Swedish Export Price Determination: Pricing to Market Shares?

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February 26, 1999

SSE/EFI Working Paper Series in Economics and Finance No 306
February 1999

Abstract

The Swedish export price determination for automobiles and kraft paper to three destination countries, over the period 1980-1994, is investigated. Formal tests on an error correction model indicate results consistent with price discrimination in Swedish exports of both goods. The exporters use their market power for pricing to market, which is characterized by the concern for foreign conditions, and implies an incomplete exchange rate pass-through. However, the pricing behaviour does not seem to be determined by the development of market shares, in any cases except one. The total pass-through to the local currency price within a year, that is the effect of an exchange rate change working through all variables and all interactions in the price determination, span between -16 % and +109 %.

Keywords: Cointegration, exchange rates, export prices, market shares, pass-through, pricing to market.

JEL: E30, F31, F41.

I would especially like to thank Anders Vredin and Paul Söderlind for valuable suggestions and advice. I have also benefited from comments by Richard Friberg, Tor Jacobson, Helen Jakobsson and Anders Warne. Financial support from Ragnar Söderberg's foundation is gratefully acknowledged.

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1 Introduction

There has been a vast interest in questions about the relation between exchange rates and prices since the large fluctuations of the U.S. dollar in the mid-eighties. This field of research contributes to the understanding of the exchange rate's effect on inflation and the trade balance as well as the transmission of inflation across countries. It is also of relevance for comprehending the competitive process and the role of market structure in international trade. If exporters have some market power and markets are segmented, an exchange rate change may induce price discrimination across destination markets (pricing to market according to Krugman, 1987). This means that the exporters set different prices, in the exporters' currency, in different destinations. This in turn implies that the exchange rate pass-through, i.e. the response of the import price to an exchange rate change, is incomplete (local currency price stabilization). A destination specific markup adjustment thus absorbs part of the exchange rate change and there will be deviations from the law of one price.

Pricing to market could depend on nominal price rigidities and exchange rate surprises (e.g. as in Giovannini, 1988) or it could be due to deliberate price discrimination, which in turn could be related to destination market conditions such as market shares (see e.g. Feenstra et al., 1996). Deviations from the law of one price, due to exchange rate fluctuations, thus consist of two parts; deliberate price discrimination and exchange rate surprises. The former render price differentials across destinations ex ante based on exchange rate expectations. Through nominal price rigidities exchange rate surprises create price differentials ex post (see Giovannini, 1988). However, the framework used in this paper does not separate the two effects.

What are the explanations of pricing to market or more specifically, what conditions determine this price discrimination and the extent of it? Some prior studies have emphasized the importance of market structure characteristics. The extent of pricing to market and thus the source of markup variations has for example been explained by the size of the market share (Feenstra et al., 1996) and the concern for maintaining market shares. Because of slow adjustment of demand, the current price will affect the future customer stock and future revenues, suggesting that it might be worthwhile to have a stable short-run price and secure market shares (Gottfries, 1994 and Krugman, 1987). In that case, intertemporal links like the expected permanence of an exchange rate change might matter for the price setting (Froot and

Klemperer, 1989). Another, but similar, reason for the importance of forward looking exchange rate expectations is adjustment costs on the supply side (Kasa, 1992). The mechanism, for pricing to market, in the models above (and most prior studies) is thus primarily deliberate price discrimination due to various market forces, and not nominal price stickiness or the choice of invoicing currency. However, empirically pricing to market is often caused by a combination of market power and nominal rigidities, and most models do not attempt to separate these effects (an exception is Giovannini, 1988).

This paper examines the market share's importance for the Swedish export price determination for a few goods and destinations. Based on the assumption of costs of adjusting the traded quantity, a dynamic error correction model is formulated. This framework can simultaneously handle several endogenous variables and long run relations between them. Different characterizations of the price determination, e.g. whether the market share matters for the degree of pricing to market or not, are tested in terms of linear restrictions on the price setting relation. Furthermore, the framework and the set of data naturally initiate to study the question of exchange rate pass-through. Since pricing to market, by definition, is induced by exchange rate changes, this form of price discrimination is closely related to the exchange rate pass-through. The degree of price discrimination could consequently be measured as being reflected by different sizes of the exchange rate pass-through across destinations. Partial as well as total exchange rate pass-through coefficients are estimated. The partial pass-through measures the effect an exchange rate change has on the price setting relation, excluding the effects going through other variables and other long run relations. The total pass-through, in contrast, measures the entire effect an exchange rate change causes, working through every interaction of the price determination.

An extensive empirical literature on the relationship between exchange rate changes and price adjustments of traded goods has been built up, both on aggregate and industry level data (for surveys see Goldberg and Knetter, 1997 and Menon, 1995). Much of the empirical work has been done on large economies, particularly the US, Japan and Germany. The empirical evidence of pricing to market and incomplete exchange rate pass-through, for these countries, is substantial. Several studies show that producers price discriminate between markets and take destination specific market conditions into consideration when setting prices (see e.g. Giovannini, 1988, Gagnon and Knetter, 1995, Marston, 1990, Kasa, 1992 and Knetter, 1989, 1993).

For small open economies the conventional presumption is that exporters are price takers. This implies that they face an exogenously determined export price in foreign currency and that there is immediate and complete pass-through of both exchange rates and world market prices to their prices in their own currency. In contrast to this, recent empirical studies indicate that the pricing to market hypothesis is relevant also for small open economies (see e.g. Alexius and Vredin, 1996, Athukorala and Menon, 1995 and Gottfries, 1994 for evidence on Sweden)[1]. Destination market conditions seem to be important for the export and import price determination. Even in small open economies, export producers thus seem to have some market power and ability to affect prices.

A simple comparison of the markup in different destination markets can indicate whether there is any long run pricing to market, since it is through markup adjustments that the exporter limits the impact of e.g. exchange rate fluctuations on competitiveness. For Swedish exports of automobiles and kraft paper, there is a significant difference between the average markup across Germany, France and the United Kingdom (see Table 1). The difference in markups seems to be somewhat greater for automobiles than for kraft paper. The markups appear to exhibit quite different paths over time in different markets (see Figures 1-6)[2], especially for kraft paper. The distinct development of the markups thus indicates price discrimination between destinations.

Since the markups are allowed to change over time, there may be a systematic covariation of markups with destination specific variables, e.g. market shares[3], that could reflect a pricing to market behaviour. A large market share could imply that the exporter faces little competition and is able to pass through an exchange rate change to a greater extent (Feenstra et al., 1996). Figure 9 indicates that there is a positive significant correlation (see also Table 2) between the relative price (P_i / P_j) and the relative market share for automobile exports to Germany and France. The export prices seem to differ between the two countries, thus indicating pricing to

[1] For evidence on other small open economies see e.g. Naug and Nymoen, 1996 (Norway), Lee, 1997 (Korea), and Menon, 1996 (Australia).

[2] The markups for automobiles are clearly trending over time, why a comparison of means is somewhat problematic since the mean is then time varying. One explanation for an upward trend could be some sort of product quality upgrading over time. This is then e.g. consistent with the Swedish exporters of automobiles gradually proceeding towards competing in the market segment for luxury cars, where markups usually are higher. For kraft paper the markup lacks a trend or is possibly, and surprisingly, trending downwards.

[3] That is, the Swedish export volume of a certain good divided by the total volume of imports of the same good in the destination market, (X_i / M_i).

market, at least in the short-run[4]. The positive relation indicates that a larger market share in Germany is associated with a higher export price compared to France. Likewise, Figure 13 indicates a positive relation between the average relative prices and the average market shares for automobiles. The relation is however negative for kraft paper (see Figure 14). A careful analysis of the market share's effect on the pricing behaviour is thus needed.

The purpose of this paper is to study the transmission of an exchange rate change to Swedish export prices and the importance of the market share for the price determination. Section 2 contains a theoretical model of pricing to market and a description of the error correction model used for the empirical estimation. The data on Swedish exports is briefly discussed in Section 3. The empirical results are presented in Section 4 and conclusions are provided in Section 5.

2 A model of pricing of market

Pricing to market requires market segmentation and barriers to arbitrage, in order for the exporter to be able to price discriminate across markets. However, markets could be segmented without the exporter being able to affect the export price. That prices differ between markets due to market segmentation is not inconsistent with the exporter being a price taker in some markets. In that case the price differential between the segmented markets may be completely determined by different prices of the competitors' products rather than reflect an ability for exporters to intentionally price discriminate. Furthermore, it can be of interest to distinguish some sort of monopoly power (represented by positive markups) from market segmentation where the latter is denoting an ability to charge different prices to different destinations, i.e. price discrimination. A monopoly producer charging positive markups does not necessarily have the power to price discriminate if e.g. arbitrage equalizes prices across destination markets.

The extent to which prices and markups are adjusted to exchange rate changes, depends on industry and destination specific factors like the degree of market segmentation (is the market integrated or separated with barriers to arbitrage?), product substitutability (is the product

[4] All relative prices between destinations, (P_i / P_j), are stationary using a univariate Augmented Dickey-Fuller test (without intercept). However, in a multivariate framework, Alexius and Vredin (1996) show that this relative price is non-stationary for most country pairs, why long run price discrimination could be present.

homogenous or differentiated?) and competition (is the market organization imperfectly competitive or are the producers price takers?). In the theoretical models changes in export prices are also highly dependent on the functional form, i.e. the convexity, of the demand curve (Dornbusch, 1987).

Pricing to market could occur due to dynamic aspects on both the demand and the supply side. Froot and Klemperer (1989) show that demand dynamics may explain producers' concern for reputation due to imperfectly informed consumers and various brand-switching costs. In that case the expected duration of an exchange rate movement will affect the pass-through, and the degree of pricing to market could be affected by the permanence of an exchange rate change. Supply side dynamics can arise from adjustment costs of changing the sales volume or fixed costs of entering and exiting a market (see e.g. Gagnon and Knetter, 1995 and Kasa, 1992). The response of the export price to an exchange rate change will then depend on both how recent the exchange rate change is and its duration. A transitory change may be completely absorbed by the profit margin without any import price response at all, while a permanent exchange rate change may induce a larger adjustment of supply allowing the exchange rate to pass-through to the import price.[5]

The model used here, is a hybrid of the models used by Gagnon and Knetter (1995) and Feenstra et al. (1996). Consider a profit maximizing firm selling a differentiated product to *n* separate destination markets, indexed by *i*. It is assumed that that the markets are segmented such that no arbitrage can take place between the different destinations (the firm is able to price to market). This imperfectly competitive setting, in which it is assumed that price is the strategic variable, will yield a partial equilibrium where the price is set as a destination specific markup over costs. The profit maximizing problem of the firm is given by:

(1a) $$\max_{P_i} \quad \left(\sum_{i=1}^{n} P_i X_i - C\left(\sum_{i=1}^{n} X_i, W\right)\right)$$

(1b) $$s.t \quad X_i = f_i(P_i / E_i, P_i^{sub}, M_i)$$

[5] This sensitivity of pricing to market could empirically be illustrated by the use of e.g. interest rate differentials representing the exchange rate expectations, along the lines of Froot and Klemperer (1989). This lies, however, outside the scope of this paper.

where P_i is the price denoted in the exporter's currency, X_i is the quantity demanded as a function of the exporter's price in the buyer's currency, E_i is the exchange rate measured as exporter's currency per unit of buyer's currency (e.g. SEK/USD), P_i^{sub} the price of competing products denoted in the buyer's currency and M_i the totally demanded quantity on all varieties of the product. C is the total cost function and W is an index of input prices denoted in the exporter's currency. The exporter takes the price of competing products as fixed which implies that there is no direct neighbour in the product space, and any strategic interaction is thus absent. The first order condition yields:

$$(2) \qquad P_i = MC\left(\frac{\eta_i}{\eta_i - 1}\right) \qquad \forall\, i$$

where MC is marginal cost and η_i = - $(\partial X_i / \partial P_i)(P_i / X_i)$ is the positive price elasticity of demand. The exporter's price, i.e. the markup, is thus determined by the elasticity of demand in the different destination markets, which in turn depends on features of the demand schedule. Since the price setting rule depends on the convexity of the demand, the price discrimination models that are consistent with pricing to market require a certain class of demand schedules, where the price elasticity of demand is not constant (Knetter, 1989). As seen from equation (2), price changes are due to either marginal cost changes or to changes in the markup. The commodity is assumed to be identical across destination markets which implies that the marginal cost is independent of the destination. This suggests that marginal cost changes will be common to all countries and it is consequently only destination specific markup changes that reflect a pricing to market behaviour.

A constant elasticity of demand, as with a log-linear demand curve, implies that the price to each market in the exporter's currency is a fixed markup over costs. This implies that an exchange rate change will be fully passed through to the price in the importer's currency. In this case there is no residual variation in export prices that could be correlated with destination specific conditions like the exchange rate or the market share. Consequently, there is no price discrimination if the markup and the marginal costs are constant across destinations. If however the perceived demand schedule becomes more elastic as the local currency price increases, then the optimal markup charged by the exporter will fall as the buyer's currency depreciates and as a result the exchange rate pass-through will be incomplete (Knetter, 1989 and Marston, 1990). The demand schedules that fulfill this requirement for pricing to market, are the curves less convex than the constant elasticity curve, e.g. linear demand[6] (Goldberg and Knetter, 1997). Assuming the markup to be variable and to respond to conditions in the destination market, i.e. assuming a non-constant elastic demand, thus implies that the exporter will adjust his markup in order to have a stable local currency price when for example the exchange rate changes.

To determine the price adjustment response to an exchange rate change, consider the case where the marginal cost is assumed to be constant, and differentiate equation (2) with respect to the exchange rate. This yields, after some manipulation, the following exchange rate elasticity of the export price (where *t* has been added, indicating the time period):

(3) $$\frac{\partial P_{it}}{\partial E_{it}}\frac{E_{it}}{P_{it}} = \frac{\partial \eta_{it}}{\partial (P_{it}/E_{it})}\frac{(P_{it}/E_{it})}{\eta_{it}}\left[\eta_{it} - 1 + \frac{\partial \eta_{it}}{\partial (P_{it}/E_{it})}\frac{(P_{it}/E_{it})}{\eta_{it}}\right]^{-1}$$

The pass-through[7] thus depends on how the demand elasticity is affected by a local currency price change. A constant elasticity of demand would imply that the export price is invariant to exchange rate changes, $(\partial P_{it} / \partial E_{it})(E_{it} / P_{it}) = 0$, and hence that the pass-through to the price in the importer's currency is complete. From the second order condition for profit maximization follows that the expression within brackets is positive[8] and if the demand elasticity increases with the local currency price, the entire equation is positive which implies that the export price will be adjusted to offset an exchange rate change. An appreciation of the exporter's currency will then lower the price, in the exporter's currency, so the exporter adjusts the profit margin, i.e. the markup, in order to have a stable local currency price and limit the deteriorated competitiveness.

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[6] The elasticity with respect to the local currency price increases for these curves.

[7] The concept pass-through is commonly used interchangeable for the effects of an exchange rate change on both export and import prices. In this paper pass-through is solely defined as the import price response to an exchange rate change (measured in local currency, $1/E$), i.e. pass-through = $-[(\partial P / \partial E)(E / P) - 1]$.

[8] To see this explicitly, define equation (2) as; $H(P) = P(1 - 1/\eta) - MC = 0$, which implies that the first order condition is equivalent to; $H(P)\frac{\partial X}{\partial P} = 0$. The second order condition for profit maximization yields; $\frac{\partial H(P)}{\partial P}\frac{\partial X}{\partial P} + H(P)\frac{\partial^2 X}{\partial P^2} < 0$, knowing that *H(P)* is zero and assuming that the commodity is normal, i.e. $(\partial X / \partial P) < 0$, this implies that $(\partial H(P) / \partial P)$ must be positive for this to hold so; $\frac{\partial H(P)}{\partial P} = \frac{1}{\eta}\left[\eta - 1 + \frac{\partial \eta}{\partial P/E}\frac{P/E}{\eta}\right] > 0$, and from $(\partial X / \partial P) < 0$ follows that $\eta > 0$, and consequently the bracket is positive.

Allowing the marginal costs to vary with the exchange rate implies that a term representing the exchange rate elasticity of marginal costs should be added in equation (3)[9]. If the marginal cost is increasing in the exchange rate, a depreciation of the exporter's currency will increase the export price more than if the marginal cost is constant, and thus further limit the pass-through effect on the local currency price. Hence, the pass-through is negatively related to the elasticity of marginal cost with respect to the exchange rate.

In most analyses of pricing to market the marginal cost is assumed to be constant with respect to the volume of sales. If the marginal cost instead were varying with supply, the optimal price in a certain market would be dependent on the quantity sold to all other destination markets. Consequently, demand conditions in every market should be incorporated into the price determination. This could also imply that the "direct" or partial pass-through effect is offset via the change in marginal costs due to an exchange rate movement. An appreciation of the exporter's currency, ceteris paribus, would increase the local currency price and thus reduce demand for the exporter's commodity. If the marginal cost were increasing in output, the reduction in output would diminish the marginal costs and consequently also reduce the export price. The pass-through of the exchange rate would thus be even more limited. The pass-through is therefore negatively related to the elasticity of marginal cost with respect to output (Yang, 1997).

Taking logarithms of equation (2) and using a first order Taylor approximation of ln (η_i/η_i - 1) around a suitable value, say the average, yields the following relation:

$$\ln P_{it} = \beta_0 + \beta_1 \ln MC_{it} + \beta_2 \ln SH_{it} + \beta_3 \ln E_{it} + \beta_4 \ln P_{it}^{sub} \tag{4}$$

where β_0 is an intercept sweeping up all the constant terms in the Taylor expansion, *MC* is the marginal costs and *SH* is the market share defined as the Swedish export volume of a good divided by the total volume of imports of the good to one destination (X_i / M_i). Assuming the elasticity of demand with respect to total imports of the good to be one, allows the simplifying

[9] In that case the exchange rate elasticity of the export price is:

$$\frac{\partial P_{it}}{\partial E_{it}}\frac{E_{it}}{P_{it}} = \left[\frac{\partial \eta_{it}}{\partial (P_{it}/E_{it})}\frac{(P_{it}/E_{it})}{\eta_{it}} + (\eta_{it}-1)(\frac{\partial MC_{it}}{\partial E_{it}}\frac{E_{it}}{MC_{it}})\right]\left[\eta_{it} - 1 + \frac{\partial \eta_{it}}{\partial (P_{it}/E_{it})}\frac{(P_{it}/E_{it})}{\eta_{it}}\right]^{-1}$$

restriction of a one-to-one relation between the export volume and total imports of a good (i.e. the market share) to matter for the price determination[10].

Recognizing that the marginal costs are likely to change due to movements in the exchange rate (e.g. because of implied changes in the prices of imported inputs, *W*), one would presumably like to control for such an indirect mechanism when estimating the pass-through coefficient of equation (4). A disaggregated producer price index, PPI^l (where l denotes product), will therefore be used as an empirical proxy for marginal costs. The exchange rate coefficient, β_3, will then capture the direct effect of an exchange rate change on the export price, excluding the effect of indirect changes in the marginal costs from this estimate. The marginal cost coefficient, β_1, will incorporate the direct and indirect destination specific effect of common marginal cost changes on the price setting rule. Furthermore, the producer price index may capture not only marginal costs but also for example markups common to all destinations. In that case, one could interpret the destination specific ratio (P_i / PPI^l) as reflecting the extent to which the exporter imposes a markup on market i above the average, or product specific, markup.

Equation (4) is static and disregards any gradual adaptations of the export price to changes in the explanatory variables, why it may be interpreted as a long run price setting relation. However, in the short-run there will be deviations from equation (4), since a disturbance (e.g. an exchange rate shock) will yield dynamic adjustment processes of both consumers and producers, for example due to nominal price rigidities and adjustment costs in demand and supply. Assuming adjustment costs on the supply side, implies that the price determination can be modelled in an error correction framework[11] where the price change depends on prior deviations from the long run cointegrating relations as well as the short-run dynamics, i.e. prior changes in the explanatory variables. This setting follows along the lines of Gagnon and Knetter (1995) which derive an error correction model for export prices using quadratic costs of adjusting the volume of trade.[12] The conventional analysis of a relation like (4) is often done within a single equation framework, possibly on error correction form[13]. The latter

[10] This implies that some information on the relation between X_i and M_i might be disregarded but due to few observations it is preferable to restrict the number of variables to a minimum to gain degrees of freedom.
[11] Quadratic loss functions like adjustment costs typically yield error correction equations (Nickell, 1985).
[12] Another example of an adjustment cost model of pricing to market is Kasa (1992) which derives an error correction model also with the use of quadratic costs of adjusting supply.
[13] See e.g. Feenstra et al. (1996), Naug and Nymoen (1996), Gagnon and Knetter (1995) and Athukorala and Menon (1995).

seems suitable given the commonly accepted non-stationarity of nominal variables such as price levels. The empirical analysis will be done in Johansen's (1988, 1991) multivariate framework which allows several cointegrating relations as well as a simultaneous estimation of the long run relations and short-run dynamics. Furthermore, the multivariate setting, in contrast to the single equation approach, makes it possible to explicitly treat problems of identifying the price setting relation. Given that information about the long run relations can be found in all equations of the system, it also makes the estimators more efficient.

The Johansen maximum likelihood procedure (Johansen, 1988) consists in estimating an error correction representation of a vector autoregressive (VAR) model of order k. The form is as follows:

$$(5) \qquad \Delta z_t = \sum_{j=1}^{k-1} \Gamma_j \Delta z_{t-j} + \Pi z_{t-1} + \mu + \Phi D_t + \varepsilon_t \qquad t = 1,....,T$$

where z_t is an n-dimensional column vector, μ is a vector of constants, D_t is a vector of deterministic variables, such as seasonal dummies and intervention dummies, and $\varepsilon_1,\ldots,\varepsilon_T$ independent identically distributed $N_n(0,\Sigma)$ disturbances. In this setting the variable vector consists of five variables, $z = [p_i, ppi^l, sh_i, e_i, p_i^{sub}]'$ (where lower case letters denote logarithmic values). Γ_j represents the short-run dynamics while the lagged level term, Πz_{t-1}, is the error correction term of stationary linear combinations of the z variables. If the rank of Π is less than n (r < n), Π can be decomposed into $\Pi = \alpha \beta'$ with α as an (n×r) matrix of adjustment coefficients toward the long run equilibrium and β an (n×r) matrix of cointegration vectors implying that the long run relation $\beta' z_t$ is stationary, even if z_t is non-stationary. When the cointegration rank is larger than one there is an identification problem, since it is only the space spanned by the cointegration vectors, β, that is uniquely determined and not the parameters of the individual vectors. The Π-matrix could equally well be decomposed into $\Pi = \alpha \xi^{-1} \xi \beta'$ with ξ as an arbitrary but non-singular (r×r) matrix of restrictions that will just work as "normalizations". Consequently there is only ((n-r)×r) free or estimable parameters, and to exactly identify these one has to impose r^2 independent restrictions on β. It is always possible to take a linear combination of the unrestricted cointegration vectors, impose r identifying restrictions to each vector without changing the likelihood function (Johansen and Juselius, 1990, 1994). A testable economic hypothesis on a specific vector thus requires an overidentified system, i.e. more than these r^2 restrictions must be imposed. In order to get an, in some sense, economic identification, i.e. the ability to distinguish the different vectors from each other and thereby interpret them in economic terms, one often has to impose overidentifying restrictions on β.

Some attention should be given to the constants, μ, through which the model allows for drift components in the data. The statistical inference, i.e. the asymptotic distribution of the test statistics, is affected by the assumptions maintained on the constant (whether the drift components are pure stochastic trends or stochastic trends with a drift). The constant can be decomposed into two parts, one contributing to the intercept in the cointegrating relation and the other determining a linear trend. If the underlying process(es) does not contain a linear trend the constant should be restricted to the cointegration space as an intercept. If there instead are deterministic trends in the variables, these will enter via the constant term in the model but not be present in the cointegrating relations since these common trends are supposed to cancel (Johansen, 1991). The model choice of an unrestricted constant is not incorrect even if there is no linear trend in the data, but restricting it to the cointegration space makes the inference more efficient in such a case. Since most series seem to trend upwards over time the alternative model with a restricted constant, i.e. an assumption of pure stochastic trends in the data, has not been tested. The constant in equation (4), β_0, will thus be excluded in the empirical estimation of the long run relations and instead incorporated into the error correction model via μ. Testing hypotheses on this "simplified" form of the long run relation will not be dependent on the constant since it is not affecting the stationarity of a possible cointegration vector, which will then instead be stationary around a non-zero mean.

3 Data

A disaggregated approach seems appropriate since the theoretical reasons for pricing to market emphasize market characteristics, and the extent of price discrimination is thus expected to differ across industries and commodities. Disaggregated price data for a certain commodity to different destinations are not available so the traditional approach of using unit values, i.e. export value in current prices divided by export volume in units, taken from the official trade statistics, is applied in this study. This introduces measurement errors in the dependent variable since fluctuations in unit values can occur for other reasons than price changes. These problems can be more or less severe and vary over products, countries and time. Using quantitatively important destinations help mitigate these problems (Börjesson, 1989).

Two commodities on the 4-digit SITC level and three destination markets have been selected for the empirical analysis. The two commodities were chosen on basis of being the largest goods, in terms of value, in Sweden's exports, namely passenger transport vehicles and kraft paper[14]. Ex ante it is also presumed that these quite different goods will illustrate different pricing behaviour. Automobiles are a highly differentiated product while kraft paper seems to be a more homogenous good. Furthermore, the market for automobiles seems to be segmented due to several reasons, e.g. service, warranties and environmental regulations that are specific to a certain destination (see e.g. Goldberg and Knetter, 1997 and Flam and Nordström, 1995), while one would expect kraft paper to be sold in a more integrated world market[15]. Nevertheless, highly customized contracts could create possibilities for price discrimination also in the kraft paper markets. In addition, the sizes of the average Swedish market shares differ substantially between automobiles and kraft paper[16], which could generate divergent pricing reactions to an exchange rate change. The destination countries are Germany, France and the United Kingdom. The data consist of quarterly averages, from the period 1980:1-1994:4[17], constructed from monthly data. A more detailed definition of the data material is provided in appendix A.1.

The price of substitutes (P^{sub}) is approximated by the unit value of total imports of each good to each destination market. This implies the somewhat disturbing simplifying assumption that the good only competes with other imported products, e.g. a Volvo car competes with BMW in France but not in Germany. A more appropriate measure of the price of substitutes would include domestic products as well as import competing goods but such data are more difficult to obtain.

[14] These sectors delivered 5.99% and 2.27% of total Swedish exports in 1993 respectively. Source: Statistics Sweden. Kraft paper is e.g. used in the manufacture of sacks and other emballage.
[15] Alexius and Vredin (1996) though show that the relative price of kraft paper between markets is non-stationary which indicates market segmentation.
[16] The average market share across destinations over the sample period is 1.2 % and 42 % respectively.
[17] For France the sample period is 1984:1-1994:4.

A disaggregated producer price index is used as a proxy for production costs in the exporting country. For automobiles a domestic producer price index for engineering (PPI^{eng}) is used while the kraft paper production costs are proxied by a producer price index for pulp, paper and paperboard (PPI^{pulp}). The producer price indices can vary due to other things than cost fluctuations, e.g. due to changes in markups why there can be some noise or measurement error in this variable. Assuming the producer prices to reflect the development of the marginal costs, e.g. captured by the marginal cost times a constant, this error will though not affect the stationarity of any hypothesized long run relation per se. Using producer prices instead of unit labor costs is preferable since the producer prices also reflect other input costs. However, an alternative specification with unit labor costs as a proxy for production costs has also been tested, indicating similar results as when using producer prices as a cost approximation.

The producer prices are affected by the exchange rate through imported inputs and given the importance of the selected sectors, it is not unreasonable to assume that these sectors exert some influence on labor demand. Thus, the export price gives feedback to the production costs and the latter are hence assumed to be endogenously determined (Kongsted, 1996). In contrast, it appears reasonable to assume that the exchange rate is free from feedback from other variables in the system, since a deteriorated competitiveness for a single commodity does not induce a monetary policy reaction, like a depreciation. Nevertheless, the devaluations of the Swedish krona in the eighties were clearly an effect of domestic policy measures that did not neglect the market conditions of export firms (i.e. their competitiveness). All variables are assumed to be endogenous in a statistical sense, where exogeneity is determined with respect to parameters in the likelihood function and not by economic reasoning. Consequently, this full system allows for any feedback effects between the variables (see e.g. Hung et al., 1993 and Kongsted, 1996 for a discussion of such matters).

4 Empirical estimation

4.1 Model specification

Non-normality of the residuals is a problem why a set of deterministic variables is included to overcome the most severe problems, which appear in the equations for the exchange rate and the price of substitutes (not shown). To account for the large devaluations of the Swedish krona in September 1981 and October 1982 and the shift to a floating exchange rate regime in November 1992 the following dummies are included in all regressions:

$$D_{i,t} = \begin{cases} 1 & if\ t \in I_i \quad i = 1,2,3 \\ 0 & otherwise \end{cases}$$

where I_1 = {1981:4}[18], I_2 = {1982:4}, I_3 = {1992:4…1994:4}. To take care of the seasonal pattern in the data, three centered seasonal dummies[19] are also included in the regressions. Furthermore, for the export of automobiles to Germany and the United Kingdom, two different sets of deterministic variables are included to explain the outliers in the two price series.[20]

To determine the adequate lag structure, conditioning the model on this set of deterministic variables, the model specification tests are applied to both the unrestricted VAR model (r = 5), (see Table 3a), and the more restricted vector error correction model (VEC) where the choice of cointegration rank is varied ($r \in \{1,\ldots,4\}$). The VAR model is tested in order to make sure that the choice of the cointegration rank is made on a correctly specified model. However, since the inference and interpretations are made on the VEC model, the residuals also need to be checked when the cointegration rank has been decided (see Tables 3b and 3c).

The number of lags, k, has been determined by checking that there is no further multivariate autocorrelation of first-order in the regressions, according to the LM test, nor any multivariate non-normality at the chosen lag specification. Two lags[21] are chosen for all markets except for

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[18] Since the exchange rate series consist of quarterly averages of the spot rates, the timing (within a quarter) of a fluctuation matters for what quarter a change primarily is reflected in. The devaluation in September 1981 appears, in the data, mainly in the last quarter of 1981.

[19] These centered dummies sum to zero for every year and have the advantage that they do not change the limit distribution of the rank tests and furthermore that the constant, μ, captures the true mean (including the parts that would be seized by uncentered seasonal dummies) in the error correction model.

[20] For the German automobile market $D_{4,t} = \begin{cases} 1 & if\ t = 1985:4 \\ 0 & otherwise \end{cases}$ and $D_{5,t} = \begin{cases} 1 & if\ t = 1988:1 \\ -1 & for\ t+1 \\ 0 & otherwise \end{cases}$ are included while for the British market $D_{6,t} = \begin{cases} -1 & if\ t = 1988:3 \\ 1 & for\ t+1 \\ 0 & otherwise \end{cases}$ is incorporated (see also Figures 15-17 respectively).

[21] That is two lags in the vector autoregressive model (in levels) or consequently one lag in the error correction model.

the export of automobiles to France (three lags). This lag structure appears to give appropriate properties of the residuals in both the VAR and the VEC model. However, the univariate tests on the residuals from the VEC model, with cointegration rank two, indicate some non-normality (see Table 3c) but given that the critical values are based on the asymptotic distribution and that the empirical values are substantially larger, these problems are left without further consideration.

The number of cointegrating relations can be found from the relation, $r = n - s$ where r is the number of cointegration vectors, n the number of variables and s the number of common stochastic trends (Stock and Watson, 1988). With five non-stationary variables[22], the results of the likelihood ratio test[23] suggest that the system contains two cointegrating relations and, hence, three common stochastic trends in all markets except for the kraft paper export to France (where three or possibly four cointegration vectors are present; see Table 4). These three trends could be interpreted as; importer’s (buyer’s) inflation, exporter’s (seller’s) inflation, i.e. foreign and domestic monetary policies, and a third trend which is harder to interpret but perhaps is reflecting some sort of commodity specific trend. In addition, if the monetary policies are common there is possibly three cointegration vectors, but given the accommodating Swedish policy and thereby the large depreciations of the krona in 1981, 1982 and 1992 it seems reasonable to assume that there are two distinct nominal trends. The two cointegration vectors are assumed to capture the long run relations between the variables in the system. It seems reasonable to interpret one as reflecting a price setting policy or supply relation like (4) and the other to capture a demand relation like (1b). If the third trend is absent, this could explain a finding of three cointegration vectors in the French kraft paper market. In that case there is a third cointegrating relation that for example could be interpreted as capturing the price determination of the substitutes.

Previous studies mostly use a single equation approach (e.g. Feenstra et al., 1996 and Gagnon and Knetter, 1995) and thus abstract from problems arising from the finding of several cointegration vectors. Given the large number of variables and a model that is not capturing all micro-foundations, additional long run relations except those two previously mentioned, are perhaps floating around in the system, e.g. a relation determining marginal cost, such as a labor demand or supply relation. This leads to problems of how to identify and interpret the

[22] All series are non-stationary according to the Augmented Dickey-Fuller test (available upon request).
[23] 5% significance is used throughout the paper.

cointegration vectors. When testing hypotheses on one of these vectors one must have in mind that without identifying the different vectors, the test could be carried out on a different vector than intended, e.g. on a demand relation instead of the price-setting (supply) relation. This implies that overidentifying restrictions must be placed on each vector in order to enable meaningful tests of hypotheses on specific relations.

Since the mechanism driving a markup variation is based on the demand elasticity, the problem of whether the estimated price and demand vectors are consistent also arises. An indication of pricing to market in a supposed price setting vector will strictly imply that a second cointegration vector can not be interpreted as a demand vector, since a log-linear demand relation results in a constant elastic demand. In this case the optimal markup will be fixed and the price setting not affected by destination specific effects like the exchange rate or the market share. An alternative less strict but also more reasonable interpretation, is that the estimated demand vector is only a linearized expression of the actual and perhaps non-constant elastic demand function. If the pass-through instead is complete and the market share does not play a role in the price determination, then it is possible to interpret the cointegration vectors as a price setting vector and a constant elastic demand vector respectively without inconsistencies with theory.

4.2 Pricing to market

To establish the exporter's long run pricing behaviour and the conditions affecting the price determination, some theoretically plausible cointegration vectors are examined. In a first step, a test for the number of cointegration vectors guides the decision on the cointegration rank. According to this test (as discussed above) the cointegration rank is two for all destinations, except for the French kraft paper market where more than two cointegration vectors seem to be present.[24] Second, it is tested whether certain theoretically motivated restrictions are contained in the cointegration space, in particular whether any vector in the space is consistent with a hypothesized price setting relation. Third, one may try to distinguish a specific cointegration vector as a price setting relation by making identifying assumptions such that all vectors have an economic interpretation.

[24] Since one would expect the number of common stochastic trends to be equal across destinations, the cointegration rank is set to two for all markets. However, for the French kraft paper market the imposed linear restrictions are also tested for a cointegration rank equal to three.

The first question to be examined is whether the exporter has some market power, and thus prices above marginal costs, or is merely a price taker in a perfectly competitive market. An empirical finding of a positive markup could arise in two different settings, in perfectly competitive markets where the producer price is a bad approximation for the marginal costs or in imperfectly competitive markets where the exporter has some market power. The producer price indices are not pure cost data but nevertheless a reasonable proxy for the development of the marginal costs[25], why a systematically varying, non-zero, markup is interpreted as an indication of market power. A stationary non-zero markup implies market power as well, but can not bring about exchange rate induced price discrimination on average since a stable long run relation between export prices and such destination specific conditions is then infeasible (given that exchange rates are non-stationary). Constant elasticities of demand that differ across destinations can cause stationary price differences, i.e. differences in the stable markups due to market segmentation. Systematic variations in markups, in contrast, can show up as autoregression, e.g. non-stationarity, or a covariation with other variables. If the markup covaries with destination specific variables, like the market share, the exchange rate or the price of substitutes, this suggests that foreign market conditions are relevant for the price determination and that the exporter prices to market. These non-stationary price differences require non-constant elastic demand schedules.

The first hypothesis (H_1), (see Table 5), is that the markup is stationary. If this hypothesis can be rejected, the markup is non-stationary and could thus be cointegrated with other non-stationary variables, which would suggest an intentional, long run, price discrimination. Therefore, it is also tested whether the market share is non-stationary in this multivariate setting (H_2). The third hypothesis (H_3) tests whether the market share is irrelevant for the entire system of price determination, i.e. if the market share can be excluded from both cointegration vectors. If the relative price (p_i - p_i^{sub} - e_i) is stationary, H_4, the exporter is said to be a "price taker". The effect of changes in the exchange rate and the price of foreign substitutes on the export price will be complete. However, a stable relative price need not necessarily be interpreted as a "forced" price taking but can be explained by a deliberate collusion where the producers agree on a common local currency price. Such mechanisms do, however, lie beyond the scope of this paper and can not be explained by the model used here.

[25] Assuming the producer price to capture the marginal cost times a constant, implies that the stationarity of a long run relation will not be affected by this marginal cost approximation.

If H_4 is rejected and furthermore the markup is cointegrated with other destination specific variables, there is a clear indication of pricing to market. To examine the sources of the markup variation three different hypotheses are tested. H_5 suggests that the market share can be excluded and thus characterizes a pricing to market behaviour that is not directed by the concern for market shares. Foreign conditions such as e.g. the degree of competition will thus primarily be reflected by the price of substitutes. H_6 states that the markup is cointegrated exclusively with the market share. H_7 relates the markup to the market share and the price of substitutes denoted in the exporter's currency. In that case, exchange rate changes and changes in the prices of substitutes will be of equal importance for the price determination.

In the short-run there might be deviations from any of the above hypothesized long run relations. The short-run influence of the market share, on the price setting behaviour, can then differ from the long run effects of the market share. The short-run dynamics of the price equation is therefore examined as well, and it is tested whether lagged changes of the market share matter for the short-run alterations of the export price. Since the primary interest is to examine the effects of the market share and the exchange rate on the export price determination, the short-run dynamics of the other variables in the price setting system are not scrutinized. Besides, the model used in this paper does not give any strict theoretical conjectures on the short-run dynamics of these other variables.

4.3 Exchange rate pass-through

Moreover, the question arises how pass-through is defined in this setting. The total effect of a change in the exchange rate, working through all interactions of the system, i.e. including the effect on all variables and through both cointegration vectors, is one possible interpretation instead of the partial effect through the price setting behaviour. However, to estimate this effect one needs to identify exogenous exchange rate movements. Given that the exchange rate is allowed to affect all variables in the system, the total effect can not be read off directly from the cointegrating relations because of the cross-effects between the variables. Here, the exchange rate pass-through will be estimated both as the partial elasticity in the long run price setting relation (i.e. the partial elasticity of the export price with respect to the exchange rate in one of the cointegration vectors) and as a total effect in the error correction model. The latter is calculated as the total response in the short-run pricing equation following the two devaluations of the Swedish krona in 1981 and 1982, and the depreciation of the krona in 1992.

To uniquely determine the long run partial pass-through elasticity one needs to impose r exactly identifying restrictions on the cointegration vector in question (i.e. on a presumed price setting relation). Different choices of these r identifying restrictions[26] will imply different pass-through coefficients. By varying the identifying restrictions one can, however, determine an interval for the exchange rate elasticity. Three different normalizations are imposed on a presumed price setting relation. The exchange rate elasticity is estimated for a relation determining the markup, for a relation where the market share is excluded and finally for a relation where the effect of an exchange rate change is the same as the effect of a change in the price of foreign substitutes. The identifying restrictions imposed are thus $[1,-1,\beta_{13},\beta_{14},\beta_{15}]'$, $[1,\beta_{12},0,\beta_{14},\beta_{15}]'$ and $[1,\beta_{12},\beta_{13},\beta_{14},\beta_{14}]'$ respectively.

A total short-run pass-through[27] in the error correction model (equation (5)), due to a pure exogenous shock to the system (i.e. a change in the dummy variables ($D_{1,t}$ and $D_{2,t}$) representing the devaluations in 1981 and 1982 respectively), is calculated by comparing the pricing equation's response with the response in the exchange rate equation.[28] In addition, the total pass-through is determined for the depreciation in 1992 (which is identified by a change in $\Delta D_{3,t}$), following the shift from a fixed to a floating currency regime. However, this dummy variable ($D_{3,t}$) represents the regime shift and not the explicit exchange rate shock per se, why the resulting pass-through might capture the effects of a combination of the depreciation and the switch to a floating currency.

The total exchange rate pass-through estimate includes all the consequences an exogenous exchange rate change causes to the pricing equation, i.e. the effect working through the entire short-run dynamics (all partial coefficients in Γ) as well as the effect working through both cointegration vectors. To see this explicitly, formulate the system in the following way (assuming a VAR model of order two):

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[26] In this case r = 2.

[27] The partial short-run pass-through is found in the dynamics of the pricing equation ($\Gamma_{j,14}$) in the error correction model (see equation (5)).

[28] Apart from the exchange rate changes the dummy variables might also capture some other distortion in the system why the results should be interpreted with caution. With further identifying assumptions one could estimate different pass-through effects from different structural shocks, which though lie beyond the scope of this paper.

$$(6)\qquad \begin{bmatrix}\Delta z_t \\ \beta' z_t\end{bmatrix} = \begin{bmatrix}\mu \\ \beta'\mu\end{bmatrix} + \begin{bmatrix}\phi \\ \beta'\phi\end{bmatrix} D_t + \begin{bmatrix}\Gamma & \alpha \\ \beta'\Gamma & (\mathrm{I}+\beta'\alpha)\end{bmatrix}\begin{bmatrix}\Delta z_{t-1} \\ \beta' z_{t-1}\end{bmatrix} + \begin{bmatrix}\varepsilon_t \\ \beta'\varepsilon_t\end{bmatrix}$$

$$y_t \quad = \quad \theta_0 \quad + \quad \theta_1 \quad D_t \; + \qquad \mathrm{B} \qquad y_{t-1} \quad + \quad \eta_t$$

Hence, the B-matrix will capture the complete effect on all variables and both the channels the exchange rate change is working through (i.e. the short-run run dynamics and both cointegration vectors). The resulting response in vector y_t due to a shift in the dummy variable is thus; (response (y_{t+s})) = $\mathrm{B}^s\ \theta_1$.[29] Since $\Delta z_t = \mathrm{G}\ y_t$ where $\mathrm{G} = [\mathrm{I}_5 \quad 0_{5\times 2}]$, the response in the levels of the z-variables is (in period $t+s$ following a depreciation in period t); (response (z_{t+s})) = $\sum_{j=0}^{s} \mathrm{GB}^j \theta_1$. The total effect on the export price in period $t+s$ of an exchange rate change in period t could thus be calculated as; (response (p_{t+s})) / (response (e_t)).

4.4 Empirical results

4.4.1 Long run hypothesis testing

For *exports of automobiles to Germany*, H_1 can be rejected at 5 % significance (see Table 6) which suggests that the exporters have market power that could be used for long run price discrimination. However, the exporters seem to agree on a common local currency price since the hypothesis of a stable relative price (H_4) can not be rejected. The Swedish exporters do not seem to be able to alter the average relation between their price and that of their competitors. Hence, an exchange rate change will be completely absorbed by the profit margin and the local currency price will stay invariant. Likewise, foreign competitors will, through changes in p^{sub}, fully affect the price in the exporter's currency. Neither H_5 nor H_7 can be rejected. These hypotheses are consistent with a stable relative price, H_4, if the coefficients, in H_5 and H_7, of the exchange rate and the price of foreign substitutes are of equal magnitude and close to one. Furthermore, the market share coefficient in the markup relation H_7 needs to be near

[29] This follows from; response (y_{t-1}) = 0, response (y_t) = θ_1, response (y_{t+1}) = B × response (y_t) = B × θ_1 and so on. The response to the depreciation in 1992 is determined by the same formula given that the exchange rate change is captured by $\Delta D_{3,t}$.

zero, in order to get consistent results altogether indicating a price determination governed by price taking behaviour.[30]

All hypotheses are rejected for the *automobile export to the United Kingdom*. The exporters seem to have some market power because the markup is non-stationary (H_1 is rejected) and the exporters are not price taking (H_4 is rejected). The source of markup variation is however unclear given that all hypotheses where the markup cointegrates with destination specific variables are rejected.

To *France, the automobile exporters* set price such that the markup is non-stationary (H_1 is rejected) which suggest long run market power. H_5 can not be rejected which indicates that the price discrimination does not seem to be related to the development of market shares. Nevertheless, this result might be compatible with a more flexible relation between the exported quantity and total imports in each market, without the restriction that it is the market share that should be excluded (which also could be the case for the United Kingdom).

The *kraft paper exporters to the German* market seem to have some market power and ability to charge a non-zero markup (H_1 is rejected). The producers do not have a long run stable relative price (H_4 is rejected). Accordingly, the export price does not fully respond to changes in the exchange rate or the competitors' price. The market share can not be excluded from the price determination and hence, seems to matter for the pricing to market behaviour (H_5 is rejected while H_7 is accepted). Furthermore, the effects of exchange rate changes and changes in substitute prices appear to be equal (H_7 can not be rejected) and are thus affecting the export price to the same extent.

For the *United Kingdom, the kraft paper exporters* use non-stationary markups and do not seem to stabilize a common local currency price (H_4 is rejected). There is no clearcut conclusion whether the market share matters for the price discrimination or not, since neither H_5, H_6 nor H_7 can be rejected. H_7 is not inconsistent with excluding the market share from the price determination (i.e. accepting H_5) since the point estimate of the market share coefficient in H_7 could be close to zero. However, simultaneously accepting H_5 and H_6 is somewhat more

[30] Instead of concentrating on consistent parameter estimates, a different explanation of the acceptance of H_5 and H_7 would be to interpret these restrictions to capture another relation among the variables, e.g. a relation determining marginal cost such as labor demand, rather than a price setting relation.

troublesome considering that they represent opposing hypotheses of the price relation. One plausible explanation is that, as above, the exclusion of the market share from the price setting (accepting H_5) is due to the restriction of the one-to-one relation between the exported and imported quantity of the product, and that a more flexible relation would be more important for the price setting.

The *kraft paper exporters' market power in the French market* is used for price discrimination (H_1 and H_4 are rejected). The pricing to market behaviour does not seem to be characterized by the concern for maintaining market shares (H_5 can not be rejected). However, excluding the market share from the entire system of price determination (H_3 can not be rejected) introduces problems of how to interpret the second cointegration vector, which can then hardly be representing a demand relation. Hence, the relation between the exported and the imported quantity captured by the market share is clearly too restrictive, and it might be fruitful to consider a system with the exported quantity (X_i) rather than the market share (X_i / M_i) (which likewise seems to be true for any destination market and both goods). Furthermore, allowing a larger cointegration rank in the French kraft paper market, which seems to be the case according to the trace test, does not change the results dramatically[31].

For a more tractable comparison and summary of which hypotheses are rejected across different destinations and goods, for the long run price setting, see Table 7.

4.4.2 The market share and the short-run dynamics

Even though the results seem to indicate that the market share does not matter for the degree of long run price discrimination it can be important for the short-run dynamics of the price determination. If for example the relative price between the price of Swedish exports and that of competing products is stable in the long run (as in the case of automobile exports to Germany) there might still be deviations from such a relation in the short-run, suggesting that the market share could matter for the short-run price setting. The coefficients on the lagged changes of the market share in the price equation ($\Gamma_{j,13}$) are displayed in Table 8. For all destinations the size of these coefficients are rather small, indicating that changes in the

[31] If the cointegration rank is set to three, all hypotheses are rejected. Consequently, it can not be determined whether the market share matters or not, and the source of markup variation is thus not characterized by any of the examined price relations.

market share do not influence the price setting to any greater extent. In order to test whether the market share affect the determination of export price changes or not, a likelihood ratio test is formulated on the hypothesis $\Gamma_{1,13} = 0$. This hypothesis can not be rejected for any of the destination markets except for the French kraft paper market (see Table 9). In the short-run it is thus only the export price of kraft paper to France that is affected by market share changes.[32]

4.4.3 Exchange rate pass-through estimates

For the kraft paper exports to Germany the long run, partial, pass-through could be complete or incomplete depending on the imposed restriction. The interval of the exchange rate elasticity of the export price is 0,42 - 1,16; see Table 10. Assuming the market share to be excluded from the price determination implies that the exporters almost completely absorb the exchange rate change (the exchange rate elasticity of the export price is 1.16 implying a pass-through to the import price of -16 %) and the import price of automobiles in Germany is thus nearly invariant to a movement in the exchange rate. Nevertheless, for most destination markets, these intervals are difficult to interpret due to abnormally large coefficients or intervals including a negative exchange rate elasticity of the export price. A negative elasticity implies that an appreciation of the exporters' currency increases the export price and thus enlarges the effect on the foreign currency price (i.e. a pass-through to the import price greater than one) instead of stabilizing the foreign currency price (as one would expect). This is probably a consequence of the problems of identifying a true price setting relation. To determine the effect of an exchange rate change more precisely, the devaluations in 1981 and 1982 and the depreciation in 1992 are therefore more thoroughly examined.

The total short-run pass-through of the devaluations in 1981 and 1982 appears to be incomplete for the automobile exports to Germany. The immediate effect on the export price is less than 50 % for both devaluations (see Table 11) and the response seems to be decreasing over the quarters following the devaluations which implies that the pass-through increases over time. For the automobile export to the United Kingdom the response in the export pricing, on average, is somewhat larger compared to Germany, and the British local currency

[32] The likelihood ratio test is carried out with the cointegrating relations unrestricted. Imposing a more restricted long run relation (e.g. excluding the market share from the long run price setting) does not alter the results.

price is thus more invariant to these exchange rate changes. The export price to the United Kingdom absorbs the exchange rate changes within a quarter while the export price to Germany does not appear to be fully adjusted after the devaluations. For the devaluation in 1981 the export price in the British automobile market seems to be completely affected immediately (94 %). However, the contemporaneous response to the 1982 devaluation is quite different, where the price in the exporters' currency only absorbs 21 % of the exchange rate change. For the kraft paper markets there is a weak indication of an incomplete pass-through to the local currency price. The exchange rate effect, within a quarter, on the export price, for the German kraft paper market, is 99 % for the 1981 devaluation and 68 % for the 1982 devaluation (implying a pass-through of +1 % and +32 % respectively). For the British kraft paper market the effect on the export price is 81 % and 98 % respectively (+19 % and +2 % pass-through). For the kraft paper markets, the devaluations seem to be almost entirely incorporated into the export price within a year on average. Hence, the results are quite similar across the two products but the pass-through in the kraft paper markets, on average, possibly works slightly more stabilizing for the local currency price compared to the automobile markets. Furthermore, the local currency price adjustment, a year after the depreciation of the exchange rate, span between -16 % and +70 % for the 1981 devaluation and between -7 % and +65 % for the 1982 devaluation. Contrary to the expected response of a stable or possibly decreased local currency price, a devaluation could hence also increase the import price. On average the pass-through response is though positive and the results indicate no distinction between the two devaluations.[33]

For the French automobile and kraft paper markets the local currency price seem to vary almost fully with the depreciation in 1992 (see Table 11). The pass-through, a year after the exchange rate change, is +73 % and +109 % respectively. For the other destination markets, the pass-through coefficients of the depreciation in 1992 seem to differ somewhat from the responses to the devaluations in the eighties. The largest disparities, compared to the devaluations in 1981 and 1982, occur in the German automobile and kraft paper markets. Furthermore, the responses, in all markets, seem to be more volatile after the regime shift in 1992 than after the devaluations in 1981 and 1982. However, given the costs of adjusting the supplied quantity the pass-through will be a result of exchange rate expectations, which probably varied more after the regime shift in 1992 than after the exogenously specified

[33] The total short-run pass-through, based on the devaluations in 1981 and 1982, can not be estimated for the French data since the sample period starts in 1984.

devaluations in 1981 and 1982 under a fixed exchange rate regime. A greater uncertainty about the future development of the exchange rate can thus yield a different pricing response to an exchange rate change. On average the exchange rate change is passed through to the local currency price to a greater extent for the depreciation in 1992 compared to the devaluations in 1981 and 1982.

For a comparison, the partial short-run dynamics, i.e. the exchange rate coefficient of the pricing equation ($\Gamma_{j,14}$), are displayed in Table 8. The partial pass-throughs differ across destinations as well as between products. As expected, the partial coefficients also differ from the total effect within a quarter, for all destination markets. These partial coefficients show that the producers only pass-through a fraction of the exchange rate change to the price in the buyer's currency. The partial pass-through to the local currency price is non-zero and less than complete, ranging between +40 % and +85 % except for the exporters of automobiles to the French market, who seem to completely absorb the exchange rate change (+8 % pass-through) and thus leave the local currency price almost constant. The partial pass-through effect, on average, seems to work less stabilizing, for the local currency price, in the kraft paper markets than in the automobile markets. However, the majority of the coefficients are insignificant.

To formally test whether the partial short-run exchange rate elasticity of the export price is complete, $\Gamma_{1,14} = 1$, (implying a partial short-run pass-through (within a quarter), to the import price, of zero) a likelihood ratio test is formulated (see Table 9). Even though the point estimates of the exchange rate elasticity are less than one for the British and French automobile markets and the French kraft paper market, the hypothesis of a full adjustment of the export price can not be rejected. The exporters thus seem to keep the local currency price stable when the exchange rate changes. For these markets the short-run pass-through to the import price within one quarter is zero, in contrast to the long run price setting relation which seems to indicate a non-zero long run pass-through. The attempt to stabilize demand in the short-run while adjusting the local currency price, and thus also quantity, to an exchange rate change in the long run, could be interpreted as an effect of the quadratic costs of adjusting supply which imply a more costly adjustment the quicker it is undertaken. For the automobile exports to Germany, and the kraft paper exports to Germany and the United Kingdom, the export price does not fully adjust to the exchange rate change and the partial short-run pass-through is thus non-zero.

4.5 Robustness of the results

The critical values of all likelihood ratio tests, of linear restrictions on the cointegration vectors, rely on asymptotic χ^2 distributions and given that simulated empirical critical values typically are substantially larger, there is a tendency to reject the null hypothesis too often. The asymptotic distribution is then a poor approximation of the small sample distribution and since the system consists of relatively many estimated parameters (resulting from many variables and several cointegration vectors) and rather few observations, the inference based on the asymptotic distribution could thus be weak. The results should therefore be interpreted with this in mind.

One way of correcting the critical values is to approximate the finite, small sample distribution with the use of response surface regressions (from a data generating process of another VEC model) adjusting for the number of dimensions (n), lags (k) and cointegration vectors (r) for a given sample size (see Gredenhoff and Jacobson, 1998 for a discussion of these matters and the response surface regressions)[34]. Using these response adjusted critical values does, however, not change the results to any greater extent.[35] For what it is worth, the use of the response adjusted χ^2 distribution, strengthens the conclusion that the market share does not matter for the price determination[36].

The alternative specification with a unit labor cost index as proxying the marginal costs indicates similar results as when using the producer price indices as cost approximations. However, in this alternative system, it seems as if the Swedish exporters to a greater extent are influenced by the price of substitutes. Apart from the seeming price taking behaviour in the German automobile market, the local currency prices are also invariant to exchange rate changes in both the French automobile and kraft paper markets. The conclusion that the market share does not matter for the price relation is robust to the specification change. Moreover, measuring the market share based on values, of X_i and M_i, instead of volumes does not alter the results.

[34] Another and more adequate approach would be to approximate the distribution by a simulated bootstrap distribution from the data of the specific model used here. However, this lies beyond the scope of this paper.
[35] These response adjusted critical values should however be interpreted with caution since they are produced by a data generating process of a different model.
[36] Disturbingly, the contrasting hypotheses H_5 and H_6 are simultaneously accepted for three of the markets.

Since the results, of all specifications, indicate that the market share is not important for the degree of price discrimination, at least in a strict one-to-one relation between the Swedish exports of the product and the destination market's total imports of the product, a system replacing the market share with the export quantity (X_i) has been tested[37]. For this system (with variable vector $[p_i,ppi_i^l,x_i,e_i,p_i^{sub}]'$), the likelihood ratio tests do not, surprisingly, give an unambiguous indication that the exported quantity matters for the price determination. For the French automobile market and the British and French kraft paper markets the supplied volumes do not seem to affect the price determination. Excluding the exported quantity from the pricing relation can only be consistent with Swedish exporters being price takers in those markets. However, the results also show that the producers have non-stationary markups, which suggests that they have some market power in every destination market.

When interpreting all results from the likelihood ratio tests, one should bear in mind that the two cointegration vectors are unidentified from a strict economic perspective. Ideally one would like to distinguish the two vectors to be sure that the restrictions really are imposed on the specific price setting relation (instead of an arbitrary vector). One could argue that the tested hypotheses are designated for a price setting vector and should not satisfy for example a demand vector. Nevertheless, the imposed restrictions might apply to some other long run relation among the variables. When trying to identify the demand vector by excluding the marginal costs (i.e. by imposing $[\beta_{21},0,1,\beta_{24},\beta_{25}]'$ on this vector), the coefficients of this presumed demand vector turn out very large and with the wrong sign, why the problems of economic identification appear to prevail. These difficulties are though not specific to the multivariate approach or framework used here but can be found in any study of demand and supply relations. However, in many studies the identification problems are overlooked and not dealt with explicitly.

5 Conclusions

The presumption that a small open economy's price taking behaviour differs from a large country's price determination is somewhat contrasted by the results, which appear to be consistent with price discrimination in Swedish exports of automobiles and kraft paper. The

[37] Perhaps a more adequate specification would be to include both the Swedish export quantity and the destination market's total import volume of the product, in the system. However, due to few observations it is preferable to restrict the number of variables to a minimum.

Swedish exporters seem to price to market and take foreign conditions into consideration, such as destination specific substitute prices and exchange rates. In the German automobile market, however, the exporters seem to agree with other exporters on a common local currency price. The average relation between the price of Swedish exporters and that of their competitors is stable. The price in the exporter's currency will therefore be fully adjusted to an exchange rate change. On the British and French automobile and kraft paper markets Swedish exporters seem to have some market power and ability to affect their price. The pricing behaviour appears to be determined by market structure characteristics, which differ between goods and destinations. The effect on the export price of changes in exchange rates and prices of foreign substitutes is incomplete. The determination of the export price in these markets is, however, not characterized by any concern for maintaining market shares. One interpretation of this is that a less restrictive relation between the exported quantity and total imports of the good to the destination market may matter although the restriction that it is the market share that is relevant can be rejected. It is only for the kraft paper exports to Germany that the market share seems to affect the long run pricing to market behaviour. For the British automobile market the source of markup variation can not be characterized explicitly by this setting, since all hypothesized long run price relations are rejected. In addition, the short-run influence of the market share on the price setting seems to be very limited for all markets. It is only the export price of kraft paper to France that is affected by market share changes in the short-run.

The conclusion that the market share does not matter for the long run price determination, for all markets except the German kraft paper market, seems to be quite robust also when using small sample adjusted critical values and another specification with a different marginal cost approximation. Changing the specification to include the exported quantity instead of the market share does not give any clearcut conclusions about the price setting relation.

Previous studies have mainly used a single equation framework, abstracting from the problems arising when finding several long run relations. The cointegration analysis in this paper indicates two cointegrating relations, for most destination markets, implying problems of identification and interpretation. Ideally one would like to interpret the two cointegration vectors as reflecting e.g. price setting (supply) and demand. However, given the number of variables there could be several potential relations affecting the system why the cointegration vectors and results have to be interpreted with caution. A finding of several long run relations also introduces questions of how to define the pass-through effect. The partial coefficient only measures the effect an exchange rate change has on the price setting relation, excluding the effects going through other variables and other interactions of the price determination system. The total exchange rate pass-through coefficients measure the effect working through all variables and through both the short-run dynamics and the long run relations.

The estimates of the total short-run effect within a quarter, of the two devaluations of the krona in the eighties, on the export price span between 52 % and 135 % (implying a pass-through of +48 % and -35 % respectively). A year after the devaluations of the exchange rate, the total pass-through span between -16 % and +70 %. The total pass-through response a year after the depreciation in 1992, in contrast, is somewhat greater and span between +16 % and +109 %. On average, there seems to be an indication of a positive, less than full, pass-through to the local currency price for both automobiles and kraft paper. The producers will thus absorb a fraction of the exchange rate change and the local currency price will be partly, but not completely, stabilized.

The results indicate no distinct disparity, between the two commodities, when it comes to the presence of a pricing to market behaviour. Automobiles are supposed to be less homogenous than kraft paper. Nevertheless, the only evidence of price taking behaviour and lack of market power, or possibly of intentional price collaboration, occurs in the German automobile market. Furthermore, for both automobiles and kraft paper there is an indication of market segmentation and the presumed difference due to product differentiation does not seem to occur. Hence, this could be interpreted as other market structure characteristics than product substitutability being important for the Swedish export price determination.

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Appendix

A.1 Data definitions

P - export unit value index (export value in kronor divided by pieces (cars) or ton (kraft paper), quarterly averages from monthly data, 1980:1=1). Source: Statistics Sweden.

E - exchange rate index (market spot averages, quarterly data, 1980:1=1). Source: Bank of International Settlements, Basel.

PPI^{eng} - producer price index[38] (Swedish engineering excluding shipbuilding, quarterly data, 1980:1=1). Source: OECD Main Economic Indicators.

PPI^{pulp} - producer price index[39] (Swedish pulp, paper and paperboard, quarterly data, 1980:1=1). Source: OECD Main Economic Indicators.

PPI - producer price index (Swedish, quarterly averages from monthly data, 1980:1=1). Source: Konjunkturinstitutet.

P^{sub} - import unit value index (total imports for each destination country in local currency divided by pieces (cars) or ton (kraft paper), quarterly averages from monthly data, 1980:1=1[40]). Source: Statitisches Bundesamt (Germany), EUROSTAT (France and United Kingdom), Department of Commerce (US) and Central Statistical Office (United Kingdom).

SH - market share index, X / M, (Swedish export volume of a good divided by the total volume of imports of the good to one destination, 1980:1=1[41]), where

X - exported quantity (pieces (cars) or ton (kraft paper), quarterly from aggregating monthly data). Source: Statistics Sweden.

M - total imported quantity to each destination (pieces (cars) or ton (kraft paper), (quarterly from aggregating monthly data). Source: Statitisches Bundesamt (Germany), EUROSTAT (France and United Kingdom), Department of Commerce (US) and Central Statistical Office (United Kingdom).

Included products:

Kraft paper, board, uncoated; SITC 6414
Passenger transport vehicles; SITC 7812

[38] 1980-1981 approximated by the development of the aggregate producer price index, *PPI*.
[39] 1994 approximated by the development of the aggregate producer price index, *PPI*
[40] France; 1984:1=1.
[41] France; 1984:1=1.

A.2 Tables and Figures

Table 1: Average markup differences between destination markets

	GE-UK	GE-FR	UK-FR
Automobiles Markup mean difference	**0.1144**	**0.1375**	**0.0232**
Kraft Paper Markup mean difference	**0.0836**	**0.0308**	**-0.0529**

Note: Bold numbers indicate significance at the 5 % level. The markup difference is defined as $\ln\ (\overline{P_i} / \overline{P_j})$, i.e. the difference in average prices on markets *i* and *j* respectively. The comparison is made over the period 1980:1-1994:4 for all destinations (for data definitions see Appendix A.1).

Table 2: Correlation between the relative price, ln (P_i / P_j), and the relative market share, ln (SH_i / SH_j)

	GE-UK	GE-FR	UK-FR
Automobiles	0.004	**0.376**	**-0.267**
Kraft paper	**-0.408**	0.236	-0.066

Note: Bold numbers indicate significance at the 5% level. For Germany - the United Kingdom the correlation is calculated over the period 1980:1-1994:4. For Germany - France and for the United Kingdom - France it is calculated over 1984:1-1994:4 (for data definitions see Appendix A.1).

Table 3a: Model specification tests (multivariate) VAR (r = 5)

Destination Number of lags	Schwarz information criterion	Hannan-Quinn info. criterion	LM(1)[42] p-value	LM(4) p-value	Normality p-value
Automobiles:					
Germany					
k=1	-30.849	-32.352	0.42	0.46	0.07
k=2	-30.247	-32.308	0.94	0.14	0.01
k=3	-29.082	-31.711	0.32	0.46	0.00
k=4	-28.157	-31.368	0.35	0.19	0.00
United Kingdom					
k=1	-28.284	-29.679	0.05	0.86	0.01
k=2	-27.295	-29.247	0.30	0.96	0.00
k=3	-26.01	-28.531	0.08	0.96	0.00
k=4	-24.969	-28.07	0.41	0.95	0.00
France					
k=1	-27.516	-28.809	0.14	0.10	0.74
k=2	-26.214	-28.179	0.01	0.45	0.49
k=3	-25.98	-28.638	0.25	0.62	0.85
k=4	-25.711	-29.081	0.51	0.78	0.24
Kraft paper:					
Germany					
k=1	-35.397	-31.25	0.09	0.08	0.37
k=2	-30.606	-32.45	0.11	0.60	0.43
k=3	-29.578	-31.988	0.23	0.74	0.13
k=4	-28.858	-31.847	0.07	0.30	0.17
United Kingdom					
k=1	-30.377	-31.665	0.00	0.37	0.69
k=2	-29.581	-31.425	0.04	0.84	0.64
k=3	-28.636	-31.047	0.55	0.38	0.84
k=4	-27.611	-30.600	0.24	0.05	0.32
France					
k=1	-30.622	-31.915	0.00	0.46	0.06
k=2	-30.404	-32.37	0.22	0.03	0.03
k=3	-29.993	-32.65	0.02	0.72	0.07
k=4	-29.712	-33.082	0.40	0.69	0.41

Note: The chosen lag specification is indicated in bold numbers.

[42] LM(q) is a Lagrange Multiplier test for autocorrelation of order q.

Table 3b: Model specification tests (multivariate) VEC

	Rank							
	r=1		r=2		r=3		r=4	
Destination Number of lags	LM(1) p-value	Norm. p-value	LM(1) p-value	Norm. p-value	LM(1) p-value	Norm. p-value	LM(1) p-value	Norm. p-value
Automobiles: Germany								
k=1	0.38	0.01	**0.65**	**0.00**	0.36	0.06	0.39	0.12
k=2	0.89	0.08	**0.94**	**0.04**	0.88	0.03	0.94	0.02
k=3	**0.28**	**0.02**	0.18	0.01	0.30	0.00	0.32	0.00
k=4	0.31	0.01	**0.43**	**0.00**	0.38	0.00	0.23	0.00
United Kingdom								
k=1	0.01	0.00	0.07	0.00	**0.06**	**0.00**	0.04	0.00
k=2	0.81	0.00	**0.36**	**0.00**	0.18	0.00	0.24	0.00
k=3	0.04	0.00	**0.10**	**0.00**	0.09	0.00	0.09	0.00
k=4	0.24	0.00	**0.18**	**0.00**	0.16	0.00	0.27	0.00
France								
k=1	0.13	0.01	0.06	0.14	0.07	0.25	0.08	0.73
k=2	0.02	0.75	0.00	0.43	**0.01**	**0.76**	0.00	0.55
k=3	0.32	0.79	**0.12**	**0.42**	0.33	0.92	0.14	0.97
k=4	0.34	0.24	0.45	0.19	**0.46**	**0.57**	0.40	0.56
Kraft paper: Germany								
k=1	0.02	0.51	**0.08**	**0.42**	0.08	0.44	0.08	0.38
k=2	0.23	0.32	**0.16**	**0.25**	0.12	0.50	0.12	0.49
k=3	**0.40**	**0.32**	0.31	0.37	0.44	0.18	0.37	0.27
k=4	0.18	0.48	**0.07**	**0.39**	0.09	0.16	0.04	0.13
United Kingdom								
k=1	0.00	0.01	0.00	0.07	**0.00**	**0.36**	0.00	0.64
k=2	0.16	0.04	**0.10**	**0.14**	0.06	0.50	0.04	0.65
k=3	0.62	0.70	**0.39**	**0.71**	0.61	0.92	0.61	0.90
k=4	0.14	0.68	0.25	0.65	**0.32**	**0.41**	0.26	0.36
France								
k=1	0.00	0.00	0.01	0.01	0.00	0.03	**0.00**	**0.05**
k=2	0.20	0.01	0.14	0.19	0.01	0.00	**0.22**	**0.03**
k=3	0.04	0.02	0.05	0.02	0.04	0.01	**0.01**	**0.04**
k=4	0.51	0.10	0.76	0.17	0.60	0.19	0.48	0.14

Note: Bold numbers indicate suggested rank at the specific lag length (according to the Trace test with 5 % significance).

Table 3c: Model specification tests VEC (two cointegration vectors, r = 2)

Destination, lags Equation	Multivariate tests LM(1) p-value	 LM(4) p-value	 Normality p-value	Univariate tests ARCH(k) statistic[43]	 Normality statistic[44]	 R^2
Automobiles:						
Germany, k=2	0.94	0.09	**0.04**			
Δp_t				2.173	4.604	0.574
Δppi_t^{eng}				3.539	**13.118**	0.818
Δsh_t				0.156	3.573	0.63
Δe_t				0.526	**8.08**	0.675
Δp_t^{sub}				4.727	2.023	0.637
United Kingdom, k=2	0.36	0.96	**0.00**			
Δp_t				0.13	1.619	0.208
Δppi_t^{eng}				3.089	**7.48**	0.772
Δsh_t				3.977	2.677	0.829
Δe_t				0.432	7.04	0.391
Δp_t^{sub}				**8.078**	**12.519**	0.787
France, k=3	0.12	0.46	0.42			
Δp_t				0.794	5.368	0.711
Δppi_t^{eng}				0.947	2.476	0.697
Δsh_t				1.494	1.017	0.764
Δe_t				0.456	0.152	0.77
Δp_t^{sub}				0.815	**8.438**	0.529
Kraft paper:						
Germany, k=2	0.16	0.56	0.25			
Δp_t				5.824	2.138	0.465
Δppi_t^{pulp}				0.179	3.168	0.589
Δsh_t				0.523	1.279	0.622
Δe_t				3.648	3.265	0.687
Δp_t^{sub}				1.529	0.636	0.377
United Kingdom, k=2	0.10	0.89	0.14			
Δp_t				0.319	0.889	0.524
Δppi_t^{pulp}				1.819	1.684	0.543
Δsh_t				0.364	**10.057**	0.475
Δe_t				1.311	1.258	0.501
Δp_t^{sub}				3.205	0.926	0.342
France, k=2	0.14	0.06	0.19			
Δp_t				0.309	3.444	0.432
Δppi_t^{pulp}				1.288	1.022	0.578
Δsh_t				1.062	0.352	0.39
Δe_t				0.064	1.35	0.72
Δp_t^{sub}				0.490	2.822	0.792

Note: Bold numbers indicate that the null hypothesis can be rejected with 5 % significance (asymptotic distribution).

[43] Test statistic from a univariate Lagrange Multiplier test for ARCH of order k. It is asymptotically $\chi^2(k)$.
[44] Asymptotically distributed $\chi^2(2)$.

Table 4: Cointegration rank

Country	Null hypothesis	Eigenvalue	Trace
Automobiles:			
Germany	r = 0	0.5048	91.28
2 lags	r ≤ 1	0.3202	50.52
	r ≤ 2	0.2920	28.14
	r ≤ 3	0.1170	8.11
	r ≤ 4	0.0152	0.89
United Kingdom	r = 0	0.4862	96.73
2 lags	r ≤ 1	0.3938	58.11
	r ≤ 2	0.2608	29.08
	r ≤ 3	0.1365	11.55
	r ≤ 4	0.0510	3.03
France	r = 0	0.7898	128.94
3 lags	r ≤ 1	0.5849	65.00
	r ≤ 2	0.3073	28.95
	r ≤ 3	0.2086	13.9
	r ≤ 4	0.0998	4.31
Kraft Paper:			
Germany	r = 0	0.5319	93.56
2 lags	r ≤ 1	0.4112	49.52
	r ≤ 2	0.1844	18.80
	r ≤ 3	0.1006	6.98
	r ≤ 4	0.0142	0.83
United Kingdom	r = 0	0.4574	86.69
2 lags	r ≤ 1	0.3158	51.23
	r ≤ 2	0.2665	29.22
	r ≤ 3	0.1515	11.24
	r ≤ 4	0.0291	1.71
France	r = 0	0.7168	133.9
2 lags	r ≤ 1	0.5902	80.91
	r ≤ 2	0.4853	43.44
	r ≤ 3	0.3038	15.55
	r ≤ 4	0.0081	0.34

Critical value 95% quantile by Osterwald-Lenum (1992) Table1 (unrestricted constant):

No. of cointegration vectors	Trace
r = 0	68.52
r ≤ 1	47.21
r ≤ 2	29.68
r ≤ 3	15.41
r ≤4	3.76

Table 5: Relevant hypotheses to test

Hypothesis	
H_1: p_i - ppi^l ~ I(0)	If non-stationary markup – monopoly power
H_2: sh_i ~ I(0)	Stationary market share
H_3: $[\beta_1, \beta_2] \in sp(\beta)$ where $\beta_k = [\beta_{k1},\beta_{k2},0,\beta_{k4},\beta_{k5}]'$	The market share does not enter in any of the vectors
H_4: $p_i - p_i^{sub} - e_i$ ~ I(0)	Stationary relative price
H_5: $p_i - ppi^i - \beta_{14}e_i - \beta_{15}p_i^{sub}$ ~ I(0)	The market share does not matter
H_6: $p_i - ppi^l - \beta_{13}sh_i$ ~ I(0)	Covaration between the markup and the market share
H_7: $p_i - ppi^l - \beta_{13}sh_i - \beta_{14}(e_i + p_i^{sub})$ ~ I(0)	Symmetry on e_i and p_i^{sub}

Hypothesis testing (variable vector: [p, ppi^l, sh, e, p^{sub}]')

Table 6a: Automobile exports to Germany

Specification	Hypothesis	Likelihood ratio statistic	p-value	
2 lags, constant	H_1=[1,-1,0,0,0]'	$\chi^2(3)$=16.47	0.00	unrestr.[45]
dummies	H_2=[0,0,1,0,0]'	$\chi^2(3)$=13.37	0.00	unrestr.
2 vectors	H_3=[β_{11},β_{12},0,β_{14},β_{15}]' [β_{21},β_{22},0,β_{24},β_{25}]'	$\chi^2(2)$=13.75	0.00	
	H_4=[1,0,0,-1,-1]'	$\chi^2(3)$=6.57	0.09	unrestr.
	H_5=[1,-1,0, -β_4,-β_5]'	$\chi^2(1)$=0.74	0.39	unrestr.
	H_6=[1,-1,-β_3,0,0]'	$\chi^2(2)$=12.30	0.00	unrestr.
	H_7=[1,-1,-β_3,-β_4,-β_4]'	$\chi^2(1)$=1.35	0.25	unrestr.

Table 6b: Automobile exports to the United Kingdom

Specification	Hypothesis	Likelihood ratio statistic	p-value	
2 lags, constant	H_1=[1,-1,0,0,0]'	$\chi^2(3)$=18.34	0.00	unrestr.
dummies	H_2=[0,0,1,0,0]'	$\chi^2(3)$=22.71	0.00	unrestr.
2 vectors	H_3=[β_{11},β_{12},0,β_{14},β_{15}]' [β_{21},β_{22},0,β_{24},β_{25}]'	$\chi^2(2)$=20.84	0.00	
	H_4=[1,0,0,-1,-1]'	$\chi^2(3)$=17.58	0.00	unrestr.
	H_5=[1,-1,0, -β_4,-β_5]'	$\chi^2(1)$=6.09	0.01	unrestr.
	H_6=[1,-1,-β_3,0,0]'	$\chi^2(2)$=18.03	0.00	unrestr.
	H_7=[1,-1,-β_3,-β_4,-β_4]'	$\chi^2(1)$=5.30	0.02	unrestr.

[45] The other vector is unrestricted.

Table 6c: Automobile exports to France

Specification	Hypothesis	Likelihood ratio statistic	p-value	
3 lags, constant	$H_1=[1,-1,0,0,0]'$	$\chi^2(3)=25.70$	0.00	unrestr.
dummies	$H_2=[0,0,1,0,0]'$	$\chi^2(3)=25.81$	0.00	unrestr.
2 vectors	$H_3=[\beta_{11},\beta_{12},0,\beta_{14},\beta_{15}]'$ $[\beta_{21},\beta_{22},0,\beta_{24},\beta_{25}]'$	$\chi^2(2)=7.23$	0.03	
	$H_4=[1,0,0,-1,-1]'$	$\chi^2(3)=20.66$	0.00	unrestr.
	$H_5=[1,-1,0, -\beta_4,-\beta_5]'$	$\chi^2(1)=0.92$	0.34	unrestr.
	$H_6=[1,-1,-\beta_3,0,0]'$	$\chi^2(2)=24.99$	0.00	unrestr.
	$H_7=[1,-1,-\beta_3,-\beta_4,-\beta_4]'$	$\chi^2(1)=20.35$	0.00	unrestr.

Table 6d: Kraft paper exports to Germany

Specification	Hypothesis	Likelihood ratio statistic	p-value	
2 lags, constant	$H_1=[1,-1,0,0,0]'$	$\chi^2(3)=24.83$	0.00	unrestr.
dummies	$H_2=[0,0,1,0,0]'$	$\chi^2(3)=9.11$	0.03	unrestr.
2 vectors	$H_3=[\beta_{11},\beta_{12},0,\beta_{14},\beta_{15}]'$ $[\beta_{21},\beta_{22},0,\beta_{24},\beta_{25}]'$	$\chi^2(2)=24.69$	0.00	
	$H_4=[1,0,0,-1,-1]'$	$\chi^2(3)=26.34$	0.00	unrestr.
	$H_5=[1,-1,0, -\beta_4,-\beta_5]'$	$\chi^2(1)=13.58$	0.00	unrestr.
	$H_6=[1,-1,-\beta_3,0,0]'$	$\chi^2(2)=9.08$	0.01	unrestr.
	$H_7=[1,-1,-\beta_3,-\beta_4,-\beta_4]'$	$\chi^2(1)=1.64$	0.20	unrestr.

Table 6e: Kraft paper exports to the United Kingdom

Specification	Hypothesis	Likelihood ratio statistic	p-value	
2 lags, constant dummies 2 vectors	$H_1=[1,-1,0,0,0]'$	$\chi^2(3)=16.25$	0.00	unrestr.
	$H_2=[0,0,1,0,0]'$	$\chi^2(3)=16.41$	0.00	unrestr.
	$H_3=[\beta_{11},\beta_{12},0,\beta_{14},\beta_{15}]'$ $[\beta_{21},\beta_{22},0,\beta_{24},\beta_{25}]'$	$\chi^2(2)=10.83$	0.00	
	$H_4=[1,0,0,-1,-1]'$	$\chi^2(3)=15.21$	0.00	unrestr.
	$H_5=[1,-1,0,-\beta_4,-\beta_5]'$	$\chi^2(1)=2.88$	0.09	unrestr.
	$H_6=[1,-1,-\beta_3,0,0]'$	$\chi^2(2)=3.73$	0.15	unrestr.
	$H_7=[1,-1,-\beta_3,-\beta_4,-\beta_4]'$	$\chi^2(1)=2.09$	0.15	unrestr.

Table 6f: Kraft paper exports to France

Specification	Hypothesis	Likelihood ratio statistic	p-value	
2 lags, constant dummies 2 vectors	$H_1=[1,-1,0,0,0]'$	$\chi^2(3)=29.11$	0.00	unrestr.
	$H_2=[0,0,1,0,0]'$	$\chi^2(3)=23.47$	0.00	unrestr.
	$H_3=[\beta_{11},\beta_{12},0,\beta_{14},\beta_{15}]'$ $[\beta_{21},\beta_{22},0,\beta_{24},\beta_{25}]'$	$\chi^2(2)=1.35$	0.51	
	$H_4=[1,0,0,-1,-1]'$	$\chi^2(3)=23.11$	0.00	unrestr.
	$H_5=[1,-1,0,-\beta_4,-\beta_5]'$	$\chi^2(1)=0.86$	0.35	unrestr.
	$H_6=[1,-1,-\beta_3,0,0]'$	$\chi^2(2)=16.28$	0.00	unrestr.
	$H_7=[1,-1,-\beta_3,-\beta_4,-\beta_4]'$	$\chi^2(1)=9.54$	0.00	unrestr.
3 vectors	H_1	$\chi^2(2)=20.08$	0.00	unrestr.
	H_2	$\chi^2(2)=13.90$	0.00	unrestr.
	$H_3=[\beta_{11},\beta_{12},0,\beta_{14},\beta_{15}]'$ $[\beta_{21},\beta_{22},0,\beta_{24},\beta_{25}]'$	$\chi^2(3)=13.64$	0.00	
	H_4	$\chi^2(2)=14.21$	0.00	unrestr.
	$H_{5a}=[1,-1,0,-\beta_4,-\beta_4]'$	$\chi^2(1)=11.43$	0.00	unrestr.
	H_6	$\chi^2(1)=6.93$	0.01	unrestr.

Table 7: Summary of the long run hypothesis testing

Hypothesis	Automobiles			Kraft paper		
	GE	UK	FR	GE	UK	FR
H_1: Stationary markup	**	**	**	**	**	**
H_2: Stationary market share	**	**	**	*	**	**
H_3: Market share excluded from system	**	**	*	**	**	
H_4: Stationary relative price		**	**	**	**	**
H_5: Market share does not matter		*		**		
H_6: Market share matters exclusively	**	**	**	*		**
H_7: Symmetry on e_i and p_i^{sub}		*	**			**

Note: * denotes rejection at 5 % significance (asymptotic distribution). ** denotes rejection at 1 % significance (asymptotic distribution). Two cointegrating relations, the second vector is unrestricted.

Table 8: Partial short-run dynamics of the market share and the exchange rate (coefficients in the pricing equation)

Destination, lags	Δsh_{t-1} ($\Gamma_{1,13}$)	Δsh_{t-2} ($\Gamma_{2,13}$)	Δe_{t-1} ($\Gamma_{1,14}$)	Δe_{t-2} ($\Gamma_{2,14}$)
Automobiles:				
Germany, k=2	-0.000		0.242	
United Kingdom, k=2	-0.014		0.617*	
France, k=3	-0.066	0.003	0.916	0.157
Kraft paper:				
Germany, k=2	-0.052		0.448*	
United Kingdom, k=2	-0.000		0.147	
France, k=2	0.073		0.408	

Note: * denotes significance at the 5 % level.

Table 9: Short-run dynamics (hypothesis testing on the pricing equation)

Destination, lags	Hypothesis	Test statistic	p-value
Automobiles:			
Germany, k=2	$\Gamma_{1,13} = 0$	$\chi^2(1)=0.00$	0.99
	$\Gamma_{1,14} = 1$	$\chi^2(1)=13.83$	0.00
United Kingdom, k=2	$\Gamma_{1,13} = 0$	$\chi^2(1)=0.18$	0.67
	$\Gamma_{1,14} = 1$	$\chi^2(1)=2.09$	0.15
France, k=3	$\Gamma_{1,13} = 0$	$\chi^2(1)=3.28$	0.07
	$\Gamma_{1,14} = 1$	$\chi^2(1)=0.035$	0.85
	$\Gamma_{1,13} = \Gamma_{2,13} = 0$	$\chi^2(2)=3.66$	0.16
	$\Gamma_{1,14} = \Gamma_{2,14} = 1$	$\chi^2(2)=4.42$	0.11
Kraft paper:			
Germany, k=2	$\Gamma_{1,13} = 0$	$\chi^2(1)=1.28$	0.26
	$\Gamma_{1,14} = 1$	$\chi^2(1)=10.86$	0.00
United Kingdom, k=2	$\Gamma_{1,13} = 0$	$\chi^2(1)=0.00$	0.99
	$\Gamma_{1,14} = 1$	$\chi^2(1)=29.41$	0.00
France, k=2	$\Gamma_{1,13} = 0$	$\chi^2(1)=4.56$	0.03
	$\Gamma_{1,14} = 1$	$\chi^2(1)=3.27$	0.07

Table 10: Exact identification of the two cointegrating relations[46]

Destination	Point estimates
Automobiles: Germany	$p - ppi^{eng} = 0.168\, sh - 0.832\, e + 1.44\, p^{sub}$ $p = 2.984\, ppi^{eng} - 0.998\, e - 0.074\, p^{sub}$ $p = 4.344\, ppi^{eng} - 0.115\, sh - 1.11\, (e + p^{sub})$ $sh = 3.963\, p + 2.966\, e - 8.729\, p^{sub}$
United Kingdom	$p - ppi^{eng} = 0.454\, sh + 4.223\, e + 1.08\, p^{sub}$ $p = - 1.78\, ppi^{eng} + 4.223\, e + 2.822\, p^{sub}$ $p = - 4.015\, ppi^{eng} - 0.365\, sh + 4.223\, (e + p^{sub})$ $sh = 3.438\, p - 14.519\, e - 5.868\, p^{sub}$
France	$p - ppi^{eng} = - 0.258\, sh - 8.982\, e + 0.902\, p^{sub}$ $p = 3.11\, ppi^{eng} - 5.806\, e - 0.266\, p^{sub}$ $p = 5.801\, ppi^{eng} + 0.329\, sh - 1.755\, (e + p^{sub})$ $sh = - 2.628\, p - 27.564\, e + 3.824\, p^{sub}$
Kraft paper: Germany	$p - ppi^{pulp} = - 2.729\, sh + 0.417\, e + 1.263\, p^{sub}$ $p = 0.136\, ppi^{pulp} + 1.164\, e + 0.543\, p^{sub}$ $p = 0.502\, ppi^{pulp} - 1.156\, sh + 0.848\, (e + p^{sub})$ $sh = 2.318\, p - 2.973\, e - 0.996\, p^{sub}$
United Kingdom	$p - ppi^{pulp} = - 2.649\, sh - 4.67\, e + 2.17\, p^{sub}$ $p = 0.258\, ppi^{pulp} + 0.382\, e + 0.79\, p^{sub}$ $p = 0.211\, ppi^{pulp} + 0.168\, sh + 0.703\, (e + p^{sub})$ $sh = 1.083\, p - 2.32\, e - 0.335\, p^{sub}$
France	$p - ppi^{pulp} = - 0.783\, sh - 4.907\, e + 2.783\, p^{sub}$ $p = - 2.499\, ppi^{pulp} + 3.042\, e + 4.867\, p^{sub}$ $p = - 3.588\, ppi^{pulp} + 0.244\, sh + 5.516\, (e + p^{sub})$ $sh = - 1.788\, p - 4.712\, e + 6.04\, p^{sub}$

[46] The different identifying restrictions are on the price setting vector; $[1,-1,\beta_{13},\beta_{14},\beta_{15}]'$, $[1,\beta_{12},0,\beta_{14},\beta_{15}]'$ and $[1,\beta_{12},\beta_{13},\beta_{14},\beta_{14}]'$ respectively, and on the demand vector; $[\beta_{21},0,1,\beta_{24},\beta_{25}]'$.

Table 11: Total short-run exchange rate effect (response (Δp_{t+s}) / response (Δe_t))

Destination, lags	s=0	s=1	s=2	s=3	s=4
Automobiles:					
Germany, k=2					
81:4	0.3482	0.5244	0.4786	0.3677	0.3046
82:4	0.4342	0.5897	0.5175	0.4079	0.3524
92:4	1.28	1.3514	1.0885	0.9033	0.8399
United Kingdom, k=2					
81:4	0.9367	1.3469	1.2976	1.189	1.1631
82:4	0.2117	0.9688	0.7948	0.7167	0.704
92:4	0.359	0.8203	0.7963	0.6095	0.5667
France, k=3					
92:4	-0.0536	0.6274	0.2948	0.4557	0.2724
Kraft paper:					
Germany, k=2					
81:4	0.8222	0.9927	1.0312	1.0622	1.1219
82:4	0.4481	0.6769	0.6868	0.7687	0.8448
92:4	-0.4182	0.1863	-0.1192	0.0116	0.0725
United Kingdom, k=2					
81:4	0.5352	0.8091	0.5626	0.5417	0.6042
82:4	0.8143	0.9828	0.8752	0.9521	1.0725
92:4	-0.9	0.9076	0.5743	0.6537	0.8387
France, k=3					
92:4	-0.0096	0.2708	0.1549	-0.0501	-0.0863

Note: The sample period for France is 1984:1-1994:4.

Markups (mup_i = ln (export price to market i / domestic producer price index))[47]

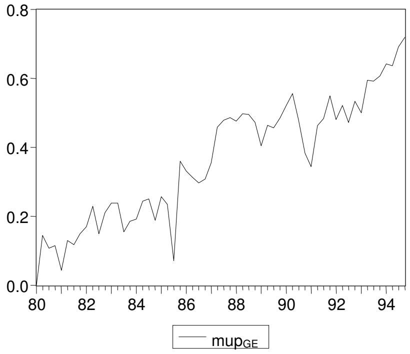

Figure 1: Automobile exports to Germany

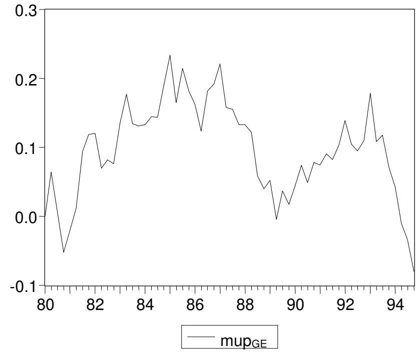

Figure 2: Kraft paper exports to Germany

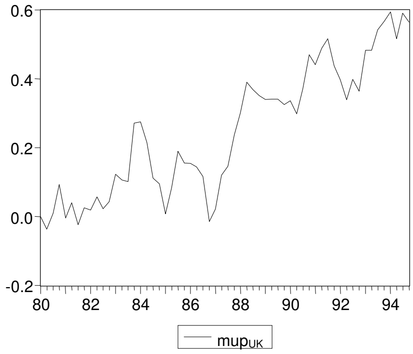

Figure 3: Automobile exports to
the United Kingdom

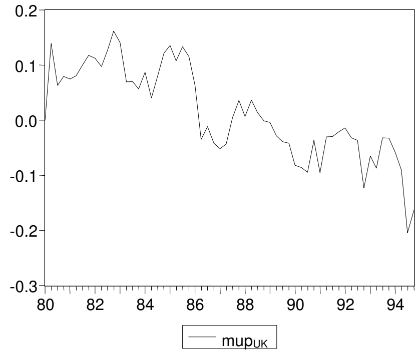

Figure 4: Kraft paper exports to
the United Kingdom

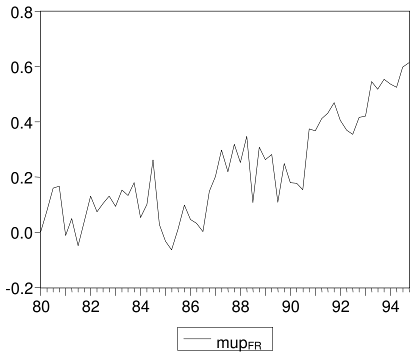

Figure 5: Automobile exports to France

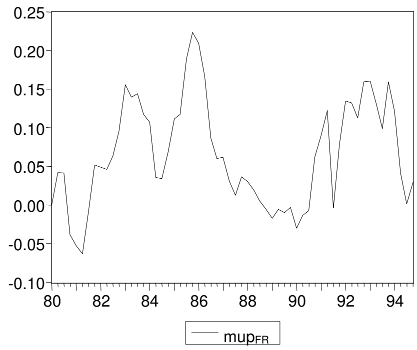

Figure 6: Kraft paper exports to France

[47] Given that the series are indices, a negative markup just indicates a quicker percentage movement in the producer price series.

Relative price, $(p_i - p_j)$, (solid, left scale) and market share, $(sh_i - sh_j)$, (dashed, right scale)

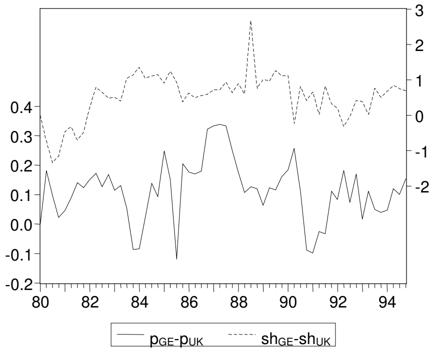

Figure 7: Automobile exports
Germany-United Kingdom

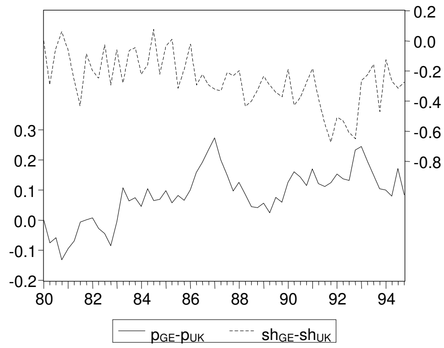

Figure 8: Kraft paper exports
Germany-United Kingdom

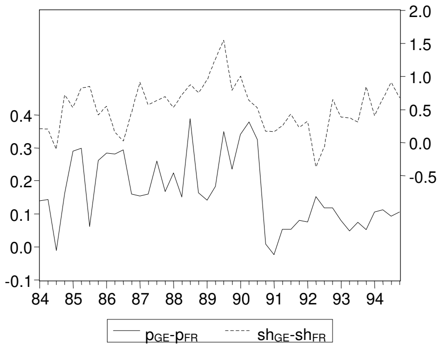

Figure 9: Automobile exports
Germany-France

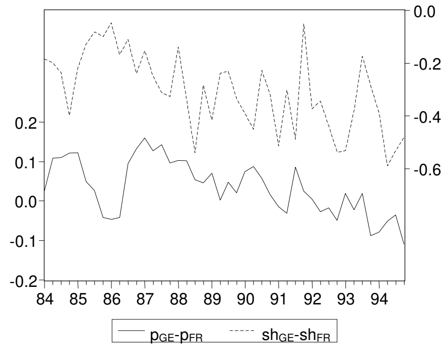

Figure 10: Kraft paper exports
Germany-France

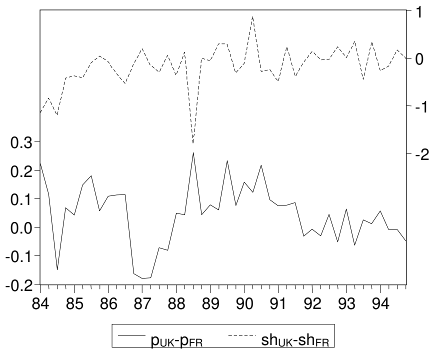

Figure 11: Automobile exports
United Kingdom-France

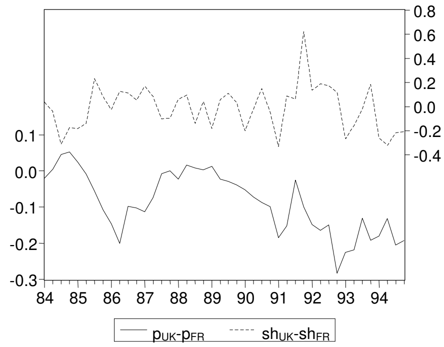

Figure 12: Kraft paper exports
United Kingdom-France

Average relative prices $(\overline{p_i - p_j})$ and average market shares $(\overline{sh_i - sh_j})$

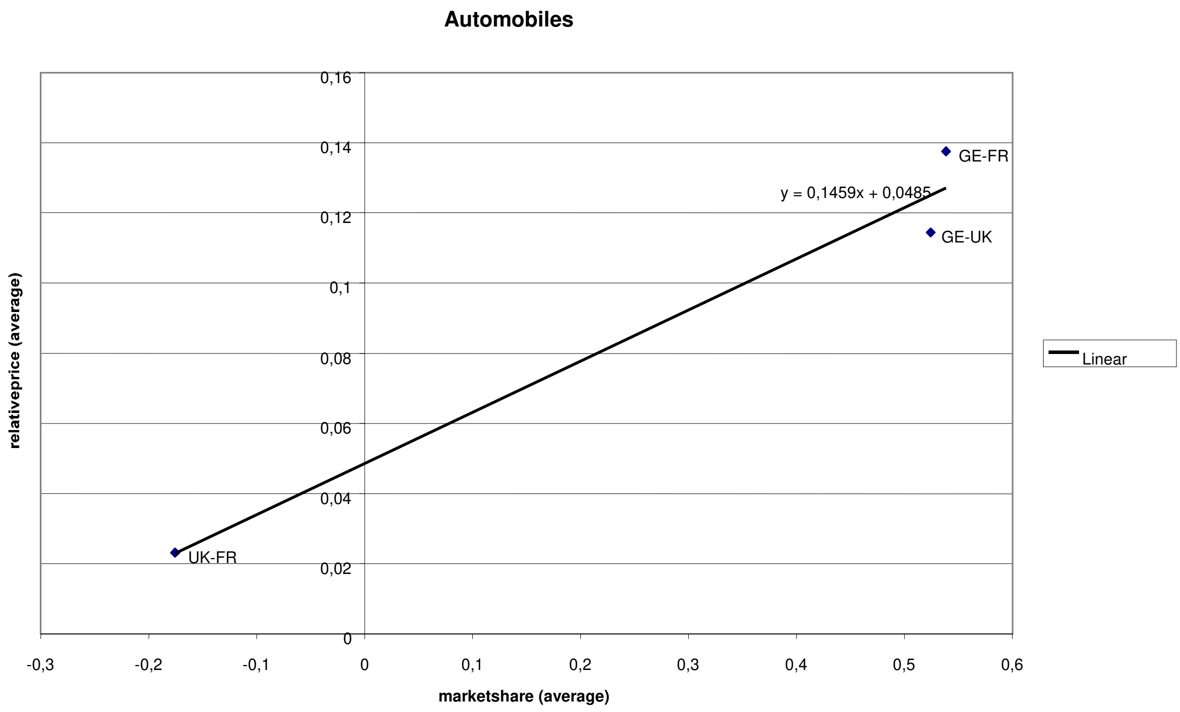

Figure 13: Automobile exports

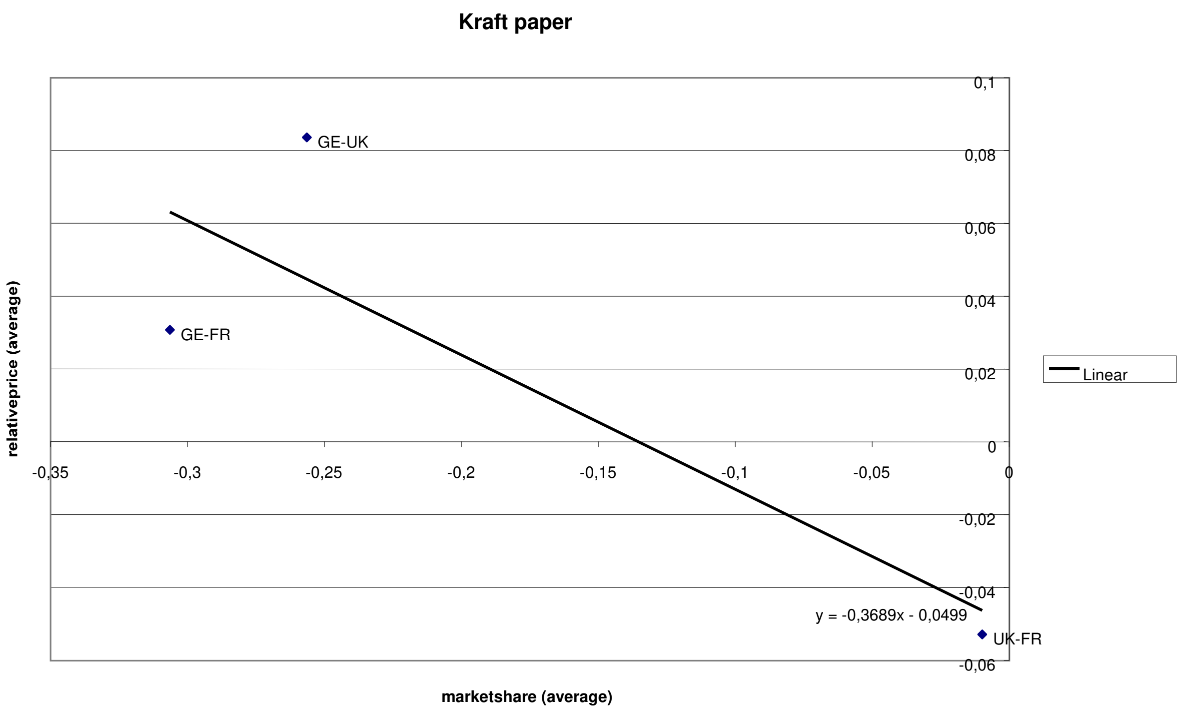

Figure 14: Kraft paper exports

Outliers in the export price series (p_i) and the series for the price of substitutes (p_i^{sub})

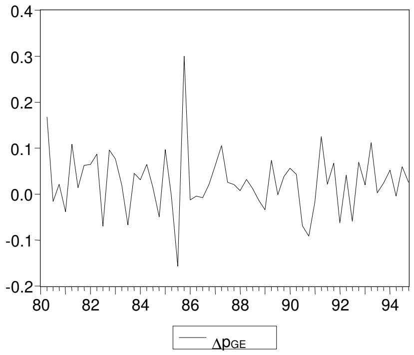

Figure 15: First difference of the export price to the German automobile market (Δp_{GE})

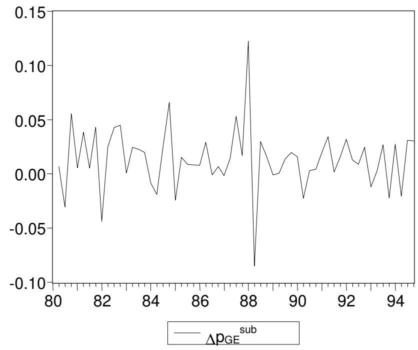

Figure 16: First difference of the price of substitutes on the German automobile market (Δp_{GE}^{sub})

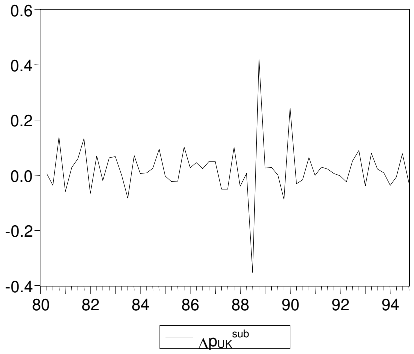

Figure17: First difference of the price of substitutes on the British automobile market (Δp_{UK}^{sub})