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EXCHANGE RATE PASS-THROUGH IN EXPORT PRICES —AN INTERNATIONAL COMPARISON—

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I. *Introduction*

The 1980s have been characterized by substantial trade imbalances in the world economy. Moreover, these imbalances have tended to persist despite substantive changes in exchange rates, both nominal as well as real. Adoption of a floating exchange rate system to govern international trade and capital flows in the early 1970s was expected to keep such imbalances within reasonable limits by suitably adjusting the currency conversion factors. The experience of the late 70s and 80s has belied these hopes and the suitability of the system is being questioned. The impact of exchange rate changes on import and export prices is an important channel for bringing about the required adjustments. One factor that has received attention in explaining the persistence of trade imbalances, therefore, is the failure of exchange rates in bringing about required changes in export/import prices and has been termed as the "pass-through" problem.

Interest in the "pass-through" problem was stimulated by the failure of the huge U.S. trade deficit to rectify in spite of a steep depreciation of the U.S. dollar following the Plaza accord in September 1985. The rise in the U.S. import prices in the wake of depreciation was found to be insufficient.[1]

The arguments explaining the insufficient pass-through of exchange rate changes into relevant prices are varied—from those stressing short-term factors like contract-currency and delivery lags to those that focus on more fundamental factors like market structure. For example, it has been suggested that exporters to the U.S. market reduce their profit margins by holding down an increase in the dollar prices of exports when faced with a deprcieating dollar [Mann (1986)]. Others believe that reduced profit margins result from rather than cause less-than-full-pass-through [Baldwin (1988)] emphasizing that the degree of competition in the U.S. market has changed permanently and is responsible for the emergence of the pass-through problem, i.e., reduced sensitivity of import prices to exchange rate fluctuations.

Most of the research on the pass-through problem has been centered around the U.S. economy and, hence, relies heavily on the U.S. data. Evidence from other economies is scant and far in between.[2] Besides, empirical studies of this phenomenon have not kept

[1] See for example, Mann (1986), Baldwin (1988), Helkie and Hooper (1988).

[2] A study by Ohno (1988) comparing export pricing behavior for the U.S. and Japan and Khosla (1989) touch on the pass-through problem in the Japanese context.

pace with theoretical developments in the field, partly due to data difficulties. In order to test the validity of alternative explanations, it is imperative to collate more evidence from as many countries as possible.

The present study is a modest attempt to fill this gap between empirical and theoretical developments by comparing the extent of pass-through in different countries and, in the process, throws some light on factors determining the degree of pass-through. No other study discussing the pass-through porblem in an international perspective has come to our notice. Data limitations do circumscribe the scope of the study but do not undermine its importance in view of the light it can shed on the pass-through phenomenon. We use readily available data for 23 countries[3] and try to determine the extent to which exchange rate changes are passed-through into export prices and analyze the observed differences. This also allows us to test some of the implications thrown up by the theoretical explanations of the pass-through phenomenon.

Having identified the main issues, Section II discusses some of the received theorectial explanations and derives some testable propositions. These propositions are then subject to an empirical analysis in Section III. Finally, Section IV summarizes the arguments.

II. *Explanations of Pass-Through: Some Testable Propositions*

In general, pass-through refers to the behavior of traded goods prices with respect to changes in exchange rates. Since these prices can be represented in two currencies, domestic and foreign, it is possible to define pass-through in two ways depending on which currency is used as the reference point. This is can be easily explained in terms of the following equation:

$$P_f = P_x/E \qquad \text{(Eq. 1)}$$

where P_f and P_x are the foreign currency and domestic currency prices of a good and E is the exchange rate expressed as home currency per unit of foreign currency.

Writing in terms of rate of change,

$$dP_f/P_f = dP_x/P_x - dE/E \quad \text{or,}$$
$$(dP_f/P_f)/(dE/E) = [(dP_x/P_x)/(dE/E)] - 1 \qquad \text{(Eq. 2)}$$

In the absence of cost changes, as E fluctuates, given the definition of E, the pass-through ratio (PTR), the extent to which export prices respond to changes in exchange rates, in foreign currency is given by $-[(dP_f/P_f)/(dE/E)]$. In terms of home currency, on the other hand, pass-through ratio is given by $1-[(dP_x/P_x)/(dE/E)]$ which is nothing but the right hand side of Eq. 2 with sign reversed. If the term on the left hand side of Eq. 2 is -1, or that within large parentheses on the right hand side is 0, pass-through is said to be complete ($PTR=1$). However, normally, the former will lie somewhere between -1 and 0 and the

[3] These are, Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom and United States among the developed countries and Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand among the developing and semi-developed countries. We wanted to include some Latin American countries but readily available data were too scanty to serve our purposes.

latter between 0 and 1 indicating less-than-full pass-through ($PTR \leqq 1$).[4] In this paper we use the domestic currency version of the pass-through relation, i.e., pass-through ratio is defined as one minus the elasticity of domestic prices with respect to exchange rate.

The first explicit reference to pass-through phenomenon is found in the literature on balance-of-payments and currency realignments of the early 1970s. Branson (1972) notes that " . . . Japanese and German exporters are . . . not passing-through the exchange rate changes, but are holding dollar prices fairly constant while home currency prices fall . . . " (p. 55). But he fails to provide any explanation as to why such a phenomenon emerges. Initially, the pass-through problem was considered to be a short-run phenomenon and, correspondingly, was attributed to short-term rigidities. In the 1980s, however, perceptions changed and the explanations advanced were in terms of more fundamental factors. In the subsequent discussion, we look at some of the explanations advanced to explain the pass-through phenomenon and derive propositions that can be empirically verified to a certain extent.

1. Lagged Responses and Pass-through

The first attempt to explain the pass-through problem is found in Magee (1973) who used the concept to explain adverse movements in the U.S. trade deficit as dollar declined. Less-than-full pass-through, in this explanation, is attributed to two factors. The first of these is the contractual nature of international transactions. Since currency denomination of exports and imports is normally fixed at the time of closing a contract, pass-through can take a value anywhere between 0 and 1 depending on the currency in which exports (imports) are contracted. For example, if Japanese exports are contracted in U.S. dollars, an appreciation of the yen after the contract has been closed does not change the dollar prices leading to zero pass-through at least during the contract period.

Another, and perhaps, a more pertinent issue is short-run fixity of the demand and/or supply functions. Over time, these elasticities shift changing the degree of pass-through. It can be shown that, generally, pass-through in export prices should decline for products with a high long-run demand elasticity and a low long-run elasticity of supply.

Both these factors indicate that pass-through changes as time passes. First, the contracts are either renegotiated or are renewed at changed terms after original contracts expire. Second, since the elasticity of demand/supply depends on the nature of the product, pass-through can either increase or decrease. An empirical verification of the first aspect is difficult at international level but it is possible to collate some indirect evidence on the latter under some assumptions. It may, however, be noted here that the importance of contract-currency explanation of pass-through may have declined with the emergence of efficient financial markets and possibilities for hedging exchange rate risks.

Proposition 1

The above discussion suggests following proposition that can be tested using international cross-section data:

The degree of pass-through, for countries with high proportion of commodities with

[4] Under certain conditions of demand and supply, it is possible to have $PTR > 1$. See Feenstra (1987).

high demand and low supply elasticities in the long-run in their export milieu, should decline over time. Conversely, for countries exporting products with low demand and large supply elasticities, pass-through is expected to rise over time.

Raw materials (SITC 0–4) and materials (SITC 5–6) can be considered to represent the first, and final goods (SITC 7–8) the second category.[5] First, on the demand side, since most raw and other materials are relatively homogeneous goods, one can expect the demand curve facing an individual exporter to be more elastic as compared to products designated as final goods where product differentiation is easier and perhaps quite pervasive. On the supply side, raw materials usually have low supply elasticity and even in materials industries elasticity of supply may be low due to high fixed costs. On the other hand, supply may be fairly elastic for final goods industries. The above proposition, therefore, can be restated as follows and empirically tested.

Pass-through in countries with a high proportion of raw and other materials in total exports should decline over time and should rise in countries exporting mostly final goods.

2. Cost Changes and Pass-Through

During most of the seventies, less-than-full pass-through was treated as a short-run problem. But persistent and ever enlarging trade imbalances in the late 1970s and 1980s could not be handled fully within the existing framework. This called for alternative explanations for the phenomenon.

One explanation thrown up was that exporters to a given market absorb a part of the exchange rate fluctuations by cutting profit margins [Mann (1986)]. This was found to be more true when exporter's currency was appreciating than when it was depreciating.[6] If prices are assumed to follow a cost-plus rule, Eq. 1 is modified to

$$P_f = P_x/E = (1+m)C/E \qquad \text{(Eq. 3)}$$

where m is the mark-up ratio and C is production cost. In this case, mark-up can be manipulated to absorb some of the changes in exchange rates.

In the above equation, however, mark-up is not the only channel through which less-than-full transmission of exchange rates into foreign currency prices can occur. A co-movement in production costs, whether due to exchange rate fluctuations or due to technological progress can also cause domestic currency prices to decline leading to lower pass-through. The popular business press, especially in the U.S., tends to ignore cost changes. Countries like Japan, on the other hand, stress that pass-through in their economies is lower due to the fact that their production costs have normally moved counter to

[5] SITC (Standard International Trade Classification) has the following 1-digit level classification: 0- Food and Live Animals; 1- Beverages and Tobacco; 2- Crude Materials Excluding Fuels; 3- Mineral Fuels etc.; 4- Animal, Vegetable Oil, Fat; 5- Chemicals and Related Products; 6- Basic Manufactures (including Paper and Paper Boards, Textiles, Iron & Steel, Nonferrous Metals, Metal Products etc.); 7- Machines and Transport Equipment; 8- Miscellaneous; 9- Goods not classified by Kind.

[6] For example, Baldwin (1988) points out that while a rise in real dollar in early 1980s was accompanied by a fall in real import prices, a decline in dollar in the later years did not show a corresponding rise in import prices.

exchange rate movements. Since such economies import a large proportion of their raw materials and other materials, an appreciation, for example of yen, lowers import costs and allows the firms to lower their yen denominated export prices causing less-than-full pass-through.[7]

This aspect has been treated scantily and cursorily in the available literature. More often than not, the relevant theoretical discussions treat wages as the only form of costs which are assumed to be fixed in national currencies[8] so that costs in foreign currency invariably rise. In reality, costs should include raw material and other costs as well. In any case, if the cost argument has any substance, it suggests two propositions that can be tested in the international context.

Proposition 2

Introduction of a proper cost variable in pass-through relationship should improve *PTR*. This improvement, furthermore, should be positively related to the proportion of raw materials and other materials in total imports since larger the imports of such products, the greater will be the change in costs accompanying an exchange rate change.

Proposition 3

A related proposition is that the countries engaged in processing trade, i.e., countries importing materials goods and exporting final goods, should have lower pass-through than the others.

This is easily deduced from the discussion above since an appreciation results in a fall in material costs and allows the countries engaged in processing trade to reduce the home currency export prices leading to less-than-full pass-through.

3. Market Structure and Pass-Through

Another explanation of the pass-through problem that has come into vogue in recent years attributes the degree of pass-through in individual industries to the nature of product market competition. In a sense, as will be clear soon, this resembles the discussion in subsection (a) above inasmuch as the nature and shape of demand and cost functions play an important role. This approach is represented by Dornbusch (1987). Using alternative market specifications, he shows that price adjustments depend on the degree of market integration, product substitutibility and relative number of foreign and domestic firms in the market. In general, pass-through—the elasticity of prices with respect to exchange rate—is found to be lower the more competitive a market. In other words, pass-through in integrated markets with high degree of product homogeneity (Cournot setting) depends on the proportion of exporting firms to total number of firms. With differentiated products (Dixit-Stiglitz or Salop setting), the extent of product substitutability is important. The higher the degree of product substitutability, the lower the pass-through.[9] To test

[7] See for example, *Tsusan Hakusho* (1987).

[8] See for example, Dornbusch (1987). Our experimentation with alternative cost measures, however, indicates that wages or unit labor costs do not have any effect on pricing. More on this later (fn 11).

[9] For some other examples of this approach, see Helpman and Krugman (1985), Krugman (1987), Krugman and Baldwin (1987), Feenstra (1987). Dornbusch's analysis is couched in terms of demand curves alone. Feenstra (1987) introduces cost functions as well and shows that pass-through could exceed unity.

the implications of this explanation, once again, we have to take recourse to assumptions regarding expected shape of demand functions.

Proposition 4

Assuming the market for material industries to be more competitive than for final goods, the degree of pass-through into export prices is expected to be higher for countries with a high final goods export ratio and vice versa.

It must be stressed here that this proposition depends heavily on the assumption regarding the nature of the markets. In general, given the fact that production technology in the materials related industries is relatively standardized and also that most of these industries are widely diffused, it may not be off the mark to assume that total number of firms in the world market is large. As against this, relatively closed nature of technology in production of final goods (inclusive of building up of product image and marketing strategies etc.) indicates that the number of firms providing close substitutes may be smaller. Moreover, as discussed earlier, product homogeneity in case of materials industries as against product differentiation in final goods industries also renders product markets in the former group of industries more competitive. Given this, it may not be unrealistic to make the assumption as stated above.

In the next section, we subject the propositions stated above to an empirical verification using international data.

III. *International Differences in Pass-Through An Empirical Analysis*

Before discussing the actual results, it is imperative to stress here that data availability does not allow for rigorous testing of the implications derived above. One must keep this reservation in mind while interpreting the results. First, we discuss the nature of the data used for this study.

1. The Data

International Financial Statistics (IFS) published by International Monetary Fund (IMF) and *International Trade Statistics Yearbook* (ITS) of the United Nations serve as the primary data sources for this study. Information on export prices, cost variables and exchange rates is derived from the former and the latter is used to obtain information on trade by partner country to derive country weights for calculating an index of effective exchange rates and the information about trade composition by industry for individual countries.

The data covers 23 countries (see note 3) and the period between first quarter of 1975 and fourth quarter of 1987.[10] The choice of countries for analysis was dictated primarily by data considerations and the fact that most available indexes of effective exchange rates take only developed countries into account ignoring the fact that some developed countries

[10] Except for countries where all series are not updated.

also have significant trade with developing countries. Besides, we also wanted to test whether behavior patterns differed between the developed and the developing countries and, if yes, why. Unfortunately data for Latin American newly industrializing economies could not be collated and the study had to be restricted to some of the Asian economies. The choice of the time period is obvious from the nature of the study.

2. Calculating Effective Exchange Rates

As stated above, available indexes of effective exchange rates cover mostly developed countries ignoring the effect of the developing countries. Only the MERM weight index (Line AMX) reported in IFS takes this effect into account indirectly as weights are derived by measuring the effect of a percentage change in exchange rate on balance-of-payments of the country concerned. However, even these indexes are reported only for developed economies. This leaves us with no alternative but to recompile such indices for all countries included in the study on a compatible basis. For this purpose we use average trade flows from the *International Trade Statistics* in dollar terms for the period 1980–82 to calculate global trade weights for each country. These weights, in conjunction with the exchange rate data expressed as national currency unit per U.S. dollar (Line *RF* in *IFS*), are used to derive effective exchange rates. The formula used was

$$NER_i = RF_i / \prod_{j=1}^{23} RF_j^{wj}$$

where NER_i is nominal effective exchange rate, RF_i is the value of i-th country's currency in terms of the U.S. dollar and ^{wj} is the share of country j in total world trade. These indices were converted into an index based on 1980 average.

3. Results of the Empirical Analysis

(i) Some Preliminary Observations

A pass-through equation was estimated for each country in four alternative specifications. All the equations were run in terms of first differences of the logarithmic variables. The equations were:

A: $PX_i = a_i + b_i\ NER_i$

B: $PX_i = a_i + b_i\ NER_i + c_i\ WPI_i(-1)$

C: $PX_i = a_i + b_i\ PDL(NER_i(3, 4))$

D: $PX_i = a_i + b_i\ PDL(NER_i(3, 4)) + c_i\ WPI_i(-1)$

where PX_i is the export price of country i in terms of of national currency (converting Line 74*D* (in US$) of *IFS* using index of exchange rates based on Line *RF*), NER_i is the nominal effective exchange rate, *PDL*(3,4) denotes polynominal distributed lags based on a third order polynominal with 4 quarter lags (inclusive of current quarter and restricted to zero in the last quarter for actual estimation), *WPI* is wholesale price index in national currency units as a cost proxy and (-1) indicates one quarter lag.

TABLE 1. ESTIMATED PARAMETERS OF THE PASS-THROUGH EQUATIONS

	EQUATION A			EQUATION B				EQUATION C			EQUATION D			
	CONST	*NER*	$\bar{R}^2/DW$	CONST	*NER*	*WPI*	$\bar{R}^2/DW$	CONST	*NER*	$\bar{R}^2/DW$	CONST	*NER*	*WPI*	$\bar{R}^2/DW$
1 AUS	0.015	0.322	0.268	−0.009	0.412	1.038	0.376	0.016	0.167	0.316	−0.013	0.208	1.327	0.466
	4.351	4.355	1.223	−1.048	5.561	2.938	1.689	4.262	1.331	1.194	−1.475	1.871	3.570	1.818
2 AUT	0.005	0.229	0.032	0.006	0.248	0.039	0.041	0.008	0.372	0.069	0.008	0.373	−0.002	0.046
	1.691	1.624	1.909	2.009	1.806	0.251	2.182	2.449	1.770	2.168	2.131	1.642	−0.012	2.167
3 BEL	0.010	0.555	0.302	0.004	0.383	0.787	0.548	0.011	0.851	0.397	0.004	0.393	0.843	0.585
	3.503	4.713	0.930	1.656	3.845	5.098	1.564	3.871	5.231	0.932	1.432	2.316	4.474	1.422
4 CAN	0.013	0.041	−0.017	−0.006	0.136	1.170	0.362	0.013	0.086	−0.060	−0.007	0.120	1.197	0.338
	3.995	0.437	1.201	−1.441	1.785	5.425	2.320	3.544	0.621	1.179	−1.456	1.096	5.124	2.313
5 DEN	0.013	0.555	0.362	0.008	0.418	0.361	0.471	0.013	0.710	0.429	0.008	0.363	0.363	0.484
	6.097	5.362	1.875	3.204	4.144	3.254	2.113	6.042	4.759	1.787	2.623	1.763	2.327	1.977
6 FIN	0.014	0.418	0.178	0.008	0.437	0.407	0.272	0.017	0.151	0.193	0.010	0.203	0.413	0.279
	5.277	3.408	1.625	2.195	3.825	2.473	2.138	5.982	0.714	1.858	2.562	1.006	2.456	2.418
7 FRN	0.016	0.474	0.386	−0.001	0.344	0.794[1]	0.444	0.015	0.716	0.462	0.000	0.548	0.689[1]	0.543
	7.586	5.416	1.578	−0.108	3.691	3.052	2.032	6.589	5.644	1.576	0.062	4.158	2.766	2.140
8 GER	0.007	0.218	0.121	0.002	0.137	0.675	0.350	0.010	0.382	0.215	0.004	0.144	0.609	0.391
	4.229	2.778	1.348	1.017	1.937	4.177	1.942	6.055	3.788	1.114	1.642	1.306	3.625	1.918
9 ITL	0.018	0.663	0.330	0.004	0.498	0.617	0.495	0.015	0.980	0.440	0.001	0.421	0.787	0.584
	4.717	5.014	1.787	0.932	4.277	4.287	2.336	3.717	5.222	1.646	0.152	1.907	3.938	2.308
10 JPN	0.006	0.543	0.432	0.004	0.499	0.404	0.494	0.007	0.551	0.448	−0.003	0.084	0.858	0.569
	1.678	6.181	1.763	1.266	5.823	2.395	2.043	1.701	3.871	1.693	−0.565	0.462	3.569	2.340
11 NET	0.010	0.690	0.289	−0.000	0.582	1.137	0.480	0.014	1.283	0.468	0.005	1.002	0.757	0.529
	2.841	4.571	1.028	−0.095	4.408	4.209	1.424	4.041	6.100	0.932	1.244	4.410	2.526	1.152
12 NOR	0.012	0.168	−0.107	−0.008	0.359	1.098	0.045	0.014	−0.089	−0.048	−0.012	0.448	1.431	0.050
	1.583	0.452	1.301	−0.640	0.950	2.044	1.661	1.659	−0.112	1.299	−0.865	0.568	2.306	1.769
13 SPN	0.017	0.060	−0.021	−0.025	−0.141	1.532	0.069	0.021	0.550	0.507	0.004	0.364	0.669	0.700
	1.387	0.198	2.014	−1.156	−0.461	2.320	2.178	6.751	5.033	1.005	0.894	3.932	5.172	2.070

TABLE 1. [Continued]

	EQUATION A			EQUATION B				EQUATION C			EQUATION D			
	CONST	*NER*	$\bar{R}^2/DW$	CONST	*NER*	*WPI*	$\bar{R}^2/DW$	CONST	*NER*	$\bar{R}^2/DW$	CONST	*NER*	*WPI*	$\bar{R}^2/DW$
14 SWE	0.016	0.102	0.019	0.006	0.086	0.533	0.320	0.017	0.141	0.002	0.007	0.045	0.538	0.278
	7.467	1.404	1.326	2.176	1.441	4.740	2.143	6.822	1.048	1.294	2.088	0.385	4.129	2.189
15 SWI	0.007	0.299	0.118	0.008	0.319	−0.025	0.111	0.009	0.343	0.089	0.009	0.349	−0.020	0.067
	1.949	2.748	2.271	1.848	2.762	−0.070	2.245	1.894	1.749	2.222	1.508	1.391	−0.039	2.217
16 UKG	0.021	0.148	0.066	0.003	0.146	0.759	0.332	0.019	0.282	0.064	0.001	0.265	0.824	0.321
	7.801	2.117	0.681	0.728	2.453	4.408	1.332	6.642	2.051	0.653	0.264	2.263	4.109	1.316
17 USA	0.011	0.031	−0.017	0.003	0.066	0.643	0.285	0.012	0.111	−0.017	0.004	0.133	0.651	0.314
	4.953	0.447	0.772	1.318	1.147	4.639	1.567	5.075	1.131	0.892	1.551	1.651	4.614	1.662
18 IND	0.010	0.748	0.162	−0.024	0.832	1.020	0.215	0.003	1.113	0.141	−0.034	0.813	1.321	0.188
	0.546	3.204	2.182	−0.939	3.598	2.068	2.619	0.134	2.705	2.272	−1.139	1.880	1.835	2.719
19 KOR	0.018	0.350	0.162	0.013	0.343	0.307	0.263	0.019	0.410	0.125	0.012	0.328	0.359	0.243
	4.487	3.237	1.094	2.886	3.655	2.581	1.727	4.346	2.481	1.280	2.517	2.093	2.741	1.873
20 PHL	−0.004	1.058	0.248	−0.016	1.014	0.472	0.284	0.006	1.018	0.228	−0.007	0.726	0.546	0.262
	−0.284	4.147	1.958	−0.967	4.190	1.673	2.126	0.426	2.611	2.339	−0.449	1.735	1.702	2.332
21 THL	0.006	0.440	0.080	0.006	0.439	0.154	0.081	0.012	0.267	0.033	0.010	0.272	0.152	0.016
	1.130	2.293	1.479	0.995	2.455	0.559	1.658	2.079	0.934	1.502	1.447	0.941	0.534	1.578

The country abbreviations are: AUStralia, AUsTria, BELgium, CANada, DENmark, FINland, FRaNce, GERmany, ITaLy, JaPaN, NETherlands, NORway, SPaiN, SWEden, SWItzerland, United KinGdom, United States of America, INDonesia, KORea, PHiLippines, and THaiLand.

Figures below the coefficient are *t*-values except under $\bar{R}^2$ where it is the *DW* ratio.

$t_{.01}(40\ d.f) = 2.704$, $t_{.05}(40\ d.f) = 2.021$, $t_{.10}(40\ d.f) = 1.684$.

Note: The sample size for all equations is 50 except for France (46), Spain (48) and Indonesia (49) where either export price series or the *WPI* series was not complete.

1. uses CPI instead of *WPI* due to unavailability of the latter after mid-1985.

The estimated results[11] corresponding to these equations are presented in Table 1[12]. Panel A reports the results of the crude pass-through equation (Eq. A) without allowing for an adjustment period and without controlling for costs. Panel D, corresponding to Eq. D above, gives the results when prices are allowed to respond to exchange rate changes with a lag and a cost index is included. Choice of 4-quarter lags on *NER* was guided by the fact that most contracts are usually of three months duration on an average (except perhaps for plant exports where lags may be longer than a year).[13] Even if we allow for menu and search costs for alternative sourcing, lags of over a year are not very plausible. A one quarter lag on the cost variable was allowed to reflect production lags.

A cursory glance at the results reveals that pass-through ratios ($1-b_t$ from respective equations) differ substantially among countries. It is possible to assume that the developing or newly industrializing economies may show a greater tendency to engage in less-than-full pass-through than the developed economies especially when faced with appreciation of the home currency in order to fend their export markets which, usually, are quite important source of demand for sustained production or of necessary foreign exchange reserves. Our results, however, indicate no consistent tendency for pass-through to be low in these economies. Cost unadjusted results reveal less than 50 percent pass-through in nine economies—Belgium, Denmark, Italy, Japan, Netherlands, Indonesia and Philippines. This is quite a diverse assortment of countries, developed and developing. Pass-through ratios for Korea and Thailand turn out to be higher than the relatively developed countries like Japan, Belgium and Denmark.

The results change when lagged price responses and cost changes are allowed for. The developed countries—Canada, Germany, Japan, Sweden and the U.S.—move to the top showing over 80 percent pass-through. It can, however, be easily noticed that there is no tendency for the pass-through ratio to rise or fall uniformly for all countries. About half the countries included show a decline in pass-through while the other half shows a rise. Among countries showing greatest declines are Netherlands, Spain and Norway where the decline is as high as 30 percentage points. The increase is highest for Japan where pass-through coefficient doubles indicating that cost element is perhaps important for economies engaged in processing trade. Only Sweden, with a pass-through ratio of 96 percent surpasses Japan in the extent of pass-through after costs and lags have been accounted for.

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[11] Following three points must, however, be noted.

First, the data are not seasonally adjusted and the results may be affected by some seasonality though fairly high DW ratios do not indicate substantial serial correlation in most cases.

Second, though the results presented here correspond to the NER measure as discussed in the text, inverse of AMX from the IFS (MERM weights) as the effective exchange rate index was also tried for the developed countries but without any substantial difference in results.

Third, the reported results use WPI as the cost proxy. Other cost indicators, wage rates in national currency units (line 65 of the IFS), and unit labor costs (line 65UM, 65UMC) were also tried where available. But these indicators failed to improve R^2 in equation A for most economies indicating that wage rates or unit labor costs may not be significantly affected by exchange rate changes.

[12] We had to delete Singapore and Malaysia from the analysis due to paucity of export price data for the former and due to the fact that estimates for Malaysia proved to be outliers. This may be due to the fact that its main export, crude oil, saw severe price fluctuations during the whole of this period and, in case of cost controlled equation, consumer price index was used to proxy costs as WPI was unavailable. The variability in the CPI may have significantly affected the results.

[13] See for example, Fukao and Nakakita (1987).

This is an interesting result in view of the furore over Japanese and German export behavior in the business press. Philippines and Italy also indicate a significant increase in pass-through ratios.

However, the basic result that development levels do not determine the extent of pass-through does not change. Thailand and Korea, among the non-developed (Korea has been designated as newly industrialized economy in recent years) economies, still show a fairly high degree of pass-through at 73 percent and 67 percent respectively. Indonesia and Philippines still rank among the lowest along with the developed economies like France and Netherlands. If development levels are not much indicative of the degree of pass-through then what can explain the pattern discussed above? We come back to this point shortly.

Another feature noticed here is that the coefficient of determination as well as the Durbin-Watson Statistic improves substantially in most cases when lags and cost factors are allowed for. There are, however, five countries—Austria, Norway, Switzerland, Indonesia and Thailand—for which the $\bar{R}^2$ is too small and does not change much. This indicates, perhaps that the cost variable—the wholesale price index— may bot be suitable cost proxy for all countries. But in the absence of an alternative measure, we stick to *WPI*s for the purposes of present analysis. It may be pointed out here that though $\bar{R}^2$ increases after introducing lags and cost variables the value is still low for a number of economies indicating further scope for improvement.

(ii) Pass-through Behavior—Some Empirical Tests

In this sub-section we test the propositions discussed in Section II to analyze the international differences in pass-through behavior. Let us take these propositions one by one.

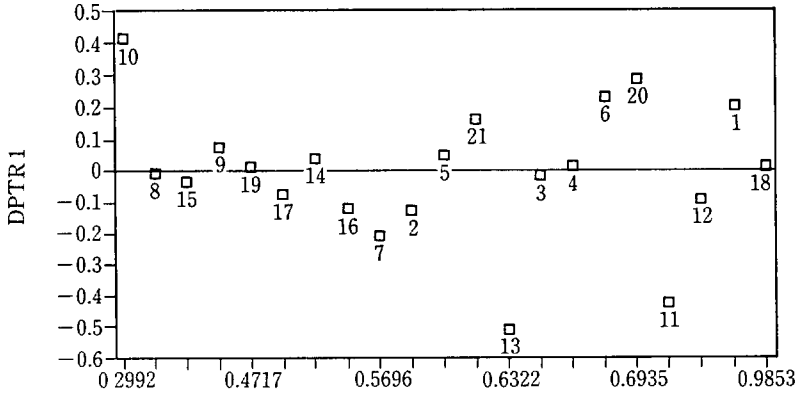
Proposition 1

The first proposition states that, since the demand curve for materials industries is assumed to be flatter reflecting a high degree of competition due to product homogeneity and relatively standard technology, countries with high proportion of materials to total exports are expected to show a decline in pass-through ratio over time. Pass-through for countries with high proportion of final goods to total exports, on the other hand, is expected to rise. That is, we expect the change in pass-through ratio to show a negative relationship with the proportion of materials goods to total exports and a positive relationship with the proportion of final goods exports.

Figures 1 and 2 below depict how changes in pass-through relationship are related to proportion of materials exports and final goods exports in the total exports of a country.[14] A first glance at the Figures reveals no relationship among the variables but a closer look shows an interesting pattern. The countries under study can be divided into three clear categories. The first category, composed of three countries, Australia, Indonesia and Philippines, have a heavily materials oriented export structure. Over 70 percent of the exports of these counties are either raw matetials or other industrial materials while final goods constitute less than 20 percent of the total. This is followed by a group of seven countries—Belgium, Canada, Denmark, Finland, Netherlands, Norway and Thailand—with materials accounting for between 60 to 70 percent and final goods for 20 to 40 percent

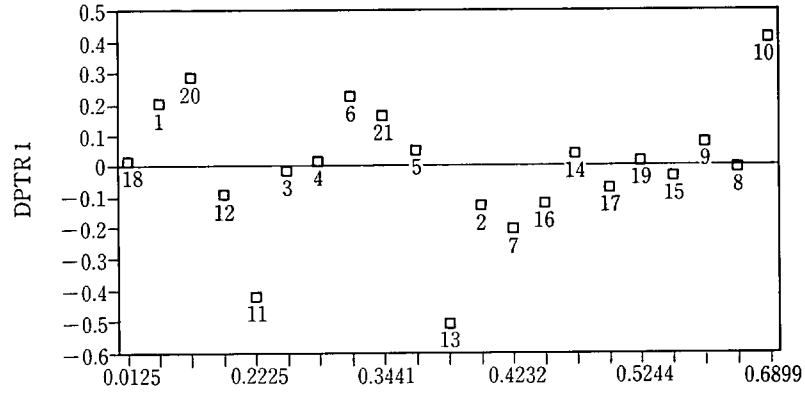
[14] For the classification of exports into materials and final goods, refer to discussion in Section 2 and footnote 4.

FIG. 1. MATERIALS EXPORTS AND CHANGES IN PASS-THROUGH



Note: Numerals in the Figure correspond to countries as presented in Table 1.

FIG. 2. FINAL GOODS EXPORTS AND CHANGES IN PASS-THROUGH



Note: Same as for Figure 1.

of exports. The remaining 11 countries have a high proportion of final goods and a low proportion of materials in their export milieu with Spain as the borderline case. It is easily discernible that, within the respective groups, changes in pass-through ratios have a strong negative relationship with the proportion of materials exports and a strong positive relationship with the proportion of final goods in exports.

The change in pass-through ratio (DPTR1) here is defined as the difference between estimates of the coefficient on *NER* in Eq. B and those in Eq. D as presented in Table 1.[15] Since both, Eq. B and Eq. D, are controlled for costs, the difference in the b_4s in the

[15] Since pass-through ratio (PTR) is 1—the coefficient on NER in respective equations.

two equations should reflect the change arising out of introduction of lagged responses to exchange rates.[16]

To test the relationship between changes in pass-through ratio and the proportion of materials and final goods exports, simple regressions using DPTR1 as the dependent variable were run for the second and the third group of countries separately. The results were as follows:

Group 2: (BEL, CAN, DEN, FIN, NET, NOR, THL)[17]

$$\text{DPTR1} = -1.1170 - 1.6214\ MX \qquad R^2 = 0.3724\ N=7$$
$$(6.07)\quad(-1.72) \qquad r = -0.61$$
$$\text{DPTR1} = -0.5557 + 1.9095\ FX \qquad R^2 = 0.4324\ N=7$$
$$(-3.17)\quad(1.95) \qquad r = 0.66$$

Group 3: (AUT, FRN, GER, ITL, JPN, SPN, SWE, SWI, UKG, USA, KOR)

$$\text{DPTR1} = 1.0676 - 2.2560\ MX \qquad R^2 = 0.8471\ N=11$$
$$(11.7)\quad(-7.06) \qquad r = -0.92$$
$$\text{DPTR1} = -1.1903 + 2.3179\ FX \qquad R^2 = 0.8551\ N=11$$
$$(-13.4)\ (7.29) \qquad r = 0.92$$

where, DPTR1 is the change in pass-through ratio as discussed above, *MX* is the proportion of materials to total exports and *FX* is the proportion of final goods exports to total exports. The parentheses carry *t*-values.

The results are quite self-evident and it does not need intricate reasoning to state that these results confirm our proposition that the direction and extent of change in pass-through is significantly influenced by export composition of individual countries.

Proposition 2

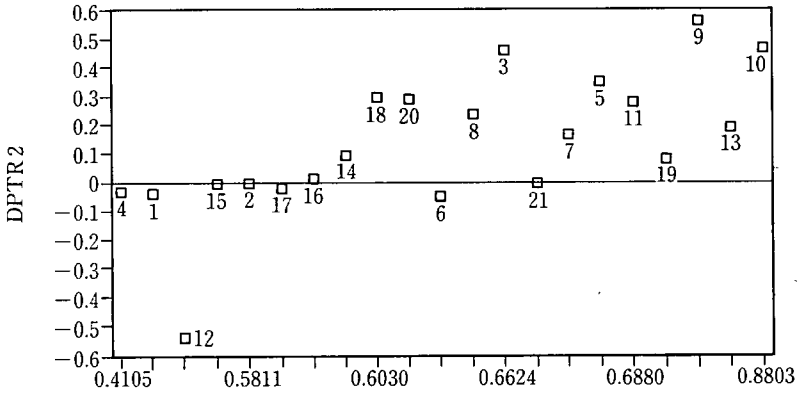
Proposition 2 states that introduction of costs into the pass-through relationship should improve the degree of pass-through and this improvement should be greater for economies which *import* significant amounts of materials, raw or semi-processed. That is, the improvement should be greater for countries whose import composition is weighed heavily towards material imports.

That introduction of cost element does improve the degree of pass-through for a large number of economies was discussed under general observations. To test whether this improvement results from introduction of cost variable and whether it is positively related to the proportion of material imports, the degree of improvement (both positive and negative) is defined as the difference in the coefficients on *NER* in Eq. D and Eq. C (DPTR2). Figure 3 plots the relationship between DPTR2 and the proportion of materials to total imports. One can easily discern an unmistakable positive relationship between the size of change in pass-through and the proportion of material imports to total.

[16] An alternative way of comparison can be the coefficients on NER from equations A and C but we preferred equations B and D since here costs were accounted for which can affect the extent of pass-through significantly for countries importing a large proportion of their materials which form a part of costs and hence prices. The no-cost equations, thus, may be overestimating the pass-through ratios for some countries distorting the results.

[17] See Table 1 for country abbreviations.

FIG. 3. MATERIALS IMPORTS AND CHANGES IN PASS-THROUGH



Note: Same as for Figure 1.

The above visual impression was checked for its numerical value by running a simple regression with DPTR2 as dependent and proportion of materials to total imports as independent variables. The estimated equation was:

$$\text{DPTR2} = -0.8140 + 1.4837\ MM \qquad R^2 = 0.3821\ N = 21$$
$$(-4.16)\ (3.43) \qquad r = 0.62$$

where MM is the proportion of material imports and figures in the parentheses are t-values.

The results confirm our argument and it is possible to state that the product-mix of imports of a country influences the degree of pass-through.

Proposition 3

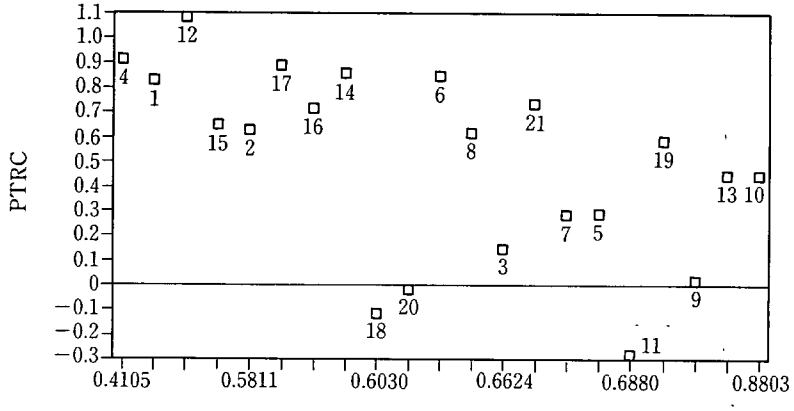
Proposition 3, related to the previous one, states that countries engaged in processing trade should have lower pass-through than the others especially when cost variable is not included. This relationship is depicted in Figure 4 using pass-through ratios calculated from Eq. C (PTRC$=1-b_4$). It is easy to observe that, though not strong, the degree of pass-through and proportion of materials to total imports does show a negative relationship. Depending on how we classify the countries in the Figure, half of them show a positive slope indicating a rise in pass-through. A simple regression gives:

$$\text{PTRC} = 1.5807 - 1.6854\ MM \qquad R^2 = 0.1995\ N = 21$$
$$(4.52)\ \ (-2.77) \qquad r = -0.45$$

indicating that though a negative relationship exists, it is not very strong. Besides, as pointed out before, if cost changes are allowed for, the relationship should vanish as pass-through in this case is 'net of cost changes' which form the basis of this proposition. Using pass-through ratios from Eq. D (PTRD$=1-b_4$), the regression estimates in the above equation change as follows:

$$\text{PTRD} = 0.7667 - 0.2017\ MM \qquad R^2 = 0.0069\ N = 21$$
$$(3.07)\ \ (-0.36) \qquad r = -0.08$$

FIG. 4. IMPORT COMPOSITION AND PASS-THROUGH



Note: Same as for Figure 1.

indicating that the variables are no longer related. Thus, it is possible to say that we do not find much support for the argument stating that pass-through in countries engaged in processing trade should be lower especially when cost changes are taken into account, as they should be, in calculating the extent of true pass-through. It may be noted here that the definition of "processing trade" is not fully captured by proportion of materials imports.

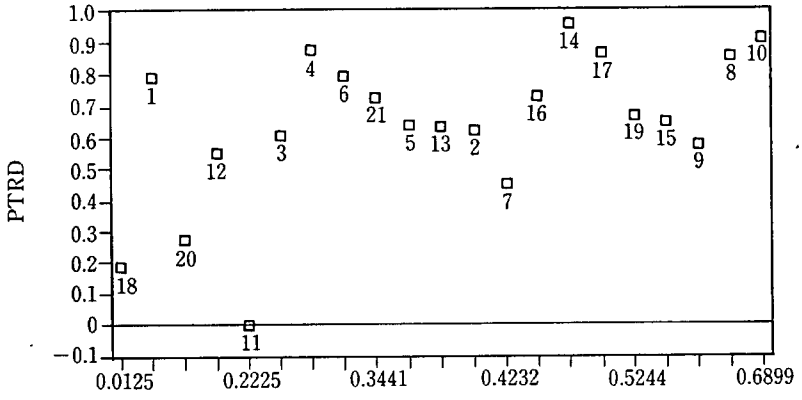
Proposition 4

Proposition 4 implies that pass-through depends on the degree of competition in the market. Industries operating in markets with less competition show high pass-through and vice versa. A direct test of such a proposition is very difficult in that it is difficult to measure the degree of competition prevailing in the market of a product or a group of products, especially in the international context. As discussed in the previous section, however, it may not be wide off the mark to assume materials industries to be more competitive than final goods industries. Using this premise, it becomes possible to devise a crude test.

Figures 5 and 6 depict the relationship between PTRD and proportion of final goods and materials exports respectively. Even a cursory glance at these Figures is enough to show that the countries with a higher proportion of final goods in their export milieu have higher pass-through ratios and vice versa. A more formal regression result for the two cases makes it clearer. Using PTRD as the dependent variable, proportion of final goods in total exports shows a correlation coefficient of +0.56 while the proportion of materials exports shows almost as strong negative result (−0.54). The equations and the estimated parameters were as follows:

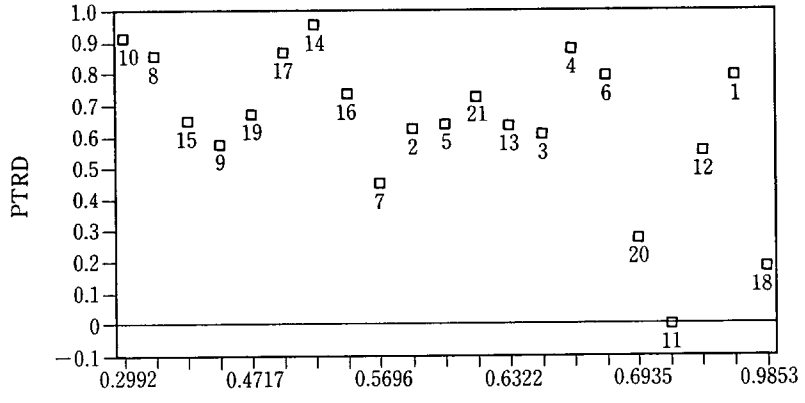
$$\begin{aligned} &\text{PTRD}=0.3523+0.7841\ FX && R^2=0.3094\ N=21 \\ &\qquad (1.69)\quad (2.92) && r\ =\ 0.56 \\ &\text{PTRD}=1.1294-0.8027\ MX && R^2=\ 0.2934\ N=21 \\ &\qquad (5.36)\quad (-2.81) && r\ =-0.54 \end{aligned}$$

FIG. 5. FINAL GOODS EXPORTS AND PASS-THROUGH



Note: Same as for Figure 1.

FIG. 6. MATERIALS EXPORTS AND PASS-THROUGH



Note: Same as for Figure 1.

Thus, it is easy to see that this proposition is fairly well supported by international cross-section data.

IV. *Conclusions*

The main results and implications of our analysis can be summarized as follows.

1. Our results show that international differences in pass-through are strongly determined by the trade composition of individual countries rather than whether a country is a developed industrial country or a developing country. In other words, pass-through problem does not seem to be an arbitrary phenomenon but has a systematic pattern.

2. In general, countries with a high proportion of final goods in their export milieu tend to have higher pass-through ratios than countries where materials exports predominate. This may be due to the fact that markets for materials group are more competitive as compared to final goods group.
3. With the elapse of time, pass-through tends to rise in countries that export final goods and fall in countries exporting material products. This is because after an initial short-run fixity in prices and demand-supply relationships, the speed of adjustment is higher in case of material goods than in final goods. Demand functions being flatter for material goods industries, as assumed, the change in price tends to be lower.
4. Introducing cost elements improves pass-through in most cases and this rise is higher for the countries exporting mainly final goods. The reason is that the decline in pass-through into the prices of material goods exports, as discussed above, changes costs for producers of final goods, especially if they import a substantial amount of materials for processing. This causes a spurious pass-through problem in the final goods export prices. Once these cost changes are accounted for, real pass-through is higher.
5. We do not find any evidence for the proposition that predominant raw material importers tend to have a lower pass-through in general. This is all the more true if the cost changes are accounted for.

The main implication derived from this analysis is that pass-through problem is not as arbitrary as the business press tends to indicate. The extent of pass-through seems to have a systematic pattern which needs closer study. Cost changes are intricately linked with pass-through phenomenon and need a careful treatment.

The above results are, however, tentative in view of the conjectural, though plausible, nature of assumptions made. It is imperative, therefore, to refine the analysis further to test their validity. For example, it is not easy to say that competition in the matetials industries is always higher. It may be possible to devise some better measure to check this assumption. On the empirical front too further work needs to be done. For example, the cost measure—wholesale price—does not seem to perform well for some countries. Besides, since the method of data collection and definitions differ among the countries, using same estimating equation for all countries may not be proper. Differences in data collection practices may be an important source of distortions in our results. On the whole, however, our results seem quite satisfactory.

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