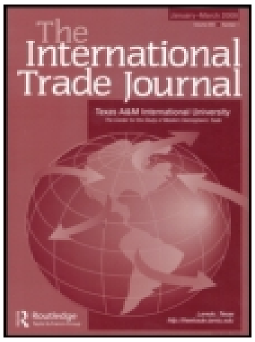

The International Trade Journal

ISSN: 0885-3908 (Print) 1521-0545 (Online) Journal homepage: http://www.tandfonline.com/loi/uitj20

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To cite this article: Mohsen Bahmani-Oskooee & Orhan Kara (2005) INCOME AND PRICE ELASTICITIES OF TRADE: Some New Estimates, The International Trade Journal, 19:2, 165-178, DOI: 10.1080/08853900590933125

To link to this article: https://doi.org/10.1080/08853900590933125

Published online: 18 Aug 2006.

INCOME AND PRICE ELASTICITIES OF TRADE: Some New Estimates

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With introduction of new estimation techniques, old theories receive a renewed attention and on this regard, trade elasticities are no exception. In this paper we employ a new cointegration technique, i.e., ARDL approach to cointegration that does not require pre-testing for unit root and estimate income and price elasticities of import and export demand for 28 countries. The results indicate that price elasticities in most instances are high enough to conclude that real depreciation could improve the trade balance.

* * * * *

I. INTRODUCTION

Economists agree that income and price elasticities are very important in international trade because of their theoretical and policy implications (Houthakker and Magee, 1969; Marquez, 1990). Following the classical work of Houthakker and Magee

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THE INTERNATIONAL TRADE JOURNAL, Volume XIX, No. 2, Summer 2005
ISSN: 0885-3908 print/1521-0545 online. DOI: 10.1080/08853900590933125

(1969), many researchers provided evidence of trade elasticities. Early studies such as Wilson and Takacs (1979), Warner and Kreinin (1983), Bahmani-Oskooee (1986), Marquez and McNeilly (1988) and Marquez (1990) employed standard econometric techniques such as ordinary least square (OLS) or two stage least square (2SLS) and provided mixed results. Recent advances in time-series econometrics, especially in unit root literature reveals that since the early studies employed non-stationary data, they suffer from "spurious regression" problem. To remedy the problem, one has to establish the integrating properties of individual variables first and the cointegration among all relevant variables next.

A few recent studies, that is, Bahmani-Oskooee (1998), Bahmani-Oskooee and Niroomand (1998), and Caporale and Chui (1999) have already applied cointegration analysis (such as Engle-Granger, 1987, and Johansen, 1988 techniques) in estimating trade elasticities. Both techniques require that all variables to be integrated of the same order d denoted by $I(d)$, but their linear combination to be integrated of any order less than d. In most models, individual variables turn out to be $I(1)$ and cointegration requires that their linear combinations to be $I(0)$. In some instances where one or two of the variables in a model are $I(0)$, researchers assume they are $I(1)$ so that they can carry the cointegration analysis. With recent advances, this need not to be the case. Pesaran et al. (2001) have now introduced a new method for establishing cointegration which does not require to classify variables into $I(1)$ or $I(0)$. As a matter of fact, this new technique does not require pre-unit root testing.

Therefore, it is the main purpose of this article to estimate income and price elasticities of import and export demand functions for as many countries as possible, depending on data availability. To this end, in section I, we review Pesaran et al.'s (2001) cointegration technique and formulate trade models following this new method. Section III reports the new income and price elasticity estimates and section IV concludes. Data definition and sources are cited in an appendix.

II. THE MODELS AND THE METHODS

If devaluation is to be effective in improving the trade balance, the Marshall-Lerner condition must be satisfied, that is, the sum of import and export demand price elasticities must sum to unity. To obtain such elasticities, we need to formulate a country's demand for imports and rest of the world's demand for its exports. In doing so we concentrate on a current floating exchange rate system and adopt the following import and export demand functions from Bahmani-Oskooee (1986). The import demand is assumed to take the following form:

$$(1) \qquad \ln M_t^d = a + b \ln Y_t + c \ln \left(\frac{PM}{PD} \right)_t + d \ln E + \varepsilon_t$$

where M^d is demand for imports, Y is a scale variable usually measured by national income, PM is price of imports, PD is price of domestic goods, E is the nominal effective exchange rate. We expect the estimate of b to be positive on the assumption that an increase in income results in an increase in the consumption of imported goods. However, if the increase in income is due to an increase in the production of import-substitute goods, imports may decline yielding a negative estimate of b. An increase in the import price relative to the domestic price is expected to depress import volume, leading to a negative estimate for c. Defined as number of units of foreign currency per unit of domestic currency, a decrease in E or a depreciation of domestic currency is expected to depress the import volume. Thus, an estimate of d is expected to be positive.

Equation (1) outlines the long-run relationship among the variables of the import demand function. Pesaran et al. (2001) showed that in estimating the long-run coefficients of a relation such as (1), we must incorporate short-run dynamics into the estimation procedure. This amounts to rewriting Eq. (1) in an error-correction format or what Pesaran et al. (2001) call it, Autoregressive Distributed Lag (ARDL) format as in Eq. (2) below:

$$\begin{aligned}
(2) \qquad \Delta \ln M_t^d = {} & \alpha + \sum_{i=0}^{n} \beta_i \Delta \ln Y_{t-i} \\
& + \sum_{i=0}^{n} \gamma_i \Delta \ln \left(\frac{PM}{PD}\right)_{t-i} + \sum_{i=0}^{n} \lambda_i \Delta \ln E_{t-i} \\
& + \sum_{i=1}^{n} \theta_i \Delta \ln M_{t-i}^d + \delta_1 \ln Y_{t-1} \\
& + \delta_2 \ln \left(\frac{PM}{PD}\right)_{t-1} + \delta_3 \ln E_{t-1} \\
& + \delta_4 \ln M_{t-1} + u_t
\end{aligned}$$

Formulation by (2) differs from a standard distributed lag model in that it includes a linear combination of the lagged level variables or a so called the lagged error-correction term. Should this linear combination be retained in (2) or be excluded? Pesaran et al. (2001) demonstrateed that the answer could be determined by standard F-test, but with new critical values that they provided. Through a Monte Carlo experiment, they provide upper and lower bounds critical values. If the calculated F-statistic happens to be greater than the upper bound critical value, the null of $\delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$ is rejected and the alternative of $\delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq 0$ is accepted. If the null is rejected, the variables involved are said to be cointegrated which justifies retaining the lagged level variables in (2). We then estimate (2) by OLS using a criterion to select the optimal lags. Estimates of long-run income and price elasticities are then obtained once we normalize estimates of δ_1 and δ_2 by the estimate of δ_4.

We also adopt the export demand function from Bahmani-Oskooee (1986) in which the rest of the world demand for a country's exports takes the following form:

$$\ln X_t^d = a + b \ln YW_t + c \ln \left(\frac{PX}{PXW} \right)_t + d \ln E_t + \omega_t \tag{3}$$

where X^d is rest of the world demand for a country's export, YW is rest of the world income, PX is export price, PXW is world export price, and E is the nominal effective exchange rate. We expect that the relation between world's demand for a country's exports (X^d) and world income (YW) to be a positive one reflecting the fact that as world income rises, their demand increases. Again, note that this relation could be negative if the increase in world income is due to an increase in their production of import-substitute goods. In addition, exports are expected to have a negative relation with the relative price of a country's export price over world export price (PX/PXW) as well as with the nominal effective exchange rate, E, since currency depreciation is expected to stimulate exports.

Again in order to incorporate the short-run dynamics into (3), we express it in an ARDL format, as in Eq. (4) below:

$$
\begin{aligned}
(4) \qquad \Delta \ln X_t^d = \mu &+ \sum_{i=0}^{m} \varphi_i \Delta \ln YW_{t-i} \\
&+ \sum_{i=0}^{m} \psi_i \Delta \ln \left(\frac{PX}{PXW}\right)_{t-i} \\
&+ \sum_{i=0}^{m} \xi_i \Delta \ln E_{t-i} + \sum_{i=1}^{m} \phi_i \Delta \ln X_{t-i}^d \\
&+ \theta_1 \ln YW_{t-1} + \theta_2 \ln \left(\frac{PX}{PXW}\right)_{t-1} \\
&+ \theta_3 \ln E_{t-1} + \theta_4 \ln X_{t-1} + \nu_t
\end{aligned}
$$

The estimation of Eq. (4) involves the same two steps explained for estimating (2). First, we use an F-test to determine the joint significance of the lagged variables (or to establish cointegration). Next we estimate (4) to obtain long-run estimates of income and price elasticities.

III. THE RESULTS

In this section we estimate import and export demand models outlined by Eqs. (2) and (4) for 28 countries for which we were able to obtain quarterly data. The list of countries are provided in Table I and data frequency as well as sources in the appendix. As indicated, the first step is to carry out the F-test to determine whether lagged level of variables in both models are to be retained or whether they are cointegrated. Bahmani-Oskooee and Brooks (1999) have demonstrated that the results will depend

Table I
F-Test Results for Cointegration

Countries	Calculated F-Statistics Exports	Imports
Australia	4.771^A	6.052
Austria	3.937^A	6.996
Belgium	4.096	4.153^A
Canada	4.806^A	7.727^A
Colombia	6.093^A	4.004
Denmark	4.430^A	5.318
Finland	4.831	4.563
France	4.349	5.006^A
Germany	6.684^A	4.821^A
Greece	5.053^A	4.756
Ireland	4.845	4.410
Israel	7.935	4.932
Italy	4.329^A	6.533^A
Japan	4.154	4.033
South Korea	4.581	4.514
Netherlands	4.559	4.849
New Zealand	6.834	4.010
Norway	5.973^A	5.743
Pakistan	4.054	6.335^A
Philippines	16.789	8.057
Poland	3.596	4.171^A
Singapore	13.537^A	4.523^A
Spain	6.159	5.138
Sweden	4.791	3.923
Switzerland	5.147	5.181^A
Turkey	4.233	3.978
United Kingdom	6.305	5.488
United States	3.579	8.677^A

Critical values: When only an intercept is included, the lower and upper bound critical values at 90% significance level are 2.425 and 3.574. The comparable figures when a constant and a trend are included are 3.063 and 4.08.
^{A}Indicates cases in which both an intercept and a trend are included in the ARDL model.

on the number of lags imposed on each first differenced variable. Therefore, we carried out the F-test by imposing different lags on each variable. In most instances cointegration was confirmed. Thus, for ease of exposition we report the results of this first step with 12 lags in Table I.[1]

It is clear from Table I that in all cases our calculated F-statistic is greater than the upper bound critical value (except for Austria, which is on the edge). This indicates that all lagged level variables in both the export and import demand equations are jointly significant, and thus they are cointegrated. After establishing cointegration, the next step is to estimate the error correction models. In doing so we rely upon Akaike's Information Criterion (AIC) to select optimum number of lags. Since our interest is in the long-run income and price elasticities, for brevity of presentation we only report these estimates.[2] While Table II reports income elasticities, Table III reports price elasticities.

From Table II we gather that income elasticities carry their expected positive signs, indicating that the higher domestic income, the higher imports. Similarly, the higher world income, the higher exports. Concentrating first on the income elasticity of export demand equations, it appears that developed countries do have income elasticities that are greater than those of the developing countries. For example, Switzerland has an income elasticity of 2.54, the United States 2.73, and France 2.66. On the other hand, Pakistan's income elasticity is only 1.01, and the Philippines' is 0.85. This is crucial for the high-income countries since high income elasticity plays an important role in their trade balance. Considering that developed countries trade

[1]Note that we included a constant and a trend in both models. Whenever the trend was insignificant, it was excluded.

[2]The full information estimates of each model is available from the authors upon request.

Table II
Income Elasticity Estimates

Countries	Income Elasticity of			
	Exports	t-Ratio	Imports	t-Ratio
Australia	2.13	(2.69)	1.77	(5.17)
Austria	0.93	(1.29)	1.55	(5.58)
Belgium	3.07	(0.85)	0.91	(0.82)
Canada	0.21	(0.07)	2.45	(5.48)
Colombia	0.66	(1.23)	1.08	(4.25)
Denmark	0.07	(0.39)	0.90	(8.37)
Finland	0.97	(1.41)	1.40	(4.08)
France	2.66	(21.11)	1.94	(6.80)
Germany	1.00	(3.07)	0.29	(0.58)
Greece	1.04	(3.40)	1.05	(1.22)
Ireland	1.33	(1.13)	0.66	(6.74)
Israel	2.09	(1.85)	1.17	(13.86)
Italy	0.39	(1.22)	1.03	(3.54)
Japan	0.45	(0.38)	0.14	(0.23)
South Korea	3.00	(2.79)	1.62	(7.62)
Netherlands	0.58	(1.47)	0.65	(1.56)
New Zealand	1.25	(1.44)	1.74	(4.32)
Norway	2.37	(0.67)	0.29	(0.35)
Pakistan	1.01	(1.42)	1.50	(3.63)
Philippines	0.85	(1.75)	3.27	(9.21)
Poland	1.10	(1.31)	0.73	(1.97)
Singapore	0.85	(1.78)	0.84	(3.36)
Spain	1.11	(6.76)	1.47	(1.20)
Sweden	1.88	(1.37)	0.56	(1.76)
Switzerland	2.54	(9.67)	3.75	(7.60)
Turkey	1.29	(0.87)	1.67	(1.82)
United Kingdom	1.46	(1.37)	1.25	(3.55)
United States	2.73	(7.54)	2.10	(21.10)

mostly with each other, slower growth in these countries affects their exports adversely. For instance, the big trade deficit in the United States could be partly explained by the sluggish world economy in recent years, particularly the economies of Europe and Japan. One interesting case is South Korea, which has a high-income elasticity of 3. South Korea, with export promotion

Table III
Price Elasticity Estimates

	Price Elasticity of			
Countries	Exports	t-Ratio	Imports	t-Ratio
Australia	−0.56	(−2.03)	−1.83	(−2.89)
Austria	−0.17	(−2.14)	−0.74	(−2.78)
Belgium	−1.50	(−0.54)	−2.59	(−4.42)
Canada	−1.88	(−0.59)	−2.35	(−3.44)
Colombia	−1.07	(−5.20)	−0.48	(−5.93)
Denmark	−0.07	(−1.33)	−0.24	(−0.89)
Finland	−5.81	(−2.95)	−1.79	(−1.77)
France	−0.04	(−0.24)	−0.09	(−1.46)
Germany	−0.07	(−0.5)	−0.64	(−2.13)
Greece	−0.10	(−0.20)	−1.74	(−1.18)
Ireland	−1.10	(−1.34)	−0.80	(−1.10)
Israel	−2.17	(−1.64)	−1.00	(−5.28)
Italy	−0.33	(−3.22)	−0.01	(−0.18)
Japan	−0.76	(−1.88)	−0.52	(−1.85)
South Korea	−1.13	(−8.00)	−2.94	(−3.44)
Netherlands	−0.61	(−2.40)	−2.32	(−9.88)
New Zealand	−2.29	(−1.51)	−1.75	(−6.40)
Norway	−1.11	(−3.04)	−1.67	(−1.76)
Pakistan	−0.47	(−0.72)	−0.80	(−2.14)
Philippines	−0.28	(−1.64)	2.36	(4.40)
Poland	−0.54	(−1.83)	−0.17	(−0.55)
Singapore	3.26	(5.23)	−0.61	(−3.08)
Spain	−1.08	(−1.73)	−3.60	(−8.16)
Sweden	−1.38	(−1.35)	−1.42	(−2.08)
Switzerland	−0.45	(−2.00)	−3.30	(−5.92)
Turkey	−0.68	(−1.29)	−0.97	(−2.77)
United Kingdom	−3.53	(−4.20)	−1.17	(−2.70)
United States	−2.35	(−2.3)	−1.53	(−4.42)

policies as its engine of growth, is clearly benefiting from this high-income elasticity. Since over the long run, world income is growing steadily, South Korea and similar countries will also grew steadily.

With regards to imports, again developed countries have higher income elasticities (except Japan). For example, the

United States has 2.1, France has 1.94, and the U.K. has 1.25. Comparing export and import income elasticities provides an interesting pattern. Even though half of the countries in our sample have income elasticities that are higher in exports than imports, developing nations tend to have higher income elasticities in imports. Since developing nations grow at a faster rate than developed nations, having higher income elasticity imposes pressure on their trade deficit. For example, the Philippines' income elasticity in the import demand function is 3.27, whereas in the export demand function is 0.85. Similarly, comparable figures for Turkey are 1.67 in imports and 1.29 in exports and for Pakistan 1.5 in imports and 1.01 in exports. This helps explain why these countries experience more trade deficits than other countries. For Japan, the import income elasticity is one-third of its income elasticity in exports, which translates into a lower trade deficit or surplus compared to the other developed nations.

Let us now turn to Table III and the estimated price elasticities. As can be seen, almost all price elasticities are negative and highly significant. They range from −5.81 (Finland) to −0.04 (France). When we look at the developing countries in the sample, one general pattern emerges. Developing countries have price elasticity less than unity, e.g. −0.68 (Turkey), −0.54, (Poland), −0.47 (Pakistan), and −0.28 (the Philippines). The only exception is the case of Columbia, which has price elasticity of −1.07, a little larger than unity. However, when we look at developed countries, there is no specific pattern. For example, in the case of exports, the United States and the U.K. have price elasticities of −2.35 and −3.53, while Germany and France have price elasticities of −0.07 and −0.04, respectively. In the import demand functions, the smallest price elasticity is found for Italy (−0.01), while the largest is for Spain (−3.60). Combining import demand and export demand price elasticities, it appears that the sum (in absolute terms) exceeds unity in a majority of the cases, indicating the fact that the Marshall-Lerner condition is met and devaluation could improve the trade balance in the long-run. Surprisingly, the cases for which the Marshall-Lerner condition is not satisfied happen to be mostly developed countries (e.g., Austria, Denmark, Finland, France, and Germany). These findings are different than those of Bahmani-Oskooee and Niroomand (1998) who employed Johansen's cointegration analysis.

IV. CONCLUSION

With the introduction of new estimation techniques, old theories and controversial empirical issues receive renewed attention. In this paper we employ the ARDL approach for cointegration introduced by Pesaran et al. (2001) to shed some new light on price and income elasticities in world trade. Although the estimated coefficients tend to be unique to each country, one general conclusion is that the sum of import and export demand elasticities exceed unity implying that the Marshall-Lerner condition is met and currency depreciation could improve the trade balance in the long-run.

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V. APPENDIX

Data Definition and Sources

Quarterly data over 1973–98 period do come from the following sources:[3]

a. International Financial Statistics of the IMF (CD ROM 2000).
b. Bahmani-Oskooee and Mirzaie (2000).

Variables

M	Index of volume of imports (1990 = 100), source a.
PM	Index of unit value of imports (1990 = 100), source a.
PD	Index of wholesale prices (1990 = 100), source a.
X	Index of volume of exports (1990 = 100), source a.
PX	Index of unit value of exports (1990 = 100), source a.
PXW	World export price index (1990 = 100), source a.
Y	Real GDP expressed as an index 1990 = 100. In its absence, index of industrial production was employed. In the case of the Philippines, real GNP was used. All come from source a.
YW	Index of industrial production in industrial countries (1990 = 100) as a proxy for world income. Source a.
E	Index of nominal effective exchange rate (1990 = 100). Note that an increase in E reflects appreciation of the domestic currency. The data for developed countries some from source a and for developing countries in the sample from source b.

[3]The exceptions are South Korea and Turkey for which data end in 1997III.