costs, as well as by current and future exchange rates. The future exchange rates are exchange rate expectations, e_E, which are unobservable. However, the exchange rate expectations can also be written as a function of interest rates (e.g., Isard 1995). Thus, to express the exchange rate expectations as a variable which is observable, the uncovered interest parity (UIP) is invoked:

$$(20)\quad \mathrm{E}_t e_{t+1}(1 + r_{tf}) = e_t(1 + r_{td})$$

where r_{td} and r_{tf} are domestic and foreign interest rate, respectively, and e_t is the spot exchange rate. This expression for UIP approximates to (Isard 1995):

$$(21)\quad \mathrm{E}_t \log e_{t+1} - \log e_t \approx r_{td} - r_{tf}$$

Interest rates are observable, and in the empirical model the domestic firm's export price can, therefore, be expressed as a function of both firms' costs, the exchange rate, and interest rate differential between the domestic country and the foreign country:

$$(22)\quad p_{tdf} = \theta_1 c_{td} + \theta_2 c_{tf} + \theta_3 e_{tdf} + \theta_4 \Delta r_{tdf} + \varepsilon_t$$

The parameter θ_4 describes the effects of exchange rate stability in domestic firm's pricing behavior. If $\theta_4 = 0$, the pricing is explained completely by costs and current exchange rates,

and the domestic firm sees the exchange rate as permanent. If $\delta_4 \neq 0$, an interest rate effect is present, and the exchange rate is perceived as temporary. Thus, the hypothesis is that, under fixed exchange rate regimes, $\delta_4 = 0$, and, under floating exchange rate regimes, $\delta_4 \neq 0$, indicating that the exchange rate regime has an effect on export pricing behavior when market share matters. If the market share does not matter, the interest rate differential term should be absent as well[2]. Additionally, it is assumed that θ_1 and θ_2 are positive and θ_3 is negative. During the floating regime, θ_4 is assumed to be negative.

5 DATA

Estimation of the model was based on monthly data on the export unit values of Finnish and Swedish newsprint, uncoated printing and writing paper, and coated printing and writing paper[3], as well as on production costs, exchange rates and interest rates 1986-1997. Unit values in foreign currency for the German and British markets prior to 1992 were derived from Außenhandel and Business Monitor, respectively, and from 1992 on from the Eurostat Comext database. The respective SITC, NIMEXE and CN codes for products are in Appendix 2. Since the Comext database uses ECUs rather than national currencies, Eurostat official ECU rates for the German Mark and the Pound Sterling were used to derive the post-1992 foreign currency unit values.

Cost index 341.1 for pulp and paper industry[4] was obtained from Indicators for Industrial Activity (OECD 1988-1997). Average monthly exchange rates for Finnish Markka and Swedish Krona against German Mark and Pound Sterling were obtained from the Bank of Finland database. Interest rate differentials between exporters and importers were calculated from 12-month Eurorates (Bank of Finland database). Figures of foreign currency unit values, exchange rates and interest rate differentials for all estimated models are in Appendix 3.

Two sub-periods were recognized in this study to permit comparison of price adjustment under fixed and floating regimes as noted in the Table 1. The inconsistency in sub-period start and end dates reflects the variation in the timing of changes in exchange rate regimes. For

[2] It should be noted that if there was no relationship between periods then the model would yield results similar to those of Dornbusch (1987) and Krugman (1987).

[3] For both forest industry's and end user's purposes it would have been useful to divide the printing and writing papers into wood-free papers (i.e., fine papers) and wood containing papers, but some trade statistics are constructed in such manner that this was not possible.

[4] More specific cost variable would be desirable but the index is the only comparable one available for all countries in the study.

Finland and Sweden, the first sub-period reflects a fixed regime and the second a floating regime.

Table1. The sub-periods for both exporters.

Exporter	First sub-period*	Second sub-period**
Finland	1/87-6/91	9/92-10/96
Sweden	11/86-5/91	11/92-12/97

* The first sub-periods end when the pegs of Markka and Krona were switched from currency baskets to the ECU.

** The second sub-periods start when Markka and Krona were allowed to float and the second Finnish sub-period ends when Markka was pegged to the ECU again.

Although the sample periods are relatively short for the method used, frequent changes in the exchange rate regimes limit the length of the sub-periods available for empirical estimation of the model for any particular trade flow. Thus, the results are relatively sensitive and this needs to be born in mind when interpretating the results.

6 ESTIMATION METHOD

6.1 The statistical model

The starting point for the Johansen's method (Johansen 1988, 1995) is a p-dimensional vector autoregressive model with Gaussian errors:

$$(23) \quad z_t = \pi_1 z_{t-1} + \ldots + \pi_k z_{t-k} + \mu + \psi D_t + \varepsilon_t \qquad t=1,\ldots,T$$

where z_t is a p x 1 column vector of stochastic variables, μ is a p x 1 vector of constant terms (e.g., linear trend), D_t is a vector of nonstochastic variables (e.g., seasonal dummies), and ε_t is a p x 1 vector of error terms of NID(0, Ω).

Any cointegrated VAR(p) process can be reformulated in the error correction form:

$$(24) \quad \Delta z_t = \Gamma_1 \Delta z_{t-1} + \ldots + \Gamma_{k-1} \Delta z_{t-k+1} + \pi z_{t-1} + \mu + \psi D_t + \varepsilon_t ,$$

where Δz_t is a stationary vector. In the model k is the lag length. Introducing sufficient lags k is necessary in order to achieve a well behaved error term of NID(0, Ω).

The hypothesis of cointegration is linked to the reduced rank r of the p x p matrix where both α and β are r x p matrices of full rank. Assuming that $z_t \sim I(1)$, i.e., assuming that the series are integrated of order one, the components of z_t are cointegrated when the rank r of the impact

matrix Π is greater than zero, but less than p. When the rank r equals zero, the variables are not cointegrated even though they are integrated. When the rank r is full (i.e. r equals p), the variables are stationary by themselves, and normal statistical inference applies. The rank of the long run matrix determines the number of cointegrating vectors. The rows of *(r x p)* (i.e., β' terms) are the stationary cointegrating vectors and the columns of *(r x p)* (i.e., α terms) give the loading, i.e., the weights with which the error-correction terms enter each equation.

Johansen (1988) derives two likelihood ratio-tests for measuring the number of cointegrated vectors. The trace test for testing the rank of cointegrating matrix is calculated as:

$$(25) \quad Trace(r) = -T \sum_{i=r+1}^{p} \ln(1 - \hat{\lambda}_i),$$

where the λ_i are the eigenvalues. The null hypothesis is that there are at most r cointegrating vectors. Another version of the test, the maximum eigenvalue test is similar, except that here the null hypothesis is that there are r cointegrating vectors and the alternative hypothesis is that there are $r+1$ cointegrating vectors:

$$(26) \quad L\max(r) = -T \ln(1 - \hat{\lambda}_{r+1})$$

After determining the rank of the matrix, the model can be reestimated for a correct number of cointegrating vectors and both long-run and short-run linear restrictions can be tested. The test statistics are asymptotically χ^2 distributed.

6.2 Empirical formulation and hypotheses testing

A 5-dimensional VAR model corresponding to equations (23) and (24) was constructed for every product-exporter-importer combination separately, resulting in 24 estimated models. In every model, the vector z_t consists of monthly time series of export price, exporter's cost, importer's cost, exchange rate between exporter and importer and the interest rate differential between the two:

$$(27) \quad z_t = \left[p_{ijk}, c_i, c_j, e_{ij}, \Delta r_{ij} \right]_t$$

where $t=1,\ldots,T$ is the length of the sub-period, i corresponds to the exporter, j to the importer and k to the product.

The hypothesis of exporters' pricing behaviour under different exchange regimes (see p.6, hypothesis 1) was examined by testing for long-run exclusion of the interest rate differential term in all cointegration vectors $\beta_1^{'}$. The restriction on β can be expressed as given earlier:

(28) $\beta = H\varphi$

where in this case

(29) $$H = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

The models were also tested in a similar fashion for complete exchange rate pass-through (see p. 6, hypothesis 2) by modifying the H-matrix.

The short-run restrictions can be tested by restricting the loadings of the cointegration vectors, α:

(30) $B^{'}\alpha = 0$

where $B^{'}$, for example, is

(31) $B^{'} = [0 \quad 0 \quad 1 \quad 0]$

In this study the equation (31) tests for the weak exogeneity of exchange rate, and thus, corresponds to the hypothesis 3 on page 6.

7 RESULTS

7.1 Perceived exchange rate uncertainty

The number of cointegrating vectors in the models were determined by Johansen's rank tests[5]. Three cointegrating vectors were found in most models indicating that there are three linearly independent stationary long-run relationships embodied in the data. The cointegration vectors for all models are given in Tables 4.1.-4.4. in Appendix 4. The number of lags in individual models was commonly 2 and was chosen to be large enough to ensure that the models did not suffer from autocorrelation. The loadings of the cointegrations vectors in Finnish and Swedish models were generally small, implying that the convergence towards the long-run equilibrium is sluggish.

In order to test for the effects of the exchange rate stability on exporter pricing behavior, the interest rate differential variable in the β-vectors was restricted to 0. The null hypothesis for the test on restrictions is that the interest rate differential term can be excluded under a fixed exchange rate regime, but not under a floating regime. Moreover, according to theory, the cost terms were expected to be positive, the exchange rate negative and the interest rate differential negative for the floating exchange period.

The empirical results for export pricing by Finnish firms did not seem to follow *a priori* expectations. According to the results in Table 2, the hypothesis of long-run interest rate differential exclusion was rejected, indicating that the exchange rates were seen as temporary, even during the fixed exchange rate regime. For the second sub-period (i.e., the sub-period under a floating regime) the results indicated that the hypothesis can be rejected for the German market, as expected. However, for the United Kingdom market, the hypothesis of long-run exclusion can be accepted for both newsprint and uncoated printing and writing paper, implying that overall the exchange rate was seen as permanent in this market.

[5] There were estimation problems with three Swedish models for the second sub-period, namely Swedish pulp exports to the UK, Swedish newsprint exports to the UK and Swedish coated printing and writing paper exports to the UK. More precisely, the largest characteristic root in each model was larger than unity, meaning that the process is explosive, and the Johansen cointegration method might not be appropriate. However, these roots were close to one, 1.0025, 1.0355 and 1.0073 respectively, and random variation would be expected to result in some roots greater than one given the number of models estimated. Therefore, also these three models were estimated by using the Johansen method.

Table 2. Interest rate differential long-run exclusion in Finnish models.

Model	**LR-test values**	**(p-value)**
Product/Exporter/Importer	1987-1991	1992-1996
Newsprint/Finland/Germany	41.66* (0.00)	12.17* (0.01)
Uncoated/Finland/Germany	33.66* (0.00)	18.76* (0.00)
Coated/Finland/Germany	14.71* (0.00)	8.11* (0.04)
Newsprint/Finland/UK	40.59* (0.00)	5.66 (0.06)
Uncoated /Finland/UK	31.57* (0.00)	0.90 (0.64)
Coated/Finland/UK	25.91* (0.00)	8.88* (0.01)

* = exceeds the 5 % critical value for χ^2 test with appropriate degrees of freedom.

Similarly to the results from the Finnish models, pricing in Swedish models during the fixed regime period was not consistent with expectations (Table 3). Results for the second sub-period indicate that the hypotheses can be rejected in the UK market, as expected. In all German models, however, the hypothesis is accepted, contrary to prior expectations.

Table 3. Interest rate differential long-run exclusion in Swedish models.

Model	**LR-test values**	**(p-value)**
Product/Exporter/Importer	1986-1991	1992-1997
Newsprint/Sweden/Germany	11.89* (0.01)	3.30 (0.19)
Uncoated /Sweden/Germany	44.36* (0.00)	4.39 (0.11)
Coated/Sweden/Germany	9.96* (0.02)	8.12 (0.02)
Newsprint/Sweden/UK	24.64* (0.00)	26.61* (0.00)
Uncoated /Sweden/UK	19.51* (0.00)	14.84* (0.00)
Coated/Sweden/UK	12.03* (0.00)	14.45* (0.00)

* = exceeds the 5 % critical value for χ^2 test with appropriate degrees of freedom.

7.2 Exchange rate pass-through

By restricting the exchange rate variable in individual models' cointegration relations, the models could, however, be tested for complete exchange rate pass-through. The results of estimating the Finnish models with these restrictions are shown in Table 4 (complete pass-through to foreign currency prices) and Table 5 (complete pass-through to domestic currency prices).

Table 4. Test for complete pass-through to foreign currency prices in Finnish models.

Model	**LR-test values**	**(p-value)**
Product/Exporter/Importer	1987-1991	1992-1996
Newsprint/Finland/Germany	10.80* (0.01)	14.80* (0.00)
Uncoated/Finland/Germany	7.39* (0.02)	19.73* (0.00)
Coated/Finland/Germany	13.78* (0.00)	17.11* (0.00)
Newsprint/Finland/UK	36.53* (0.00)	15.00* (0.00)
Uncoated /Finland/UK	35.87* (0.00)	15.98* (0.00)
Coated/Finland/UK	18.56* (0.00)	22.86* (0.00)

* = exceeds the 5 % critical value for χ^2 test with appropriate degrees of freedom.

Table 5. Test for complete pass-through to domestic currency prices in Finnish models.

Model	**LR-test values**	**(p-value)**
Product/Exporter/Importer	1987-1991	1992-1996
Newsprint/Finland/Germany	9.48* (0.02)	16.88* (0.00)
Uncoated/Finland/Germany	11.11* (0.00)	21.85* (0.00)
Coated/Finland/Germany	15.23* (0.00)	13.77* (0.00)
Newsprint/Finland/UK	37.70* (0.00)	7.41* (0.02)
Uncoated /Finland/UK	37.37* (0.00)	18.78* (0.00)
Coated/Finland/UK	37.13* (0.00)	2.07 (0.36)

* = exceeds the 5 % critical value for χ^2 test with appropriate degrees of freedom.

The results suggest that there was no complete exchange rate pass-through to foreign currency prices in the Finnish models during either sub-period. Similarly, there was no complete pass-through to domestic prices, except in case of coated printing and writing paper exports to the UK during the second sub-period. On the whole, pass-through tests for the Finnish models imply incomplete pass-through for all paper grades.

The results for the Swedish models are in Table 6 (complete pass-through to foreign currency prices) and Table 7 (complete pass-through to domestic currency prices). They indicate that in most of the Swedish models there was not complete exchange rate pass-through to foreign currency, exceptions being the uncoated printing and writing paper exports to the UK in the first sub-period and the coated printing and writing paper exports to the UK in both sub-periods. The results of tests for complete exchange rate pass-through to domestic prices were more varied, but suggested incomplete pass-through in more than half of the models. Overall, the pass-through tests for Swedish models imply incomplete pass-through in imports of Swedish papers.

Table 6. Test for complete pass-through to foreign currency prices in Swedish models.

Model	LR-test values	(p-value)
Product/Exporter/Importer	1986-1991	1992-1997
Newsprint/Sweden/Germany	23.01* (0.00)	19.08* (0.00)
Uncoated /Sweden/Germany	47.43* (0.00)	12.92* (0.00)
Coated/Sweden/Germany	29.04* (0.00)	21.31* (0.00)
Newsprint/Sweden/UK	13.36* (0.00)	22.76* (0.00)
Uncoated /Sweden/UK	1.42 (0.49)	54.65* (0.00)
Coated/Sweden/UK	3.98 (0.26)	0.54 (0.76)

* = exceeds the 5 % critical value for χ^2 test with appropriate degrees of freedom.

Table 7. Test for complete pass-through to domestic currency prices in Swedish models.

Model	LR-test values	(p-value)
Product/Exporter/Importer	1986-1991	1992-1997
Newsprint/Sweden/Germany	17.55* (0.00)	11.77* (0.00)
Uncoated /Sweden/Germany	21.31* (0.00)	7.74* (0.02)
Coated/Sweden/Germany	21.58* (0.00)	4.84 (0.09)
Newsprint/Sweden/UK	3.11 (0.21)	18.38* (0.00)
Uncoated /Sweden/UK	4.65 (0.10)	51.22* (0.00)
Coated/Sweden/UK	3.01 (0.39)	1.65 (0.44)

* = exceeds the 5 % critical value for χ^2 test with appropriate degrees of freedom.

The determination of exact degree of exchange rate pass-through was somewhat difficult. Only in the models where it is possible to identify one of the cointegrating vectors as corresponding to the underlying theory can the exchange rate pass-through be determined. The identification of vectors was troublesome in this data, possibly due to the relatively short nature of monthly data series, which do not describe the long-run relationships well. No single vectors could be identified. There are, however, some ways of getting estimates for the exchange rate pass-through in such a model, but this is beyond the scope of this paper.[6]

The overall results of incomplete exchange rate pass-through are in accordance with several previous studies concerning paper markets. The studies by Uusivuori and Buongiorno (1990), as well as, by Vesala (1992), indicated that pass-through in export prices for paper was incomplete and, in fact, relatively low. On the other hand, a study by Hänninen and Toppinen (1999) indicated that the pass-through is 0.60 and 0.46 for Finnish newsprint exports to the United Kingdom and Germany, respectively. These results also agree with the conclusion

[6] For further information on estimating exchange exchange rate pass-through when identification of cointegrating vectors fails, see Laaksonen (1998).

reached by Hung *et al.* (1993), that exchange rate has smaller effects on export price than previous studies would indicate.

7.3 Weak exogeneity of exchange rate

The purpose of testing for weak exogeneity is to determine whether differences in the exchange rate variable contain any information about the long-run parameter β. In this case, testing the weak exogeneity of exchange rate will imply whether the industry's pricing behavior has any effect on exchange rates. Especially since product level data was used, it was assumed that under both exchange rate regimes the exchange rates would be weakly exogeneous and that the test hypothesis would be accepted, indicating that the exchange rates affect prices but not vice versa.

The results of testing for weak exogeneity in the Finnish models are given in the Table 8. For the German models, during the first sub-period the hypothesis of weak exogeneity was accepted according to expectations, and therefore, the exchange rate differential does not contain information about the β vectors, i.e., prices are assumed to have no effect on exchange rate. With newsprint exports to the UK, as well as with coated printing and writing paper exports to the UK and Germany during the floating period, the product price was indicated to affect the exchange rate. The hypothesis of weak exogeneity was, however, rejected in all UK cases for the fixed regime sub-period (1987/1-1991/6). Similar results were found for the floating regime for the newsprint exports to Germany and uncoated printing and writing paper exports to Germany and the U.K. Especially for the floating period, the result that product level prices would have an effect on the exchange rate is abnormal and very hard to justify. It is possible that the small number of observation have had an effect on these results.

Table 8. Weak exogeneity of the exchange rate in Finnish models.

Model	**LR-test values (p-value)**	
Product/Exporter/Importer	1987-1991	1992-1996
Newsprint/Finland/Germany	5.28 (0.15)	11.92* (0.01)
Uncoated/Finland/Germany	1.85 (0.40)	9.68* (0.02)
Coated/Finland/Germany	2.34 (0.51)	6.03 (0.11)
Newsprint/Finland/UK	6.04* (0.00)	2.23 (0.33)
Uncoated /Finland/UK	23.60* (0.00)	17.95* (0.00)
Coated/Finland/UK	20.96* (0.00)	2.23 (0.33)

* = exceeds the 5 % critical value for χ^2 test with appropriate degrees of freedom

The results for weak exogeneity of exchange rate for Swedish models are given in the Table 9. In all cases in the fixed regime period (i.e., first sub-period), the hypothesis of weak exogeneity was accepted. This result was expected, and indicates that the loadings of the exchange rate variable do not convey information about the long-run relationships, i.e., exchange rates have an effect on prices, but not vice versa. The contrary result was found during the floating regime period for all UK cases and also for German newsprint imports from Finland. As in the Finnish cases, this kind of result is puzzling and might indicate problems with the data.

Table 9. Weak exogeneity of the exchange rate in Swedish models.

Model	**LR-test values (p-value)**	
Product/Exporter/Importer	1986-1991	1992-1997
Newsprint/Sweden/Germany	3.63 (0.30)	6.41* (0.04)
Uncoated /Sweden/Germany	2.11 (0.55)	3.79 (0.15)
Coated/Sweden/Germany	2.45 (0.49)	0.78 (0.68)
Newsprint/Sweden/UK	2.00 (0.37)	25.04* (0.00)
Uncoated /Sweden/UK	1.11 (0.57)	24.93* (0.00)
Coated/Sweden/UK	1.61 (0.66)	7.37* (0.03)

* = exceeds the 5 % critical value for χ^2 test with appropriate degrees of freedom

The results from the empirical testing of weak exogeneity of exchange rate variable were, in several cases, not in accordance with expectations. Since the results were unexpected, the weak exogeneity of the interest rate differential variable was also tested, with similar. Finding an explanation for these results is difficult. It cannot be expected that an export price of a single paper grade could have an effect on exchange rate, especially a floating one. It is possible that problems with short time series could lead to this unexpected result.

8 CONCLUSIONS

This paper contributes to the understanding of export price adjustment of forest products under fixed and floating exchange rate regimes. The theoretical framework for this study anticipated that exchange rates would be perceived as permanent under a fixed exchange rate regime, and as temporary under a floating regime. The results of empirical tests were somewhat mixed. None of the 12 fixed exchange rate regime models supported the interest rate differential long-run exclusion, i.e, exporter's perception of permanent exchange rates. On the other hand, 7 of the 12 floating exchange rate regime models had results conforming to

expectations. The theoretical model further assumed that exchange rate pass-through would be larger under fixed than under floating regimes. Due to identification problems the difference in the degree of pass-through under fixed and floating exchange rate regimes could not be empirically tested. However, the empirical results did clearly indicate that the exchange rate pass-through was incomplete under both exchange rate regimes.

The empirical results would indicate that the Finnish forest industry did not feel that a fixed regime reduced exchange rate uncertainty and the industry perceived in the exchange rates as temporary. An explanation for this perception could be the instability in domestic economy as Finland experienced an exceptionally strong boom at the end of the 1980's, followed by one of her deepest recessions ever, due to the collapse of the Soviet Union, Finland's largest trading partner, and the simultaneous recession in the European market. Moreover, it could be considered that the forest industry might have had self-realizing expectations of future exchange rate changes, which were taken into account in decisions designed to maintain their market share. In the past, the Finnish forest industry, among other export industries, appealed for devaluations of the Markka when they have perceived it to be "too strong", and the government was often not united in its rejection of these demands.

The pricing behavior of Sweden's forest industry was similar to that of Finland's. This is an interesting finding because the Swedish economy was more stable during the end of 1980's and the beginning of 1990's. Sweden's decent into recession was not as fast or deep as Finland's. Moreover, the Riksbanken and the government strongly advocated and supported a hard Krona policy throughout the 1980's, and the fixed exchange rate also had almost unanimous support from the unions and industry representatives (Hörngren and Lindberg 1994). This would imply that, even with this wide base of support, the Swedish Krona's peg was not found more credible than Finnish Markka's.

The results for both exporter countries implied that, even under a floating exchange rate regime, in some models the exchange rate was seen as permanent. This finding is difficult to justify. However, Finland, Sweden, and the UK were all hit by the same turmoil in exchange rate markets at the end of 1992. All these countries let their currencies float, and throughout the 1990's their exchange rate and interest rate movements closely tracked one another's. Since the testing of exporters' perceptions about future exchange rates closely relates to these rates through the UIP used in the study, this phenomenon could be related to this assumption of the study.

Overall, the estimation results seemed to imply that exporter pricing behaviour is affected by exchange rate expectations but not by the exchange rate regime. For example, a fixed exchange rate regime does not necessarily reduce exchange rate uncertainty unless the exchange rates are credible and the government is committed to defending the peg. Only a credible peg lends protection from speculative attacks on a currency, reducing exporters' perceived uncertainty about future exchange rates. The credibility of the European Monetary System in the 1980's could explain the finding of Sapir and Sekkat (1995) that a fixed regime (in their case the EMS) enhances adjustment. The results in this study would also indicate that a floating exchange rate regime does not necessarily foster a perception of increased uncertainty which is in agreement with the Sapir and Sekkat result that the adjustment process is not necessarily hindered by flexible rates.

Moreover, the results of this study suggested that export industries in small open economies, like Finland and Sweden, have taken into consideration uncertainty about future exchange rates, even when the exchange rate uncertainty should have been reduced by a fixed exchange rate regime. Due to this remaining uncertainty, it is possible that Finnish and Swedish forest product exporters have not realized the benefits commonly associated with fixed exchange rate regimes. This could further indicate that Finland and Sweden might have difficulties capturing the potential gains from a single currency that are generally expected in the first few years. The results would then, by extension, also imply that the failure of Finland and Sweden to join the EMU concurrently might not have resulted in a competitive advantage to Finland, whereas it had been suggested that it would have been most advantageous for both countries' forest industries if Finland and Sweden had joined the EMU simultaneously.

The European market will change considerably since the Euro will remove all exchange rate uncertainty from trade between the EMU countries, and therefore, Finland will benefit from this exchange rate stability in her trade with, e.g., Germany. Consequently, Finnish forest product exporters' pricing behaviour at the Euro market will most likely differ from earlier behaviour as there are no exchange rate changes to adjust prices for. The Euro is also very likely to be a much harder currency than either the fixed Markka or Krona was. Therefore, the Euro could reduce the exchange rate uncertainty in the trade with non-EMU countries to a greater extent than the fixed regimes have done in the past, and thus, modify export pricing both in EMU and non-EMU countries.

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Appendix 1. Exchange rate pass-through under fixed and floating regimes.

Assuming the presence of switching costs and that the exchange rate is seen as permanent, i.e., e_E is e_p, and thus equals to e_1, the partial derivative of domestic firm's second period inverse demand with respect to e_p is:

$$(19)\quad \frac{\partial P_{11}^*}{\partial e_p} = \frac{(\sigma^2 e_1 - e_1\eta)(-9\sigma a + \varphi_{12}\phi - \varphi_{\partial 2}\gamma - 4\sigma\varphi_\partial - 9\sigma\varphi_{12} + a\rho + \varphi_\partial\rho - 4\varphi_{\partial 2}\sigma)}{(\sigma^2 e_1 - e_1\eta)^2} - \frac{(-9a\sigma\varphi_{11} + \varphi_{12}e_1\phi - \varphi_{22}e_1\gamma - 4\sigma\varphi_{21} - 9\sigma e_1\varphi_{12} + \varphi_{11}\rho - \varphi_{21}\rho - 4e_1\sigma\varphi_{22})(\sigma^2 - \eta)}{(\sigma^2 e_1 - e_1\eta)^2}$$

where:

$\sigma, \sigma_e, \rho, \rho_e, \varphi_{11}, \varphi_{12}, \varphi_{21}, \varphi_{22}$ are as defined before and

$\beta = (36e_1 s c_{21} / e_m^2 - 16as^3 - 32s^2 c_{22})$

$\phi = (81 + 36s^2)$

$\varphi_\partial = (as - 2sc_{22})$

$\gamma = (36 - 16s^2)$

$\eta = (81 + 16s^4)$

Equation (19) is always negative.

On the other hand, assuming that the realization of the expected exchange rate is seen as temporary, i.e., e_E is e_m, and that the switching costs are present, the partial derivative of domestic firm's second period inverse demand with respect to e_m is:

$$(20)\quad \frac{\partial P_{11}^*}{\partial e_m} = \frac{(\sigma\sigma_e - 81e_1 + 36s^2(e_1 - e_m) - 16e_m s^4)(\varphi_{12}36s^2 - 2\beta - 4\varphi_\partial + 72s^2 - \varphi_\partial\rho + 4\beta)}{(\sigma\sigma_e - 81e_1 - 36s^2(e_1 - e_m) - 16e_m s^4)^2} - \frac{(-9\sigma\varphi_{11} + \varphi_{12}e_1\phi - \varphi_{22}e_1\gamma - 4\sigma\varphi_{21} - 9\sigma e_1\varphi_{12} + \varphi_{11}\rho - \varphi_{21}\rho - 4e_1\sigma\varphi_{22})(8s^2\sigma - 36s^2 - 16s^4)}{(\sigma\sigma_e - 81e_1 - 36s^2(e_1 - e_m) - 16e_m s^4)^2}$$

Like equation (19), equation (20) is always negative. It is also smaller in absolute value than (19). Therefore, the theoretical results from the model imply that, in the case of fixed exchange rates, i.e., when the exchange rates are perceived to be permanent, exporters are willing to change their prices more than if they were operating under a floating exchange regime. This is consistent with the notion that the market share is an investment when the second period demand depends on first period demand. A temporary devaluation (appreciation) of exchange rate makes the future own-currency profits more (less) valuable

than the current own-currency profits, and thus market share is more (less) valuable. Therefore, firms will prefer to increase (decrease) their market shares, and are not (are more) willing to change their prices in response to a change in the exchange rate.

Appendix 2. CN, NIMEXE and SITC codes for all products.

German trade statistics:

1987
Pulp: 4701 712, 4701 714, 4701 790
Newsprint: 4801 010, 4801 790
Uncoated printing and writing paper: 4801 806, 4801 807, 4801 816, 4801 817
Coated printing and writing paper: 4807 570, 4807 590

1988-1991
Pulp: 4703 21, 4703 29
Newsprint: 4801 00 10, 4801 00 90
Uncoated printing and writing paper: 4802 52 006, 4802 52 008, 4802 60 106, 4802 60 108, 4802 60 906, 4802 60 908
Coated printing and writing paper: 4810 11 902, 4810 11 904, 4810 21 000, 4810 29 109, 4810 29 900

British trade statistics:

1987
Pulp: 251.72
Newsprint: 641.10 (included in 641.21)
Uncoated printing and writing paper: 641.21
Coated printing and writing paper: 641.22

1988-1991
Pulp: 251.51, 251.52
Newsprint: 641.1
Uncoated printing and writing paper: 641.26, 641.29
Coated printing and writing paper: 641.32, 641.34

Eurostat Comext database:

1992-1996
Pulp: 470321, 470329
Newsprint: 480100
Uncoated printing and writing paper: 480252, 480260
Coated printing and writing paper: 481011, 481021, 481029

Appendix 3. Figures of foreign currency unit values, exchange rates and interest rate differentials in all models.

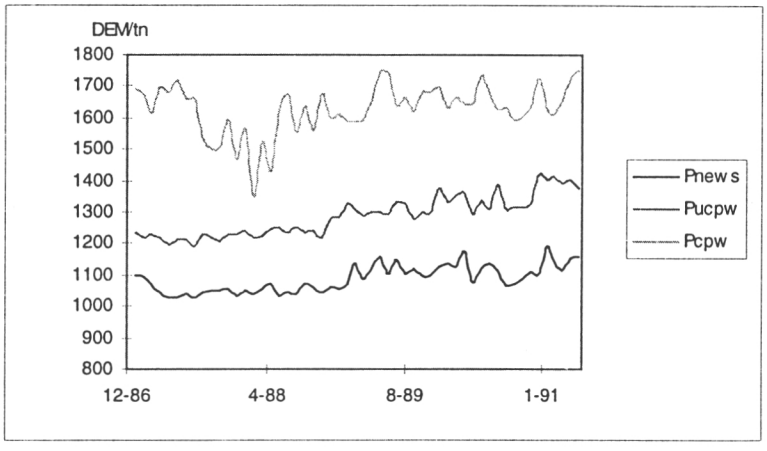

Figure 3.1.A. Newsprint, uncoated printing and writing paper and coated printing and writing paper export prices from Finland to Germany 1987/1-1991/6.

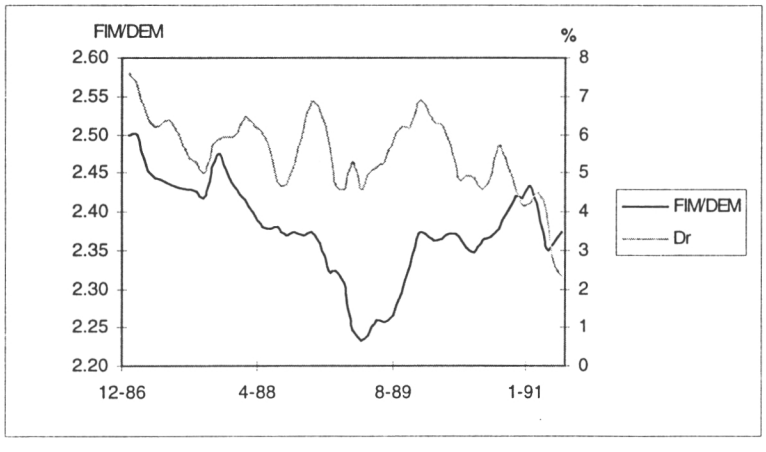

Figure 3.1.B. FIM/DEM exchange rate and the Finnish/German interest rate differential 1987/1-1991/6.

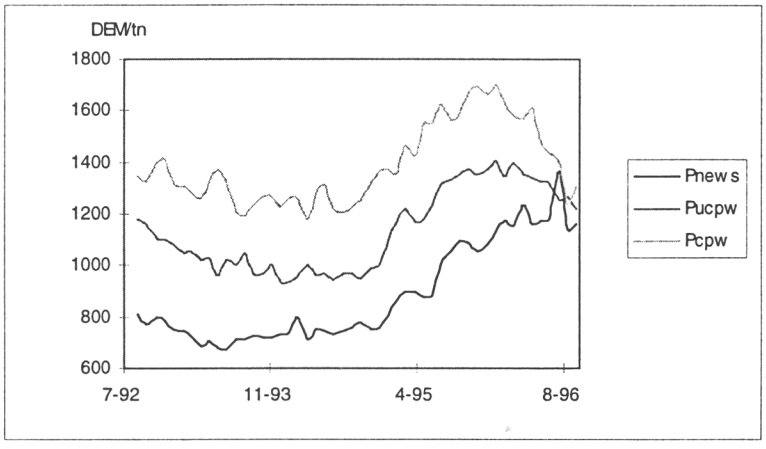

Figure 3.2.A. Newsprint, uncoated printing and writing paper and coated printing and writing paper export prices from Finland to Germany 1992/9-1996/10.

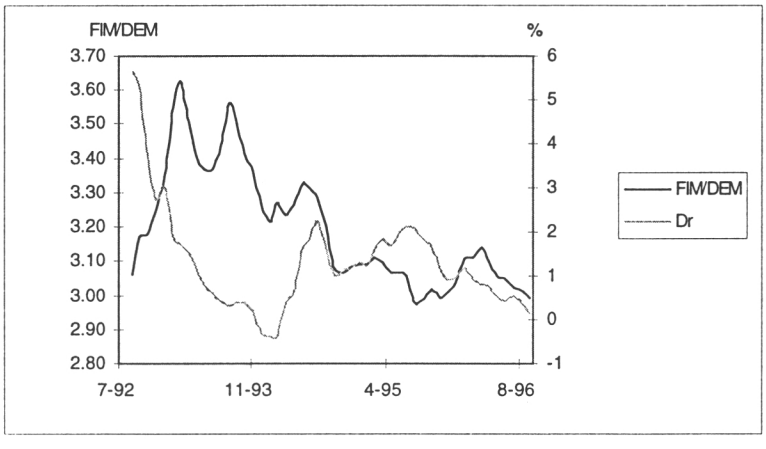

Figure 3.2.B. FIM/DEM exchange rate and the Finnish/German interest rate differential 1992/9-1996/10.

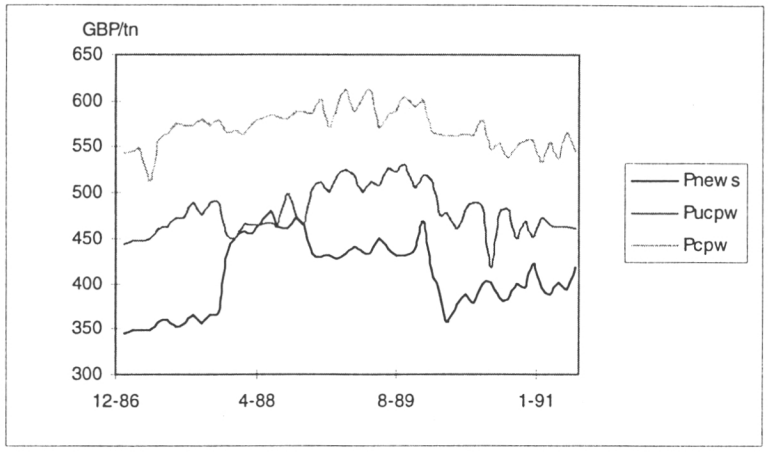

Figure 3.3.A. Newsprint, uncoated printing and writing paper and coated printing and writing paper export prices from Finland to the United Kingdom 1987/1-1991/6.

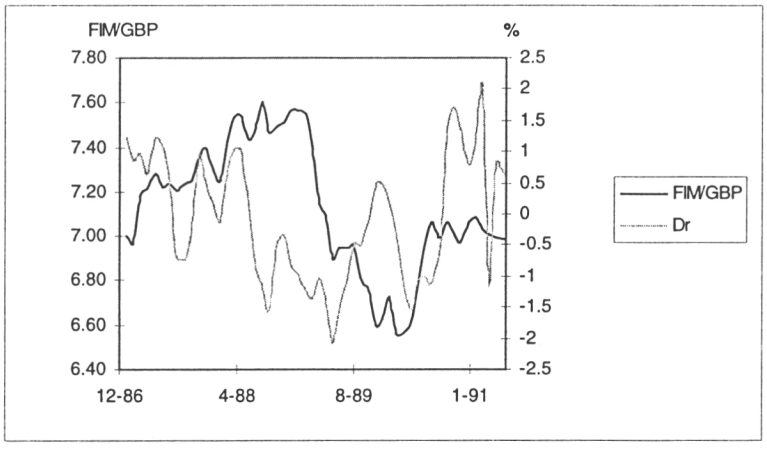

Figure 3.3.B. FIM/GBP exchange rate and the Finnish/British interest rate differential 1987/1-1991/6.

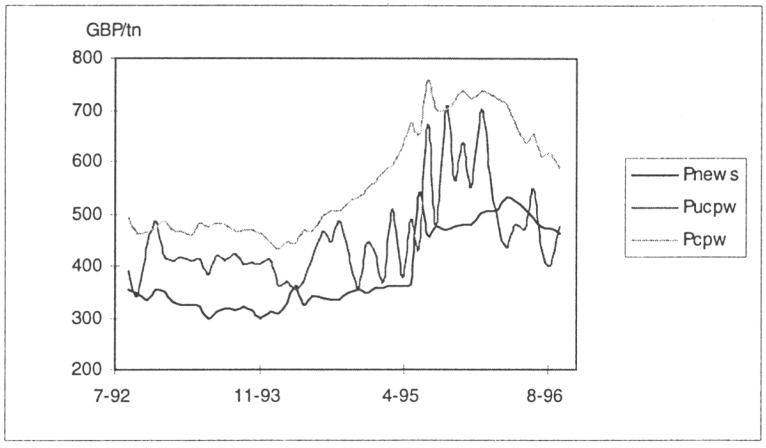

Figure 3.4.A. Newsprint, uncoated printing and writing paper and coated printing and writing paper export prices from Finland to the United Kingdom 1992/9-1996/10.

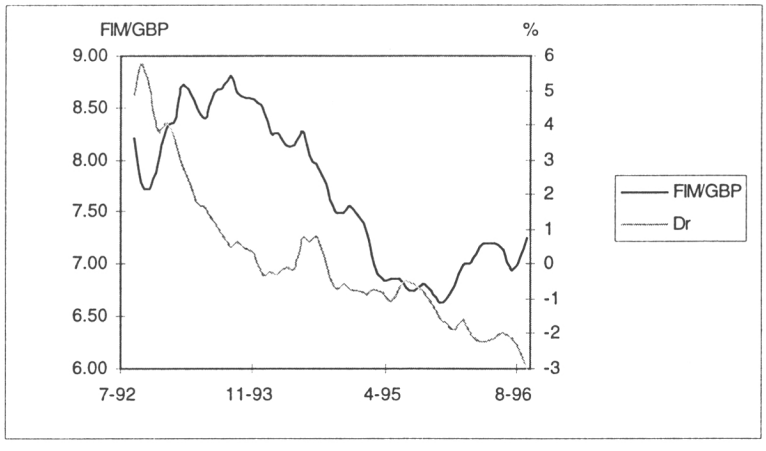

Figure 3.4.B. FIM/GBP exchange rate and the Finnish/British interest rate differential 1992/9-1996/10.

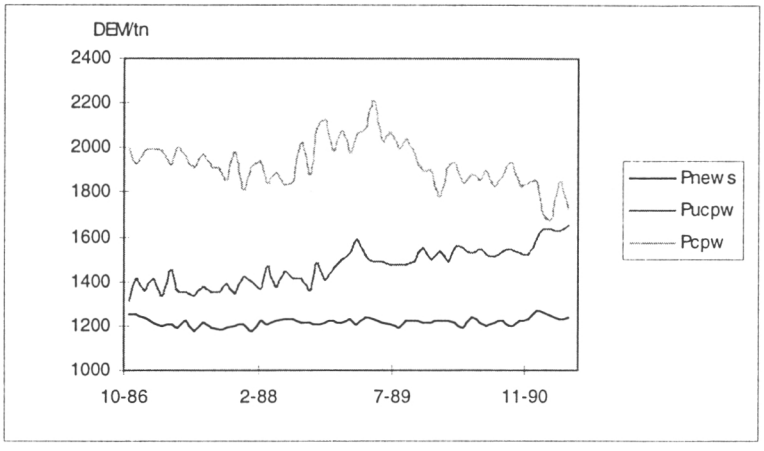

Figure 3.5.A. Newsprint, uncoated printing and writing paper and coated printing and writing paper export prices from Sweden to Germany 1986/11-1991/5.

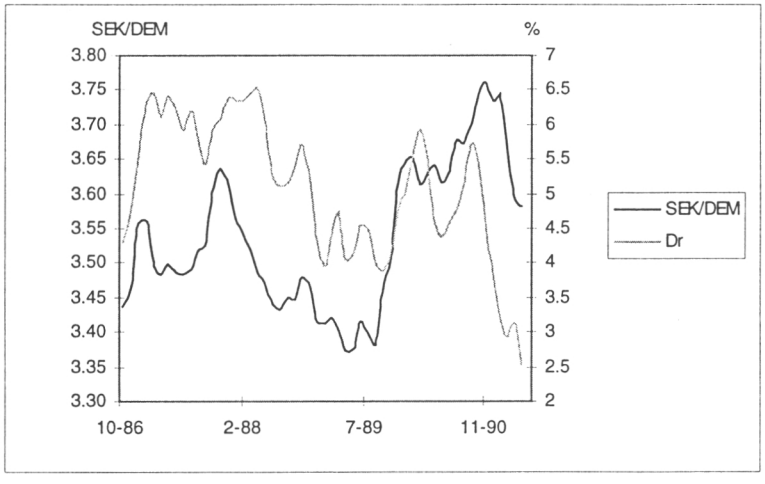

Figure 3.5.B. SEK/DEM exchange rate and the Swedish/German interest rate differential 1986/11-1991/5.

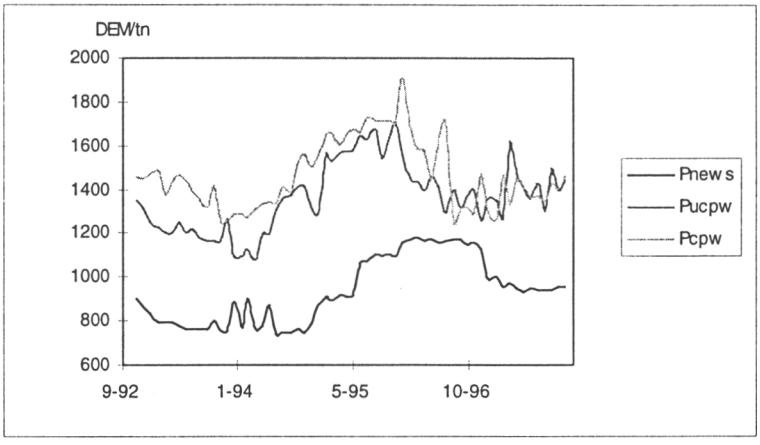

Figure 3.6.A. Newsprint, uncoated printing and writing paper and coated printing and writing paper export prices from Sweden to Germany 1992/11-1997/12.

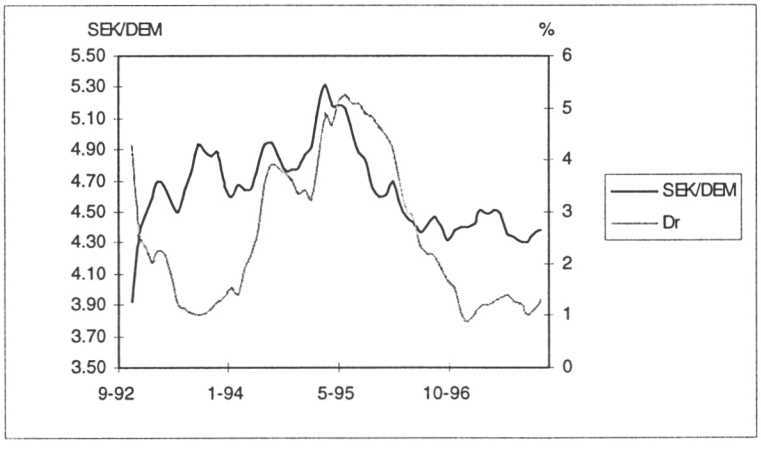

Figure 3.6.B. SEK/DEM exchange rate and the Swedish/German interest rate differential 1992/11-1997/12.

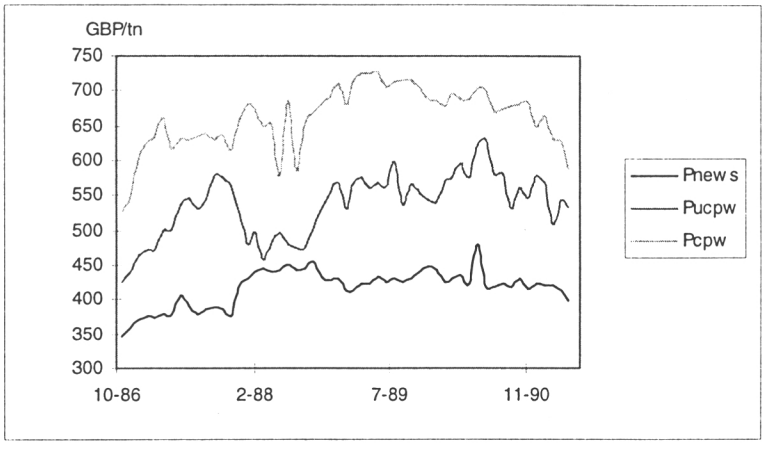

Figure 3.7.A. Newsprint, uncoated printing and writing paper and coated printing and writing paper export prices from Sweden to the United Kingdom 1986/1-1991/5.

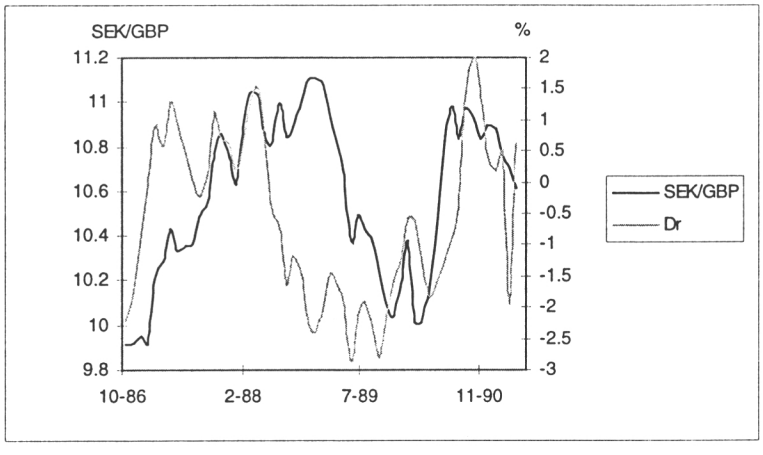

Figure 3.7.B. SEK/GBP exchange rate and the Swedish/British interest rate differential 1986/1-1991/5.

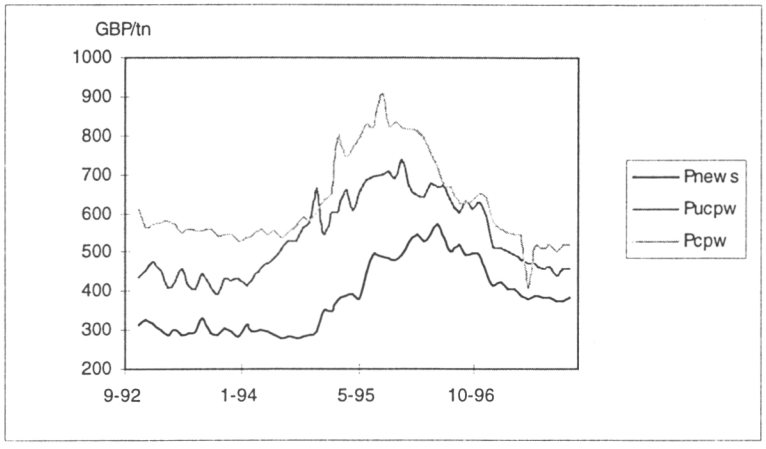

Figure 3.8.A. Newsprint, uncoated printing and writing paper and coated printing and writing paper export prices from Sweden to the United Kingdom 1992/11-1997/12.

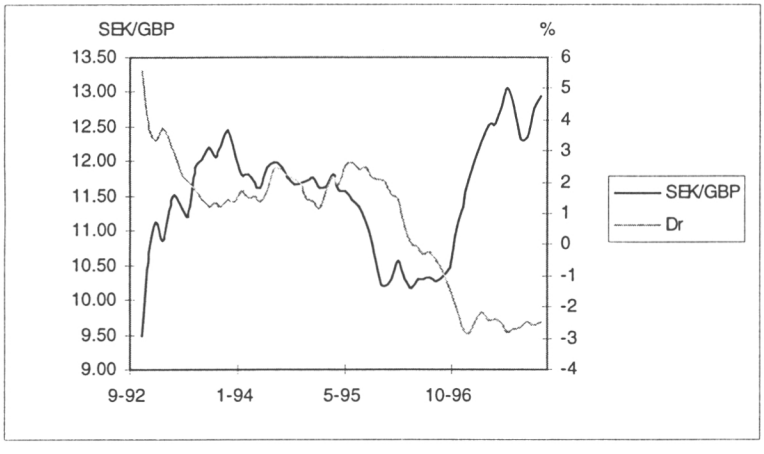

Figure 3.8.B. SEK/GBP exchange rate and the Swedish/British interest rate differential 1992/11-1997/12.

Appendix 4. Cointegration vectors in all models.

Table 4.1. Cointegration vectors in Finnish models for 1987-1991.

Models	Variables				
Product/Exporter/Importer	p	$c_{exporter}$	$c_{importer}$	e	dr
Newsprint/Finland/Germany	1.000	-0.438	0.114	-0.437	0.141
	1.000	-0.795	5.920	2.670	0.521
	1.000	2.863	-3.541	2.059	0.032
Uncoated/Finland/Germany	1.000	-0.545	0.663	-0.465	0.243
	1.000	4.226	6.340	14.750	0.359
Coated/Finland/Germany	1.000	-1.282	-11.774	-9.899	-0.775
	1.000	6.138	-9.172	3.958	-0.308
	1.000	-0.414	-0.334	-2.443	0.277
Newsprint/Finland/UK	1.000	-3.831	0.744	-3.478	-2.380
	1.000	0.624	-0.987	0.877	-0.417
	1.000	-5.124	1.115	-1.676	-1.293
Uncoated/Finland/UK	1.000	1.270	-0.775	1.818	0.943
	1.000	-1.063	0.061	-0.284	-0.198
	1.000	0.674	2.415	-2.908	3.728
Coated/Finland/UK	1.000	-8.842	3.534	-7.660	-3.679
	1.000	-0.341	0.283	-0.034	0.174
	1.000	-0.673	-0.242	0.279	-0.715

Table 4.2. Cointegration vectors in Finnish models for 1992-1996.

Models	Variables				
Product/Exporter/Importer	p	$c_{exporter}$	$c_{importer}$	e	dr
Newsprint/Finland/Germany	1.000	2.645	-2.060	5.146	-0.965
	1.000	1.233	-2.939	5.415	2.553
	1.000	-32.505	-79.771	-87.853	24.641
Uncoated/Finland/Germany	1.000	0.295	-2.266	1.904	1.033
	1.000	3.073	-2.347	4.262	-0.691
	1.000	-1.896	-5.561	-5.630	-0.343
Coated/Finland/Germany	1.000	0.389	-1.112	0.750	-0.218
	1.000	-0.212	-0.439	0.872	0.151
	1.000	-1.241	0.545	-0.346	-0.324
Newsprint/Finland/UK	1.000	0.777	-0.779	1.718	-0.061
	1.000	-5.101	3.501	0.388	0.447
Uncoated/Finland/UK	1.000	3.407	-16.668	-17.934	0.335
	1.000	-0.365	-0.887	0.461	0.023
Coated/Finland/UK	1.000	-0.692	-0.849	0.122	-0.047
	1.000	-2.928	.0314	-1.057	0.154

Table 4.3. Cointegration vectors in Swedish models for 1987-1991.

Models	Variables				
Product/Exporter/Importer	p	$c_{exporter}$	$c_{importer}$	e	dr
Newsprint/Sweden/Germany	1.000	0.068	-0.050	0.099	0.060
	1.000	-0.324	1.064	-0.387	-0.004
	1.000	-1.710	4.594	-0.122	0.164
Uncoated/Sweden/Germany	1.000	-0.170	0.427	0.155	0.206
	1.000	0.496	-2.254	0.856	0.130
Coated/Sweden/Germany	1.000	0.987	-5.024	0.354	-0.323
Newsprint/Sweden/UK	1.000	-1.052	-0.232	0.437	-0.734
Uncoated/Sweden/UK	1.000	-21.059	35.283	-14.814	-1.004
	1.000	-0.259	-0.815	-0.000	0.105
	1.000	-4.858	2.372	-1.603	-2.225
Coated/Sweden/UK	1.000	-0.919	0.942	0.129	0.072
	1.000	2.314	-4.807	2.769	0.073

Table 4.4. Cointegration vectors in Swedish models for 1992-1996.

Models	Variables				
Product/Exporter/Importer	p	$c_{exporter}$	$c_{importer}$	e	dr
Newsprint/Sweden/Germany	1.000	-1.240	-0.257	-0.389	0.450
	1.000	0.337	1.080	2.649	-0.281
	1.000	-2.538	3.130	-0.054	0.331
Uncoated/Sweden/Germany	1.000	-0.153	-0.529	0.416	-0.245
	1.000	-0.292	-1.912	-0.985	0.138
	1.000	0.689	-2.171	2.270	0.404
Coated/Sweden/Germany	1.000	-0.087	-0.516	-0.048	-0.272
	1.000	-0.517	-2.611	-3.607	0.064
	1.000	0.516	-2.187	0.902	0.341
Newsprint/Sweden/UK	1.000	-0.704	-1.160	-1.473	0.126
	1.000	-1.829	1.907	2.877	0.328
	1.000	37.553	-57.354	-10.601	-0.163
Uncoated/Sweden/UK	1.000	0.789	-2.276	0.638	0.067
	1.000	2.061	-4.679	-1.421	-0.051
	1.000	-3.324	3.544	0.941	-0.029
Coated/Sweden/UK	1.000	-1.122	-0.102	-1.017	-0.225
	1.000	-7.999	10.832	3.496	-0.075
	1.000	-0.348	-0.707	0.655	-0.101

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