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ON THE INTERDEPENDENCE OF FINNISH AND SWEDISH NEWSPRINT PRICES*

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This study explores the interdependence of Finnish and Swedish newsprint prices. Since newsprint represents a very homogenous product, the law of one price (LOP) is assumed to hold between the Finnish and the Swedish common currency newsprint prices in the long run. The results support the LOP hypothesis, and the Swedish prices are found to be weakly exogenous, implying that the Finnish prices follow fundamentally the Swedish ones in the long run. Moreover, deviations from the LOP are found to be economically relatively small and short-lived. (JEL: F36, F41)

1. Introduction

Common to the Finnish and the Swedish economies is the significant role of the forest industry in the total manufacturing production and total exports. In 1993 it covered 28% and 24% of Finland's and Sweden's manufacturing value added and 30% and 14% of total exports, respectively (Ahonen and Pyyhtiä, 1996; Erkkilä and Widgrén, 1996). As the structure of foreign trade is relatively similar for Finland and Sweden, the bulk of export products constituting forest and metal industry products for both countries, this has led to a situation where a large portion of Finnish exports competes directly with Swedish exports in international markets. During 1985–1993 this portion varied between circa 50 and 60% of the total Finnish exports (Erkkilä and Widgrén, 1996). Thus, knowledge of a possible connection between the Finnish and the Swedish export price determination is important in such a situation.

Conceptually, the relation of the Swedish and the Finnish prices can be linked to the interdependent questions concerning the character of the products, the nature of competition in the markets, and whether the markets are integrated or segmented (cf. Goldberg and Knetter, 1997). It is conventional to assume that the more similar the Finnish and the Swedish products are, the more strongly the prices are connected to each other, provided that the relevant markets are integrated. In integrated markets geography or nationality should not have systematic effects on transaction prices for similar products. This implies that common currency prices of similar products should be equated over time. Hence the law of one price (hereafter LOP) should hold in integrated markets, and these markets can be characterized as perfectly competitive. Segmentation of markets, in turn,

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implies lack of integration, and buyers in different markets face systematically different prices for the same products. In such a situation the LOP does not hold and competition is imperfect.

This paper focuses on the potential interdependence of Finnish and Swedish newsprint prices. Newsprint represents an important export commodity for Finland. In 1990 (1995) it was the fourth (eighth) most important commodity of Finnish exports (ETLA 1998; pp. 51). More specifically, we are interested in the possible existence of a stable long-term LOP relationship between the two newsprint prices.

Traditionally the LOP is assumed to be the more reasonable hypothesis for homogenous rather than differentiated products. Since newsprint represents the most homogenous paper grade among different paper industry products (Hänninen *et al.,* 1997), there seem to be good grounds for testing the LOP in this context. Although the LOP belongs to the fundamental classic hypotheses in international economics, the empirical validity of it has remained questionable. Thus, new empirical results are welcome.

Isard (1977) and Richardson (1978) represent classic references to the empirical failure of the LOP. However, it can be argued that from a modern perspective these studies are questionable since by analyzing differenced data, the fundamental nature of the LOP as a long-term relationship was not taken into account properly in these studies. Recent advances in the analysis of non-stationary time series, especially unit root and cointegration testing, are capable of correcting this flaw. The LOP seems to have gained more support from cointegration and unit roots based tests, but on the whole the evidence has remained ambiguous[1]. The results by Baffes (1991), Michael *et al*. (1994), and Vataja (2000a), among others, suggest that the LOP holds fairly well for a number of relatively homogenous commodities, while Ardeni (1989), using the same data-set as Baffes (1991), provides strongly contrasting evidence. The conflicting test results may be explainable by Baffes' use of a more efficient testing method. Ceglowski (1994) and Engel (2000) rejected the LOP almost totally for narrowly defined manufacturing goods and for somewhat more aggregated goods categories, respectively, but Wei and Parsley's (1996) potentially more powerful panel-based analysis for tradeable sectors provided strong support for the hypothesis.

Regarding paper products, Buongiorno and Uusivuori (1992) provided rather strong support for the long-term LOP for US pulp and paper exports, while Hänninen *et al.* (1997) rejected the LOP for newsprint import prices in the U.K. between Finland and Sweden, but not between Sweden and Canada. Moreover, the hypothesis was rejected unambiguously in the German market[2] implying that the U.K. and German markets could not be regarded as integrated but merely segmented, and, consequently, imperfect competition would be a suitable framework for modeling the price determination in these markets. Hänninen and Toppinen (1999) addressed this explicitly by specifying a variable mark-up pricing model for the Finnish newsprint and pulp exports in the U.K. and Germany. The prices were modeled to depend on production costs, exchange rates and competitors' prices. According to the empirical results, the LOP could not be supported in the U.K. and German newsprint markets, but both production costs and competitors' prices and exchange rates were important determinants of the prices. As to Finnish pulp exports, the LOP could hold in the U.K. markets, but not in the German markets, thus implying segmentation of the markets, again. From the perspective of this study, Hänninen and Toppinen's (1999) model is of interest since the LOP was included in the model as a special case. Thus overall, the previous evidence concerning paper products and newsprint is by and large ambiguous.

The rest of the study is organised as follows. Section 2 describes the data. The model and the

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[1] See, e.g., Vataja (2000a) for a more detailed discussion of the previous commodity level LOP tests utilizing cointegration and unit root analysis.

[2] The results of Hänninen et al. (1997) are somewhat difficult to interpret as a pure LOP test, since the analysis was carried out for newsprint import prices deflated by producer prices, i.e., for real newsprint import prices. Also the use of unit values instead of true price series may effect the test results.

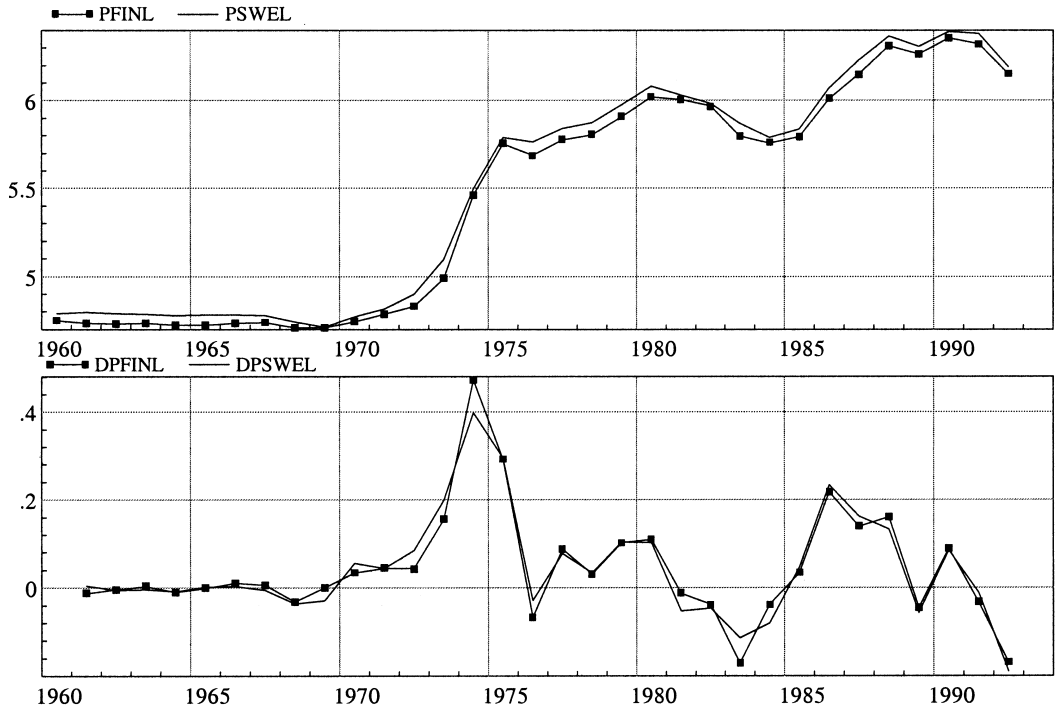


Figure 1. Levels and first differences of the logarithms of the Finnish and the Swedish dollar quoted newsprint prices.

econometric methods are discussed in Section 3. Section 4 contains and interprets the empirical results. Finally, Section 5 concludes the study.

2. The data

The data, taken from the IMF *International Financial Statistics Yearbooks* 1990 and 1995, consist of the Finnish and the Swedish newsprint price levels denoted in US dollars ($/short ton of newsprint). The data are annual and cover the period 1960–1992. The prices are given explicitly in US dollars by IMF.[3]

Figure 1 displays the levels and first differences of the Finnish and Swedish dollar-quoted price series. All data are transformed into natural logarithms. As can be seen, both price series have developed very similarly. Visual inspection of the data suggests also that the differenced price series are stationary, i.e., prices follow I(1) process. This was confirmed also by formal unit root tests not presented here to conserve space.[4]

Before continuing with the empirical analysis, it is useful to take a closer look at the structure of the Finnish and Swedish paper industries, to which newsprint, the main concern of this study, belongs. As seen in Table 1, Finland's paper industry is strongly concentrated on production of printing and writing paper, while the Swedish production is distributed

[3] The US dollar has been the single most important invoicing currency for the Finnish paper exports with a share of 21% in 1994. The other invoicing currencies were distributed as follows: deutsche mark 17%, pound sterling 16%, Swedish crown 5%, Finnish markka 7%, and EU countries altogether 68% (Erkkilä and Widgrén, 1996, pp. 55). The distribution changes in the Swedish case: in 1994 the Swedish crown was the single most important invoicing currency with a share of 40%, followed by deutsche mark (13.4%), the US dollar (9.9%), lira (6.5%) and pound sterling (5.4%) (Friberg and Vredin, 1997, pp. 569).

[4] The unit root test results are available from the author on request.

Table 1. The structure of the Finnish and the Swedish paper industry in 1995.

	Finland		Sweden	
	million tons	%-share	million tons	%-share
Newsprint	1.4	13	2.3	25
Printing and writing paper	6.3	58	2.1	23
Paperboard	2.3	21	1.9	21
Kraft paper	0.5	4	1.1	12
Other paper	0.4	4	1.8	19
Total	10.9	100	9.2	100

Source: Hetemäki *et al*. (1997, pp. 6).

more evenly. In 1995 the Swedish newsprint production was almost 1.7 times larger than the Finnish production, and newsprint constituted the largest share of the Swedish paper industry (25%), but for Finland its share was the third largest (13%) after printing and writing paper (58%) and paperboard (21%).

3. The model and econometric methods

Suppose that the Finnish and the Swedish newsprint as very homogenous products are close substitutes for each other. If international markets function well, permanent deviations from the common currency prices should not arise. If there are deviations in the prices in the short run, they will be eliminated in the long run because of arbitrage, the length of the "long run" being an empirical question. Possible reasons for short-term deviations might be different lengths in the trade contracts, for example. Thus, existence of the long-term LOP between the Finnish and the Swedish common currency prices can be tested by means of the following model:

$$PFinl_t = \alpha + \beta \, PSwel_t + u_t \quad (1)$$

where *PFinl* and *PSwel* denote natural logarithms of the Finnish and the Swedish prices quoted in US dollars, α is a constant term, β is a coefficient parameter, *u* is a stochastic error term, and subscripts *t* refer to the time. A necessary condition for the long-term LOP is that $\beta = 1$ and that the error term is a stationary process [$u_t \sim I(0)$] in (1). In such a case *PFinl* and *PSwel* are said to be cointegrated with the cointegrating vector (PFinl, PSwel, α) = $(1, -1, -\hat{\alpha})$ and the relative version of the LOP holds in the long run. Moreover, if $\hat{\alpha} = 0$, then the absolute version of the LOP holds in the long run (e.g., Froot and Rogoff, 1995). The absolute version implies that the levels of the common currency newsprint prices develop one-by-one in the long run, while the less restrictive, and likely more realistic, relative version implies the one-by-one development of the rate of changes for both common currency price levels. The latter case might be relevant if the Finnish and the Swedish newsprint differed in quality, for example, but still act as close substitutes for each other. On the basis of Figure 1, the relative version of the LOP seems *a priori* more realistic in the present case.

Previous ambiguities in empirical evidence, already discussed in the introductory section of this study, pointed to the potentially non-negligible role of testing methods in finite samples. In this study cointegration is tested by means of the maximum likelihood estimation procedure developed by Johansen (1991, 1995). Currently, it can be regarded as the preferred way of testing cointegration (cf. Phillips, 1991; Gonzalo, 1995). As the procedure is nowadays well known, only a brief description of it is given here.

The Johansen procedure is based upon the *p*-dimensional VAR-model (2) transformed in the vector error correction model form (VECM) (3):

(2) $X_t = \mu + \phi_1 X_{t-1} + \ldots + \phi_k X_{t-k} + \psi D_t + \varepsilon_t$

(3) $\Delta X_t = \mu + \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-1} + \psi D_t + \varepsilon_t$

where X_t is a $p \times 1$ vector of I(1) endogenous variables at time t, μ is a $p \times 1$ vector of constant terms, D_t is a vector of non-stochastic variables, such as seasonal and intervention dummies, and ε_t is a $p \times 1$ vector of *niid* $(0, \Sigma)$ error terms. ϕ_i, Γ_i, Π, and ψ are $p \times p$ matrices of unknown coefficients. The system (3) is estimated subject to the hypothesis that matrix π has a reduced rank (r), $r < p$.

(4) $\Pi = \alpha\beta'$

where α and β are $p \times r$ matrices of full rank. If $0 < r < p$, then there exist r cointegrating relations in the data. The β-matrix contains the coefficients of the cointegrating vectors while α gives the matrix of loading coefficients containing information about the speed of adjustment to disequilibrium. In addition, the α-matrix contains information about exogeneity properties of the endogenous variables in X_t for the long-run parameters in the model. More specifically, if all the elements in row i are zero (i.e. $\alpha_{ij} = 0$, $j = 1,..,r$), this indicates that the cointegrating vectors in β do not enter the equation determining $\Delta X_{i,t}$. In such a case these variables are said to be weakly exogenous for the long-run parameters in the model (Johansen, 1992b).

The constant term (μ) has an important role in the VECM-model (3). If it is non-zero, then the level process contains a linear trend. However, if the level process does not contain a linear trend, then the constant term can be restricted to the cointegration relation. The knowledge of the presence of a linear trend in a model is important, since the asymptotic test distributions differ in terms of whether the model contains a linear trend or not. Johansen (1992a) proposes a general approach, the so-called *Pantula-principle,* to determine jointly the cointegration rank and presence/nonpresence of a linear trend in the model. The test procedure consists of estimating both models, and presenting the results from the most restrictive alternative (i.e., the level process does not contain a linear trend) through to the least restrictive (i.e., the level process contains a linear trend). Then one moves through from the most restrictive model and at each stage the test statistic is compared. The procedure is stopped the first time the null hypothesis is not rejected.

4. Empirical results

4.1. Cointegration analysis

Table 2 presents the results of cointegration analysis. The lag length of the VAR-model in levels was set to two ($k=2$) on the basis of diagnostic testing[5]. Since the analysis is based on a small sample, the main emphasis is here laid on the degrees-of-freedom adjusted test statistics as proposed by Reimers (1992).

The cointegration test results in panel (a) indicate that cointegration is supported unambiguously. As to trend properties of the data in levels, the results, based on the use of the Pantula-principle, suggest nonexistence of linear trends.

Panel (b) presents the unrestricted cointegrating vector normalised on Finnish prices. The estimate of the slope coefficient is correctly signed and very close to unity, the value implied by the LOP hypothesis. The estimates of the α-matrix indicate statistical significance of the adjustment coefficient for the Finnish price equation and the estimate is correctly signed while the magnitude of the estimate appears too large. In the case of the Swedish price equation the adjustment coefficient is not statistically significant, suggesting weak exogeneity for the Swedish prices in the VAR. Consistent with this result, none of the estimates of the $\alpha\beta'$ matrix are significant in the Swedish price equation.

Panel (c) contains test results for various structural hypotheses. So far, more and more evidence has been accumulated to show that structural hypothesis tests based on the Johansen procedure suffer from severe size distortions in small, or even moderately sized samples (see, e.g., Podivinsky, 1992; Cushman *et*

[5] *The diagnostics test results are presented in the Appendix.*

Table 2. Cointegration analysis.

(a) Cointegration tests:

constant restricted:				
H_0: *rank = r*	λ_{max}	$\lambda_{max}(T\text{-}nm)$	λ_{trace}	$\lambda_{trace}(T\text{-}nm)$
$r = 0$	20.80***	18.12**	23.33**	20.32**
$r \leq 1$	2.53	2.20	2.53	2.20
constant unrest.:				
H_0: *rank = r*	λ_{max}	$\lambda_{max}(T\text{-}nm)$	λ_{trace}	$\lambda_{trace}(T\text{-}nm)$
$r = 0$	20.70***	18.03**	22.85***	19.90**
$r \leq 1$	2.15	1.87	2.15	1.87

(b) α and β' matrices (rank = 1, constant restricted):

β' = (PFinl, PSwel, constant) = [1, –0.99 ($0.49*10^{-2}$), 0.18 10^{-1} ($0.27*10^{-1}$)]

α =	PFinl	–2.93 (1.20)
	PSwel	–1.80 (1.20)

αβ' =

	PFinl	PSwel	constant
PFinl	–2.93 (1.20)	2.91 (1.19)	$-0.51*10^{-1}$ ($0.21*10^{-1}$)
PSwel	–1.80 (1.20)	1.79 (1.20)	$-0.32*10^{-1}$ ($0.21*10^{-1}$)

(c) Structural hypothesis' tests:

	H_0 *[distribution]:*	*LR test statistic:*
c.1.	β'= (1,–1,0) [$\chi^2(2)$]	15.75***
c.2.	β'= (1,–1,*) [$\chi^2(1)$]	0.96
c.3.	β'= (1,–1,*), αPFinl = 0 [$\chi^2(2)$]	4.94*
c.4.	β'= (1,–1,*), αPSwel = 0 [$\chi^2(2)$]	2.30

(d) Restricted cointegrating vector subject to accepted H_0:s:

β' = (PFinl, PSwel, constant) = (1, –1, $0.47*10^{-1}$)

(e) Summary statistics for the cointegrating vector in panel (d):

Mean = 0.00; standard deviation = 0.02; minimum = –0.06; maximum = 0.04; normality [$\chi^2(2)$] = 3.04

Notes: (a): The number of lags in the VAR-model is 2. $\lambda_{max}(\lambda_{trace})$ = the maximal eigenvalue (the trace) test statistics (Johansen 1991, 1995). (T-nm) refers to the degrees of freedom correction by Reimers (1992). Significance levels: *,**,*** = 10%, 5%, 1% (Osterwald-Lenum 1992). (b): Standard errors in parentheses.

al., 1996; and Edison *et al*., 1997).[6] For this reason we applied the degrees-of-freedom correction to the test statistics as proposed by Reinsel and Ahn (1992). The correction is conducted by multiplying the test statistics by the factor $(T-pk)/T$, where T = sample size, p = number of endogenous variables in the system, and k = order of autoregressions of VAR in levels. The simulation results by Cushman *et al*. (1996) suggested that even this correction may not be sufficient in small samples.

The structural hypothesis test results suggest that the absolute version of the law of one price hypothesis (LOP) is rejected unambiguously (panel c.1), but the relative version of the LOP is, however, clearly accepted (panel c.2). Putting more structure into the analysis, the joint null hypothesis of the relative version of LOP and weak exogeneity of the price series was tested next. Now the null hypothesis can not be rejected in the case of Sweden (panel c.4), but it is rejected for the Finnish prices (panel c.3).

It is noteworthy that this rejection is consistent with the results from the unrestricted analy-

[6] *For example, the Monte Carlo results by Podivinsky (1992) suggest the empirical size of* LR(β) *and* LR(α) *tests to be more than twice as high as the nominal 0.05 significance level for T = 25. See also Edison* et al. *(1997), who report even larger size distortions for these tests.*

sis presented in panel (b). Moreover, weak exogeneity of *both* of the prices would have implied that the prices are not cointegrated, which is totally contrary to our basic results of strong support for cointegration presented in panel (a).

Finally, panel (d) presents the cointegrating vector when the accepted restrictions (i.e. relative LOP and weak exogeneity of Swedish prices) are imposed on the system, and panel (e) contains summary statistics for the cointegrating vector presented in panel (d).

4.2. Single equation error correction model

The preceding section revealed weak exogeneity of the Swedish newsprint prices. This property is very useful, since it implies that analysis can be conducted efficiently via a single equation error correction model (Johansen, 1992b, pp. 321–323). Moreover, Finnish prices can be conditioned on the current period values of the Swedish prices. The error correction term (Z_{ECM}) was specified as Z_{ECM}=PFinl–PSwel+0.05 according to the results in the previous section. The preferred error correction model, obtained via the general-to-specific modeling (cf. Hendry and Doornik, 1996) is given in Table 3.

The preferred ECM-model passes all the diagnostic tests. Economically the results suggest a reasonably rapid adjustment process: 0.83% of the price differentials between the Finnish and Swedish dollar quoted newsprint prices are eliminated within one year. This result is consistent with Vataja's (2000a) results of considerably faster adjustment speeds for relatively homogenous products than what has been found previously for broad price indices (see, e.g., Rogoff, 1996). Moreover, the short-run connection of the price changes seems to be very close on the basis of the point estimate of 0.97 for ΔPSwel. Overall, the results appear reasonable for homogenous products and the character of the LOP hypothesis.

Table 3. Error correction model for the Finnish newsprint prices.

$$\Delta Finl = \underset{(0.03)}{0.97}\,\Delta Swel \; \underset{(0.19)}{-0.83}\,ECM$$

R^2 = 0.98, σ = 0.02, DW = 1.92, AR 1– 2 F(2,28) = 1.28 [0.30], ARCH 1 F(1,28) = 2.30 [0.14], Normality $Chi^2(2)$= 0.92 [0.63], Xi^2 F(4,25) = 0.89 [0.48], Xi*Xj F(5, 24) = 1.46 [0.24], RESET F(1,29) = 3.07 [0.09]

Notes: The figures in parentheses below the estimates are standard errors. R^2 = coefficient of determination. σ = standard error of the regression. AR 1–2 = LM test for up to the 2^{nd} order autocorrelation, H_0: no autocorrelation. ARCH 1= LM test for 1^{st} order autoregressive conditional heteroscedasticity, H_0: no ARCH effects. Normality = normality test for residuals, H_0: normality. Xi^2 and Xi*Xj = White's (1980) heteroscedasticity tests, H_0: no heteroscedasticity. RESET = specification test, H_0: correct specification. Figures in brackets after the test statistics are *p*-values. For details and references of the tests, see Hendry and Doornik (1996).

4.3. Are the results liable to the Lucas critique?

The usefulness of econometric results in policy analysis is potentially problematic if there are regime shifts in the economy: if economic agents change their behavior in different economic regimes, statistical results based on the historical data may not be relevant; that is, the results would suffer from the Lucas critique (Lucas, 1976). Since the estimation period of this study consists of the major exchange rate regime shift from fixed to flexible exchange rates in 1973, the question involving the Lucas critique appears relevant. Econometrically the Lucas critique can be tested by investigating the presence of super exogeneity[7] of the parameters in the restricted VECM model (cf. Table 2) and the single equation ECM-model (cf. Table 3).

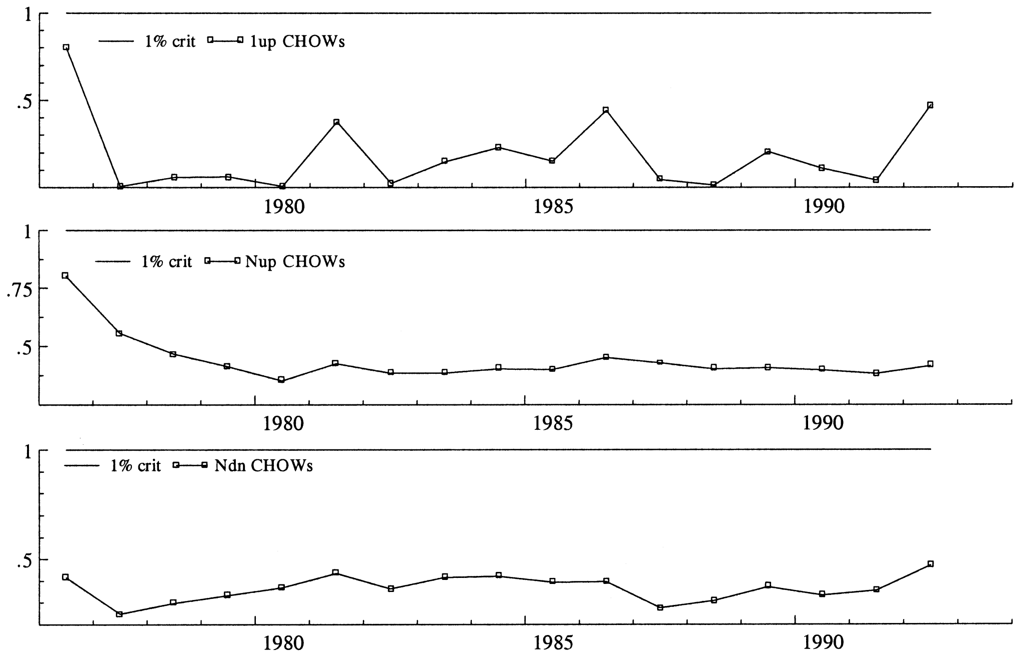
One way of analyzing this is by means of recursive analysis (e.g., Ericsson *et al*., 1998). If the LOP relation between the Finnish and Swedish newsprint prices proves to be stable, the super exogeneity is validated and the empirical results should not be liable to the Lucas critique.

Figure 2 displays sequences of breakpoint Chow tests scaled by their 1 per cent significance levels[8]. In no cases the null hypothesis of

[7] *For different exogeneity concepts, see Engle* et al. *(1983).*

[8] *In Figure 2. 1 up CHOWs refers to a 1-step forecast test, Nup CHOWS (Ndn CHOWS) refers to sequences of Chow tests with an increasing (decreasing) number of forecasts (for details, see Hendry and Doornik, 1996; and Doornik and Hendry, 1997).*

(a) VECM-model:



(b) Single equation ECM-model:

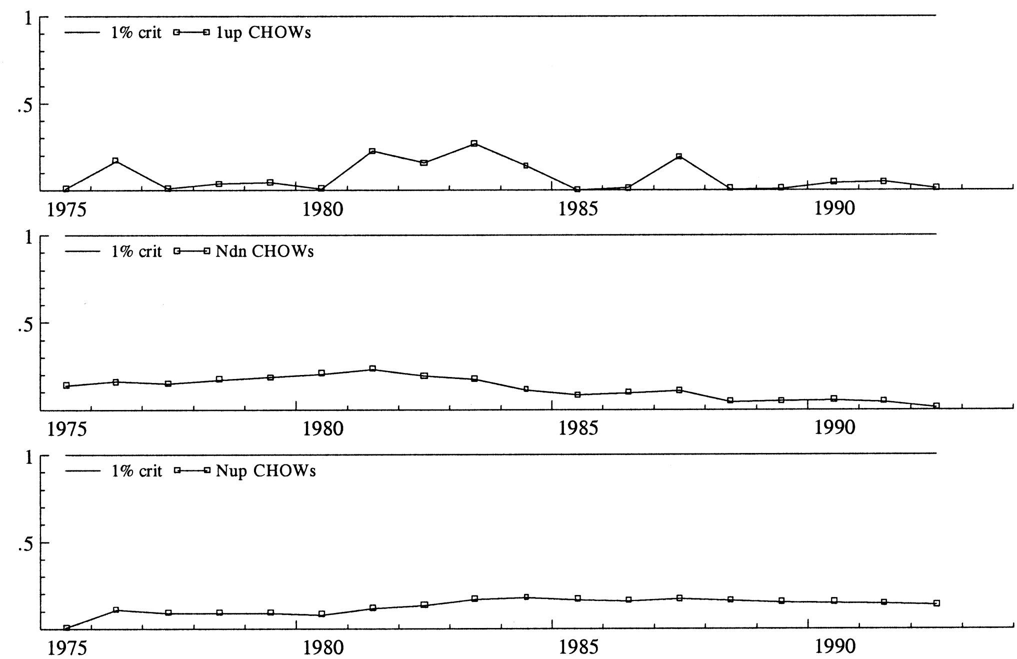


Figure 2. Recursive Chow tests.

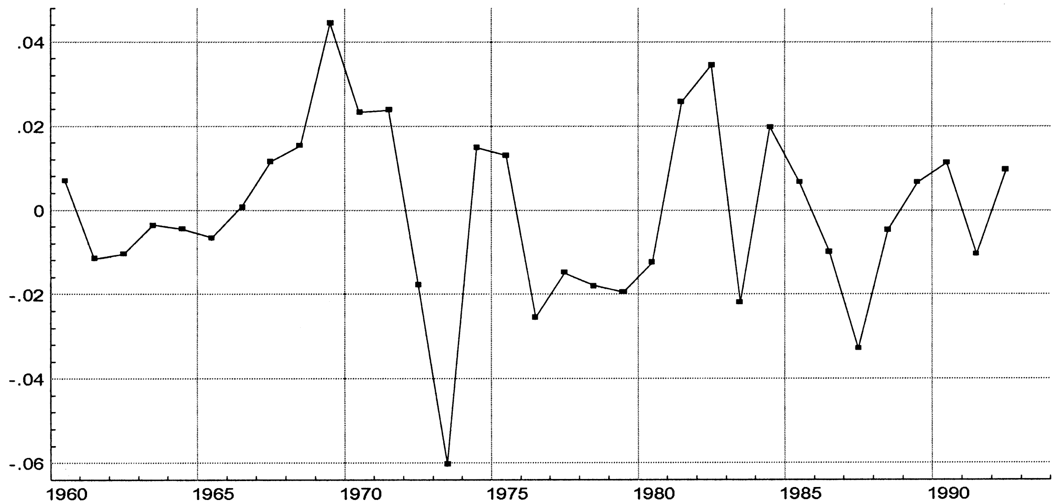


Figure 3. Deviations from the (relative) law of one price between the newsprint prices.

constant parameters is rejected, thus implying that the Lucas critique would not pose a severe problem in the present case.

4.4. Economic interpretations of the empirical results

The empirical results of this study lend support to the LOP between the Finnish and Swedish newsprint prices. Moreover, the results suggest that the Finnish prices follow the Swedish prices fundamentally. This section provides further economic evaluation of these results.

If the LOP holds in the long run, then the next natural question is the quantitative importance of transitory deviations from the LOP. This is illustrated in Figure 3, which displays the cointegrating vector $\beta' = PFinl - PSwel + 0.05$.

As visible, deviations from the LOP are distributed fairly symmetrically the standard deviation being as small as about 2% from the mean zero (cf. panel (e) in Table 2)[9].

The largest deviation of the prices (about 6%) took place in 1973. Possibly the emergence of the first oil crisis has something to do with this, but on the whole, the quantitative deviations from the LOP have been economically reasonably small. Given that newsprint represents a very homogenous product, such a result may be regarded as expected.

[9] *Normality of the deviations from the LOP is not rejected either (cf. panel (e) in Table 2).*

6. Summary and conclusions

This study focused on whether one of the classic hypotheses in international economics, the law of one price (LOP), holds between the Finnish and Swedish common currency newsprint prices. The analysis was motivated by the distinctive role of the forest sector in production and exports in these countries and the very homogenous character of newsprint, making it an extremely suitable product for testing the LOP.

The empirical results, based on annual data over the period 1960–1992, provided clear support for the relative LOP between the US dollar quoted Finnish and Swedish newsprint prices. The Swedish prices were found to be weakly exogenous, implying that the Finnish prices follow the Swedish ones fundamentally in the long run. As to deviations from the LOP, the results indicated that the deviations have been distributed fairly symmetrically and that economically their magnitude has been small. Moreover, the deviations from the LOP were found to be fairly short-lived as about 80% of the price differentials were found to be eliminated within one year.

The empirical results were also tested against the Lucas critique, which was rejected. So the results should be suitable for policy analysis, too.[10]

References

Ahonen, J., and I. Pyyhtiä (1996). "Integrating Finland's Economy into the EU". *Bank of Finland Bulletin* 70: 5, 3–6.

Ardeni, P. (1989). "Does the Law of One Price Really Hold for Commodity Prices?" *American Journal of Agricultural Economics* 71, 661–69.

Baffes, J. (1991). "Some Further Evidence on the Law of One Price: Law of One Price Still Holds." *American Journal of Agricultural Economics* 73, 1264–1273.

Buongiorno, J., and J. Uusivuori (1992). "The Law of One Price in the Trade of Forest Products: Cointegration Tests for US Exports of Pulp and Paper." *Forest Science* 38, 539–553.

Ceglowski, J. (1994). "The Law of One Price Revisited: New Evidence on the Behavior of International Prices." *Economic Inquiry* 32, 407–418.

Cushman, D.O., S.S. Lee, and T. Thorgeirsson (1996). "Maximum Likelihood Estimation of Cointegration in Exchange Rate Models for Seven Inflationary OECD Countries." *Journal of International Money and Finance* 15, 337–368.

Doornik, J.A., and H. Hansen (1994). "A Practical Test for Univariate and Multivariate Normality." Discussion Paper, Nuffield College.

Doornik, J.A., and D.F. Hendry (1997). *Modeling Dynamic Systems Using PcFiml 9.0 for Windows*. London, Bonn etc: International Thomson Business Press.

Edison, H.J., J.E. Gagnon, and W.R. Melick (1997). "Understanding the Empirical Literature on Purchasing Power Parity: The Post-Bretton Woods Era." *Journal of International Money and Finance* 16, 1–17.

Engel, C. (2000). "Local-currency Pricing and the Choice of Exchange-rate Regime." *European Economic Review* 44, 1449–1472.

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

Ericsson, N., D. Hendry, and G. Mizon (1998). "Exogeneity, Cointegration, and Economic Policy Analysis." *Journal of Business & Economic Statistics* 16, 370–387.

Erkkilä, M., and M. Widgrén (1996). Finland and the Functioning of the Internal Market in EMU. The Research Institute of the Finnish Economy. ETLA B 129. Helsinki.

ETLA (1998). Suhdanne 3/1998.

Friberg, R., and A. Vredin (1997). "Exchange-rate Uncertainty and Microeconomic Benefits from the EMU." *Swedish Economic Policy Review* 4, 547–594.

[10] *For an attempt to interpret the results of this study in the context of the Finnish EMU participation in the situation where Sweden is staying outside EMU, see Vataja (2000b)*

Froot, K., and K. Rogoff (1995). Perspectives on PPP and Long-run Real Exchange Rates. In *Handbook of International Economics, Vol. III*. Eds. G. Grossman and K. Rogoff. Elsevier Science B.V. 1647–1688.

Goldberg, P., and M. Knetter (1997). "Goods Prices and Exchange Rates: What Have We Learned?" *Journal of Economic Literature* XXXV, 1243–1272.

Gonzalo, J. (1994). "Five Alternative Methods of Estimating Long-run Equilibrium Relationships." *Journal of Econometrics* 60, 203–233.

Hendry, D., and J. Doornik (1996). *Empirical Econometric Modelling Using PcGive 9.0 for Windows.* London, Bonn etc: International Thomson Business Press.

Hetemäki, L., R. Hänninen, J. Kuuluvainen, P. Ollonqvist, P. Ruuska, R. Seppälä, A. Toppinen, and J. Uusivuori (1997). EMU ja Suomen metsäsektori. Valtioneuvoston kanslian julkaisusarja 17. Helsinki.

Hänninen, R., A. Toppinen, and P. Ruuska (1997). "Testing Arbitrage in Newsprint Imports to UK and Germany." *Canadian Journal of Forest Research* 27, 1946–1952.

Hänninen, R., and A. Toppinen (1999). "Long-run Price Effects of Exchange Rate Changes in Finnish Pulp and Paper Exports." *Applied Economics* 31, 947–956.

IMF. *International Financial Statistics*. Yearbook 1990, 1995.

Isard, P (1977). "How Far Can We Push the Law of One Price?" *American Economic Review* 67, 942–948.

Johansen, S. (1991). "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models." *Econometrica* 59, 1551–1580.

– **(1992a).** "Determination of Cointegration Rank in the Presence of a Linear Trend." *Oxford Bulletin of Economics and Statistics* 54, 383–397.

– **(1992b).** "Testing Weak Exogeneity and the Order of Cointegration in UK Money Demand Data." *Journal of Policy Modelling* 14, 313–334.

– **(1995).** *Likelihood-based Inference in Cointegrated Vector Autoregressive Models.* Oxford: Oxford University Press.

Lucas, R.E. Jr. (1976). Econometric Policy Evaluation: A Critique. In *The Phillips Curve and Labor Markets*. Eds. K. Brunner and A.H. Meltzer. Carnegie-Rochester Conference Series on Public Policy, Vol 1. Amsterdam: North Holland. 19–46.

Michael, P., A. Nobay, and D. Peel (1994). "Purchasing Power Parity Yet Again: Evidence from Spatially Separated Commodity Markets." *Journal of International Money and Finance* 13, 637–57.

Osterwald-Lenum, M. (1992). "A Note with Quatiles of the Asymptotic Distribution of the ML Cointegration Rank Test Statistics." *Oxford Bulletin of Economics and Statistics* 54, 461–472.

Phillips, P. (1991). "Optimal Inference in Cointegrated Systems." *Econometrica* 59, 283–306.

Podivinsky, J. (1992). "Small Sample Properties of Tests of Linear Restrictions on Cointegrating Vectors and their Weights." *Economics Letters* 39, 13–18.

Reimers, H.-E. (1992). "Comparisons of Tests for Multivariate Cointegration." *Statistical Papers* 33, 335–359.

Reinsel, G., and S.K. Ahn (1992). "Vector Autoregressive Models with Unit Roots and Reduced Rank Structure: Estimation, Likelihood Ratio Test, and Forecasting." *Journal of Time Series Analysis* 13, 353–375.

Richardson, J. (1978). "Some Empirical Evidence on Commodity Arbitrage and the Law of One Price." *Journal of International Economics* 8, 341–351.

Rogoff, K. (1996). "The Purchasing Power Parity Puzzle." *Journal of Economic Literature* 34, 647–668.

Vataja, J. (2000a). "Should the Law of One Price be Pushed Away? Evidence from International Commodity Markets." *Open Economies Review* 11, 399–415.

– **(2000b).** On the Interdependence of Finnish and Swedish Newsprint Prices. Should the Finnish Newsprint Newsprint Producers Care about it in EMU? Proceedings of the University of Vaasa. Discussion Papers 276.

Wei, S., and D. Parsley (1996). "Convergence to the Law of One Price without Trade Barriers or Currency Fluctuations." *The Quarterly Journal of Economics* 111, 1211–1236.

White, H. (1980). "A Heteroscedasticity-consistent Covariance Matrix Estimator and a Direct Test for Heteroscedasticity." *Econometrica* 48, 817–838.

Appendix

Model evaluation diagnostics for the VAR model in levels

	PFinl	PSwel
Single equation tests:		
AR 1–2 F(2, 24)	0.75 [0.48]	0.72 [0.49]
Normality $Chi^2(2)$	1.29 [0.53]	0.73 [0.69]
ARCH 1 F(1, 24)	0.24 [0.63]	0.08 [0.77]
Xi^2 F(8, 17)	0.52 [0.93]	0.43 [0.89]
Xi*Xj F(14, 11)	0.43 [0.97]	0.33 [0.97]
Multivariate tests:		
Vector AR 1–2 F(8, 42)	0.70 [0.69]	
Vector AR 1 F(4, 46)	0.41 [0.80]	
Vector normality $Chi^2(4)$	3.51 [0.48]	
Vector Xi^2 F(24, 44)	1.01 [0.47]	
Vector Xi*Xj F(42, 27)	1.24 [0.28]*	

Notes: lag length of the VAR-model is two. Single equation tests: AR 1–2 (1) = LM test for up to the 2*nd* (*1st*) order autocorrelation in residuals (H_0: no autocorrelation). Normality = Doornik and Hansen's (1994) test for normality (H_0: normality). ARCH 1 = test for first order autoregressive conditional heteroscedasticity (H_0: no ARCH). Xi^2 and Xi*Xj = White's (1980) heteroscedasticity tests (H_0: homoscedasticity). Multivariate tests: vector mis-specification tests correspond to single equation tests. *P*-values in brackets. For details of the tests, see Doornik and Hendry (1997).