An Aggregate Import Demand Function for India: A Cointegration Analysis

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ABSTRACT
This paper investigates the behaviour of Indian aggregate imports during the period 1971-1995. In our empirical analysis of the aggregate import demand function for India, cointegration and error correction modelling approaches have been used. In the aggregate import demand function for India, import volume is found to be cointegrated with relative import price and real GDP. Our econometric estimates of the import-demand function for India suggest that import-demand is largely explained by real GDP, and is generally less sensitive to import price changes. Import liberalisation is found to have had little impact on import demand.

Section 1

Introduction

In a recent paper, Sinha (1996) investigated the behaviour of Indian aggregate imports and argued that there was no empirical evidence in favour of the existence of any cointegrated relationship among the variables used in the aggregate import demand function during the period 1960-92. In this paper we reinvestigate the problem using data for the period 1971-95. Specifically, the objectives of the paper are two fold. In the first place, we intend to determine whether there exists a long-run relationship between India's aggregate import volume and its major determinants, on the basis of annual data for the period 1971-95. The hypothesis of the existence of a cointegrated relationship between aggregate import volume and its major determinants is tested using cointegration technique developed by Johansen (1988, 1991) and Johansen-Juselius (1990, 1992 and 1994). Secondly, this paper also investigates the effect of India's import liberalisation policy on its demand for imports. The remainder of this paper is organised as follows. Section 2 gives an overview of import liberalisation in India. The import demand function for India is modelled in section 3. In section 4, the empirical results are reported and discussed. Section 5 concludes the paper.

Section 2

Import Liberalisation in India

Prior to the nineties, the import regime of India was dominated by both quantitative restrictions on imports and a highly protectionist import tariff structure. The tariff structure was characterised by a very high or prohibitive tariff on final goods and a lower tariff on intermediate and primary products. This anomalous import regime, among other factors, has been a major stumbling block for the sustained growth of an efficient industrial structure in India. During the periods 1963-73 and 1973-85 the World Bank classified 41 countries, including India, as "strongly inward-oriented" countries meaning that the overall incentive structure strongly favoured production for the domestic market[1].

The Indian economy has been undergoing substantial changes since 1991. Reform efforts have been continual and strong since 1991, with significant changes occuring in 1993 (Dean, Desai and Riedel, 1994). Almost all areas of the economy have been opened to both domestic and foreign private investment, import licensing restrictions on intermediates and capital goods have been mostly eliminated, tariffs have been significantly reduced, and full convertibility of foreign exchange earnings has been established for current account transactions (Dutta, 1998, p. 11).

More specifically, the following import policy reforms have been introduced in India (Rana, 1997):
(i) Except for a small list of negative items, import licensing has virtually been abolished;
(ii) Quantitative restrictions on imports have been replaced by tariffs; and
(iii) Tariffs have been reduced in stages: the maximum tariff rate was reduced from 400 per cent in 1990-91 to 50 per cent in 1995, and the average duty has been reduced from about 50 per cent to 27 per cent during the same period.

To appreciate the prospects and problems arising out of import liberalisation in India, it may be useful to look into some of the historical trends in terms of the import orientation ratio, import penetration ratio, nominal rates of protection (NRP) and effective rates of protection (ERP)[2]. The data relates to five years before liberalisation (1986-90) and five years after (1991-95).

The import orientation ratio, measured as the average ratio of aggregate imports to GDP, is shown in Table 1. We find a higher import orientation ratio during the 1991-95 period (8.74%) than that in the 1986-91 period (6.98%).

Table 1: Import Orientation Ratio in India, 1986-95

Year	Imports (billions of n. c.)	GDP (billions of n. c.)	Imports as % of GDP
1986	194.50	2929.50	6.64
1987	216.13	3332.00	6.49
1988	266.06	3957.80	6.72
1989	334.01	4568.20	7.31
1990	413.57	5355.30	7.72

1991	459.38	6168.00	7.45
1992	611.13	7059.20	8.66
1993	694.46	8097.70	8.58
1994	842.17	9536.80	8.83
1995	1121.47	10985.80	10.21
		Periodic Averages	
1986-90			6.98
1991-95			8.74

Source: Based on IMF's *International Financial Statistics* (various issues).

Another outcome-based measure of import liberalisation is the import penetration ratio: the average ratio of aggregate imports to aggregate consumption. This is probably a more reliable indicator of restrictive trade policy than the import orientation ratio since in most developing countries, it is imports of consumption goods that are the most stringently restricted (Andriamananjara and Nash, 1997). Table 2 shows a higher import penetration ratio during 1991-95 than that in the period 1986-90.

Table 2: Import Penetration Ratio in India, 1986-95

Year	Imports (billions of n. c.)	Aggregate consumption (billions of n. c.)	Imports as % of aggregate consumption
1986	194.50	2332.30	8.34
1987	216.13	2633.90	8.21
1988	266.06	3047.50	8.73
1989	334.01	3424.40	9.75
1990	413.57	3921.50	10.55
1991	459.38	4513.50	10.18
1992	611.13	5087.80	12.01
1993	694.46	5790.80	11.99
1994	842.17	6701.60	12.57
1995	1121.47	7617.10	14.72
		Periodic Averages	
1986-90			9.12
1991-95			12.29

Source: Based on IMF's *International Financial Statistics* (various issues).

In order to compare the extent of protection of Indian industries through import tariffs, the nominal rate of protection (NRP) and the effective rate of protection (ERP) have been used.

Table 3: Nominal and Effective Rate of Protection in India, 1989-96

Items	Nominal Rate of Protection			Effective Rate of Protection		
	1989-90	**1993-94**	**1995-96**	**1989-90**	**1993-94**	**1995-96**
A. Based on Tariff Rates						
Average (Import weighted)	93.3	62.9	31.0	87.5	60.7	30.4
Average (Simple)	104.8	66.7	35.2	102.0	65.4	34.6
Standard deviation	36.2	26.5	14.5	48.2	33.4	18.5
Coefficient of variation	35	40	41	47	51	53
B. Based on Collection Rates						
Average (Import weighted)	50.0 (55.0)	39.0 (37.0)	31.5* (27.0)	48.8	39.3	32.1*

Average (Simple)	73.0	52.6	40.1*	76.6	55.0	42.0*
Standard deviation	40.0	33.0	27.8*	54.1	56.3	48.6*
Coefficient of variation	55.0	63.0	69.0*	71.0	102.0	116.0

Note: * stands for the year 1994-95.
Source: Mehta (1997), p.781.

Table 3 shows that the average estimated ERP declined from 49 per cent in 1989-90 to 32 per cent in 1994-95, whereas the average NRP came down from 55 per cent in 1989-90 to 27 per cent in 1995-96. It is evident from the table that although the average NRP and ERP declined over the period 1989-96, their dispersion, as measured by coefficient of variation, shows an upward trend. The increased tariff dispersion may be because of (i) the prevalence of multiple tariff rates, and (ii) the continued provision of tariff concessions for end-users.

Section 3

Modelling an Aggregate Import-Demand Function for India

In modelling an aggregate import demand function for India, we follow the imperfect substitutes model, in which the key assumption is that neither imports nor exports are perfect substitutes for domestic goods of the countries under consideration (Goldstein and Khan, 1985). Since India imports only a relatively small fraction of total world imports, it may be quite realistic to assume that the world supply of imports to India is perfectly elastic. This assumption seems to be realistic in the case of India because the rest of the world may be able to increase its supply of exports to this country even without an increase in prices. This assumption of infinite import supply elasticity reduces our model to a single equation model of an import demand function.

Econometric investigations of import demand postulate that the demand for imports is a function of relative prices and real income (Houthakker and Magee, 1969; Leamer and Stern, 1970; Murray and Ginman, 1976; Goldstein and Khan, 1985; and Carone, 1996). Studies by Khan and Ross (1977) and Salas (1982) suggest that in modelling an aggregate import demand function, the log-linear specification is preferable to the linear formulation. Accordingly, the long-run import demand function for India is specified as follows:

$$LRIMPORT_t = \alpha_0 + \alpha_1 LRIMPRICE_t + \alpha_2 LRGDP_t + \alpha_3 D_t + u_t \quad (1)$$

where RIMPORT = real quantity of merchandise imports;
RIMPRICE = relative price of imports;
RGDP = gross domestic product at 1990 prices;
D = a dummy variable with values 0 for 1971-91 and 1 for 1992-95 to capture the effect of import liberalisation on import volume;
u = random disturbance term with its usual classical properties; and
L = natural logarithm

It is expected that $\alpha_1 < 0$; and $(\alpha_2, \alpha_3) > 0$.

The theory of demand suggests that quantity rather than value is the appropriate dependent variable. So we deflate the value series of imports *c.i.f.* by a measure of prices to obtain the proper dependent variable (see APPENDIX 1).

In the model, import price and real income (RGDP) variables are crucial, because the effectiveness of an import trade policy is highly dependent upon the size of their elasticities. The quantity of imports demanded depends upon the price of imports in domestic currency as well as the price of domestically produced substitutes. Since data on the price of domestically produced substitutes are simply not available, researchers use a more general price index, *ie.*, the wholesale price index, the consumer price index, the GDP deflator *etc*. And thus, the range of goods covered in the domestic price index could differ substantially from those covered in the import unit value index.

A dummy variable has been included in the model to capture the effect of the import liberalisation policy on import demand. Import liberalisation, through easing access to imports, is likely to result in a larger aggregate import demand by the economy.

If the time series variables of $LRIMPORT_t$, $LRIMPRICE_t$, and $LRGDP_t$ have unit roots, then we need to take the first difference of the variables (as in equation 2) in order to obtain a stationary series:

$$\Delta LRIMPORT_t = \alpha_0 + \alpha_1 \Delta LRIMPRICE_t + \alpha_2 \Delta LRGDP_t + \alpha_3 D_t + u_t \qquad (2)$$

Equation (2) ignores any reference to the long-run aspects of decision-making. That is, this procedure of differencing results in a loss of valuable "long-run information" in the data (Maddala, 1992). The theory of cointegration addresses this issue by introducing an error-correction (EC) term. The EC term lagged one period (*ie.*, EC_{t-1}) integrates short-run dynamics in the long-run import demand function. This leads us to the specification of a general error correction model (ECM):

$$\Delta LRIMPORT_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta LRIMPORT_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta LRIMPRICE_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta LRGDP_{t-i} + \beta_4 EC_{t-1} + \beta_5 D_t + \varepsilon_t \qquad (3)$$

where EC_{t-1} = error-correction term lagged one period.

The modelling strategy adopted in this study involves three steps:

(i) determining the order of integration of the variables by employing Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF) and Phillips-Perron (1988) unit-root tests;
(ii) if the variables are integrated of the same order, we apply the Johansen -Juselius (1990, 1992, 1994) maximum likelihood method of cointegration[3] to obtain the number of cointegrating vector(s); and

(iii) if the variables are cointegrated, we can specify an error correction model and estimate it using standard methods and diagnostic tests.

Section 4

Empirical Analysis

4.1 Summary Statistics

Data on RIMPORT, RIMPRICE and RGDP for the 1971-1995 period are shown in Table 4 as are their means, standard deviations (SD), coefficients of variation (CV), and annual compound growth rate.

Table 4: Summary Statistics of Variables Used

Variable	Description	Mean	SD	CV	Annual compound growth rate (%)
RIMPORT	Volume of imports	3.47	2.06	0.59	6.9
RIMPRICE	Relative import price	36.26	9.42	0.26	1.2
RGDP	Real Gross Domestic Product	3977.3	1556.1	0.39	4.9

Note: Annual compound growth rates are trend values significant at 5 per cent level.
Source: Authors' calculation based on IMF's *International Financial Statistics* (various issues).

4.2 Unit-Root Tests

In this section we analyse the time-series properties of the data during the period 1971-1995. We have conducted the Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF), and Phillips-Perron (PP) unit root tests. These unit-root tests are performed on both levels and first differences of all the three variables.

The DF-ADF tests (Table 5) and the PP test (Table 6) confirm stationarity for all the three variables (LRIMPORT, LRIMPRICE and LGDP). Interestingly, however, first differencing of all the variables shows stationarity under the tests.

Table 5: DF-ADF unit root tests for stationarity

		DF		ADF (1)		
Variables	**Level/ First Diff.**	**Without Trend**	**With Trend**	**Without Trend**	**With Trend**	**Conclusion**
LRIMPORT	Level	-0.03	-2.49	-0.11	-2.86	I(1)
	First Diff.	-4.95	-4.86	-4.62	-4.58	I(0)
LRIMPRICE	Level	-2.28	-2.07	-2.25	-2.01	I(1)
	First Diff.	-5.26	-5.19	-4.95	-5.06	I(0)
LRGDP	Level	1.50	-2.85	1.90	-2.46	I(1)
	First Diff.	-5.91	-6.38	-3.63	-4.19	I(0)

Notes: (i) Unit root tests were performed using Microfit 4.0.
(ii) 95% critical values for ADF statistic (without trend) = -2.90
(iii) 95% critical values for ADF statistic (with trend) = -3.46

Table 6: Phillips -Perron (PP) unit root test for stationarity

Variables	Level/ First Diff.	Constant, No Trend	Constant, Trend	Conclusion
LRIMPORT	Level	-0.24	-2.16	I(1)
	First Diff.	-5.00	-5.01	I(0)
LRIMPRICE	Level	-2.43	-2.18	I(1)
	First Diff.	-5.29	-5.36	I(0)
LRGDP	Level	-2.03	-2.41	I(1)
	First Diff.	-5.45	-6.38	I(0)

Notes: (i) PP test was performed using SHAZAM 8.0.
(ii) 95% critical values for ADF statistic (without trend) = -2.90
(iii) 95% critical values for ADF statistic (with trend) = -3.46

4.3 Cointegration Tests

Before undertaking cointegration tests, let us first specify the relevant order of lags (p) of the Vector Autoregression (VAR) model. Given the annual nature of the data, $p = 1$ seems to be a reasonable choice (Pesaran and Pesaran, 1997).

The results obtained from the above unit-root tests show that all the three variables are integrated of order one. On the basis of the above unit-root tests, we apply the Johansen (1988 and 1991) and Johansen and Juselius (JJ) (1990, 1992, 1994) cointegration tests. Table 7 presents the results obtained from the JJ method.

Table 7: Johansen-Juselius Maximum Likelihood Cointegration Tests

Null	Alternative	Statistic	95 % Critical Value
		Maximal Eigenvalue Test	
$r = 0$	$r = 1$	36.34	22.04
$r \leq 1$	$r = 2$	11.01	15.87
$r \leq 2$	$r = 3$	5.63	9.16
		Trace Test	
$r = 0$	$r \geq 1$	52.98	34.87
$r \leq 1$	$r \geq 2$	16.64	20.18
$r \leq 2$	$r \geq 3$	5.63	9.16

Notes: (i) The test was performed using Microfit 4.0.
(ii) r stands for the number of cointegrating vectors.

In Table 7 the results of both maximal eigenvalue and trace tests are reported. Starting with the null hypothesis of no cointegration (r = 0) among the three variables of LRIMPORT, LRIMPRICE and LRGDP, both the maximal eigenvalue and the trace statistic suggest r = 1. Therefore, we conclude that there is only one cointegrating relation among the variables. Estimates of long-run cointegrating vectors are given in Table 8.

Table 8: Estimates of Long-Run Cointegrating Vectors (Linearised)

LRIMPORT	LRIMPRICE	LRGDP
1.00	-0.37	-0.03
	(2.39)	(3.92)

Notes: 1. The long-run equilibrium relation is:
LRIMPORT = -0.37LRIMPRICE - 0.03LRGDP
2. Figures in parentheses indicate standard errors.

4.4 Estimation of an Error-Correction Model

Once a cointegrating relationship is established, then an Error-Correction Model (ECM) can be estimated to determine the dynamic behaviour of import demand. Following Hendry's (1995) general-to-specific modelling approach, we first include 4 lags of the explanatory variables, and then gradually eliminate the insignificant variables. After experimenting with the general form of the ECM (equation 3), the following model is found to fit the data best (Table 9):

Table 9: Estimated Error-Correction Model

Dependent Variable: ΔLRIMPORT			
Regressors	**Parameter Estimates**	**T-Ratio**	**P-Values**
Intercept	0.25	1.52	0.15
ΔLRIMPRICE	-0.47	-3.78	0.00
ΔLRGDP(-2)	1.48	1.97	0.05
D	0.14	1.51	0.15
EC (-1)	-0.12	-1.98	0.05
Adj R^2 = 0.59 D. W. = 2.53 Serial Correlation = 2.45 (0.12) RESET = 0.65 (0.42) Normality = 1.85 (0.40) HET = 0.02 (0.88)			

In the above estimated model, real import price, real GDP (lagged two years) and the dummy variable capturing the effect of import liberalisation on import volume have emerged as significant determinants of the import demand function for India.

The aggregate import volume is found to be price-inelastic, the coefficient estimate being -0.47. The value of income elasticity of demand for imports lagged two years is greater than unity (1.48 in the model), implying that the demand for imports increases more than proportionately to the increase in real GDP. The income and price elasticity estimates are in line with the Goldstein-Khan ranges of [-0.50, -1.0] for typical price elasticity and [1.0, 2.0] for typical income elasticity (Goldstein and Khan, 1985). The coefficient estimate of the dummy variable is low (0.14) and is statistically significant above 10 per cent level.

The estimated coefficient of the error correction term (-0.12) is statistically significant at the 5 per cent level and with the appropriate (negative) sign. This suggests the validity of a long-run equilibrium relationship among the variables in equation (1). The estimated coefficient value of -0.12 suggests that the system corrects its previous period's disequilibrium by 12 per cent a year. Diagnostic test statistics show no evidence of misspecification of functional form, no serial correlation, nor any problem of heteroscedasticity.

Section 5

Summary and Conclusions

In this paper we have examined the effect of import liberalisation on India's import demand both at the aggregate level. In our empirical analysis of the aggregate merchandise import demand function for India, cointegration and error correction modelling approaches have been used. In the aggregate import demand function, aggregate import volume is found to be cointegrated with relative import price and real GDP. In the estimated ECM, real import prices, real GDP (lagged two years) and a dummy variable, introduced to capture the effect of import liberalisation policies on import demand, have all emerged as important determinants of the import demand function for India. The estimated coefficient of the error correction term (-0.12) indicates a slow speed of adjustment to equilibrium.

Our econometric estimates of the aggregate import-demand functions for India suggest that import-demand is largely explained by real GDP, which relates to the general level of economic activity in the country. The demand for imports appears to be less sensitive to import price changes. This implies that a lowering of import prices through removal of tariff and non-tariff barriers will not lead to a proportionate rise in the flow of imports. This also reflects the noncompetitive nature of India's imports. The result that the quantity of imports is influenced largely by changes in real GDP than import prices is significant, since it reveals the ineffectiveness of exchange rate policy in influencing import demand. Moreover, the low coefficient estimate of the dummy variable shows little effect of import liberalisation policy on aggregate import volume.

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APPENDIX 1
Variable Definitions and Data Sources of an Aggregate Import Demand Function for India

In the empirical analysis of an aggregate import demand function for India we use annual data for the period 1971-1995. All the variables are expressed in real terms. Natural logarithms are taken on all variables.

RIMPORT: Nominal value of aggregate merchandise imports c.i.f. is deflated by the unit value index of imports (1990 = 100) to obtain real quantity of imports.
Source: IMF, *International Financial Statistics* (various issues).

RIMPRICE: Relative price of imports (1990 = 100). This is obtained by the unit value index of imports (1990 = 100), adjusted for import tariff rate, deflated by Wholesale Price Index.
Source: IMF, *International Financial Statistics* (various issues).
RGDP: Gross Domestic Product at 1990 prices. .
Source: IMF, *International Financial Statistics* (various issues).

D = An intercept dummy variable with values 0 for 1971-1991 and 1 for 1992-1995 is taken to capture the effect of import liberalisation on the volume of aggregate imports.