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IMPORT PRICES AND NOMINAL EXCHANGE RATES IN SWEDEN*

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The relationship between the nominal exchange rate and import prices is central to the determination of inflation in a small open economy like Sweden. Since the pass-through of exchange rate changes to import prices appears to be affected by the size of the country, it may be expected to be higher in Sweden than what has been documented for major nations. Using the Johansen (1988) approach to cointegration, the long-run pass-through of exchange rate changes to import prices on manufactured goods is estimated to be 0.6–0.8. This is slightly higher than what is typically found for small countries. A second result is that import prices are affected by Swedish macroeconomic conditions, which violates the small open economy assumption. Finally, neither the law of one price nor the small open economy assumption is rejected in the case of Swedish oil imports. (JEL F14, F31, F41)

1. Introduction

The formation of import prices is an important determinant of inflation in small open economies like Sweden. 20 to 25 percent of the Swedish consumption basket consists of imported goods and another 20 to 25 percent is import competing goods whose prices are closely linked to those of imports. If there is complete pass-through of exchange rate changes, a depreciation of 10 percent will cause import prices to increase by 10 percent. If the long run pass-through is 0.5, they only increase by 5 percent. It is also possible that import prices increase more in times of high Swedish inflation and/or low Swedish unemployment. These are important questions in a small open economy since it is primarily through import prices that the nominal exchange rate affects inflation.

There are several potentially relevant hypotheses concerning the relationship between import prices and the nominal exchange rate. According to the law of one price, foreign currency prices of goods imported to Sweden would be the same as in other markets. Nominal exchange rate changes would then have a one to one effect on Swedish currency import prices or the pass-through would be complete. Even in this case, the short run effects may be smaller due to sluggish price adjustment. There is ample evidence that the law of one price does not hold in empirical tests. While transportation costs or trade barriers may prevent complete price equalisation between national markets, deviations from the law of one price appear to be closely related to exchange rate changes.[1] Firms may for instance choose to stabilise prices in the currency of the importing country in order

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[1] *Goldberg and Knetter (1996) provide a survey of the empirical literature.*

to preserve market shares in case of a devaluation. They may also find it profitable to charge lower prices in recessions, when the unemployment rate is high. If firms are concerned with the relative price of their products, they will also increase prices less in times of low Swedish inflation.

If import prices are systematically related to Swedish macroeconomic conditions, the small open economy assumption is violated since a small open economy is assumed to be a price taker on the world market. The small open economy assumption is frequently used in international economics. If it does not hold for a small and open economy like Sweden, it may have limited relevance.

In this paper, the relationship between aggregate import prices on manufactured goods and the nominal exchange rate in Sweden is studied using cointegration techniques. First, the long-run pass-through of exchange rate changes to import prices is estimated. The small open economy assumption that domestic macroeconomic variables do not influence import price setting is tested both as a long-run restriction and as a short-run restriction on data. Since the real effects of nominal exchange rate changes persist until nominal prices have adjusted, the length of this adjustment process is also studied. Finally, the same hypotheses are tested on the import price of oil in order to investigate whether the pass-through of exchange rate changes is more complete and/or the small open economy assumption holds better for a homogenous product with an observable foreign currency world market price. This is relevant for evaluating the total influence of the nominal exchange rate on Swedish inflation via import prices since non-manufactured goods are mainly homogenous.

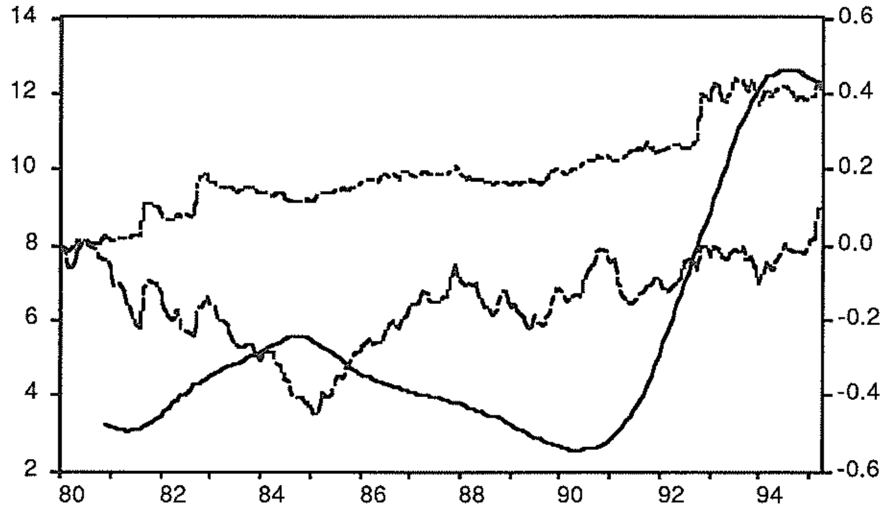
Following Goldberg and Knetter (1996), the various hypotheses about the relationship between import prices and nominal exchange rates can be expressed as restrictions on the following equation:

$$(1) \quad ip_t = \beta_0 + \beta_1 e_t + \beta_2 p_t^* + \beta_3 Z_t + \varepsilon_t,$$

where ip_t is the import prices on manufactured goods, p_t^* is the foreign export prices expressed in foreign currency, e_t is the nominal exchange rate expressed as domestic currency per unit of foreign currency, Z_t contains Swedish macroeconomic variables and ε is an error term. β_1 is the long run pass-through of nominal exchange rate changes. It would be equal to one in the case of complete pass-through. According to the law of one price, also β_2 is equal to one. If β_3 is significantly different from zero, the small open economy assumption is violated since import prices are systematically affected by Swedish macroeconomic variables. The relationship between the import price formation studied in this paper and tests of purchasing power parity is also clarified from (1). Substituting aggregate Swedish consumer prices for ip_t and foreign consumer prices for p_t^*, purchasing power parity would imply that β_1 and β_2 were equal to one and β_3 equal to zero.

If the time series on nominal prices and exchange rates are integrated of order one, cointegration techniques are well suited to study the relationship in (1). Within the Johansen framework, hypotheses about the long run equilibrium are testable as restrictions on the cointegrating vector(s) β. The short-run dynamics contain information about the adjustment of import prices in response to a change in the nominal exchange rate the short-run pass-through.

This paper is similar to Naug and Nymoen (1996) in terms of econometric techniques and level of aggregation of the price indices. In their study of the relationship between aggregated import prices and nominal exchange rates in Norway, they estimate the long run pass through of changes of the nominal exchange rate and foreign prices to 0.63, which is significantly less than one. Import prices are not even cointegrated with the nominal exchange rate and foreign prices alone. The small open economy assumption is rejected in favour of pricing to market behaviour since domestic variables have significant effects on import prices. Unemployment affects import prices both in the long run and the short run and firms appear to take domestic inflation into consideration when setting import prices. Other papers focusing on the pass-through of exchange rate changes to import prices in small open economies are Kuismanen (1995), who estimates the pass-



– – – –	unemployment (left scale)
--------	the deviation from the law of one price using import weighted foreign export prices
……….	the deviation from the law of one price using import weighted foreign producer prices

Figure 1. The deviation from the law of one price using two different proxies for foreign prices and the Swedish unemployment rate.

through coefficient of the Finnish exchange rate to 0.7 and Menon (1995), whose estimate for Australia is 0.66.

2. *The Data*

The sample period is January 1980 to May 1995. Monthly data on domestic consumer prices and import prices on manufactured goods and oil are collected from Statistics Sweden. The import weighted nominal exchange rate has been calculated by the Riksbank. As proxy for domestic demand, the total unemployment rate from the OECD data base Main Economic Indicators is used.[2] The world market price of oil has been collected from the IFS data tape. Logarithms of level data are used except for the unemployment rate, which is expressed as percentage points.

When studying the effects of exchange rate changes on prices of imported manufactures, corresponding data on foreign export prices or world market prices are needed. This is obviously a problem when investigating import prices on aggregated manufactured goods. Here, two different price series are used as proxies: Import weighted producer prices of OECD 14 (from Main Economic Indicators) and import weighted export prices of the nine countries for which such series are available on the IFS data tape. Figure 1 shows the deviations from the law of one price, defined as the import price minus the nominal exchange rate and the for-

[2] *An alternative would have been to use industrial production. Variables like consumer expenditure or GDP are not available on a monthly basis. Our experience from various econometric work at the Riksbank is that unemployment is a better indicator of demand pressure than industrial production.*

eign price index, using the two proxies for foreign prices.

Import weighted foreign export prices behave rather differently from import weighted foreign PPI. The dollar appreciation in the mid 1980s appears to have a major influence on foreign export prices, while there is no corresponding fall in foreign PPI. On the other hand, foreign PPI has increased more over the sample period which results in an increasing deviation from the law of one price. The PPI series is also smoother since price movements around the trends of individual countries tend to even out as more countries are added. In the empirical tests, both these series will be used as proxies for World market prices. There also appears to be a negative correlation between the deviation from the law of one price and unemployment in Figure 1.[3]

3. Empirical Results

Given that nominal prices and exchange rates are I(1), cointegration techniques are well suited to study the relationships between these variables. The Johansen (1988) maximum likelihood approach to cointegration has two major advantages compared to single equation tests like the Engle and Granger (1987) procedure. It is multivariate and estimates the entire system of equations simultaneously, thereby determining the number of cointegrating vector in the data set. Second, linear restrictions on the cointegrating vectors may be tested within the Johansen approach.

Before proceeding to cointegration analysis, it is useful to know the order of integration of the time series involved. The ADF and Phillips–Perron tests for unit roots indicate that all six series are integrated of order one (see Appendix A for details).

Second, the number of lags in the VAR-model has to be determined. The Akaike, Schwarz and Hannah–Quinn information criteria indicate four, one and two lags, respectively. In addition, residual tests may indicate that the model is misspecified. In particular, it is important that a sufficient number of lags to remove autocorrelation are included since it produces biased estimates in autoregressive models. Five lags are needed for the residuals to pass the multivariate Box–Ljung test for autocorrelation.[4] Therefore, five lags are used in the estimations.

The Bera–Jarque tests indicate non-normality is a problem at all lag lengths. Given data on nominal exchange rates in a fixed exchange rate regime with occasional realignments and import prices that tend to jump with the nominal exchange rate, it is not surprising that the residuals are not normally distributed. Although this is a potential problem, simulations show that the Johansen procedure is sensitive only to severe non-normality, but also that adding dummy variables for devaluations only has a very small effect. The small sample properties of the Johansen tests appear to be at least as important for the results as non-normality.[5]

The Johansen approach focuses on the rank of the Π-matrix in equation (2):

$$(2) \quad \Delta x_t = \sum_{i=1}^{P} \Gamma_i \Delta x_{t-i} + \Pi x_{t-P} + \varepsilon_t$$

Here, x_t consists of five time series: Import prices, the nominal exchange rate, foreign prices, Swedish CPI and the unemployment rate. If the Π-matrix has reduced rank, it can be decomposed into $\alpha\beta'$ where the β-matrix contains the coefficients of the cointegrating vector(s) and the α-matrix contains the corresponding error correction parameters. Once the rank of Π has been established, linear restrictions on the space spanned by β can be tested using a likelihood ratio test. As shown in Table 1, the Johansen procedure indicates that there are two cointegrating vectors both when import weighted foreign producer prices and import weighted foreign export prices are used as a proxy for foreign marginal costs.

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[3] *The correlation coefficients are –0.818 using foreign PPI as proxy for foreign prices and and –0.417 using foreign export prices.*

[4] *45 lags are used in the Box–Ljung test.*

[5] *Simulations of the Johansen test under non-normal errors have been made by Cheung and Lai (1993), Gonzalo (1994), Alexius (1995) and Jacobson (1995).*

Table 1: Test for cointegration rank

H_0	foreign export prices trace	foreign export prices λ-max	foreign producer prices trace	foreign producer prices λ-max
r = 0	71.20*	29.19*	71.27*	33.62*
r = 1	42.01*	21.80*	37.65*	22.56*
r = 2	20.21	13.21	14.89	7.87
r = 3	6.99	6.04	7.02	6.72
r = 4	0.95	0.95	0.30	0.30

* Significant at 10 percent

It seems reasonable to assume that one of the cointegrating vectors contains a PPP-relationship, linking domestic prices to the nominal exchange rate, foreign prices and possibly unemployment while the other determines import prices.

3.1 *The Long-Run Equilibrium Relationships*

Once the rank of the system in (2) has been determined, linear restrictions on the cointegrating vectors may be tested. One interesting such linear restriction is the law of one price. It states that import price should equal the foreign export price plus the nominal exchange rate. In the five variable system of import prices, the nominal exchange rate, foreign prices and unemployment, this hypothesis means that [1, –1, –1, 0, 0] belongs to the cointegrating space. The first row of Table 2 shows that the likelihood ratio test clearly rejects this hypothesis using foreign PPI. When critical values from the asymptotic distribution are used, it is rejected also for foreign export prices. However, it is well known that the likelihood ratio test is oversized in small samples.[6] Simulated empirical distributions of the test statistics in this particular situation confirm the results from previous studies.[7] For instance, in case of the law of one price, the five percent critical value from the χ^2-distribution is 5.99, while the corresponding value from empirical distributions is 12.04. Hence, the law of one price is rejected for foreign export prices also using empirical critical values.

If importing firms adjust their prices to domestic demand, high unemployment may be associated with lower import prices. The second row of Table 2 shows the test results from

Table 2: Tests of linear restrictions on the cointegrating vectors

Restrictions	LR test statistics, export prices	Parameter estimates	LR test statistics, producer prices	Parameter estimates
[1, –1, –1, 0, 0]	12.99 (0.00) [0.04]		21.15 (0.00) [0.00]	
[1, –1, –1, 0, β_{15}]	9.16 (0.01) [0.16]	$\beta_{15} = 3.133$	12.51 (0.00) [0.08]	$\beta_{15} = 44.526$
[1, β_{12}, β_{12}, 0, 0]	7.35 (0.01) [0.31]	$\beta_{12} = -0.627$	15.01 (0.00) [0.05]	$\beta_{12} = -0.694$
[1, β_{12}, β_{12}, 0, β_{12}]	7.19 (0.01) [0.27]	$\beta_{12} = -0.506$ $\beta_{15} = 1.641$	13.31 (0.00) [0.07]	$\beta_{12} = -0.837$ $\beta_{15} = 2.128$
[1, β_{12}, β_{13}, 0, 0]	0.01 (0.92) [1.00]	$\beta_{12} = -0.306$ $\beta_{13} = -1.456$	0.04 (0.85) [0.98]	$\beta_{12} = -0.200$ $\beta_{13} = -0.318$
no restrictions		$\beta_{12} = -3.198$ $\beta_{13} = 0.024$ $\beta_{15} = -2.209$		$\beta_{12} = -3.939$ $\beta_{13} = -1.287$ $\beta_{15} = 4.137$

p-values using asymptotic critical values within parenthesis
p-values using simulated empirical critical values within brackets

[6] *The small sample properties of the Johansen tests have been studied by Gonzalo (1994), Jacobson, Vredin and Warne (1994), Jacobson (1995) and Alexius (1995), among others.*

[7] *Empirical distributions are generated as follows. First, the parameters of the data generating process in (2) are estimated conditional on the cointegrating rank and the relevant β_i vector from Table 2.*

Second, 10 000 syntethic data sets are created by generating normally distributed error terms and adding them to (2). The likelihood ratio test is applied to each data set and the resulting test statistics are collected and ordered. Empirical five percent critical values are found by calculating the value at which the true null hypothesis is rejected exactly five percent of the time. Similarily, the empirical marginal significance of the test statistics in Table 3 is found by calculating the proportion of the empirical distribution that is higher than the relevant test statistics.

allowing the unemployment rate to enter the cointegrating relationship. The hypothesis that this vector belongs to the cointegration space is rejected using asymptotic critical values but not rejected according to empirical critical values. In the foreign export price formulation, β_{15}, the coefficient associated with the unemployment rate in the import price equation is estimated to 3.133, implying that one percentage point higher unemployment would lower import prices by 3.1 percent.

A third possibility is that nominal exchange rate and foreign prices have the same effects on import prices but it differs from one and that the unemployment rate does not enter into the equation. The hypothesis that $[1, \beta_{12}, \beta_{12}, 0, 0]$ belongs to the cointegrating space is tested in the third row of Table 2. Again, it is rejected according to both sets of critical values using foreign producer prices but not rejected according to the simulated empirical critical values in the case of foreign export prices. The estimates of the long run pass through of foreign prices and the exchange rate are 0.627 and 0.694 using foreign export prices and foreign PPI, respectively, as proxies.

Relaxing the number of restrictions further, the coefficients on foreign prices and the nominal exchange rate may be allowed to differ from minus one *and* the unemployment rate allowed to enter into the relationship. In the fourth row, the hypothesis that $[1, \beta_{12}, \beta_{12}, 0, \beta_{15}]$ is a cointegrating vector is tested. When foreign export prices are used, β_{15} has the wrong sign. Using foreign producer prices, the estimate of β_{12} or the long-run pass through of exchange rate changes is now 0.837. The estimated effect of the unemployment rate β_{15} is 2.128, which means that one percentage point higher unemployment is associated with 2.1 percent lower import prices in the long run.

If the restriction is not to be rejected according to the critical values from the asymptotic distribution, the coefficients on the nominal exchange rate and foreign prices are equal must be allowed to differ. The restriction that these two coefficients are equal is removed in the fifth row of Table 2. In this case, the estimated pass-through of the nominal exchange rate to import prices falls from 0.6–0.8 to 0.2–0.3. Hence, there is some evidence that nominal exchange rates are less important to import prices than foreign prices are.

To sum up the results from Table 2, the law of one price is rejected using both foreign export prices and producer prices as proxies for the foreign cost variable. The long-run pass through of exchange rate changes is estimated to 0.6–0.8, which is slightly higher than in previous studies on small open economies. It falls to 0.2–0.3 when the coefficients on nominal exchange rates and foreign prices are allowed to differ. The unemployment rate enters with the correct sign in three out of four cases. A parameter estimate of 2–3 implies that import prices decrease by 2–3 percent as unemployment increases by one percentage point, which appears to be a reasonable magnitude.

For comparison, the same hypotheses are also tested on the import price of oil, which is a homogenous product with an observable world market price. The cointegration rank tests indicate that there is only one cointegrating vector in the five variable system where unemployment and domestic prices are included.[8] The unrestricted estimates of the cointegrating vector are:

$$(3)\quad p_t^{om} = 1.151{*}e_t + 0.943{*}p_t^{ow} + 0.112{*}p_t^{d} - 0.844{*}u_t + \varepsilon_t$$

The coefficients on the nominal exchange rate and the World price of oil are close to one. The unemployment rate and the domestic price level also enter with the expected signs although the coefficients are rather small.

The likelihood ratio test statistic for the law of one price is 19.28. While the five percent critical value from the χ^2 (4) distribution is 9.49, the empirical critical value is 21.37. Hence, the law of one price is rejected in the first case but not in the second.

[8] *The first two λ-max are 56.89 and 16.76, while the corresponding trace statistics are 87.61 and 30.72. In both cases, only the first two are significant. With four lags, the residuals pass the multivariate Box–Ljung test but not the Bera–Jarque normality test. However, non-normality is a less serious problem here than in the system with import prices on manufactured goods.*

Table 3: Tests of linear restrictions on the cointegrating vectors, import price of oil

Restrictions	LR test statistics,	Parameter estimates
[1,–1, –1, 0, 0]	19.28 (0.00) [0.06]	
[1, β_{12}, β_{12}, 0, β_{15}]	16.88 (0.00) [0.09]	$\beta_{15} = -0.508$
		$\beta_{12} = -0.931$
[1, β_{12}, β_{13}, 0, 0]	4.77 (0.09) [0.48]	$\beta_{12} = -1.133$
		$\beta_{13} = -0.901$
[1, β_{12}, β_{13}, 0, β_{15}]	1.61 (0.20) [0.97]	$\beta_{12} = -1.187$
		$\beta_{13} = -0.880$
		$\beta_{15} = 0.631$

p-values using asymptotic critical values within parenthesis
p-values using simulated empirical critical values within brackets

Again, only when the coefficients on the nominal exchange rate and the World market price of oil are allowed to differ is the hypothesis not rejected using asymptotic critical values.[9] The restricted estimate of the long-run pass-through of exchange rate changes is 1.133, while the world market price of oil has a long run effect of 0.901. If the unemployment rate is allowed to enter the cointegrating vector, the test statistic is reduced further to 1.61 with an asymptotic p-value of 0.20. The estimated imply that there is an insignificant tendency for the import price of oil to decrease by 0.6 percent as unemployment increases by one percentage point.

3.2 *The Short Run Dynamics*

The Johansen procedure estimates not only the long run equilibrium relationships between the variables, but also the short run dynamics. The error correction parameters in the α-matrix in equation (2) determine how fast each variable adjusts to deviations from the long run equilibrium. Furthermore, the Γ-matrix contains information about the direct response of each variable to changes in the other variables.

If a row in the α-matrix is zero, the variable in question is weakly exogenous. Not surprisingly, the foreign price level is found to be weakly exogenous, i.e. foreign prices do not adjust to restore Swedish exchange rates and price levels to equilibrium. The larger the α-parameters are, the faster do the variables adjust to restore long-run equilibrium. The error correction parameter for changes in the Swedish import price with respect to the long-run import pricing equilibrium is –0.112 with a *t*-value of –4.367. Since monthly data are used, this estimate implies that import prices adjust to close 10 percent of the deviation from long run equilibrium each month. Half of the effect of a shock to the equilibrium relationship has then disappeared after six months.

There are two hypotheses to be investigated concerning the Γ-matrix in equation (2). According to the small open economy assumption, the Swedish inflation and unemployment rates should not affect import prices. If they do, Sweden is not a price taker on the world market. Second, we are interested in how fast import prices adjust to changes in the nominal exchange rate. The coefficients that relate to the import price on manufactured goods when foreign export prices are used as the foreign price variable are presented in Table 4. Bold numbers denote significant estimates.

Table 4: The short run dynamics of import prices on manufactured goods.

	Δip	Δp^d	Δp^*	Δe	Δu
t-1	**0.17** (2.00)	**0.01** (4.57)	0.17 (0.58)	–0.01 (–0.57)	–0.00 (–0.72)
t-2	–0.15 (–1.29)	**0.35** (2.92)	**–0.05** (–2.29)	**0.10** (2.95)	–0.00 (–0.46)
t-3	–0.14 (–1.13)	**0.24** (1.93)	0.00 (0.19)	**0.10** (2.90)	–0.00 (–0.47)
t-4	0.05 (0.44)	–0.04 (–0.13)	–0.01 (–0.64)	0.03 (1.03)	–0.00 (–0.61)
t-5	0.01 (0.15)	–0.02 (0.10)	**0.06** (3.08)	0.05 (1.34)	0.00 (1.09)

t-values within parenthesis.

[9] *The likelihood ratio test statistics for the hypotheses [1, –1, –1, 0, β], where the unemployment rate is allowed to enter the long run relationship is 18.07 and for [1 β_p β_p 0, β_2], it is 16.88.*

As evident from the second column, high domestic inflation increases import prices significantly the first three months. This violates the small open economy assumption. In the fourth column, the coefficients on lags two and three of the exchange rate are individually significant, implying some price inertia. While the effects after four and five months are individually insignificant, joint significance of these two parameters is not rejected. Less interestingly, foreign prices have one significant entry of each sign. Finally, changes in the unemployment rate do not appear to affect import prices. Estimating the short run dynamics using foreign PPI as proxy for the foreign cost variable yields comparable results, i.e. import prices respond to exchange rate changes with some sluggishness and there is a significant tendency for domestic inflation to increase import prices.

4. Conclusions

This paper investigates the relationship between the nominal exchange rate and import prices in Sweden, focusing on the pass-through of exchange rate changes and the small open economy assumption that domestic macroeconomic variables do not affect import prices. The empirical results show that exchange rate changes are not simply passed on to import prices on a one to one basis as would be expected from the law of one price. The estimated long run pass-through of exchange rate changes to the import prices on manufactured goods is 0.6–0.8 depending on the exact formulation of the hypothesis. This is slightly higher than in other studies of small open economies and much higher than corresponding estimates for the US, Japan and Germany.

There is also some evidence that the unemployment rate matters for import prices in the long run. This violates the small open economy assumption that macroeconomic conditions in small countries should not affect import prices since they are assumed to be price takers on the world market. The estimated coefficients imply that import prices fall by 2–3 percent in response to an increase of the unemployment rate by one percentage point.

Estimation of the error correction mechanism indicates that 10 percent of the deviation from long run equilibrium is closed each month. This implies that the effect of a shock to the equilibrium relationship is cut to half after six months. In the short-run dynamics, exchange rate changes in the five preceding months have jointly significant effects on the import price. Import prices tend to increase more in times of high domestic inflation but not significantly less in times of increasing unemployment. The first result is evidence of nominal price inertia while the second result indicates that pricing to market mechanisms are at work also in the short run.

The law of one price was expected to hold better in the case of import price of crude oil. The estimated long run pass-through coefficients are close to one: 1.151 for the nominal exchange rate and 0.943 for the World market price of oil. The law of one price is rejected according to the oversized asymptotic critical values but it is not rejected when simulated empirical critical values are used. These results are comforting since if the law of one price and in particular the small open economy assumption did not hold even for a small country's imports of a heavily traded homogenous product with a dollar world market price, it would be difficult to find situations where the hypotheses are empirically relevant.

References

Alexius, A. (1995). »Long Run Real Exchange Rates – a Cointegration Analysis.» Arbetsrapport Nr 26, Sveriges Riksbank.

Cheung, Y., and K. Lai (1993). »Finite Sample Sizes of Johansen's Likelihood Ratio Test for Cointegration.» *Oxford Bulletin of Economics and Statistics*, 55, 313–328.

Engle, R.F., and C. Granger (1987). »Co-integration and error correction: Representation, estimation and testing.» *Econometrica*, 55, 251–276.

Goldberg, P., and M. Knetter (1996). »Goods prices and exchange rate: What have we learned?» NBER Working Paper No. 5861.

Gonzalo, J. (1994). »Five alternative methods of estimating long-run equilibrium relationships.» *Journal of Econometrics*, 60, 203–233.

Jacobson, T., A. Vredin, and A. Warne (1994). »Common Trends and Hysteresis in Unemployment.» Working Paper Series in Economics and Finance No. 34, Stockholm School of Economics.

Jacobson, T. (1995). »Simulating small-sample properties of the maximum likelihood cointegration method: Estimation and testing.» *Finnish Economic Papers*, 8, 96–107.

Johansen, S. (1988). »Statistical analysis of cointegrating vectors.» *Journal of Economic Dynamics and Control*, 12, 231–254.

Kuismanen, M. (1995). »Exchange Rates and Import Prices in Finland: Estimation of Exchange Rate Pass-Through.» Bank of Finland Discussion Papers No. 17.

Menon, J. (1995). »Exchange Rates and Import Prices for a Small Open Economy.» *Applied Economics*, 27, 297–301.

Naug, B., and R. Nymoen (1996). »Import price adjustment and pricing to market: A test on Norwegian data.» *Scandinavian Journal of Economics*, 98, 329–350.

Appendix A: Unit Root Tests

a) Levels

	ADF[10A]	ADF[11B]	PP[12C]
Import prices on manufactured goods	–0.082	–1.603	0.150
Import price of oil	–1.632	–2.319	–1.816
Effective nominal exchange rate	–0.378	–2.016	–0.275
SEK/USD nominal exchange rate	–1.938	–2.248	–2.206
Import weighted foreign PPI	–1.631	–2.486	–2.674
Import weighted foreign export prices	–0.054	–2.329	–2.196
Domestic CPI	–1.264	–1.952	–1.332
Unemployment	–0.257	–0.119	–0.071

b) First differences

	ADF[A]	PP[C]
Import prices on manufactured goods	–5.393***	–7.021***
Import price of oil	–7.053***	–8.014***
Effective nominal exchange rate	–6.445***	–11.521***
SEK/USD nominal exchange rate	–5.537***	–9.130***
Import weighted foreign PPI	–3.680***	–2.809*
Import weighted foreign export prices	–6.115***	–10.436***
Domestic CPI	–3.732***	–9.192***
Unemployment	–6.240***	–12.140***

[10A] *This is the univariate augmented Dickey–Fuller test for unit roots with a 5 percent critical value of –2.878*

[11B] *This is the univariate augmented Dickey–Fuller test for unit roots, including a deterministic trend, with a 5 percent critical value of –3.436*

[12C] *This is the univariate Phillips–Perron test for unit roots with a 5 percent critical value of –3.435*

* *significant at 10 percent*

** *significant at 5 percent*

*** *significant at 1 percent*