*The Pakistan Development Review*
Vol. XXVI, No. 1 (Spring 1987)

# Disaggregated Import Demand Functions for Pakistan

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This paper estimates demand elasticities of relative prices and those with respect to the activity variable for selected imports of Pakistan at different levels of aggregation for the 1969-70 – 1983-84 period. The relative price elasticities, adjusted for tariffs, are found to be quite small and distinctly different from those estimated for developed countries. Elasticities with respect to the activity variable are on the higher side which may reflect the increased outward orientation of the economy during this period. We have also found evidence which supports the argument that import substitution of consumer and capital goods has led to increased import dependence on inputs.

## INTRODUCTION

In the field of international trade, little systematic information on disaggregated trade elasticities is available for the developing countries.[1] The primary reason for this is the unavailability of adequate data pertaining to prices of different categories of imports and exports. The empirical determination of the relationship between imports, relative prices and economic activity at the disaggregated level is important for policy decisions relating to changes in the level of tariffs and domestic taxes, exchange rate, etc., as well as for estimating the effect of relative price changes on production and employment in specific sectors and industries.[2]

This study examines the behaviour of selected imports of Pakistan at both the aggregate and disaggregated levels for the period from 1969-70 to 1983-84 and

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[1] With the important exception of, e.g., Khan [3] and Melo and Vogt [8].

[2] An obvious problem with aggregate elasticities (even those estimated at the one-digit level of the SITC) is that different product groups are treated as a homogeneous commodity even when there is no justification for assuming that relative prices do not vary, with a common elasticity estimate being applied to all commodity subgroups.

provides elasticity estimates for seventeen different categories of imports at the three-digit level and for more aggregate levels.[3]

## THE IMPORT FUNCTION

In empirical economic literature, the demand for imports has been estimated by relating the quantity of imports to a domestic economic activity variable and to the ratio of the price of imports to domestic prices. When relative prices are adjusted by tariffs, the function can be written in logarithm form as follows:[4]

$$\log M_{it}^{d} = \alpha + \beta \log (1 + t_{it}) RP_{it} + \gamma \log Y_t + u_{it} \quad \ldots \quad \ldots \quad (1)$$

where

$M_{it}^{d}$ = quantity of goods $i$ imported;

$t_{it}$ = tariff rate on the $i$th import;

$RP_{it}$ = ratio of the unit value of the $i$th import to its domestic price;

$Y_t$ = activity variable;[5]

$\beta, \gamma$ = elasticities with respect to relative price and activity variable; and

$u_{it}$ = a random disturbance term such that $u_{it}$ NID $(0, x_u^2)$.

In general, the relative price elasticity $\beta$ is expected to be non-positive ($\beta < 0$) while the elasticity with respect to the activity variable may be either greater or less

[3]The data for this purpose have been compiled from six-digit value and quantity data reported in the *Foreign Trade Statistics of Pakistan*. From 1981-82 onwards, the data are reported at the seven-digit level.

[4] The log-linear formulation of the import demand function is most common in empirical economic work; see e.g. Khan [4], Magee [6], Hamilton [2], Boylan *et al.* [1] and Melo and Vogt [8]. The choice of the functional form was made by comparing standard goodness-of-fit criteria for linear and log-linear formulations. It is much more convenient to use the log-linear specification as it constrains the elasticity estimates to be constant over the estimation period, which precludes the possibility of a secular fall in the elasticities with respect to price and the activity variables when the dependent variable rises faster than the independent variable. The predictive power of the model may be affected by inclusion of variables that reflect the rigidities of the system, but adequate time-series data for these variables are not available.

[5]A number of activity variables were tried in the import functions. For total and aggregated imports, real Gross Domestic Product (GDP) gave the best results; for imports of Milk, Milk Products and Fruits, real consumption expenditure was used as the activity variable; for other imports at the three-digit level, real value added in the manufacturing sector yielded the best results in terms of goodness-of-fit criteria.

than one, reflecting the fact that domestic production can increase more or less than consumption of importables as the level of income rises.[6]

Equation (1) is estimated with the assumptions that, firstly, importers are always in equilibrium $(M_{it}^d = M_{it})$[7]; secondly, there is an infinite supply elasticity of imports with respect to price so that import prices are determined exogenously[8]; and, thirdly, prices of domestic goods and the real activity variable are exogenous.[9]

## RESULTS

The estimates of price and income elasticities obtained from estimating Equation (1) are given in Table 1. In several cases, there was evidence of first-order auto-correlation in the residuals. For these cases, the elasticities were re-estimated by removing auto-correlation using the Cochrane-Orcutt iterative technique for a first-order autoregressive scheme. The fit of the equations is good in many cases and fair in others.

[6]For total imports and imports of consumer goods – Milk and Cream (022), Milk Products and Fruits (051) – Equation (1) was re-estimated including the variable real foreign exchange reserves. In all the cases, the foreign-exchange reserves variable was found to be statistically insignificant even at the 85-percent level. The estimated coefficients are not affected significantly and there is a slight decrease in the value of R-squared (with the exception of imports of Milk Products in which case the R-squared is the same). This suggests that during the period from 1969-70 to 1983-84 foreign-exchange availability did not act as a constraint to imports, which may partly be explained by the large inflow of foreign remittances during this time.

[7]The results of estimating a partial-adjustment mechanism for imports show that while the disequilibrium model holds for a few cases, in general, adjustment was made within the year. For developing countries Khan [3] and Melo and Vogt [8] and for developed countries Kreinen [5] have also found an insignificant lag structure at the disaggregated level.

[8]The simultaneous relationship between the quantity of imports demanded and import price may be considered untenable in the case of Pakistan because of its small effect, so that as long as tariffs are the only trade barriers the OLS estimates of relative price and income elasticities can be considered unbiased.

[9]The disadvantage of using the domestic price of goods as the measure of the price of domestically produced tradable goods is that it includes imported goods and non-tradable domestically produced goods. However, it is the best available measure of the price of domestic goods. Assuming that the domestic price is a weighted average of the import price and the true price of domestically produced goods, it is a simple matter to show that

$$\eta p_m^t = \eta p_m^o (1-w)\, p_d^t/p_d^o$$

where $\eta p_m^t$ is the true price elasticity of demand for imports, $\eta p_m^o$ is the observed price elasticity and $(1-w)\, p_m^t/p_d^o$ is the weight of the true price of domestic goods in the observed price of goods. The extent of the bias in the estimated price elasticity of demand for imports depends on the latter factor.

Table 1

*Estimates of Price and Income Elasticities*

| Commodity Group | PSTC* Equivalent | Price Elasticity | Income Elasticity | $\bar{R}^2$ | *D.W.* | *S.E.* |
|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Total Imports | | −0.230<br>(−3.290) | 1.290<br>(8.350) | 0.890 | 1.930 | 0.089 |
| Total Imports excluding Petroleum Imports | | −0.540<br>(−2.200) | 1.630<br>(8.100) | 0.830 | 1.530 | 0.220 |
| Food Products | 0 | −0.740<br>(−1.580) | 3.160<br>(3.130) | 0.430 | 1.680 | 0.470 |
| Milk and Cream | 022 | −0.941<br>(−2.060) | 3.198<br>(5.043) | 0.638 | 1.495 | 0.598 |
| Milk Products | | −0.828<br>(−1.688) | 3.146<br>(5.138) | 0.645 | 1.433 | 0.583 |
| Fruits | 051 | −0.739<br>(−4.650) | −0.276<br>(−0.357) | 0.602 | 1.412 | 0.240 |
| Crude Materials | 2 | −0.816<br>(1.961) | 1.444<br>(2.325) | 0.755 | 1.858 | 0.585 |

*Continued –*

Table 1 – (*Continued*)

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|---|---|---|---|---|---|---|
| Fuels | 3 | –0.051<br>(–0.856) | 0.736<br>(5.154) | 0.744 | 1.945 | 0.113 |
| Animal and Vegetable Oils | 4 | –0.580<br>(–3.590) | 2.530<br>(11.910) | 0.920 | 2.360 | 0.220 |
| Animal Oils | 411 | –0.461<br>(–2.128) | 1.416<br>(9.251) | 0.873 | 2.032 | 0.204 |
| Vegetable Oils | 421 | –0.495<br>(–2.294) | 2.145<br>(8.883) | 0.863 | 2.032 | 0.300 |
| Chemicals | 5 | –0.720<br>(–2.860) | 2.020<br>(6.360) | 0.820 | 2.200 | 0.190 |
| Inorganic Chemicals | 514 | –0.651<br>(–1.639) | 1.910<br>(5.522) | 0.773 | 2.088 | 0.233 |
| Cleansing Preparations | 554 | –0.877<br>(–2.020) | 2.067<br>(5.510) | 0.729 | 1.729. | 0.195 |
| Plastic Materials | 581 | –0.660<br>(–2.099) | 1.399<br>(3.582) | 0.452 | 1.836 | 0.285 |
| Manufactured Goods | 6 | –0.730<br>(–1.820) | –3.070<br>(–3.980) | 0.520 | 2.000 | 0.550 |

*Continued* –

Table 1 – (*Continued*)

| Commodity Group | PSTC* Equivalent | Price Elasticity | Income Elasticity | $\bar{R}^2$ | *D.W.* | *S.E.* |
|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Articles of Rubber | 629 | –0.319<br>(–1.681) | 2.126<br>(3.229) | 0.775 | 2.267 | 0.198 |
| Articles of Paper | 642 | –1.151<br>(–1.907) | –3.943<br>(–3.145) | 0.518 | 2.195 | 1.008 |
| Iron and Steel Ingots | 672 | –1.028<br>(–0.944) | –2.885<br>(–3.447) | 0.565 | 1.806 | 0.809 |
| Aluminium Products | 684 | –0.910<br>(–1.912) | 2.269<br>(7.084) | 0.836 | 2.227 | 0.422 |
| Tin Products | 687 | –0.753<br>(–2.919) | –2.932<br>(–4.288) | 0.697 | 1.734 | 0.728 |
| Machinery and Transport Equipment | 7 | –0.450<br>(–0.190) | 4.140<br>(6.260) | 0.770 | 1.640 | 0.250 |
| Office Mechines | 714 | –0.706<br>(–3.406) | 0.741<br>(1.430) | 0.453 | 1.761 | 0.248 |
| Electric Equipment | 725 | –1.059<br>(–3.206) | 4.711<br>(3.121) | 0.568 | 1.675 | 0.610 |

*Note*: *Pakistan Standard Trade Classification.
The figures in brackets are t-values.

The results show that in all the cases the price elasticities have the expected negative sign and, like the income elasticities, the vast majority of them are significantly different from zero at the 10-percent level. A number of other interesting observations can also be made: Firstly, the (absolute) price elasticities are on the lower side with only import elasticities of paper products, iron and steel ingots, and electric equipment (PSTC 642, 672 and 725) having a value of more than one. Secondly, the sizes of the price elasticities at the three-digit level are significantly different from those of developed countries.[10] This is also true for the one-digit and aggregate levels. These comparisons conform with theoretical expectations about the different response to relative price changes in the developing and developed countries.[11] Thirdly, the absolute price elasticities are, in general, also lower than those obtained by Khan [3] and Melo and Vogt [8] for Venezuela. Khan's estimates of price elasticities, −2.042 and −1.176 for food and agriculture products, are similar to those obtained by Melo and Vogt, as against our estimates, −0.740 and −0.816 for imports of food products and crude materials (PSTC 0 and 2). Similarly, for the imports of machinery, paper and cardboard, and chemical goods Khan's estimates range from −0.765 to −1.277 as compared with our estimates, −0.450, −0.730 and −0.720 for imports of machinery and transport equipment, manufactured goods, and chemicals (PSTC 7, 6 and 5), which are higher than the price elasticities −0.456 and −0.200 for imports of chemicals and manufactures reported by Melo and Vogt. Fourthly, the high aggregate price elasticity is due, in large part, to the influence of the inelastic demand for petroleum imports. A higher aggregate price elasticity (−0.540) is obtained when petroleum imports are excluded from total imports. Fifthly, the higher price elasticities within the seventeen import groups are associated, in general, with products which are either consumer goods or capital goods,[12] e.g. food products and crude materials (PSTC 022, 051 and 2) have price elasticities ranging from −0.739 to −0.941. Similarly, the price elasticities of machinery and transport equipment (PSTC 714 and 725), which are capital goods, are −0.706 and −1.059. With a few exceptions, the price elasticities for the rest of the import groups, which are raw materials for consumer and capital goods, are lower than −0.700.[13] Sixthly, import groups within the same industry have more or less similar sensitivity to relative price changes.[14] Among the imports of food and crude

[10] This observation can be only of a very general nature because of differences in aggregation and estimating equations in, e.g., Kreinin [5] and Hamilton [2].

[11] Developing countries' demand for imports is generally believed to be inelastic as compared with that of the developed countries.

[12] For the classification of Pakistan's imports into consumer goods, raw materials for consumer goods, capital goods and raw materials for capital goods, see Mahmood [7].

[13] These results tend to confirm the view that import substitution of consumer and capital goods has led, in general, to greater import dependence on inputs of these industries.

[14] This is contrary to the results obtained for developed countries. Hamilton [2] has found large variance of price elasticities within import groups for Sweden.

materials (PSTC 0 and 2) elasticities range from −0.739 to −0.941. For imports of animal and vegetable oils (PSTC 4) and chemical imports (PSTC 5) the variance is similar or even less. However, price elasticities vary slightly more for imports of manufactured goods (PSTC 6), ranging from −0.319 to −1.153. These results reinforce the argument made above that development policy has influenced the growth of specific import-substitution industries, namely consumer goods and capital goods, to the neglect of others. However, within the import group for manufactured goods (PSTC 6), it is more appropriate to talk of neglected commodities than of industries.

**Aggregation Bias**

Distribution elasticities were calculated to investigate the extent of the aggregation error which arises from the use of the direct estimate of price elasticity instead of estimates based on disaggregate elasticities.[15] (See Table 2.)

Table 2

*Distribution Elasticities*

| Commodity Group | PSTC Equivalent | Distribution Elasticity |
|---|---|---|
| Food Products | 0 | 0.9218 |
| Crude Materials | 2 | 1.4765 |
| Fuels | 3 | 1.3330 |
| Animal and Vegetable Oils | 4 | 0.1918 |
| Chemicals | 5 | 0.6901 |
| Manufactured Goods | 6 | 1.1259 |

An aggregation error results when either or both of the following two conditions hold: (i) price changes at the disaggregated level are not uniform, and (ii) such changes are correlated with the product of the corresponding elasticities and weights [6].

[15] Distribution elasticities have been estimated from the equation

$$\Delta \log P_{it} = \beta_i \Delta \log P_t + V_t$$

where $P_t$ is the relative price variable adjusted for tariffs, $P_t = \Sigma P_i$, $\beta_i$s are the distribution elasticities and $V_t$ is a random disturbance term.

The derived aggregate price elasticity was calculated as the sum of the products of the individual elasticities, the corresponding distribution elasticities and the average share of individual imports in total imports. The results (reported in Table 3) show an upward aggregation bias for the relative price elasticity.[16] When no adjustment is made for the distribution elasticity, the absolute derived estimate of the relative price elasticity is higher but the upward aggregation bias is still present, even though the extent of the bias is much reduced.

Table 3

*Derived Aggregate Import Elasticities*

| | Weighted Average | Weighted Average including Distribution Elasticities |
|---|---|---|
| Price Elasticity | –0.222 | –0.140 |

## CONCLUSION

Estimates of the elasticities with respect to the relative price, adjusted for tariffs, and the activity variable for selected imports at different levels of aggregation have been obtained for the period extending from 1969-70 to 1983-84. The absolute relative price elasticities are low and distinctly different from those estimated for developed countries. The higher elasticities with respect to the activity variable may be an evidence of an increase in the import/income ratio reflecting a greater outward orientation of Pakistan's economy during this period.

In some cases, the higher absolute relative price elasticities suggest that, while progress has been made in import-substitution in specific industries, it has led to a precarious dependence on imported inputs.

Like Khan [3] and Melo and Vogt [8] we have found an upward aggregation bias for the relative price variable.

[16] Khan [3] and Melo and Vogt [8] also give evidence of an upward aggregation bias for the relative price elasticity.

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