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EXCHANGE RATE PASS-THROUGH TO SWEDISH IMPORT PRICES*

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Swedish import price determination is investigated using disaggregated monthly data from 1980:1 to 1995:05 for eight different industries. The cointegration analysis indicates two cointegrating relations, in all industries, between import prices, the exchange rate, world market prices and domestic prices. Two-equations systems involve an unclear definition of long-run exchange rate pass-through. Pass-through is defined as the total effect a nominal exchange-rate change has on the import price. The estimate thus includes the direct effect on import prices as well as the effect working through home market prices. Total pass-through estimates indicate a limited pass-through and thus pricing to market behaviour in the majority of industries. Tests of linear restrictions on the cointegrating vectors indicate, in a more formal, statistical sense, a complete long-run pass-through in most industries. (JEL F31, F41)

1. Introduction

The small open economy assumption of price taking behaviour implies that import prices are exogenously determined in foreign currency on the world market. The pass-through of a change in the exchange rate or foreign prices to the import price, in domestic currency, will then be complete and immediate. Domestic market conditions will be of no importance in the determination of import prices. Studies of small open economies like Norway (Naug and Nymoen, 1996) and Australia (Menon, 1995) have, however, shown that foreign producers respond to market conditions in the importing country and that an exchange rate change is not fully passed through to import prices. Two unpublished studies of Swedish aggregate data provide similar results (Adolfson, 1996b and Alexius, 1996).

The effects of exchange rate changes on import prices are however hard to identify in aggregate data. The reason for this is that the exchange rate is endogenously determined, partly in response to earlier domestic and foreign price changes. When the exchange rate changes, the import price has perhaps already been adjusted to higher domestic inflation and labour costs. (See Appendix A3, Figure A1 where the import price rises before the devaluations in 1981 and 1982.) If so, domestic factors matter and pricing to market is relevant.

Using disaggregated data enables one to estimate the pass-through coefficient more accu-

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rately since the exchange rate can be treated as exogenous to a single industry. Furthermore, the theoretical explanations for incomplete pass-through emphasize conditions that are industry specific. The degree of pass-through is supposed to differ between different industries because of differences in market structure characteristics such as the degree of substitutability between the domestic and the imported good and the demand elasticity (Menon, 1996a). It is therefore interesting to study Swedish disaggregated data to see if there is a difference between total pass-through and pass-through at the industry level, as well as between the industries themselves.

If pricing to market is caused by nominal price rigidities, invoicing practices are important. Invoicing in different currencies, with different volatilities, could then be expected to have an effect on the pass-through coefficient. Simple trade-weights will not reflect a particular currency's importance for import payments if there is invoicing in a third currency. The most obvious example is that the U.S. dollar is more important for Swedish import payments than the share of imports from the U.S. indicates. To overcome this problem, two different weighting schemes could be used when computing industry specific effective exchange rates and world market prices. One set of weights could be based on trade weights and the other on the different currencies' importance in payments for imports. The pass-through results of the two different weighting schemes are however quite similar (see Adolfson, 1996a) and in this paper only trade-weights are used.[1]

The purpose of this paper is to study the relation between exchange rate changes and import prices using disaggregated data on different industries. The exchange rate pass-through will be estimated using Johansen's maximum likelihood procedure, which allows the short-run dynamics, in e.g. exchange rates and prices, to be taken into consideration when the long-run relations between the variables are investigated (and vice versa). The estimated model contains a variable vector with four variables for each industry; the import price, the exchange rate, the world market price and the home market price. It will be tested whether there exist stationary long-run relations between these variables and whether these relations are consistent with the pricing to market hypothesis or with full pass-through.

The theoretical framework is presented in Section 2. In Section 3 a brief discussion of data is provided, and in Section 4 the empirical results are presented. Section 5 contains the conclusions.

2. *Theory*

The law of one price (no pricing to market) implies that the prices of traded goods in different geographical areas should be equal, i.e.:

$$(1) \quad P_i^m = E\, P_i^{w*}$$

where P_i^m is the import price in domestic currency on good i, E is the nominal exchange rate and P_i^{w*} is the price in foreign currency on the world market.

Pricing to market or incomplete pass-through means that an exchange rate change does not affect the import price one-for-one. The exchange rate change is instead partly absorbed by the profit margin of the producer. The explanation for this is that imperfect competition gives possibilities to price discriminate between markets. Dynamic aspects both on the demand and the supply side could explain the lack of arbitrage (Krugman, 1987). This pricing behaviour, by limiting pass-through to defend market shares, creates a wedge between import prices and foreign prices of the same product and to different degrees of pass-through for different segmented markets (Marston, 1990).

Short-run departures from full pass-through, or temporary departures from the law of one price, do not prevent a complete pass-through in the long run (Menon, 1996a). They may be due to nominal price rigidities in the short run (menu costs etc.) and adjustment costs in either demand or supply. There may still be an adjustment process where prices gradually change as a response to the exchange rate change result-

[1] *See Appendix A2 for a comparison of the two weighting schemes.*

ing in a complete pass-through in the long-run (Gottfries, 1994).

Under conditions of imperfect competition the producers will be able to charge a markup on costs. The markup will depend on two factors; the degree of substitutability between the domestic and the imported good and the degree of market segmentation. Both these factors determine the firms' price setting power and thus the degree of pass-through. The lower the substitutability and the lower the degree of market integration, the greater will be the market power of sellers (Menon, 1996b).

The two necessary conditions for price discrimination are thus a downward-sloping demand curve and the possibility to separate between markets with different price elasticities (i.e. there must be barriers to arbitrage). Then the producer is not forced to accept an exogenous world market price but can instead influence the price and use it as a strategic tool. Foreign producers will take domestic market factors (demand and supply conditions) into consideration when setting the import price. They will set lower prices in markets with high demand elasticities compared to markets with low demand elasticity (Dorward, 1987).

The profit maximizing price (in the importing country's currency) of a foreign producer will be:

$$(2) \quad (1 - 1 / \eta_d)\, P^m = E\, C^*$$

where P^m is the import price, E the nominal exchange rate, C^* the marginal cost in foreign currency and η_d the demand elasticity defined as $\eta_d = [-(\delta Q / \delta P^m)\, P^m / Q]$ where Q is quantity. When the demand elasticity is low (in absolute value), a higher price can be charged with little loss of market shares resulting in a larger pass-through to these markets.

The analytical framework with a markup model to measure pass-through has been employed in previous studies.[2] Given that manufactured goods are typically viewed as highly differentiated and frequently sold in imperfectly competitive and segmented markets, where arbitrage is costly, the markup model seems appropriate in this case (Menon, 1996a).

The representative foreign producer, in industry i, thus sets the price of exports, to a particular importing country, in its own currency (PA_i^*) as a markup (λ_i) over its marginal production costs (C_i^*)[3]:

$$(3) \quad PA_i^* = \lambda_i\, C_i^*$$

The import price, in the importing country's currency, is obtained by multiplying PA_i^* by the nominal exchange rate (E_i):

$$(4) \quad P_i^m = E_i\, PA_i^* = E_i\, \lambda_i\, C_i^*$$

which is consistent with equation (2) if $\lambda_i = [1 / (1 - 1/\eta_{d,i})]$.

The markup is commonly assumed to be variable and to respond to the competitive pressure and the demand pressure in the importing country. The competitive pressure may be measured by the ratio between the price of competing products (home market price index, P_i^d) and the foreign production costs in the importing country's currency ($C_i^*\, E_i$). Hooper and Mann (1989) and Naug and Nymoen (1996) specify the markup as:

$$(5) \quad \lambda_i = (P_i^d / C_i^*\, E_i)^{\phi}$$

Substituting equation (5) into equation (4) and taking logarithms yields:

$$(6) \quad p_i^m = e_i + \phi\, (p_i^d - e_i - c_i^*) + c_i^*$$

where lower-case letters denote logarithmic values.

In the empirical analysis an index of foreign producer prices (P_i^w) will be used as a proxy for foreign production costs. After rearranging this yields:

$$(7) \quad p_i^m = (1 - \phi)\, e_i + \phi\, p_i^d + (1 - \phi)\, p_i^w$$

The pass-through coefficient or the partial derivative of p_i^m with respect to e_i is $(1 - \phi)$. If

[2] *Hooper and Mann (1989), Naug and Nymoen (1996) and Menon (1996a, 1995).*

[3] *The model is based on Hooper and Mann (1989).*

$\phi = 1$ the pass-through is zero, thus an exchange rate change has no effect and will be completely absorbed by the profit margin. Domestic market conditions, on the other hand, are highly relevant and changes in the home market price will be reflected one-for-one in the price of imports. When $\phi = 0$ the pass-through will be complete and the profit margin will remain unchanged. This also implies that the home market price has no effect in determining the import price.

Equation (7) can be rewritten as:

$$(8) \quad p_i^m - e_i - p_i^w = \phi\,(p_i^d - e_i - p_i^w)$$

where the profit margin is a function of the ratio between the home market price and the foreign price (in common currency). When ϕ is positive, incomplete pass-through, a depreciation of the importing country's currency will result in a decline of the exporter's profit margin.

In the short run various disturbances may create deviations from the long-run relations modelled above (equation (8)). The short-run import price determination can be explained by a dynamic error correction model where changes in the import price depend on prior deviations from the long-run stationary relationship and on prior changes in all variables. Since the exchange rate and the world market price are assumed to be exogenous, the first differences of these variables are included without lag in the error correction model. The endogenous variables are included with lags:[4]

$$(9) \quad \Delta p_t^m = \alpha_1 ECM_{t-1} + \alpha_2 \Delta p_{t-1}^m + \alpha_3 \Delta e_t + \alpha_4 \Delta e_{t-1} + \alpha_5 \Delta p_t^w + \alpha_6 \Delta p_{t-1}^w + \alpha_7 \Delta p_{t-1}^d + \varepsilon_t$$

where

$$(10) \quad ECM_t = p_t^m - e_t - p_t^w - \phi\,(p_t^d - e_t - p_t^w)$$

The Johansen maximum likelihood procedure (Johansen, 1988) involves estimating an error-correction representation of a vector-autoregressive model of order k. This is a multivariate version of equation (9) which can be modelled as follows:

$$(11) \quad \Delta x_t = \sum_{i=1}^{k-1} \Gamma\, \Delta x_{t-i} + \Pi\, x_{t-1} + \varepsilon_t$$

where x_t is a column vector of n variables. In this application, $n = 4$; $x_t' = [p_i^m,\ p_i^d,\ e_i,\ p_i^w]$. Γ represents the short-run dynamics and the lagged level terms (x_{t-1}) capture the error-correction terms which are linear combinations of I(1) variables. If the Π matrix has reduced rank ($r < n$ where r is the number of cointegrating vectors), implying $\Pi = \alpha\,\beta'$, the variables are cointegrated with β as the cointegrating vectors and α as the adjustment coefficients towards long-run equilibrium. If there is no cointegration between the variables, Π must be a zero matrix ($r = 0$). If the variables are stationary (in levels), Π would have full rank ($r = n$). The rank of the system is determined by investigating how many of the eigenvalues are non-zero.

3. *Data*

Eight industries have been selected, the industries with the largest shares of Sweden's imports. Five 2-digit SNI and three 3-digit SNI industries are studied (see Appendix A1, Table A1). Monthly data from the period 1980:1–1995:05 are used in the empirical analyses. All series are normalised to 1.0 1980:1. Logarithms are used throughout. The price series are all price indices and not unit values. Foreign production costs are approximated by foreign producer prices. The exchange rate and the world market price (based on foreign producer prices) are differently defined for every industry according to the weighting scheme (see Appendix A2, Table A3). The weights are based on import shares, in 1993. A more detailed definition of the data is provided in Appendix A1.

None of the series are stationary in levels according to the Augmented Dickey–Fuller test. All series are assumed to be non-stationary and have a unit root.[5]

The graphs in Appendices A3 and A4 seem to indicate that long-run pricing to market is rele-

[4] *Assuming the relevant laglength is one. To lessen the notation the i indicating industry has been omitted.*

[5] *The ADF tests are available upon request.*

vant for most industries. The graphs of total imports (Fig A11), aggregate sample imports, which is an aggregate of the eight industries included in the study (Fig A12)[6], textiles (Fig A15), chemicals (Fig A16), machinery (Fig A18) and electrical machinery (Fig A19) all seem to show less than full pass-through in the long run and thus possible pricing to market. No long-run pricing to market is obvious in the graphs of oil (Fig A13) and food (Fig A14) which both seem to be consistent with almost full pass-through (i.e. the relative price $p^m - e - p^w$ is trend-less). Metals (Fig A17) and transport equipment (Fig A20) are borderline cases.

4. *Empirical results*

The empirical analysis starts with model specification tests. Then the number of cointegrated vectors is established for every industry and tests of linear restrictions on the estimated cointegrated vectors are presented.

Economic theory suggest a few theoretically plausible cointegration vectors. There are four non-stationary variables (p^m, p^d, e and p^w) in the system. If domestic and foreign monetary policy are independent, the system should be driven by two stochastic trends in the long run. It is reasonable to interpret these trends as reflecting domestic and foreign monetary policies. It seems reasonable to expect one cointegration relation to reflect import price determination and one cointegration relation to determine the home market price. Specifically, three different hypotheses are tested:

$$H_1 : p_i^m - e_i - p_i^w \sim I(0)$$
$$H_2 : p_i^d - e_i - p_i^w \sim I(0)$$
$$H_3 : (p_i^m - e_i - p_i^w) - \phi\,(p_i^d - e_i - p_i^w) \sim I(0)$$

H_1 corresponds to the case of no long-run pricing to market. The deviations from the law of one price are stationary and the small open economy assumption may thus be said to hold in the long-run. The pass-through of both exchange rates and world market prices is then complete in the long-run. If H_1 can be rejected, pricing to market is said to be present since the deviations from the law of one price are non-stationary. H_2 implies that the relative price between domestic goods and goods sold on the world market is stationary. If neither H_1 or H_2 holds, there could still be an equilibrium relationship such that a linear combination of the two relative prices is stationary. H_3 (cf. equation 8) may be interpreted as a test of whether the pass-through is affected by the competitive pressure in the domestic market.

4.1 *Model specification tests*

The number of lags has been chosen according to the Hannan–Quinn information criterion (LIL) (see Table 1). The Akaike criterion (AIC)

Table 1: Model specification

Industry	AIC[7] min. lag	LIL[8] min. lag	SBC[9] min. lag	chosen lag	LM(1)[10] p-val	L–B[11] p-val
Total imports	10	2	2	2	0.47	0.00
Aggregate sample imports	4	1	1	2	0.73	0.00
Oil	1	1	1	1	0.82	0.00
Food	7	2	1	2	0.80	0.02
Textiles	2	1	1	1	0.81	0.12
Chemicals	2	2	2	2	0.33	0.21
Metals	2	2	2	2	0.28	0.20
Machinery	10	1	1	1	0.77	0.01
Electrical machinery	6	2	1	3	0.40	0.22
Transport equipment	2	2	1	2	0.25	0.00

[6] *See Appendix A2, Table A2 for the aggregation-weights.*

[7] *Akaike information criterion minimized at lag shown.*

[8] *Hannan–Quinn information criterion.*

[9] *Schwarz information criterion.*

[10] *LM test for autocorrelation of first order at the chosen lag.*

[11] *Ljung–Box Q-test for higher order autocorrelation at the chosen lag.*

Table 2: Cointegration rank

Industry	Eigenvalue	Null hypothesis[13]	Likelihood ratio statistic λ-max	Likelihood ratio statistic Trace	Rank[14]
Total imports	0.102	r = 0	19.74	24.74	
	0.027	r ≤ 1	5.00	5.00	2
Aggregate sample imports	0.228	r = 0	47.02	62.18	
	0.080	r ≤ 1	15.16	15.16	2
Oil	0.127	r = 0	24.91	31.69	
	0.036	r ≤ 1	6.78	6.78	2
Food	0.072	r = 0	13.76	25.49	
	0.062	r ≤ 1	11.73	11.73	2
Textiles	0.126	r = 0	24.70	29.80	
	0.028	r ≤ 1	5.10	5.10	2
Chemicals	0.087	r = 0	16.49	25.22	
	0.047	r ≤ 1	8.73	8.73	2
Metals	0.213	r = 0	43.78	56.32	
	0.066	r ≤ 1	12.54	12.54	2
Machinery	0.111	r = 0	21.65	25.67	
	0.022	r ≤ 1	4.01	4.01	2
Electrical machinery	0.124	r = 0	24.00	29.81	
	0.031	r ≤ 1	5.81	5.81	2
Transport equipment	0.215	r = 0	44.38	56.22	
	0.063	r ≤ 1	11.85	11.85	2

in most cases indicates more lags but the LM test shows that no further autocorrelation is present in the regression at the chosen lag specification. Non-normality of the residuals (not shown) is a problem in all the industries and not significantly reduced by adding a dummy variable for the devaluation of 1982. The results should therefore be interpreted with caution as the assumptions of the statistical model are not completely fulfilled. The subsequent analyses are based on specifications without a devaluation dummy.

4.2 The cointegration rank

The prices in all industries seem to have two cointegrating vectors using the 5% significance level (see Table 2). This empirical result seems reasonable as, one cointegrating vector could reflect import price determination and one home market price determination.[12]

4.3 The cointegrating vectors

Prior international studies have only estimated single-equation models.[15] The finding of two cointegrating vectors leads to the problem of how to define the long-run pass-through. If pass-through is defined as the total effect an exchange rate change has on the import price, the effect working through the home market price should be incorporated into the pass-through estimate. The estimated, unrestricted, cointegration vectors (see Table 3) indicate an incomplete pass-through in several industries when the vectors are normalised so that the coefficient of p^d is 0 in the p^m equation. The textile industry reports a pass-through of about 50 %, while oil, chemicals, metals, electrical machinery and transport equipment all have

[12] *The number of cointegrating vectors will be two from the relation r = n – u where r is the number of cointegrating vectors, n the number of variables and u the number of trends that drive the system in the long-run.*

[13] *Number of cointegrating vectors = r.*

[14] *Critical value 95 % by Osterwald-Lenum (1992) Table 0*
r = 0 λ-max = 11.44 Trace = 12.53
r ≤ 1 λ-max = 3.84 Trace = 3.84

[15] *See Menon (1996a) for a survey of the pass-through literature.*

Table 3: Estimated cointegration vectors

	Vectors normalised so that the coefficient on p^d is 0
Total imports	
$p^m = 0.191\ e + 0.655\ p^w + 0.082\ p^d$	$p^m = 0.268\ e + 0.705\ p^w$
$p^d = 0.997\ e + 0.774\ p^w - 0.219\ p^m$	$p^d = 0.821\ e + 0.310\ p^w + 0.438\ p^m$
Aggregate sample imports	
$p^m = 0.592\ e + 0.823\ p^w + 0.126\ p^d$	$p^m = 0.645\ e + 1.069\ p^w$
$p^d = 2.101\ e + 4.74\ p^w - 2.608\ p^m$	$p^d = -0.175\ e + 0.967\ p^w + 0.921\ p^m$
Oil	
$p^m = 1.328\ e + 1.092\ p^{oil} + 0.246\ p^d$	$p^m = 0.867\ e + 0.825\ p^{oil}$
$p^d = -2.799\ e - 1.968\ p^{oil} + 1.072 p^m$	$p^d = -0.974\ e - 0.230\ p^{oil} - 1.034\ p^m$
Food, beverages and tobacco	
$p^m = 1.018\ e + 4.572\ p^w - 1.343\ p^d$	$p^m = 1.301\ e + 0.872\ p^w$
$p^d = -0.722\ e + 2.412\ p^w + 0.393\ p^m$	$p^d = -1.013\ e + 2.218\ p^w + 0.615\ p^m$
Textiles, clothing and leather industries	
$p^m = 0.846\ e + 1.940\ p^w - 0.519\ p^d$	$p^m = 0.519\ e + 1.336\ p^w$
$p^d = -0.208\ e - 0.995\ p^w + 1.614\ p^m$	$p^d = 0.311\ e + 0.340\ p^w + 0.616\ p^m$
Chemicals etc.	
$p^m = 0.872\ e + 2.628\ p^w - 0.997\ p^d$	$p^m = 0.848\ e + 0.431\ p^w$
$p^d = 0.339\ e + 2.363\ p^w - 0.370\ p^m$	$p^d = -0.406\ e + 1.984\ p^w + 0.511\ p^m$
Metals	
$p^m = 1.032\ e + 0.690\ p^w - 0.079\ p^d$	$p^m = 0.944\ e + 0.593\ p^w$
$p^d = 1.095\ e + 1.231\ p^w + 0.007\ p^m$	$p^d = 0.355\ e + 0.767\ p^w + 0.790\ p^m$
Machinery	
$p^m = -0.735\ e - 1.029\ p^w + 1.765\ p^d$	$p^m = -2.776\ e + 3.715\ p^w$
$p^d = -0.308\ e + 1.551\ p^w + 0.306\ p^m$	$p^d = 0.471\ e + 0.510\ p^w + 0.586\ p^m$
Electrical machinery	
$p^m = 0.717\ e + 0.818\ p^w + 0.051\ p^d$	$p^m = 0.716\ e + 0.911\ p^w$
$p^d = -0.695\ e + 0.981\ p^w + 0.924\ p^m$	$p^d = -0.533\ e + 1.186\ p^w + 0.698\ p^m$
Transport equipment	
$p^m = 0.652\ e + 0.484\ p^w + 0.391\ p^d$	$p^m = 0.801\ e + 1.100\ p^w$
$p^d = 0.136\ e + 1.237\ p^w + 0.306\ p^m$	$p^d = -0.191\ e + 0.788\ p^w + 0.714\ p^m$

pass-through estimates around 85 %. The aggregate sample imports (an aggregate of the eight industries included in the study) reports a pass-through of 65 %. This number is more than twice as high as the pass-through estimate of total imports (27 %). This would imply that the included industries are closer to the full pass-through case than overall imports which is somewhat surprising, given that the sample covers about 80 % of all imports. This suggests that estimates of exchange rate pass-through based on aggregate data may be severely distorted because of aggregation problems.

Many of the pass-through coefficients are quite close to unity and the likelihood ratio test of H_1 (see Table 4) is used to formally analyse if they are significantly different from one or consistent with the full pass-through hypothesis and no pricing to market.

Since oil is a homogeneous good traded in an integrated world market, the pass-through is expected to be complete because arbitrage will eliminate price differentials in a common currency. The likelihood ratio test does not reject stationarity of the relative price between the import price of oil and the world market price, i.e. H_1 is accepted and the law of one price is confirmed. The short-run pass-through is also complete which is consistent with the small open economy assumption (See Table 5).

For aggregate sample imports all hypotheses are rejected (5 % significance). The rejections of H_1 and H_2 indicate that the average exchange rate pass-through is limited and that pricing to

Table 4: Tests of linear restrictions on the cointegrating vectors

Industry	Hypothesis	Likelihood ratio[18]	p-value
Total imports	H_1	$\chi^2(2) = 4.99$	0.08
	H_2	$\chi^2(2) = 4.13$	0.13
	H_3	$\chi^2(1) = 0.10$	0.75
Aggregate sample imports	H_1	$\chi^2(2) = 12.76$	0.00
	H_2	$\chi^2(2) = 7.62$	0.02
	H_3	$\chi^2(1) = 6.13$	0.01
Oil	H_1	$\chi^2(2) = 0.55$	0.76
	H_2	$\chi^2(2) = 5.95$	0.05
	H_3	$\chi^2(1) = 0.03$	0.86
Food	H_1	$\chi^2(2) = 6.56$	0.04
	H_2	$\chi^2(2) = 11.43$	0.00
	H_3	$\chi^2(1) = 5.65$	0.02
Textiles	H_1	$\chi^2(2) = 5.04$	0.08
	H_2	$\chi^2(2) = 1.94$	0.38
	H_3	$\chi^2(1) = 0.28$	0.60
Chemicals	H_1	$\chi^2(2) = 8.68$	0.01
	H_2	$\chi^2(2) = 6.55$	0.04
	H_3	$\chi^2(1) = 6.54$	0.01
Metals	H_1	$\chi^2(2) = 8.58$	0.01
	H_2	$\chi^2(2) = 8.92$	0.01
	H_3	$\chi^2(1) = 0.03$	0.85
Machinery	H_1	$\chi^2(2) = 0.82$	0.66
	H_2	$\chi^2(2) = 0.73$	0.69
	H_3	$\chi^2(1) = 0.71$	0.40
Electrical machinery	H_1	$\chi^2(2) = 5.79$	0.06
	H_2	$\chi^2(2) = 5.77$	0.06
	H_3	$\chi^2(1) = 4.81$	0.03
Transport equipment	H_1	$\chi^2(2) = 4.00$	0.14
	H_2	$\chi^2(2) = 6.82$	0.03
	H_3	$\chi^2(1) = 3.98$	0.05

market is relevant. Since H_3 is rejected this implies that the competitive pressure, defined as $(p_i^d - e_i - p_i^w)$, does not affect the pass-through coefficient and that the theoretical model does not explain the development of the aggregate sample import prices.

For disaggregated data, H_1 is rejected (at the 5% significance level) for food, chemicals and metals. Of these industries H_3 is accepted for metals (i.e. there is a stationary relation between the degree of pricing to market and the relative price of domestic goods). For food the graph over the relative import price (see Figure A14) is indicating mean reversion, though it is rather slow. The rejection of H_1 may thus be explained by the oversized likelihood test and the slow reversion. The short-run pass-through is however limited to 27 %.

For chemicals and metals the results clearly indicate an incomplete long-run pass-through. H_1 is rejected and long-run pricing to market is thus present. For chemicals, pass-through is estimated to about 85 % which is in line with Menon (1996a) who estimates a long-run pass-through of 83 % in Australian imports of organic chemicals. For metals H_3 is accepted and with this restriction, the pass-through is estimated to 88 % which is similar to Menon's (1996a) estimate of a pass-through of 89 % in Australian imports of iron and steel.

For textiles the results weakly indicate less than full pass-through, estimated to about 50 %. (H_1 can be rejected at 8 % significance.) H_3 is accepted indicating that the pass-through coefficient is affected by the competitive pressure on the market. An exchange rate change is not passed through immediately and the short-run pass-through is estimated to 25 %.[16]

For transports, machinery and electrical machinery H_1 is accepted and the results for these industries are thus consistent with a full long-run pass-through. Menon (1996a) estimates the pass-through to 81 % in Australian imports of road vehicles. Full long-run pass-through in transports is somewhat surprising since previous international studies[17] of the car industry find less than full pass-through, and this industry is categorized as a typical pricing to market-industry. The immediate pass-through is, though, limited to 33 %.

The unrestricted short-run coefficients of the exchange rate in the import price equations indicate an incomplete short-run pass-through in all industries but oil (see Table 5). Other industries record an immediate pass-through of about 25 % implying that profit margins absorb the larger part of the exchange rate change in the short run.

[16] *Menon (1996a) estimates long-run pass-through between 50 % and 80 % for Australian imports of different textiles.*

[17] *See Menon (1996a) for a survey.*

[18] *Restrictions on one vector, the other unrestricted, the degrees of freedom, $df = (n - s - r_2)\, r_1$ where n is the number of variables, s the number of restrictions, r_2 is the number of unrestricted vectors and r_1 is the number of restricted vectors (Johansen 1992).*

Table 5: Short-run pass-through

(Coefficients, t-statistics in parenthesis) Industry	Δe_t	Δe_{t-1}	Δe_{t-2}
Total imports	0.207 (6.87)	0.121 (3.62)	
Aggregate sample imports	0.396 (16.87)	0.129 (3.45)	
Oil	0.998 (8.30)		
Food	0.266 (6.42)	0.090 (1.94)	
Textiles	0.252 (6.47)		
Chemicals	0.436 (8.09)	–0.019 (–0.29)	
Metals	0.264 (5.84)	0.026 (0.51)	
Machinery	0.416 (16.06)		
Electrical machinery	0.279 (9.86)	0.196 (5.18)	0.001 (0.03)
Transport equipment	0.328 (9.13)	0.107 (2.25)	

The full pass-through hypothesis thus seems to be a good approximation for the majority of the industries, at least in the short run. For the sample on average, however, pricing to market is present and the average long-run pass-through is 65%. This is in line with the result for total imports which weakly indicates that pricing to market is relevant (H_1 can be rejected at 8 % significance).

5. *Conclusions*

The cointegration analysis of prices and exchange rates using Johansen's maximum likelihood procedure indicates two cointegrating vectors in all industries at reasonable significance levels. Since there are two cointegrating vectors the definition of long-run pass-through becomes somewhat unclear. If pass-through is defined as the total effect a nominal exchange rate change has on the import price, the effect working through the home market price should be incorporated into the estimate. The point estimates of total long-run pass-through indicate less than full pass-through in the majority of industries. The majority of the estimates are clustered around 80 %.

Different linear restrictions on the cointegrating vectors are tested in order to analyse the pass-through estimates in a more formal, statistical sense. The likelihood ratio tests, of the linear restriction H_1, weakly indicate a complete pass-through in most industries. The evidence of full pass-through is most distinct in the oil, machinery and transport industries. Only the chemical and metal industry show test statistics that are clearly inconsistent with complete long-run pass-through. In these industries, foreign producers thus adjust their profit margins to the domestic market conditions when an exchange rate change occurs. The statistical rejection of complete pass-through could, however, be due to the fact that the mean reverting process in relative prices is very slow.

The likelihood ratio tests thus give stronger support to the full pass-through hypothesis than the unrestricted point estimates suggest. But the tests must be interpreted cautiously since there is a problem with non-normality in the residuals.

Irrespectively of whether there is complete or incomplete pass-through in the long-run, the long-run effect is not reached immediately. Short-run pass-through is limited in all cases except for oil. This is probably due to the fact that oil is a very homogeneous product with a well defined world market price. In the other industries the short-run pass-through ranges from 21 to 44 %. In the short-run, the profit margins absorb the larger part of the exchange rate change. There is a clear indication that the price determination differs between industries, probably reflecting different market structure characteristics. This should be an important issue for further research.

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Appendix

A1 Data definitions

– P_i^m = Import price index for Sweden. 1980: 1 = 1. Source: SCB, Statistics Sweden.

– P_i^d = Home market price index for Sweden. 1980:1 = 1. Source: Konjunkturinstitutet.

– E_i = Trade-weighted exchange rate index (price of foreign currency in terms of kronor). 1980:1 = 1. Including OECD 14 except Canada. Weights (Table A3) are based on import shares, from 1993, for every industry. Source: Sveriges Riksbank, NUTEK (Swedish National Board for Industrial and Technical Development).

– P_i^w = Trade-weighted producer price index#. 1980:1 = 1. Including OECD 14 except Canada. Weights are based on import shares, during 1993, for every line. Source: SCB, Statistics Sweden; OECD Indicators of Industrial Activity, NUTEK (Swedish National Board for Industrial and Technical Development).

– P^{oil} = Oil price index (US dollars). 1980:1 = 1. Source: International Financial Statistics.

Where i denotes the industry.

The 14 OECD-countries are Canada, USA, Japan, Belgium, the Netherlands, France, Great Britain, Germany, Switzerland, Austria, Italy, Norway, Denmark and Finland.

The following producer prices were unavailable on the disaggregated level and approximated by different aggregate prices. Source: OECD Main Economic Indicators:

Danish producer prices approximated by aggregate producer prices for all industries.

Food, SNI31
Austria –82:12 approximated by aggregate wholesale prices
Great Britain –83:12 approximated by producer prices, food
The Netherlands –84:12 and from 94:1– approximated by producer prices, total output

Textiles, SNI32
Austria –86:12 approximated by aggregate wholesale prices
France –83:12 approximated by aggregate consumer prices
The Netherlands –84:12 and from 94:1– approximated by producer prices, total output
Switzerland approximated by aggregate wholesale prices

Chemicals, SNI35
Austria –86:12 approximated by aggregate wholesale prices
Germany –84:12 approximated by industrial producer prices
The Netherlands –84:12 and from 94:1– approximated by producer prices, total output
The USA –81:12 approximated by producer prices, chemicals

Machinery, SNI382
Switzerland approximated by aggregate wholesale prices
France approximated by aggregate consumer prices
Norway approximated by aggregate wholesale prices
The USA approximated by aggregate producer prices

Electrical machinery, SNI383
Switzerland approximated by aggregate wholesale prices
France approximated by aggregate consumer prices
Norway approximated by aggregate wholesale prices

Transport equipment, SNI384
Switzerland approximated by aggregate wholesale prices
Germany approximated by industrial producer prices
France approximated by aggregate consumer prices
The Netherlands approximated by producer prices, total output
Norway approximated by aggregate wholesale prices

Table A1: Included industries in the study. Division from the Swedish Standard Industrial Classification of all Economic Activities, SNI69.

Crude petroleum and natural gas	SNI22
Manufacture of food, beverages and tobacco	SNI31
Textiles, clothing and leather industries	SNI32
Manufacture of chemicals and of chemical, petroleum, rubber and plastic products	SNI35
Iron, steel and metal industries	SNI37
Manufacture of machinery	SNI382
Manufacture of electrical machinery	SNI383
Manufacture of transport equipment	SNI384

A2 Weights

Table A2: Swedish imports by industry (1993) (aggregation-weights).[19]

Crude petroleum and natural gas, SNI22	6.62 %
Manufacture of food, beverages and tobacco, SNI31	7.48 %
Textiles, clothing and leather industries, SNI32	10.13 %
Manufacture of chemicals and of chemical, petroleum, rubber and plastic products, SNI35	24.17 %
Iron, steel and metal industries, SNI37	5.66 %
Manufacture of machinery, SNI382	18.48 %
Manufacture of electrical machinery, SNI383	14.78 %
Manufacture of transport equipment, SNI384	12.68 %

Table A3: Country share of imports[20] % (trade-weights) in 1993

	Food	Textiles	Chemicals	Metals	Engineering products[21]
Austria	1.43	2.30	1.20	4.91	1.53
Belgium	3.26	0.84	5.89	5.48	4.14
Canada	–	–	–	–	–
Switzerland	4.67	0.91	2.02	1.45	2.64
Germany	14.43	7.99	24.12	23.90	26.69
Denmark	19.46	16.07	3.62	4.28	5.14
Finland	4.56	8.60	6.62	15.24	5.78
France	8.51	4.52	15.88	8.61	5.79
Great Britain	9.96	22.62	12.40	14.66	9.46
Italy	5.50	27.31	2.45	2.84	4.16
Japan	0.16	0.44	2.72	1.36	10.94
The Netherlands	10.67	2.06	10.49	4.75	3.67
Norway	9.84	1.77	6.69	10.20	3.33
The USA	7.55	4.57	5.90	2.32	16.73

Table A4: Currency share of payments[22] % (currency-weights) in 1993

	Food	Textiles	Chemicals	Metals	Engineering products[23]
ATS	1.87	3.66	0.59	2.88	1.21
BEL	1.65	1.96	1.88	1.04	2.51
CAN	0.41	0.07	0.20	0.03	0.58
CHF	2.84	3.66	3.51	0.04	2.20
DEM	17.07	33.99	27.16	11.57	32.68
DKK	12.85	7.92	3.29	1.21	2.70
FIM	1.08	3.11	2.56	1.80	2.11
FRF	4.62	4.67	17.78	2.55	5.92
GBP	4.77	7.86	6.85	13.92	11.24
ITL	1.52	5.89	0.72	0.28	1.50
JPY	0.11	0.68	1.49	0.34	6.48
NLG	8.75	3.11	5.71	0.82	2.57
NOK	7.16	6.09	2.02	2.06	2.82
USD	35.30	17.33	26.24	61.46	25.48

[19] *Source: Statistics Sweden.*

[20] *Source: Swedish National Board for Industrial and Technical Development (NUTEK).*

[21] *SNI 38. The same weights are used for machinery, electrical machinery and transport equipment.*

[22] *Source: Sveriges Riksbank.*

[23] *SNI 38. The same weights are used for machinery, electrical machinery and transport equipment.*

A3 Graphs over the import price (p^m) and the exchange rate (e)

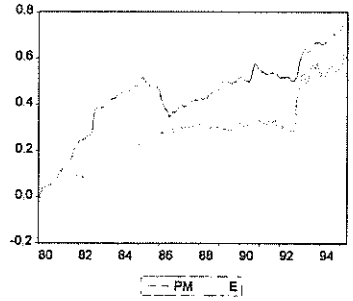


Figure A1: Total imports

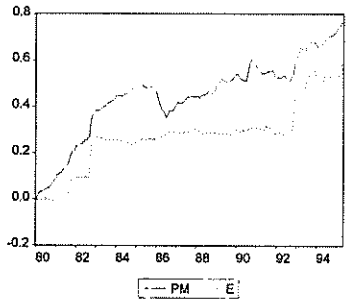


Figure A2: Aggregate sample imports

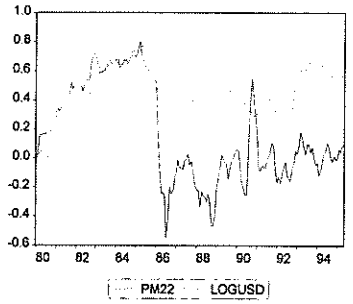


Figure A3: Oil

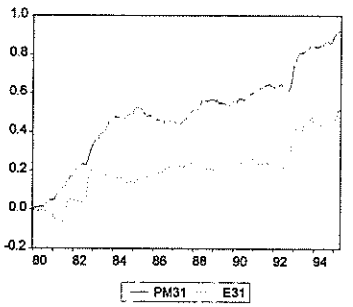
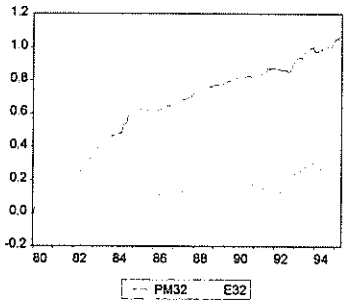


Figure A4: Food



FigureA5: Textiles

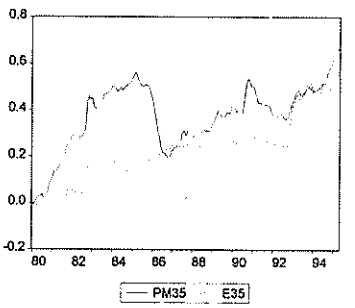


Figure A6: Chemicals

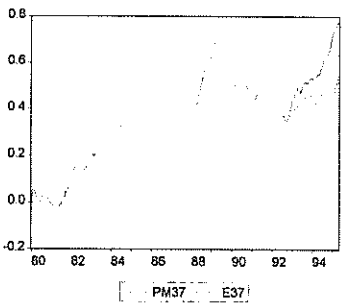


Figure A7: Metals

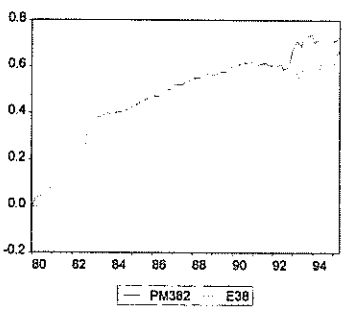


Figure A8: Machinery

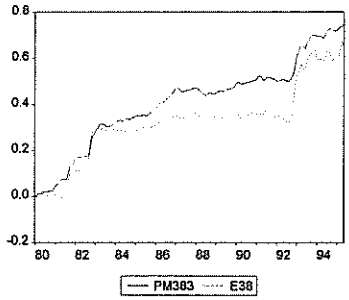


Figure A9: Electrical machinery

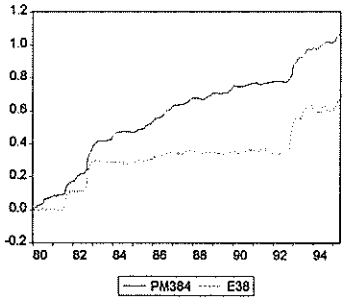


Figure A10: Transport equipment

A4 Graphs over the relative price ($p^m - e - p^w$)

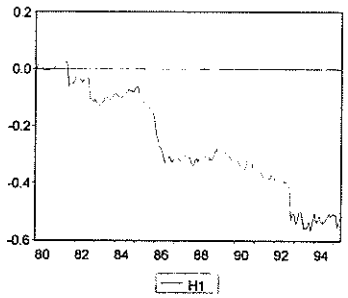


Figure A11: Total imports

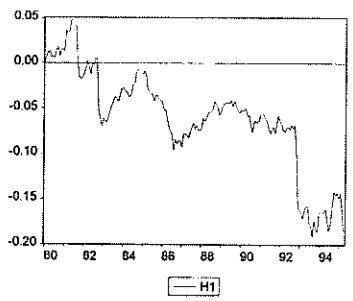


Figure A12: Aggregate sample imports

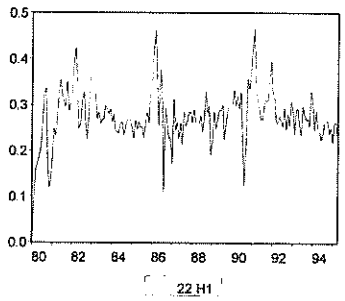


Figure A13: Oil

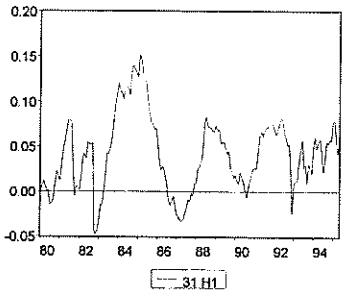


Figure A14: Food

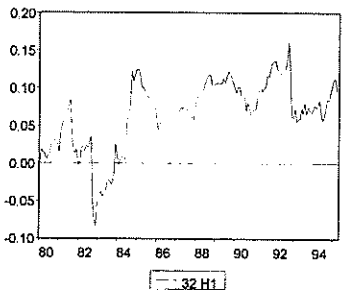


Figure A15: Textiles

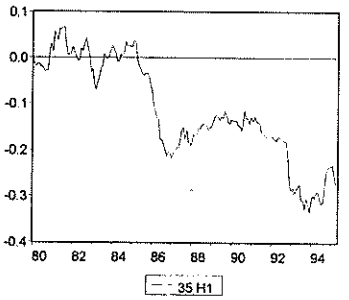


Figure A16: Chemicals

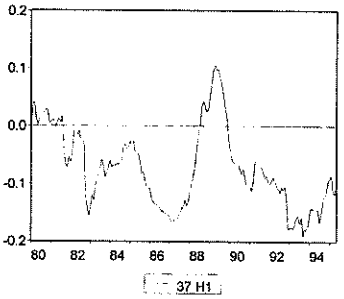


Figure A17: Metals

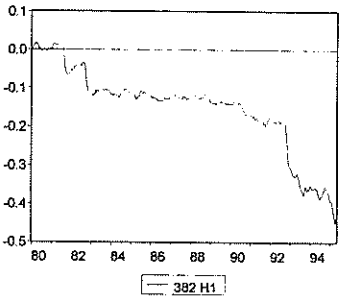


Figure A18: Machinery

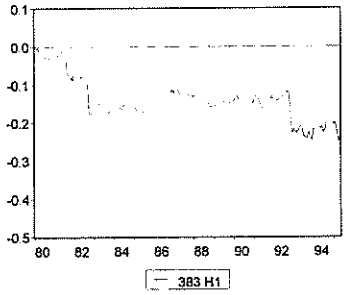


Figure A19: Electrical machinery

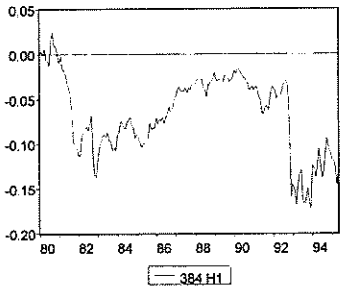


Figure A20: Transport equipment

A5 Graphs over the world market price (p^w)

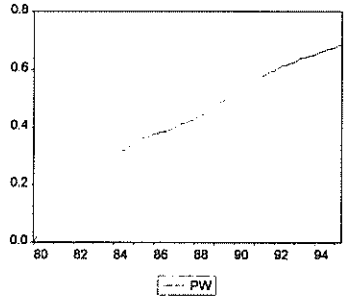


Figure A21: Total imports

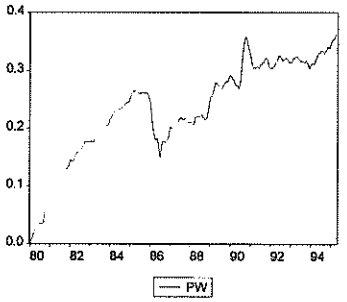


Figure A22: Aggregate sample imports

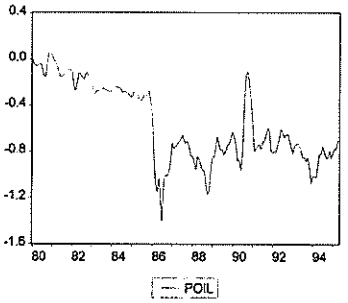


Figure A23: Oil

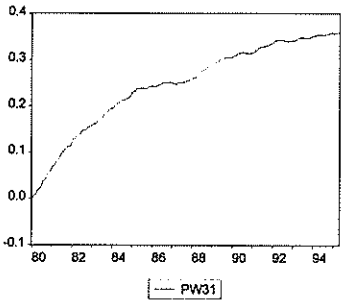


Figure A24: Food

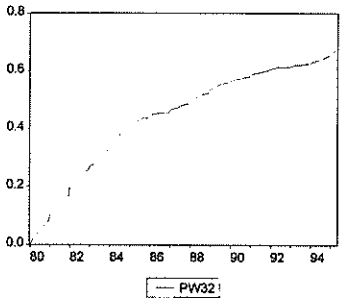


Figure A25: Textiles

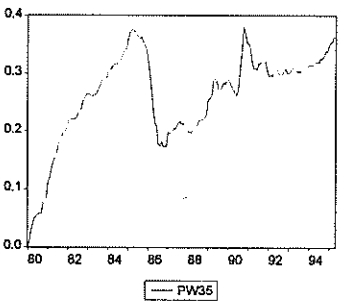


Figure A26: Chemicals

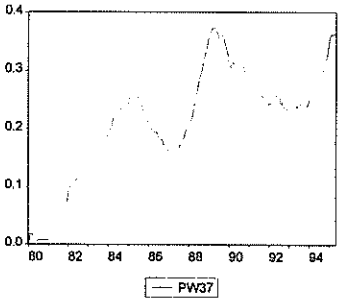


Figure A27: Metals

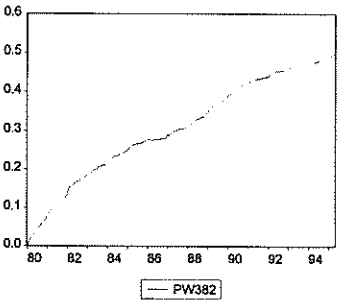


Figure A28: Machinery

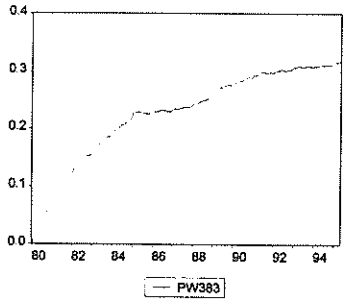


Figure A29: Electrical machinery

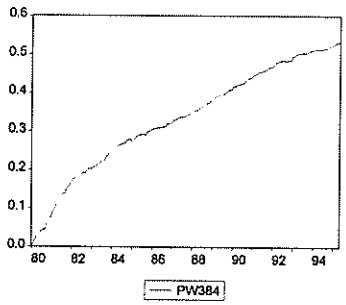


Figure A30: Transport equipment