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Import and Export Price Equations for Manufactures

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No. 43: IMPORT AND EXPORT PRICE EQUATIONS FOR MANUFACTURES

by

Richard Herd
(Balance of Payments Division)

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This paper presents a new system for the consistent determination of import and export prices of manufactured products for use in the world trade block of the OECD INTERLINK model. It uses a system design which directly couples the bilateral determinants of export prices with the bilateral determinants of import prices. The results, however, will be obtained without the need for specific bilateral information other than the bilateral exchange rate. The model allows for price discrimination between different markets for the same exporter and features less than full pass-through of exchange rate movements into import prices.

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Cet article presente un nouveau système cohérent de détermination de prix à l'importation et à l'exportation de produits manufacturés pour le bloc du commerce exterieur du modèle mondial INTERLINK de l'OCDE. Dans sa conception, ce système met en relation directe les déterminants bilatéraux des prix à l'importation et à l'exportation. Les résultats sont cependant obtenus sans que des données bilatérales autres que celles relatives aux taux de change ne soient nécessaires. Le modèle fait, pour chaque exportateur, une discrimination selon les différents marchés et est caractérisé par une réaction non totale des prix à l'importation aux variations de taux de change.

IMPORT AND EXPORT PRICE EQUATIONS FOR MANUFACTURES

by

Richard Herd

(OECD, Balance of Payments Division)

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I. INTRODUCTION

1. This paper presents a new system for the consistent determination of import and export prices of manufactured products for use in the world trade block of the OECD INTERLINK model. It uses a system design which directly couples the bilateral determinants of export prices with the bilateral determinants of import prices. The results, however, will be obtained without the need for specific bilateral information other than the bilateral exchange rate. The model allows for price discrimination between different markets for the same exporter and features less than full pass-through of exchange rate movements into import prices.

2. The original world trade models were developed in the early 1970s at a time when exchange rates were pegged to the dollar as the numeraire currency. Exchange-rate changes were generally achieved by a uniform devaluation or revaluation of a currency against the dollar. Devaluations or appreciations of differing amounts against different currencies could only occur if there was a simultaneous devaluation or appreciation of several currencies -- such as now happens in parity changes within the European Monetary System, but which had rarely happened under the Bretton Woods System. Up to the early 1970s, then, there was little scope for exchange rate movements to influence the export prices of a given country in a way which differed across its markets. In those circumstances it was natural that the export prices of one country should be seen as uniform (or in a stable relationship) across all markets. If there were major demand shifts in the importing countries, the absence of perfect elasticity of supply might even then have caused import prices to change in a noticeable way. However this possibility was often ignored, enabling the import prices of a given country to be determined as a weighted average of the export prices of all other countries. Likewise, large inflation differentials across markets might have produced visible evidence of price discrimination but, of course, rates of inflation were relatively low and uniform over this period.

3. The advent of floating exchange rates meant that the possibility of discrimination between markets became more likely. Furthermore, especially since the late 1970s, the increasing use of quantitative restrictions on trade has widened the likelihood of price discrimination. The recent past, marked by the large appreciation of the dollar up to 1985, and its equally large decline since then has illustrated the existence of price discrimination in the determination of import prices.

4. Table 1 illustrates this in the case of passenger car exports from both Germany and Japan. Japanese exporters (first panel) increased yen prices to North America in the early 1980s when prices charged to the Benelux area were kept stable. In 1986 prices of North American prices were reduced though prices for Europe were raised. Although the phenomena of price discrimination and absorption of exchange rate movements has been most evident in Japan

recently because of its high dependence on the United States market coupled with a significant exchange rate movement, exporters from other countries appear to have shown the same reaction to exchange-rate movements. The second panel of Table 1 suggests that German exporters of passenger cars raised there export prices to the U.S. market significantly in the period of dollar appreciation.

5. When the changes in the bilateral export prices of Japanese and German passenger car exporters are compared. In both cases, the U.S. markets had the largest increases, while the Dutch and Belgian markets had the smallest increses. Italy was midway between the two in both cases. This suggests that at least some export prices are set with regard to conditions in the destination market as well as with regard to the costs prevailing in the domestic market. It also suggests that exporters discriminate not only between the foreign and domestic markets but also among different foreign markets.

6. The same negative correlation of export prices with exchange rates is not limited to passenger cars. It can be seen in the development of most other categories of U.S. import prices of Japanese products in the year following the peak in the dollar's effective exchange rate (Table 2). Overall U.S. import prices in the year following the peak of the dollar rose by 11 per cent in dollar term's but fell by over 20 per cent in yen terms (first two columns of the table). However, at the same time overall Japanese export prices in dollars rose by over 20 per cent. This suggests that export prices to markets other than the United States were not being cut so much in yen terms. The last two columns of the table suggests that this did indeed happen on the United Kingdom market. On this market (where the yen appreciated less) Japanese export prices were cut by only 6 per cent in yen terms while rising by 7 per cent in local currency terms. The differences in price movements were spread across all products and not just confined to those where stict quantitative restrictions were in force. On average, a significant price differentials opened up between Japanese export prices to the United States and the United Kingdom. The differential corresponded to almost three quarters of the change in the sterling dollar exchange rate, suggesting that exchange rate movements have increased the possibility for exporters to charge different prices to different markets.

7. A conventional model of supply and demand curves would predict that there is a relationship between supply and demand elasticities and the proportion of a given exchange rate movement which is passed through to the domestic import prices of a country subject to an exchange rate movement. The relationship is given by:

$$(pm/pm(-1))-1) = (s/(s+d))*(r/r(-1) -1)$$

where
- pm = local currency import price
- s = supply elasticity of the foreign producer
- d = demand elasticity of the domestic producer
- r = exchange rate

Table 1

Export unit values of Japanese passenger cars
(1000 -- 2000 c.c.)

Destination	1980 = 100, yen index					
	1981	1982	1983	1984	1985	1986
United States	109	127	136	150	159	140
Canada	114	128	144	156	161	140
United Kingdom	108	116	117	121	115	126
Italy	107	112	119	112	127	144
France	99	106	101	108	108	99
Sweden	98	100	111	107	110	112
Germany	95	101	108	105	104	111
Belgium	99	99	105	100	98	105
Netherlands	100	101	104	99	96	102
Japanese producer prices	101	101	100	101	102	102

Export unit values of German passenger cars

Destination	1980 = 100, deutschmark index					
	1981	1982	1983	1984	1985	1986*
United States	126	147	163	184	196	204
Canada	108	123	123	138	138	129
United Kingdom	120	127	125	132	144	156
Italy	110	119	123	135	147	161
France	109	115	122	125	144	152
Sweden	107	112	118	126	137	142
Belgium	104	107	110	108	112	117
Netherlands	103	109	114	118	128	134
German producer prices	105	109	111	115	117	119

(*) First ten months.

Sources: Japan, Exports and Imports, Commodity by Country Japanese Tariff Association.
Germany: OECD Foreign Trade Statistics Series C and Aussenhandel nach Waren und Landern, Fachserie 7.

Note: German unit values for car exports to the U.S. market were affected by a marked switch to larger cars in 1986. Without this switch prices would have fallen.

Table 2

Price of Imports from Japan
United States & United Kingdom markets
selected finished manufactured products
% increase

	United States market		United Kingdom market	
	Dollar	Yen	Pound	Yen
Passenger cars	19	-16	11	-2
Video tape recorders	-5	-33	19	4
Trucks	12	-20	10	-3
Data processing machines	18	-17	-	-
Integrated circuits	-41	-58	-52	-58
Copying machines	17	-17	18	3
Radio-tape players	15	-19	5	-7
Motor cycles over 290cc	24	-13	13	-1
Still cameras	-1	-30	21	6
Colour TV sets	7	-25	-7	-18
Microwave ovens	-16	-41	9	-4
Video cassettes	-9	-36	2	-10
All manufactured products*	11	-21	7	-6
Exchange rate (bilateral)	42	-30	14	-13

Source: United States Bureau of the Census FT135. United Kingdom Department of Trade Overseas Trade Statistics.

(*) The aggregate sample consists of the 123 categories of U.S. finished manufactured products for which US imports from Japan in the first half of 1985 were greater than $15 million. The sample accounts for 75 per cent of all U.S. imports of finished manufactured products from Japan. The overall price index was calculated on a base weighted basis. The aample for the United Kingdom consisted of 156 products representing over 90 per cent of all finished manufactured products from Japan.

Branson (1972) used this relationship to compute theoretical pass through coefficient presented in Table 3. If the supply elasticity to a given market is less than perfectly elastic, exchange rate movements will not be fully reflected in movements in local currency import prices. For a large market which is important to a given exporter of manufactured products it is unlikely that supply would be perfectly elastic. A smaller country though might be faced with a more elastic supply curve. If, on the other hand the supply curve is perfectly inelastic (such as might be the case if quantitative restrictions were limiting exports to a given market -- Japanese cars to the United States or French markets, for instance) then local currency import prices would not be affected by exchange rate movements until the exchange rate had moved sufficiently for the quantitative restriction no longer to be the binding constraint on import volumes.

8. This analysis is essentially short term. The ability of exporters to act as discriminating monopolists is limited in the long term. If a particular market is no protected either by quantitative restrictions or by unique technical specifications then higher prices in one market than in an another may create an arbitrage opportunity between the two markets. Even when quantitative restrictions are in place, price margins can be eroded by the development of parallel import markets. This appears to have happened, for instance, in the case of automobile imports into the U.K. during the period of sterling appreciation and with television imports into the U.S. during the period of voluntary export restraints. The other factor which might be expected to limit the scope for long term price discrimination would be capital mobility in the supplying country. Capacity would tend to increase in the supplying country if exports were over profitable so making the supply curve more elastic and reducing the scope for price discrimination between markets.

Table 3

Pass-through to import prices of a given percentage devaluation

Elasticity of supply	Elasticity of demand				
	-1.0	-2.0	-3.0	-5.0	-10.0
1.0	0.50	0.33	0.25	0.17	0.09
2.0	0.67	0.50	0.40	0.29	0.17
5.0	0.83	0.71	0.63	0.50	0.33
10.0	0.91	0.83	0.77	0.67	0.50
00	1.00	1.00	1.00	1.00	1.00

9. The next section starts with a review of the literature on price discrimination in international trade and on the determination of import prices. It selects one model from the literature and then adapts the model to the needs of the INTERLINK system. Estimates of the model are then presented and the results of the model are subjected to stability tests and then compared to the existing system.

II. PREVIOUS RESEARCH

10. For a small country purchasing a well-defined commodity, it can be expected that the local currency price of imports of this commodity will follow movements in exchange rates. The conditions for this to apply are straightforward: that there should be an infinite supply of the product at the given world price but also, as pointed out by Flood, that the product should be easily transported, that it should be homogeneous (i.e. many different producers can produce the same item), that there should be an efficient market in information about the product and that there should be a large number of purchasers. Equally the more the product is bought by sophisticated purchasers, the more likely that price differentials will not exist between different markets. With all of these conditions fulfilled, it is likely that the product will be traded for the same price in many countries. This does not mean that the price of such an internationally traded product will move directly with the exchange rate of a given country. If the country concerned is large and so its consumption (or production) of a commodity is large relative to the world total, then its exchange rate movement will influence the unique world price. Dornbusch has estimated the relationship between commodity prices and the dollar exchange rate. While it is fairly well established that the law of one price holds for well-defined commodities such as coffee or zinc (Protopapadakis and Stock), it is not the case that the law of one price holds for manufactured products that enter into world trade.

11. Kravis and Lipsey (1978) present evidence pointing to substantial differences in price levels and movements for goods in the same 4 or even 5 digit SITC categories. While it is possible to argue that compositional evidence vitiate any comparison of these supposedly similar products, they conclude that "the price differences that do exist do not point to high degrees of substitutability between the exports of main industrial countries". Here we are not concerned with an overall notion of one price including tradeable and non-tradeable products but Hill (1986) has shown that this does not exist either. Richardson has shown, for a group of matched U.S. and Canadian wholesale price indices that perfect commodity arbitrage can be rejected for every commodity group considered over a period as long as two years. Dunn too found that "models based on perfect competition cannot explain how industrial prices could react to a flexible exchange rate". An exchange rate movement does change the terms of trade of countries. Kravis and Lipsey (op. cit.) found that in only two of the 10 cases of substantial currency devaluations or appreciations studied were there no changes trade prices relative to world prices after a period of five years. They suggest that in an oligopolistic market with significant transport and distribution costs and with differing demand elasticities between countries, producers may be expected to charge different prices in different markets in order to maximize profits.

12. Kravis and Lipsey (1971) also found large persistent price differentials for many industrial products when analysed at the 2-digit SITC level. For the period 1953-1964, "substantial absolute price differences persisted while the low-priced sellers gradually expanded their market share

and the high priced sellers saw their market share contract". Price discrimination between foreign and domestic markets was also clearly evidenced in their 1977 paper. Isard (1977) also concluded that "there were persistent differences between prices of similar goods in international trade produced by different countries and that while careful econometric studies of data for a longer sample period might indeed find that the relative price changes associated with any given exchange rate movement are completely offset over long periods of time, in reality exchange rates are rarely stable for long periods of time and thus for practical purposes, products (at the 4- and 5-digit SITC level) are not sufficiently close substitutes to preclude substantial and persistent changes in relative common currency prices".

13. This much, however, has been common ground to international trade modellers for many years Samuelson (1973). In most models, export prices depend on domestic costs and foreign prices. This indicates that the models accept price discrimination between home and export markets. Exchange rates have persistent effects on relative price levels -- though these may be offset by the economy wide repercussions of an exchange rate movement.

14. The movement of import prices has provoked somewhat less interest in the literature on linked international models and the reponse of trade balances to exchange rate changes. For the international modeller the reason is that it is necessary to obtain a set of equations for both and export and import prices which satisfy the global accounting framework that export and import prices are equal. Moriguchi (1973) presents the model structure utilised in the LINK system in which import prices are determined by identity from a share matrix of world trade -- given the movement in each country's export prices and exchange rates. A similar structure is used in the OECD INTERLINK model, but with the nuance that the growth of prices on individual markets depend on the differential between the domestic inflation rate and the world inflation rate. Systems such as LINK or the original INTERLINK model assume that the import supply curve facing any given country is perfectly elastic -- though the level of the supply curve may differ according to the suppliers on a particular market.

15. In the absence of a perfectly elastic supply curve, as shown above, there will be less than full pass-through of exchange rate movements. Empirical estimates of the "pass-through" for a given change in the US exchange rate following the Smithsonian exchange rate realignments are given in Clark, Logue and Sweeney (1974) with the general result that over a two-year period import prices do not follow the exchange rate fully. Kreinen (1980) used a method of comparing similar countries to obtain the conclusion that for the United States the pass-through of exchange rate movements to import prices was between 30 and 55 per cent. For Japan and Germany he found pass-through ratios of about 60 per cent while for the smaller countries such as Austria and Switzerland the pass-through was complete. However, these results were not based on strict econometric analysis. Other researchers [Spitäller (1980) and Spencer (1984)] have either found full pass through for nearly all countries. However, these conclusions are questionable the Spitäller study was based only on the period January 1973 to April 1978 using monthly data while Spencer imposed full pass-through as part of his estimation strategy.

16. In an import price equation there is a relationship between the coeffecients in the reduced form equation and the supply and demand elasticities. These latter can be identified if certain assumptions are made. Haynes and Stone (1983) assumed that the demand elasticity is infinite and that it is possible to explain price movements by past quantities and so identify the supply elasticities. They found supply elasticities of 1.7 and 4.5 for United Kingdom and United States exports to the rest of the world and 2.4 and 10.0 for rest of the world exports to the U.K. and U.S.

17. The recent appreciation of the dollar has provoked several analyses of the reaction of US import prices to exchange rate movements. Mann (1986) reports a pass-through ratio of 60 per cent estimated over the period 1965 to 1982. Fieleke (1985) also presented evidence that U.S. import prices move less than exchange rates would suggest. He shows that U.S. imports from Japan declined in price relative to the general U.S. price level but not by as much as would have been expected given the decline of the overall Japanese price level relative to the U.S. price level. This is another way of stating that movements in exchange rates have been absorbed to some extent.

18. Llewellyn (1974) and Llewellyn and Pesaran (1976) suggest that only 60 per cent of a change in foreign prices is reflected in U.K. prices with a delay that is practically completed after two quarters. This result was confirmed for manufactured imports in the U.K. by Bond (1981). Although the first researchers suggest that their finding may have related to the dominant position that U.K. had within the then sterling area, during the period of sterling appreciation between 1978 and 1980 of U.K. import prices did not fall as rapidly as would have occurred with full pass-through. By the end of the 1970's the U.K. was no longer in the position of a dominant buyer. This suggests more weight should be given to the explanation of a less than perfectly elastic supply curve.

19. Previous research in the OECD has suggested that for many countries import prices do not fully react to foreign export prices and exchange rates in the short term. Turner (1982) found that for many countries there was less than full pass-through of exchange rate movements, though interestingly in the case of the United States there was full pass-through. However, over the longer term he suggests that import prices follow foreign average export prices quite closely. This, however, is most probably because large real exchange rate movements do not tend to persist for long periods of time. Thus oppurtinities for price discrimination tend to disappear over time. In earlier unpublished work, Masson (1978 and 1979) found that manufactured import prices had a pass-through with respect to foreign import prices that was significantly less than unity for nearly all of the countries considered.

20. The issue to whether there is full long-run pass-through of exchange rate movements to import prices is still open in the literature. The Federal Reserve MCM model for example has 90 per cent pass-through but spread over three years while other models of the US have much less than full pass-through. The evidence is summarised by the Brookings Institute.

21. There is then considerable evidence that import prices respond less than fully to exchange rate movements and that exporters differentiate their prices between different markets. However, for a consistently linked world model it is difficult to incorporate such a mechanism, given the absence of readily available bilateral price data. The Atlas model, presented by Boniface (1984), has attempted to incorporate this evidence into a formal linked model that respects the international linkage identities. The following section reviews the basis of this approach.

III. MODEL UTILISED

22. In a consistent international model the phenomenon of price discrimination between different export markets has to be modelled in way that ensures that export and import prices are constrained to be equal for the world as a whole. The simple procedure of adding a set of import price equations which are independent of the export price equations (as a single country analyst might do) will not necessarily genereate results in which aggregate import and export prices are equal.

23. The approach adopted is that utilised in the French Atlas model. It assumes that the individual exporter operates in an enviroment of imperfect competition and consequently faces a downward sloping demand curve. The prices of a given exporter will then depend on his costs and the prices of the competitors. The size of these coefficients will depend on the supply and demand elasticities (but no attempt is made in this model to link the elasticities in the import volume equations with the price equations developed here).

24. The basic price specification is assumed to apply to each bilateral price equation in the world system. The price in a given bilateral market depends on costs and competitors prices. In contrast to the current INTERLINK model, competitors include not only other exporters but also the domestic producer. The individual bilateral equations can then be aggregated to give the overall import and export price equations for any country. However, given that there is no readily available bilateral price data, it is necessary to reduce the number of coefficients in the system in line with available information. Two assumptions, described below, are sufficient to permit this reduction so that the model solution can proceed through the aggregation of bilateral price relationships even though no bilateral price data are available. The advantage of this methodology is that differing amounts of price discrimination can be allowed on different markets while at the same time preserving the overall equality between export and import prices.

25. The algebra of the system is set out below. It assumes that a bilateral price formation model can be specified as follows:

$$PX_{ij} = a_i K_i + (1-a_i)\ PCOM_{ij}$$

$$PCOM_{ij} = e_j PM_j + (1-e_j)\ PDOM_j$$

where K_i = costs of the ith exporter

$PCOM_{ij}$ = price of competitors to the ith exporter on the jth market

PM_j = overall import price on the jth market

$PDOM_j$ = domestic price on the jth market

26. The two (plausible) assumptions needed are:

(i) that the coefficient on the cost variable is constant across all markets for a given exporter so that the pass-through of costs into prices is the same for all export markets; and

(ii) that the method of formation of competitors prices is independent of the exporter but depends on the import market with the relative importance of domestic and foreign producers free to vary between zero and unity. A manageable aggregation of the bilateral prices can be achieved by making. (It is also important to note that the method assumes that the overall import price on a given market is a good proxy for competitors prices on that market. It will, of course, be somewhat biased because it includes the price of the exporter under consideration.)

27. Given these assumptions, the detailed derivation of the model is as follows:

The bilateral price equation is given by

$$PX_{ij} \quad = \quad a_{ij}K_i + b_{ij}\ PM_j + c_{ij}PN_j$$

The following assumptions are made

$$a_{ij} \quad = \quad a_i,\ \text{for } j$$

$$b_{ij} \quad = \quad e_j b_i \quad ,\ \text{for all } i$$

$$c_{ij} \quad = \quad (1-e_j)b_i$$

$$1 \quad = \quad a_{ij} + b_{ij} + c_{ij}$$

So $$1 \quad = \quad a_i + e_j b_i + (1-e_j)b_i = a_i + b_i$$

thus $$b_i \quad = \quad (1-a_i)$$

The bilateral equations can thus be written

$$PX_{ij} \quad = \quad a_i K_i + (1-a_i)\ (e_j PM_j + (1-e_j)PD_j)$$

by summation across j for each i

$$PX_i \quad = \quad \sum_j x_{ij} a_i K_i + \sum_j x_{ij}(1-a_i)(e_j PM_j + (1-e_j)PD_j)$$

where x_{ij} is the share of the jth country in the exports of the ith country

So

$$PX_i \quad = \quad a_i K_i + (1-a_i) \sum_j x_{ij}(e_j PM_j + (1-e_j)PD_j)$$

Given an initial estimte for the e_j vector the competitors price term inside the summation bracket) can be calculated. The value of a_i can then be estimated using the equation shown below:

$$PX_i - \sum_j x_{ij}(e_j PM_{ij} + (1-e_j)PD_j) = a_i \ (K_i - \sum x_{ij}(e_j PM_j + (1-e_j)PD_j)$$

The derivation of the import price equation follows:

By summation across i for each j

$$PM_j = \sum_i m_{ij}a_iK_i + \sum_i m_{ij}(1-a_i)(e_jPM_j + (1-e_j)PD_j) \quad \ldots 1$$

$$= \sum_i m_{ij}a_iK_i + (e_jPM_j + (1-e_j)PD_j)\sum_i m_{ij}(1-a_i) \quad \ldots 2$$

$$\text{Substitute } Q_j = (\sum_i m_{ij}a_iK_i)/\sum_i m_{ij}a_i$$

So

$$PM_j = (\sum m_{ij}a_i)Q_j + (e_jPM_j + (1-e_j)PD_j)\sum m_{ij}(1-a_i)$$

or

$$PM_j \ (1-e_j \sum_i m_{ij}(1-a_i)) = (\sum_i m_{ij}a_i)Q_j + (1-e_j)PD_j\sum_i m_{ij}(1-a_i) \quad \ldots 3$$

But note that the sum of the coefficients on a Q_j and PD_j is equal to the coefficient on PM_j as is shown below

$$\sum_i m_{ij}a_i + (1-e_j)\sum_i m_{ij}(1-a_i) = \sum_i m_{ij}a_i + \sum_i m_{ij}(1-a_i) - e_j \sum_i m_{ij}(1-a_i)$$

$$= \sum_i m_{ij}a_i + \sum_i m_i - \sum_i m_{ij}a_i - e_j \sum_i m_{ij}(1-a_i)$$

$$= 1 - e_j\sum_i m_{ij}(1-a_i)$$

So we write

$$g_j = \sum_j m_{ij}a_i \ /(1-e_j \sum m_{ij}(1-a_i) \quad \ldots 4$$

Equation (4) can then be substituted in equation (3) to yield the import price equation

$$PM_j = g_jQ_j + (1-g_j)PD_j$$

This equation can be estimated for each import market and the value of g_j so obtained can be used to calculate a new value for e_j using equation (4).

28. In summary, then, the export and import price equations become:

$$PX_i = a_i K_i + (1-a_i) \sum_j x_{ij} (e_j PM_j + (1-e_j) PDOM_j)$$

$$PM_j = g_j Q_j + (1-g_j) PDOM_j$$

where $$Q_j = \sum_i m_{ij} a_i K_i / \sum_i m_{ij} a_i$$

and $$g_j = (1 - e_j / \sum_i m_{ij} a_i) / \sum m_{ij} (1-a_i)$$

X_{ij} is the importance of the jth import market to the ith exporter

m_{ij} is the importance of the ith exporter to the jth importer

29. The estimation used is OLS but is iterative between the export price equation and the import price equation. An initial estimate is taken for the vector of e_j. This allows estimation of the vector of a_i coefficients. These etimates can then be used to calculate the variable Q_j and so to estimate the coefficient g_j. This in turn serves to calculate a new value for the e_j vector and estimation restarts.

30. It should be noted that there are some problems at the derivation stage. In particular the equation is estimated in differences of logarithms but the aggregation is in terms of levels. The constant term has been freely estimated in both equations whereas clearly the constant terms are related between the equations.

IV. THE ESTIMATION RESULTS

31. In the chosen model, export prices depend on domestic costs and competitor's price where competitors are defined as weighted average of all foreign competitors on on a given market and the domestic producer on that market. Import prices depend on the weighted average of foreign costs and the domestic prices on the given market. The restrictive assumptions chosen enable the three coefficients of a given bilateral equation to be completely identified so that there will be no problem in assuring international consistency as the solution routine can proceed by adding the bilateral variables.

32. The focus of the model has been on obtaining consistency and so the precise definition of costs used is relatively simple. Cost indices defined as a weighted average of indices of unit labour costs in manufacturing industry, import prices of non-energy goods and the the price paid by business for energy. This latter variable is only available for the seven major countries. For all other countries it has been replaced by the price of imported energy. The weights used to combine these indices are the shares of labour, imports and energy in total private sector costs in the period prior to that under consideration. The domestic demand deflator is used as the domestic price. No attempt has yet been made to integrate the work of Stiehler (1987) in which prices are determined through the dual of the production function because at present the INTERLINK supply block covers only the seven largest countries. This study covers eighteen OECD countries and three non-OECD regions.

(1) Data and methods

(a) Data sources

33. All data has been taken from the Analytic Data Base of the Economics & Statistics Department. For unit labour costs in manufacturing there is choice of data series and that used by the Balance of Payments Division for its competiteveness indicators has been used in this study.

(b) Iterative estimation results

34. The results of the iterative estimation are shown in Tables 4 and 5. The independent and dependent variables are all in differences of logarithms. the restriction that the sum of the coefficients on the cost and price variable is unity has been imposed both on the import and export price equations. Thus the R squared statistics refer to the extent to which the variance of the difference between the growth of the export or import price and the growth of appropiately weighted competitors prices or domestic prices has been explained.

(2) Results

(a) Export prices

35. The results of the export price equation show, on average, that competitors prices have a 35 per cent weight in determining the movement of export prices (Table 4). The weight of competitors' prices is noticeably lower in the case of the United States, Germany, the United Kingdom and Canada. The importance of competitors though is much higher for Japan, France and Italy. The results for some of the small countries are somewhat surprising in that they indicate a significant dependence of export prices on domestic costs rather than on competitors' prices. This suggests that some small countries are to some extent extent price makers rather than price takers perhaps because they export different types of goods. No attempt was made to model the lag structure other than entering lagged variables directly. Significant second degree autocorrelation was present in the equations for Japan, Germany and the U.K. and also for Denmark and Sweden, and the estimated results are shown after correction for autocorrelation in these cases (Table 10).

(b) Import prices

36. The import equations (Table 5) showed an average coefficient on domestic prices of 0.25. This indicates that on average 75 per cent of an exchange rate or foreign cost movements are passed through into import prices.

37. The import price equations are less satisfactory than the export price equations. The period 1973 to 1975 was one in which the normal relationships between export and import prices were significantly disturbed. Thus in many cases the estimation period was shortened to exclude the 1973-1975 period (see Table 6A). Other researchers have used dummy variables for this period. It is possible that the inability of the model to handle the 1973-1975 period stems from the absence of any pressure of demand variable in the basic import price equation. The import equations also required more correction for autocorrelation than the export equations (Table 10).

(c) Convergence

38. The model specification required an iterative estimation between the export and import equations. The initial value for the relative importance of foreign as opposed to domestic producers of a given import market was set to unity. This corresponds to the classic INTERLINK foreign trade pricing system in which the only competition is between different exporters to a given market. The second estimate for this coefficient (Table 8) shows a marked move away from unity towards zero -- except in a few cases (Japan, Italy and New Zealand). The estimates generally converged after three iterations.

(d) Interpretation of the coefficients

39. Overall, the results of this estimation point to the significant role that domestic producers have as a competitor for a given exporter. On average, the domestic producer enters the competitive price term with a weight of 0.7 (Tables 8 and 9). This compares with a share of the domestic producer in domestic absorption of manufactured products of about 76 per cent. The relative importance of domestic and foreign producers as competitors on a

given market is determined in this model by a relationship between the estimated coefficient on world costs in the import price equation and the weighted average of the coefficients on domestic costs in the export equations (as in equation 4 above). If these two estimates are equal then other foreign producers have no influence as competitors in a given import market.

40. In certain cases the initial estimated values of e_j (which measures the importance of other foreign suppliers as a source of competition) obtained from the relationship between the weighted coefficients in the export equations and the coefficient in the import equation is negative. Where this is the case, the value of e_j was set to zero for the recomputation of the independent variables in the export equations. The significance of the constraint that has been imposed for certain countries to ensure no negative values of e_j can be judged by comparing the freely-estimated coefficient (g_j) in the import price equation with the weighted average coefficient from the export price equations (Table 6). In four out of five of the cases, the final value of the freely-estimated coefficient in the import equation was extremely close to the constrained value that was utilised to calculate e_j.

41. In the case of Canada there was a significant difference between the estimated coefficient and the theoretical minimum (to which the coefficient was constrained). This case is interesting because it illustrates the interdependence of the export and import equations. The primary supplier of Canada is the United States. The coefficient on domestic costs in the U.S. export price equation is high. Consequently the coefficient on world (primarily U.S.) costs in the Canadian import price equation should be high. It is actually rather low giving an implied negative estimated for e_j. It proved to be essential for the convergence of the model for the minimum constaint of zero to be adopted for the coefficient ej.

(e) <u>Comparison with previous results</u>

42. The estimates of the paper can be contrasted to those of the ATLAS model (Table 9). The estimated coefficients of the import price equations are very similar to those of that model. However, the export price equations give much more weight to domestic costs than do the ATLAS estimates.

43. This is especially the case for the United States and Germany. The equations presented here appear more in line with the literature. The consequence of the coefficients in the export price equation being higher is that the implicit estimate of the weight given to domestic producers in the import equation is raised compared with the estimates of ATLAS. Indeed the estimates suggest that competition on a given import market is largely between the exporter to a given market and the domestic producer on that market -- rather than the competition being between different exporters to that market. Overall the average weight given to domestic producers is 0.7. This moreover is biased downwards because of the structure employed here implicitly assumes that domestic producers have no competitive role in markets of developing countries. The results in Tables 8 and 9 point to European exporters to European markets being primarily in competition with domestic producers (cf. the low estimates for e_j in the cases of Germany, Austria, Belgium, Denmark, Ireland, Netherlands, Norway, Sweden and Switzerland). Outside of this group of countries there tends to be more competition between different exporters. These parameter estimates are relatively sensitive to small changes in the estimated coefficients on costs in the export and import equations.

Table 4 - Export price equations

(T statistics in brackets)

Country	Constant * 100	Domestic costs	Lagged costs	Foreign prices	R^2	DW	SE
United States	0.97	0.87		0.13	0.61	1.92	0.0234
	(2.02)	(5.87)					
Japan	-0.44	0.44		0.56	0.76	1.97	0.0228
	(0.63)	(5.76)					
Germany	0.10	0.84		0.16	0.77	1.79	0.0152
	(0.33)	(7.86)					
France	-0.12	0.58		0.42	0.69	2.06	0.0141
	(0.42)	(7.00)					
United Kingdom	-0.03	0.43	0.31	0.26	0.93	1.86	0.0133
	(0.10)	(2.50)	(2.31)				
Italy	0.17	0.39		0.61	0.39	2.16	0.0227
	(0.37)	(3.75)					
Canada	-0.48	0.77		0.23	0.55	1.23	0.0195
	(1.20)	(5.15)					
Austria	-0.35	0.79		0.21	0.48	1.79	0.0198
	(0.87)	(4.48)					
Belgium-Lux.	-0.04	0.72		0.28	0.35	1.56	0.0230
	(0.09)	(3.41)					
Denmark	-0.05	0.30	0.15	0.55	0.78	1.62	0.0093
	(0.29)	(5.91)	(2.54)				
Finland	0.17	0.56		0.44	0.61	2.25	0.0300
	(0.27)	(3.38)					
Ireland	-0.24	0.33	0.36	0.31	0.49	1.58	0.0206
	(0.57)	(1.36)	(2.25)				
Netherlands	-0.12	0.69		0.31	0.28	1.72	0.0136
	(0.31)	(2.35)					
Norway	-0.06	0.70		0.30	0.12	2.00	0.0529
	(0.06)	(1.74)					
Sweden	-0.26	0.31	0.44	0.24	0.73	1.91	0.0185
	(0.52)	(1.84)	(5.36)				
Switzerland	-0.24	0.36	0.26	0.37	0.68	1.85	0.0241
	(0.27)	(3.94)	(2.98)				
Australia	-0.24	0.34	0.17	0.49	0.57	1.90	0.0434
	(0.27)	(4.33)	(2.11)				
New Zealand	-0.28	0.32	0.22	0.46	0.67	1.90	0.0220
	(0.44)	(11.2)	(0.72)				

Table 5

Import Price Equations
(T statistics in brackets)

Country	Constant * 100	Foreign costs	Lagged costs	Domestic prices	R^2	DW	SE
United States	0.81	0.57		0.43	0.39	1.49	0.0226
	(1.20)	(3.01)		-			
Japan	0.70	0.84	0.15	0.01	0.87	2.38	0.0296
	(0.98)	(9.00)	(1.69)	-			
Germany	0.42	0.63		0.37	0.53	1.74	0.0201
	(0.59)	(5.09)					
France	0.24	0.87		0.13	0.73	1.90	0.0221
	(0.31)	(6.96)					
United Kingdom	0.47	0.67	0.08	0.24	0.92	1.91	0.0111
	(0.82)	(13.00)	(1.51)	-			
Italy	1.19	0.99		0.01	0.33	2.36	0.0369
	(1.40)	(3.19)		-			
Canada	0.19	0.64		0.36	0.79	1.43	0.0106
	(0.85)	(8.36)		-			
Austria	-0.32	0.74		0.26	0.21	2.06	0.0168
	(0.57)	(2.34)		-			
Belgium-Lux.	0.55	0.65		0.35	0.54	1.74	0.0226
	(1.25)	(4.24)		-			
Denmark	-0.17	0.66		0.34	0.76	2.28	0.0111
	(0.70)	(7.03)		-			
Finland	0.18	0.52	0.44	0.05	0.63	2.02	0.0192
	(0.36)	(2.35)	(2.07)	-			
Ireland	0.03	0.75		0.25	0.93	2.40	0.0118
	(0.11)	(11.45)		-			
Netherlands	-0.29	0.72		0.28	0.73	2.29	0.0100
	(1.14)	(7.23)					
Norway	-0.61	0.56		0.44	0.21	1.33	0.0251
	(1.01)	(2.49)		-			
Sweden	-0.44	0.44	0.25	0.31	0.80	1.67	0.0123
	(1.01)	(5.08)	(3.24)	-			
Switzerland	0.53	0.52	0.16	0.32	0.76	2.06	0.0159
	(1.87)	(7.02)	(2.23)	-			
Australia	0.63	0.81		0.19	0.76	1.63	0.0190
	(1.48)	(8.16)		-			
New Zealand	0.33	0.74	0.23	0.03	0.67	2.55	0.0188
	(0.68)	(4.16)	(1.68)				

Table 6

Coefficient estimates g_i

(Standard error in brackets)

	Freely estimated		Constrained
Belgium	0.65	(0.15)	0.68
Denmark	0.66	(0.09)	0.70
Switzerland	0.68	(0.07)	0.69
Norway	0.56	(0.22)	0.66
Canada	0.64	(0.08)	0.78

Table 6A

Dummy variables

Export prices		Import prices	
Japan	1974 S1	Canada	1974 S2
Germany	1976 S1	Ireland	1974 S1
United Kingdom	1974 S1	Netherlands	1976 S2
Finland	1974 S2		
Denmark	1974 S1		

Starting period for estimation

Export prices		Import prices	
1972	1975	1972	1975
All other countries	Belgium	Germany	United States
		Italy	Japan
		Canada	Germany
		Austria	United Kingdom
		Belgium	Denmark
		Ireland	Finland
		Norway	Netherlands
		Switzerland	Sweden
		Australia	New Zealand

(f) Dynamics and error correction

44. The link between the export and import price equations means that it is difficult to incorporate complicated lag structures in the bilateral equations. The dynamics of the model have to be essentially determined in either the import or the export equation and then imposed on the other price equation. Preliminary tests suggested that there was weak evidence that on the one hand import prices eventually adjust to world costs (adjusted for exchange rate movements) and that export prices adjust to domestic costs. This is a reasonable long run result. It prevents, for instance, profit margins in the export sector being permanently higher than in the domestic sector. The economic rationale behind this movement would be that supply side movements tend to move capital and labour into those industries where competitivity has increased so increasing supply and lowering export prices relative to costs. (An inverse movement would occur after a loss of competitiveness.) On the import side the evidence suggested that eventually excess profit margins of importers following an appreciation would be eliminated. However this group of import and export equations were estimated independently. They cannot be used in a linked model and are not reported here. The model used was an error correction model and the relevant error correction terms had very small values and statistically were only on the borderline of significance.

45. In order to test further whether in the long run, exchange rates have no impact on export prices and a full impact on import prices, the data for export prices for all countries was pooled and similarly for import prices. This method of analysis gives greater precision to the coefficients in the model while losing country detail. Using this database two pooled time series regressions were run. Both used an error correction model. The results of the two regressions are in Table 7.

46. The pooled regression results give strong backing to an eventual competitive equilibrium in which export prices are determined by costs and in which exchange rate movements are fully passed into import prices. The time of eventual adjustment is however extremely long. 95 per cent of total adjustment is achieved after 15 years and 20 years in the case of export and import prices respectively, even though half of the adjustment takes place in the first half year. The pooled results also indicate the need for a slight lag on import prices which is in line with the expectations of a transportation lag. This lag though was very difficult to find in the individual country regressions.

47. The regression results presented above support the idea that exchange rate movements (or foreign price movements more generally) are not fully reflected in either export or import prices of manufactured goods in the short or medium term. Evidence was found that in the long term there is a full reaction of prices to the exchange rate. However this very slow reaction could not successfully be incorporated in to the linked estimation system described above. Consequently it was the linked system without eventual long-run adjustment that was tested for stability and predictive performance.

Table 7

Pooled Regression Results
(T statistic in brackets)

	Constant	X_1	$X_1(-1)$	X_2	X_3	n	R^2	S.E.
Export prices	-0.3	0.46		0.54	0.032	576	0.56	0.0167
	(2.6)	(24.4)		-	(4.1)			
Import prices	-1.7	6.38	0.15	0.47	0.015	506	0.54	0.0157
	(3.9)	(13.6)	(5.0)		(3.8)			

Definition of variables

All variables in differences of logarithms

	Export prices	Import prices
Y_1	export prices	import prices
X_1	domestic costs	world costs
X_2	weighted average of competitors prices	domestic prices
X_3	$X_1(-1)/Y_1(-1)$	$X_1(-1)/Y_1(-1)$

(3) Stability and out-of-sample predictions

(a) Summary stability tests

48. The estimation period of the individual country regressions was deliberately cut short at end 1983 in order to allow for out of sample stability tests using the next three observations (up to 1985 S1)(*). The out of sample stability test used was a Chi squared test and is described in the annex. Of the 36 equations tested only two (Denmark and Finland importprices) fail the stability at five per cent confidence level. Certain other equations show signs of instability notably French and German export prices and Irish import prices. (The Chi squared statistics are shown in Table 11).

49. Next, two tests of in-sample stabilitiy were undertaken using recursive regression techniques. The results are shown in Tables 12 and 13, display in-sample stability for most equations and especially for export prices.

(b) Out-of-sample prediction

50. Finally the predictions of the new equations was compared to predictive power of the existing equations in the world trade block of INTERLINK (Tables 14 and 15). Two measures are utlised in the comparison the root mean squared error in the period 1984 SI to 1985 SI and the cumulated error in the same period. For import prices the RMSE error was the same but the cumulative error was, on average, 10-15 per cent lower. For export prices a similar pattern emerged: the root mean squared errors for the new equations are the same but the cumulated error is 10-15 per cent lower.

51. For import prices though it is probable that a weighted RMSE and a weighted mean cumulative error would show more of an improvement as the deteriorations compared with the existing model were concentrated on small countries (Denmark, Ireland and Finland). A similar pattern emerges for export prices with the major deteriorations concentrated on small countries (Sweden, Ireland and Finland). Among the major countries only the French import and export price equations are noticeably worse than the existing model.

52. The results of the five tests are brought together in Table 16. Marked instability, showing up in three of the five tests, appears in only three import price equations (Ireland, Germany and Denmark) and no export price equation.

(c) The dollar appreciation period

53. Finally a combined in- and out-of-sample prediction test was undertaken over the period of the dollar appreciation -- that is 1981 SI to 1985 SI (Table 17). The results are quite significant. The mean cumulative error for import prices is reduced by 58 per cent while that for export prices is reduced by 35 per cent. The RMSE statistics are reduced by 53 per cent for import prices and 43 per cent for export prices. The improvements in the import price equation are very large in some cases (United States, United Kingdom, Germany, Netherlands, Austria, Norway and Sweden). The improvements are less pronounced and less concentrated for the export price equations.

(*) The model has not yet been tested or etimated over the period of dollar depreciation after 1985 SI.

CONCLUSIONS

54. The results presented above suggest that adoption of this new model of export and import price determination should significantly improve the tracking and forecasting properties of the world trade block. The pass-through of exchange rate movements into domestic prices should be significantly sloved down. On the other hand the inflationary impact of given domestic shocks will tend to be enhanced as import prices will now tend to increase in line with domestic prices. Given the wage price spiral this tend to push import prices back up towards the level they would have reached follwing a depreciation. The next stage of this work will be to implement a version of INTERLINK with these equations. Thereafter further attention is intended to be given to the dynamic responses of the equations.

Table 8

The importance of other exporters as competitors on import markets

Country	Iteration number				
	1	2	3	4	5
United States	1.00	0.28	0.19	0.17	0.17
Japan	1.00	0.98	0.98	0.98	0.98
Germany	1.00	0.18	0.14	0.12	0.12
France	1.00	0.77	0.70	0.69	0.69
United Kingdom	1.00	0.52	0.42	0.40	0.39
Italy	1.00	0.90	0.96	0.97	0.97
Canada	1.00	0	0	0	0
Austria	1.00	-0.07	0.08	0.08	0.08
Belgium-Lux.	1.00	0	0	0	0
Denmark	1.00	0	0	0	0
Finland	1.00	0.91	0.89	0.89	0.88
Ireland	1.00	0.24	0.15	0.14	0.13
Netherlands	1.00	0.29	0.13	0.09	0.08
Norway	1.00	0	0	0	0
Sweden	1.00	0.24	0.14	0.11	0.10
Switzerland	1.00	0	0	0	0
Australia	1.00	0.65	0.63	0.63	0.63
New Zealand	1.00	0.96	0.96	0.96	0.96

Table 9

Comparison with results of ATLAS

Coefficient on domestic costs or world costs

	Export prices		Import prices	
	Atlas	This paper	Atlas	This paper
France	0.57	0.58	0.72	0.87
U.K.	0.70	0.74	0.57	0.75
Japan	0.52	0.44	0.82	0.99
United States	0.34	0.87	0.84	0.57
Belgium	0.27	0.72	0.67	0.65
Canada	0.55	0.77	0.67	0.64
Germany	0.51	0.84	0.72	0.63
Italy	0.43	0.39	0.82	0.99
Netherlands	0.37	0.69	1.00	0.72
Average	0.47	0.67	0.76	0.76

Weight attached to foreign competitors

	Atlas	This paper
France	0.74	0.69
U.K.	0.59	0.39
Japan	0.87	0.98
United States	0.84	0.17
Belgium	0.57	0
Canada	0.70	0
Germany	0.79	0.12
Italy	0.84	0.97
Netherlands	1.00	0.08

Table 10

Auto correlation correction - Import Prices

	LAG ONE	LAG TWO
United Kingdom	0.52 (2.9)	
Germany	0.43 (2.4)	
Belgium	0.41 (2.1)	-0.53 (2.7)
Netherlands	0.33 (1.3)	-0.38 (1.6)
France	0.39 (2.0)	
Denmark	0.31 (1.5)	-0.48 (2.5)
Ireland	0.60 (5.9)	-0.59 (5.7)
Sweden	0.33 (1.4)	
Switzerland	-0.40 (2.3)	-0.30 (1.7)

Auto correlation correction - Export Prices

	LAG ONE	LAG TWO
United Kingdom	0.41 (1.8)	-0.27 (1.1)
Germany	-0.37 (1.8)	0.32 (1.5)
Japan	0.62 (2.9)	-0.31 (1.5)
Denmark	0.18 (1.0)	-0.47 (2.4)
Sweden	0.74 (3.6)	-0.42 (2.0)

Table 11

Stability tests: out-of-sample predictions
Hendry chi-squared test

	Export Prices	Import Prices
United States	0.14	5.32
United Kingdom	0.08	5.50
France	6.03	3.17
Germany	6.42	1.72
Italy	0.52	1.04
Belgium	0.40	0.24
Netherlands	2.21	0.89
Canada	0.50	3.36
Japan	1.16	1.81
Australia	2.21	4.55
Austria	1.87	9.57*
Denmark	1.80	9.93*
Finland	0.43	2.12
Ireland	1.17	6.59
Norway	1.08	0.69
Sweden	1.71	3.33
Switzerland	2.65	0.25
New Zealand	1.63	2.50

* indicates instability at 5 per cent.

** indicates instability at 1 per cent.

Table 12

Stability tests: Cusum squared residuals

	Import prices		Export prices	
	Forward	Backward	Forward	Backward
United States	0.237	0.166	0.309*	0.252
United Kingdom	0.194	0.271	0.175	0.254
France	0.481**	0.253	0.257	0.208
Germany	0.367**	0.354*	0.164	0.177
Italy	0.346*	0.392**	0.120	0.193
Belgium	0.198	0.182	0.187	0.193
Netherlands	0.199	0.243	0.293	0.209
Canada	0.384	0.388*	0.176	0.173
Japan	0.165	0.143	0.292	0.213
Australia	0.240	0.170	0.136	0.060
Austria	0.260	0.327*	0.160	0.155
Denmark	0.275	0.278	0.068	0.121
Finland	0.181	0.236	0.175	0.188
Ireland	0.511**	0.466**	0.182	0.171
Norway	0.360*	0.344*	0.160	0.214
Sweden	0.511**	0.288	0.173	0.167
Switzerland	0.261	0.295	0.361*	0.164
New Zealand	0.268	0.375*	0.346*	0.483**
NIC	-	-	0.208	0.189
OOP	-	-	0.332*	0.277
LMI	-	-	0.363	0.247

* indicates significant instability at 5 per cent.

** indicates significant instability at 1 per cent.

Table 13

Stability tests: Cusum residuals

	Import prices		Export prices	
	Forward	Backward	Forward	Backward
United States	0.401	0.474	0.430	0.281
United Kingdom	0.607	0.812	0.551	0.442
France	0.324	1.173**	0.790	0.440
Germany	0.416	0.724	0.374	0.312
Italy	0.248	0.533	0.537	0.521
Belgium	0.555	0.331	0.345	0.510
Netherlands	0.314	0.428	0.458	0.651
Canada	0.358	0.545	0.482	0.304
Japan	0.553	0.453	0.435	0.658
Australia	0.510	0.701	0.418	0.385
Austria	0.467	0.515	0.256	0.370
Denmark	0.437	0.449	0.839	0.646
Finland	0.460	0.261	0.409	0.502
Ireland	0.354	1.071*	0.449	0.672
Norway	0.321	1.013*	0.503	0.292
Sweden	0.415	0.366	0.490	0.751
Switzerland	0.439	0.344	0.339	0.513
New Zealand	0.263	0.764	0.463	0.692
NIC	-	-	0.719	0.325
OOP	-	-	0.449	0.372
LMI	-	-	0.332	0.445

* Indicates significant instability at 5 per cent.

** Indicates significant instability at 1 per cent.

Table 14

<u>Predictive power import prices</u>

Period: S1 1984 to S1 1985
(out-of-sample)

	Root mean squared error (%)		Cumulative error (%)	
	Proposed	Existing	Proposed	Existing
United States	3.01	3.62	2.79	7.99
United Kingdom	1.50	2.02	-1.18	-5.19
France	2.27*	1.24	5.90*	2.50
Germany	1.52*	0.95	1.61*	-1.35
Italy	2.17	1.85	5.90	5.52
Belgium	0.64	1.08	0.24	-0.93
Netherlands	0.55	1.46	-0.61	-3.00
Canada	1.12	1.23	-0.63	-2.28
Japan	2.30*	1.64	-2.55*	-1.74
Australia	2.34	2.58	-2.66	-2.52
Austria	2.99*	2.48	1.59	-2.61
Denmark	2.01*	1.08	5.82*	1.59
Finland	1.61*	0.71	4.74*	1.78
Ireland	1.74*	1.31	4.31*	3.19
Norway	1.20	1.87	1.12	-3.39
Sweden	1.29	1.36	0.49	-2.03
Switzerland	0.46	1.42	0.21	-4.25
New Zealand	1.71	2.53	0.18	-1.63
<u>Average errors</u>				
Mean absolute error	-	-	2.4	3.0
Root mean square error	1.8	1.8	3.1	3.5
Mean	1.7	1.7	1.5	-0.5

Table 15

Predictive power export prices

Period: S1 1984 to S1 1985
(out-of-sample)

	Root mean squared error (%)		Cumulative error (%)	
	Proposed	Existing	Proposed	Existing
United States	0.51	0.58	0.09	1.25
United Kingdom	0.21	1.14	-0.42	-3.33
France	1.99*	0.73	5.70*	1.98
Germany	2.22*	1.31	0.84*	0.20
Italy	0.94	1.60	-0.27	-3.17
Belgium	0.85	0.71	0.55	-0.22
Netherlands	1.17	1.61	2.49	-2.34
Canada	0.80	1.26	-0.14	-0.84
Japan	1.42	1.35	1.52	3.36
Australia	3.73*	2.20	-0.10	-3.89
Austria	1.57	2.01	2.85*	-2.39
Denmark	0.72	1.23	1.24	-0.60
Finland	1.13	1.14	2.72*	0.74
Ireland	1.29	0.90	2.22*	-0.67
Norway	3.17	2.96	0.75	1.91
Sweden	1.40	0.92	2.45*	0.55
Switzerland	2.27	2.56	-5.40	-6.52
New Zealand	1.62	2.68	4.31	7.07
Average error				
Mean absolute error	-	-	1.9	2.3
Root mean square	1.7	1.7	2.6	3.0
Mean	1.5	1.5	1.2	-0.4

Table 16

Stability tests

Summary of different measures

	Hendry chi squared	Cusum residuals	Cusum squared residuals	Comparison with WTM RMSE	Comparison with WTM Sum
Export prices					
	-	-	-	France	France
	-	-	-	Germany	Germany
	-	-	-	Australia	-
	-	-	-	-	Sweden
	-	-	-	-	Finland
	-	-	-	-	Ireland
	-	-	-	-	Austria
	-	-	-	-	-
	-	-	New Zealand	-	-
Import prices					
	-	-	Ireland	Ireland	Ireland
	-	-	-	France	France
	-	-	Germany	Germany	Germany
	-	-	Canada	-	-
	Austria	-	-	Austria	-
	Denmark	-	-	Denmark	Denmark
	-	-	-	Japan	Japan
	-	-	-	Finland	Finland
	-	-	Italy	-	-
	-	-	Norway	-	-

Table 17

Predictive power in the dollar appreciation phase
Period: S1 1981 to S1 1985

	Cumulative Errors (%)			
	Export Prices		Import prices	
	Proposed	Existing	Proposed	Existing
United States	2.46*	1.59	-0.26	17.24
United Kingdom	1.61	-19.19	-4.89	-19.84
France	7.66*	-1.34	6.03	-6.10
Germany	1.13	-5.47	2.88	-8.67
Italy	-1.92	-11.64	1.44*	-0.59
Belgium	2.24	-5.64	-0.10	-9.46
Netherlands	4.84	-6.06	0.08	-15.83
Canada	-7.15*	-0.49	1.21	1.58
Japan	4.30	1.02	-8.97*	-6.87
Australia	6.37	-16.42	-6.91	-7.02
Austria	5.97	-8.06	2.36	-9.25
Denmark	3.42*	-1.91	7.78*	-3.10
Finland	5.44*	-2.99	10.28*	1.51
Ireland	4.29	-9.19	3.60	-3.92
Norway	0.58	-5.82	-2.54	-14.25
Sweden	4.22	-5.31	1.42	-13.76
Switzerland	-1.78	-2.49	-1.42	-4.71
New Zealand	7.73	9.09	1.10	-4.67
Average error				
Mean absolute error	4.1	6.3	3.5	8.2
Root mean square	4.6	8.1	4.7	10.0
Mean	2.9	-5.0	0.7	-6.0

Annex

Description of the stability tests utilized*

The Hendry Chi-squared test

1. The Hendry Chi-squared test consists of estimating an equation through to the breaking point and then making a static forecast of each observation after the breaking point. The test statistic compares the sum of the squared forecast errors to the variance of the residuals over the estimation period. A large enough test statistic suggests that the post-breaking point observations do not obey the same relation as the pre-breaking point equation. See Hendry (1979) for details.

2. The test tends to reject the hypothesis of stability. That is because the test assumes that the parameters of the estimated regression equation are known with certainty. This substantially reduces the level of the sum of the squared forecast errors which leads to rejection of the hypothesis of stability. So, passing is a relatively strong sign of stability, but failure is not conclusive.

Recursive regression tests

3. These tests proceed by running regressions over longer and longer periods. The foreward regressions start from the earliest period. The backward regressions start from the most recent period. the forecast errors of these equations can be used to compute two tests for consistency of the regression equation: the CUSUM test and the CUSUM squared test.

4. The first step in calculating the test statistics is to forecast one period beyond the estimation period. The second step is to calculate the standarized one-period ahead forecast errors. Finally, these errors are used to compute the CUSUM and CUSUM squared statistics. The tests are somewhat biased towards rejecting stability, especially for small samples. Therefore, they are more useful for identifying equations with possible instability, than for reaching strong conclusions about stability.

(*) These descriptions were written by Menachem Prywes.

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