

## Structural Change in the Import Demand Function for Pakistan

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### I. INTRODUCTION

The question of structural stability of the Aggregate Import Demand Function (IDF) has important implications for modelling, forecasting as well as policy-making related to the trade sector, in general and imports in particular. A structural change, in quantitative terms, may be reflected as a change in one or more parameters of the import demand function. Analysing the possibilities, timing and the nature of such a change is important since it affects the estimates of the relevant elasticities.

In the case of Pakistan, the issue of the possible structural change in the IDF has not been studied much in spite of its importance. The two notable exceptions are Sarmad (1989) and Naqvi and Khan (1989).

In Sarmad (1989) while the main purpose was to choose between the linear and log-linear functional forms for the IDF there is incidental treatment of structural change when he specifies a dummy to account for the dislocation of economic activity caused by the separation of East Pakistan in 1971. Thus he implicitly hypothesizes that structural change occurred only in term of the intercept.<sup>1</sup> However, he also reports that there may have been a structural shift in 1982-83 in the import demand for manufacturing.

Again, Naqvi and Khan (1989) report a significant 1971-72 dummy coefficient in case of imports of manufactured goods and significant 1972-73 dummy for imports of services adjusted for interest payment on foreign debt.

In fact, the relative paucity of the studies on the structural change in the IDF for Pakistan is surprising given a general awareness that in the early 1970s, Pakistan experienced significant political upheavals including the breakup of the

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<sup>1</sup>[Sarmad (1989), p. 1623].

country in December 1971.<sup>2</sup>

The purpose of this paper is to determine the exact year of structural change in Pakistan's aggregate import demand function for the time period 1959-60 to 1987-88.

The rest of this paper is organized as follows. Section II describes the methodology while Section III describes the data used. Section IV discusses the empirical results. Finally, Section V presents the conclusions of this paper.

## II. METHODOLOGY

We combine *a priori* information and the methodology of "Switching Regression" (SR) in order to determine the exact year of structural change in Pakistan's aggregate import demand function for the time period 1959-60 to 1987-88.<sup>3</sup>

The SR methodology is based on the pioneering work of Quandt (1958) and its updated version in Goldfeld and Quandt (1973). Let the term 'regime' refer to a change in the parameters of the model corresponding to the different mutually exclusive subsets of the total sample. Then, the general approach of the SR methodology is based on the assumption that there is a known (finite, in fact, small) number of different regimes but the switching points are not known *a priori*. Such points are determined by using a maximum likelihood procedure. In fact, the essential features of the SR methodology can be described as follows.

Let  $Y_t$  = Natural logarithm ( $Ln$ ) of Total Imports in year  $t$ ; and

$X_t$  = a  $k \times l$  vector of independent variables such as  $Ln$  GNP which determine imports in year  $t$ . Suppose we have  $n$  sample observations  $t = 1, \dots, n$ .

We hypothesize that the parameters of the aggregate import demand function for Pakistan obey two separate regimes as defined below:

$$\text{Regime 1: } Y_t = \alpha_1 + \beta_1 X_t + U_{1t} \text{ holds for } t \leq t^*$$

$$\text{Regime 2: } Y_t = \alpha_2 + \beta_2 X_t + U_{2t} \text{ holds for } t > t^*$$

<sup>2</sup>However there have been a few studies in other areas. For instance, Khan (1980) studies the issue of structural change during the 1959-60 to 1977-78 in demand for money for Pakistan. He finds that the estimated coefficient of the expected rate of inflation is insignificant for the period 1959-60 to 1970-71 while it becomes statistically significant during 1971-72 to 1977-78. This suggests that there had been a single structural change in 1970-71.

<sup>3</sup>In fact, as discussed later in this section, we restricted the SR based search to the 1970-71-1972-1973 time period on grounds of *a priori* information.

Where  $t^*$  is unknown. Assuming the error terms to be independently and normally distributed with zero means and variances  $\sigma_1^2$  and  $\sigma_2^2$ , the log likelihood is given by:

$$\ln L = -\frac{n}{2} \ln 2 \Pi - \frac{t^*}{2} \ln \hat{\sigma}_1^2 - \frac{n-t^*}{2} \ln \hat{\sigma}_2^2 - \frac{1}{2\hat{\sigma}_1^2} \sum_{i=1}^{t^*} (Y_i - \alpha_1 - \beta_1 X_i)^2 - \frac{1}{2\hat{\sigma}_2^2} \sum_{i=t^*+1}^n (Y_i - \alpha_2 - \beta_2 X_i)^2 \dots \dots \dots (1)$$

Where,  $\hat{\alpha}_i$ ,  $\hat{\beta}_i$  and  $\hat{\sigma}_i^2$  ( $i = 1,2$ ) are the maximum likelihood (ML) estimates of  $\alpha_i$ ,  $\beta_i$  and  $\sigma_i^2$  respectively.

In fact, the above log likelihood function simplifies to the following expression:

$$\ln L = -\frac{n}{2} \ln 2 \Pi - \frac{n}{2} - \frac{t^*}{2} \ln \hat{\sigma}_1^2 - \frac{n-t^*}{2} \ln \hat{\sigma}_2^2 \dots \dots \dots (2)$$

Then, in principle, an estimate of the switch point,  $t^*$  could be made by evaluating Equation (2) for all possible values of  $K \leq t^* \leq n - k$  and choosing the one that maximizes the (logarithm of the) likelihood function.

However, we decide to *a priori* restrict the search for the switch point to a three-year period only i.e., 1970-71 – 1972-73 since it is often posited that the Pakistan economy is most likely to have experienced a structural change in the aftermath of the events in the early 1970s.<sup>4</sup> Thus, essentially our approach is to maintain that while a range for a probable structural change is known on *a priori* grounds, the exact point of such a change within that range is unknown and must be determined on the basis of the formal tests. Such an approach is sort of a compromise between the Bayesian approach with its emphasis on integrating *a priori* information into the analysis and that of the classical inference theory based primarily on ‘pure’ statistical test results.

### III. DATA DESCRIPTION

In this paper, we have used annual data for Pakistan for the period 1959-60 to 1987-88. The names of the relevant variables and their definitions are being given below. Their respective source is noted in the parenthesis while the Table 1 gives their means and standard deviations for the different sub-periods.

<sup>4</sup>For instance, the political turmoils of 1969-70, start of civil war in March 1971 and ultimately war with India and separation of East Pakistan in December 1971 after.

Variable's Name	Definition (Source)
<i>Ln TI</i>	Natural logarithm of real imports demanded in year <i>t</i> as given by the value of imports calculated at constant 1959-60 prices. (Source: Foreign Trade Statistics of Pakistan: Various Issues.)
<i>Ln GNP</i>	Natural logarithm of real Gross National Product in year <i>t</i> calculated at constant 1959-60 prices. (Source: Economic Survey 1989-90.)
<i>Ln P</i>	Natural logarithm of the relative price of imports in year <i>t</i> calculated as the ratio of the index of unit value of imports to the domestic wholesale price index. This ratio has been adjusted for the aggregate rate of tariff. (Source: Various Issues of the Pakistan Statistical Year Book and the Monthly Statistical Bulletin.)
<i>Ln FR</i>	Natural logarithm of the real foreign exchange reserves in year <i>t</i> measured in constant 1959-60 prices. (Source: Annual Reports, State Bank of Pakistan; Various Issues.)
<i>W</i>	Dichotomous (0,1) dummy variable which is equal unity for 1965-66 to account for the possible effects of the September 1965 war with India.
<i>S</i>	Dichotomous (0,1) dummy variable which equals unity for 1971-72 to account for the East Pakistan separated from the Federation in December 1971.

Table 1

*Mean (X) and Standard Deviation (SD) of Variables*

Variables	1959-60-1987-88		1959-60-1971-72		1972-73-1987-88	
	Whole-sample		Sub-sample 1		Sub-sample 2	
	<i>N</i> = 29		<i>N</i> = 13		<i>N</i> = 16	
	<i>X</i>	<i>SD</i>	<i>X</i>	<i>SD</i>	<i>X</i>	<i>SD</i>
<i>Ln TI</i>	3.57	0.33	3.32	0.25	3.77	0.25
<i>Ln GNP</i>	10.56	0.50	10.10	0.24	10.94	0.30
<i>Ln P</i>	0.66	0.45	0.19	0.11	1.04	0.15
<i>Ln FR</i>	7.18	0.60	6.68	0.38	7.58	0.41
<i>TI</i>	37.30	12.05	28.44	7.14	44.49	10.34
<i>GNP</i>	43655.10	21697.61	24946.23	5888.13	58856.06	17356.22
<i>P</i>	2.12	0.89	1.22	0.14	2.86	0.44
<i>FR</i>	1556.48	1003.33	851.62	327.15	2129.19	1006.51

## IV. RESULTS

Tables 2 and 3 report the empirical results for this study. These estimates are the Maximum Likelihood Estimates that take into account first order autocorrelation of the error term. We may refer to them as AR(1) ML and briefly discuss them below.<sup>5</sup>

Table 2  
*AR(1) Maximum Likelihood Estimates for the Aggregate  
Import Demand Function  
(1959-60 to 1987-88)*

Variables	1	2	3	4
<b>Dependent Variable = Ln TI</b>				
Constant	-8.73* (-4.53)	-9.32* (-5.74)	-8.43* (-5.08)	-8.43* (-4.68)
Ln GNP	1.20* (6.23)	1.26* (7.84)	1.17* (7.09)	1.17* (6.81)
Ln P	-0.72* (-3.53)	-0.83* (-5.20)	-0.69* (-4.08)	-0.69* (-3.59)
Ln FR				0.0004 (0.009)
W			-0.16* (-1.97)	-0.16** (-1.93)
S		-0.34* (-4.37)	-0.33* (-4.53)	-0.33* (-4.18)
Adjusted R <sup>2</sup>	0.69	0.82	0.84	0.83
DW	1.92	1.81	1.58	1.58
SE	0.13	0.09	0.09	0.09
N	29	29	29	29

\*Significant at 95 percent level; 2-tailed *t*-test (*t*-statistics are in the parentheses).

\*\*Significant at 90 percent level for 2-tailed *t*-test yet significant at 95 percent level for 1-tailed *t*-test.

<sup>5</sup>OLS did not give satisfactory results since for most cases,  $H_0$  of 'no first order autocorrelation in error terms' could not be rejected. In order to correct for this we decided to use AR(1) ML rather than the more commonly used iterative Cochrane-Orcutt since (a) we needed ML estimates for the Quandt Likelihood test (Equation (2), Methodology Section) and (b) as [Johnston (1984), pp.326] points out, AR(1) ML may be a relatively superior way to correct for AR(1) in the error term.

Table 3

*AR(1) Maximum Likelihood Estimates for the  
Import Demand Equation  
(Breakpoint 1971-72)*

	1959-60 to 1987-88 Whole-sample	1959-60 to 1971-72 Sub-sample 1	1972-73 to 1987-88 Sub-sample 2
<b>Variables</b>			
Constant	-8.73* (-4.53)	-4.12 (-1.58)	-9.03* (-3.46)
<i>Ln GNP</i>	1.20* (6.23)	0.76* (2.91)	1.20* (4.79)
<i>Ln P</i>	-0.72* (-3.53)	-1.61* (-5.82)	-0.52** (-1.83)
Adjusted $R^2$	0.69	0.90	0.92
<i>DW</i>	1.92	1.56	1.67
<i>SE</i>	0.13 0.11	0.10	
<i>N</i>	29	13	16

\* Significant at 95 percent level; 2-tailed *t*-test (*t*-statistics are in the parentheses).

\*\* Significant at 90 percent level for 2-tailed *t*-test yet significant at 95 percent level for 1-tailed *t*-test.

First, in order to set the stage, we present AR(1) ML estimates of the IDF that are based on the whole sample i.e., 1959-60 – 1987-88. It can be seen that the coefficients of *Ln GNP* and of *Ln P* are of the correct sign and are significant at the 95 percent level of significance. With reference to Column (3), note that the output elasticity<sup>6</sup> is 1.17 and the (relative) price elasticity is 0.69. Again, while the dichotomous dummy variable *S* that accounts for the 1971 separation of East Pakistan is significant, the coefficient estimate of *Ln FR* is not so (Column 4).

Let us now turn to Table 3 which gives results pertaining to the main purpose of the paper i.e., an analysis of the timing of structural change in the aggregate IDF. Since the value of the Quandt's log likelihood test statistic is the largest<sup>7</sup> when  $t^* = 1971-72$ , the relevant Regime 1 and Regime 2 for the import

<sup>6</sup>Sarmad (1989) reports output elasticity of 0.63 and the price elasticity of -0.669 for the same variables and notes the output elasticity to be 'too low'. However, the time period for his study is 1960-86. Also his specification includes *Ln FR*.

<sup>7</sup>The respective log likelihood values were 29.38, 30.51 and 26.12, respectively for  $t^* = 1970-71$ , 1971-72, 1972-73 respectively.

demand function correspond to 1959-60 – 1971-72 and 1972-73 – 1987-88 respectively.

After having determined the timing of the structural change in the IDF, the *nature* of this change was investigated. Was the change only in the constant term (as results of Table 2 columns 2 through 4 would indicate) or both slope and intercepts coefficients changed across regimes? The Chow test rejected the null hypothesis of same specification across Regime 1 and Regime 2 at the 1 percent level ( $F_{\text{calculated}} = 7.44 > F_{\text{table}} = 3.03$ ). This implies that there is more to the nature of the structural change between the above regimes than can be captured by just introducing a dummy variable for the suspected year of change. In fact, the null hypothesis of equality of the respective elasticities of output and price across the regimes was rejected at one percent level.<sup>8</sup>

In the light of the above result, an interesting aspect of the problem of the structural change in the IDF would be to investigate the economic reasons as to why these elasticities change across the two regimes? In fact, this is one of the directions in which we plan to extend this work in the future.

## V. CONCLUSIONS.

The main conclusions of this study and their relevant policy implications are being noted below:

- (1) It is found that the Aggregate Import Demand Function (IDF) for Pakistan experienced a structural break at the end of 1971-72. Thus, in fact, the IDF obeys two distinct 'regimes': 'Regime 1' corresponds to 1959-60 to 1971-72 while 'Regime 2' corresponds to 1972-73 to 1987-88.
- (2) The nature of the above structural change cannot be captured adequately by simply adding a dummy variable for the year 1971- 72. In fact, the Chow test rejects at the 1 percent level the null hypothesis of similar structures across the regimes.
- (3) It is found that both the output as well the price elasticities changed across the regimes. In fact, between Regime 1 and Regime 2, the output elasticity increased by about 58 percent while the price elasticity declined by nearly two-thirds.

<sup>8</sup> Assuming independence of the coefficient estimates across the regimes the test statistic is  $t = (\beta_2 - \beta_1) / (\text{Var } \beta_2/n_2 + \text{Var } \beta_1/n_1)^{1/2}$  with  $(n_1 + n_2)$  d.f. where  $n_1$  and  $n_2$  are respective sample sizes for the two regimes.

Since imports related policy prescriptions take the output and price elasticities as datum, the question of their stability or lack thereof has very significant implications. The above findings regarding the timing and the nature of structural break in the Aggregate Import Demand Function may thus serve a very useful purpose in terms of policy-making. These results also have important implications in terms of modelling and forecasting of the trade sector in general, and of imports in particular.

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**Comments on**  
**“Structural Change in the Import Demand**  
**Function for Pakistan”**

The paper by Tayyeb and Riaz explores the timing and nature of a once for all shift in the aggregate import demand function for Pakistan. The paper is well targeted and precise. The results confirm that the import demand function shifted in the year 1972-73 in such a way that imports became more sensitive (elastic) to GNP and less sensitive to the relative price of imports. Thus, while after 1971-72 increase in income has been a source of fast growth in imports in Pakistan, the increase in the relative price of imports has not been a forceful disincentive for imports. This finding is an indication towards the nature of change in the tastes and technology for importables in Pakistan and the authors can explore its implications for the import policy of Pakistan.

The possible causes for the shift in the structure of the import demand function include changes in commodity/geographic composition of imports and various forms of import restrictions. The authors may also like to relate such factors with their finding in the discussion.

On the technical side of the paper I have two comments to make. First, the authors estimate three parameters for each of the two sub-samples and one parameter as the 'optimal' switching point,  $t^*$ . Since  $t^*$  is determined endogenously, it can be treated as a parameter along with the other six parameters and the degrees of freedom can be defined for the two equations combined.

Second, I have some reservations on the use of a unique event dummy (taking a non-zero value for one sample point and zero for the rest). It has been established that use of a unique event dummy in a regression equation is equivalent to excluding the sample point corresponding to the unique event and estimating the equation without the unique event dummy. It is, therefore, important to note the implications of the two unique event dummies  $W$  and  $S$  (for the years 1965-66 and 1971-72) present in the estimated import demand functions. Due to the identically zero value of regression residuals for the sample points corresponding to the two unique events the values of  $R$ -square and  $F$ -statistic are inflated upward. Further, in the presence of unique event dummies the regression equation has essentially been estimated using discontinuous time series with two missing observations and, hence, the value of  $D. W.$  statistics require some adjustment. It

may be noted, however, that the authors did not use any unique event dummy in their main analysis on the determination of the timing and nature of shift in the import demand function.

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