Import Demand Function for Petroleum in India during Liberalization

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ABSTRACT

At the end of seventies, Indian foreign trade sector received a big jolt on account of ongoing price hikes of petroleum products by OPEC and entire Indian economy got exposed to international economic shocks to a greater extent. This paper estimates a petroleum import demand function for India for the period 1981:04-2006:03. In our empirical analysis of the petroleum demand function for India, cointegration and error correction modeling approaches have been used. Empirical results suggest that there exists a unique long-run or equilibrium relationship among quantities of imports of petroleum, relative import price, income variable, wholesale price index, total import duty, and foreign exchange reserve.

Key words: *Demand function, Equilibrium, unit root, Cointegration, and error correction model*

1. Introduction

At the end of seventies, Indian foreign trade sector received a big jolt on account of ongoing price hikes of petroleum products by OPEC and entire Indian economy got exposed to international economic shocks to a greater extent. The value of imports exceeded the value of exports by high margins in the subsequent years resulting in soaring trade deficits and it finally led the Indian Government to approach the IMF in November, 1981 for a huge loan. During the years 1982-83 onwards, however, it was possible to check internal demand for POL through various policy measures, especially through domestic exploration of oil by ONGC and demand rationing. But the trend of Indian imports did not turn back and thus imports went on rising heavily. This can be explained by the fact that India gradually stepped in the era of weak liberalization through import liberalization and changes in licensing policy of import licenses.

2. Review of Literature

The study of empirical estimation of import demand in economics has been traced back to take place in the sixties (Ball and Marwah, 1962). There is vast literature on empirical studies on this issue. Murray and Ginman (1976) in a methodological study on the specification problem of import demand function criticize the traditional aggregate import demand function that uses the price variable as a ratio of import price to domestic price. Khan and Ross (1977) go through vigorous theoretical analysis to establish on empirical grounds whether the linear or log-linear specification of imports demand function is to be adopted as imports demand model and used the OLS method to estimate. In Erlat and Erlat's(1991) study who applied Seemingly Unrelated Regression (SUR), the total volume of imports is regressed on real income, price of imports (including tariffs) relative to domestic prices, real internal reserves and one period lagged value of the dependent variable. Dutta and Ahmed (1997) have estimated the imports demand function for Bangladesh for the period 1974-1994 with the help of Cointegration tests, Error Correction Model and VAR model. Sinha (1997) estimates both the short-run and the long-run imports demand functions for Thailand for the time span 1953-1990 using cointegration approach. In another study by Kotan and Saygili (1999) the imports demand function for Turkey is estimated using quarterly data for the period 1987:1 to 1999:4. Saygili, et al (1999) has estimated the short-run and long-run imports and exports demand functions. In an important study by Huseyin Kalyoncu(2006) an import demand function for

Turkey for the period 1994:01-2003:12 is estimated. The author has used the functional form as was introduced by Mayes (1981) as

$$\ln M = a_0 + a_1 \ln Y + a_2 \ln(P_m / P_d) + u$$

where Y is some measure of national income and, P_m and P_d are the import price and the domestic price of the substitutes in the economy, respectively. Using the time series techniques of econometrics such as the ADF test and the Phillips –Perron unit root test the author reached the conclusion that all the data are nonstationary at levels. Therefore, cointegration tests (Engel-Granger test and Johansen-Juselius) are applied and it comes out that there is at least one cointegrating relationship involving the variables. The VAR model is also used. The conclusion in favour of a unique equilibrium to exist among the real quantity of imports, relative prices and real GNP is established.

3. Objectives of the Study

The Cointegration approach to look into the impact of liberalization on India's import demand for petroleum consists of five distinct steps. First, since we shall use time series data, we have felt the necessity of getting our data free from seasonal and cyclical fluctuations by the Hodrick Prescott method (1997).

Our ultimate objective is to know whether there is any stable long-run relationship between the quantity of import time series and its other explanatory variables such as import prices, income variable, exchange rate, foreign exchange reserve, total import duty and wholesale price index.

4. Methodolody and Data

We have used the monthly data from 1981:04 to 2006:03. Second, we shall use the tests of CUSUM and CUSUM of squares of the recursive residuals to locate the exact time period when the structural shift in India's imports occurred. Third, once we confirm the time point of structural break by the tests of stability, we shall use the unit root tests for all the time series variables in the periods of weak liberalization as well as of strong liberalization and the entire time period following Dickey–Fuller (1979) and Phillips-Perron (1988) to confirm the stationarity of the data we use. Fourth, Granger-causality (Granger, 1969) between the demand for imports of petroleum and its several determinants will be examined for both of the liberalization periods and for the entire period. We would like to test the cointegration of the demand for imports and its various determinants by Engel-Granger (1990) and Johansen-Juselius (1990) test procedures and examine whether there exists a unique long-run stable equilibrium import demand function. Fifth, the cointegrating regression of the aggregate import demand on its postulated explanatory variables will be estimated by least squares method. Finally, an error correction model will be offered.

Petroleum Import Demand Function

Model 1: Import Demand Function for Petroleum at the First Differences of the Variables

$$D(\ln IMP)_t = C(1)+C(2)*D(\ln IMPR)_t+C(3)*D(\ln IIP)_t+C(4)*D(\ln EXR)_t+C(5)*D(\ln FER)_t +C(6)*D(\ln CSDT)_t +C(7)*TIME +C(8)*(PIMPACTDV)_t +U_t \quad (3.6)$$

Model 2: Import Demand Function for Petroleum at Levels of the Variables

$$\ln(IMP)_t = C(1)+C(2)*\ln(IMPR)t+C(3)*\ln(IIP)_t+C(4)*\ln(EXR)_t+C(5)*\ln(FER)_t + C(6)*\ln(CSDT)_t +C(7)*(TIME)_t+C(8)*(PIMPACTDV)_t+U_t \quad (3.7)$$

Where,

ln(IMPET): Natural log of India's Import Quantity of Petroleum in '000 Tonnes. The Import Quantity has been deflated by the wholesale price at 1993 – 94 base in order to get real import quantity.

ln(IMPRPET): Natural log of India's Import Price of Petroleum per tonne in US $ relative to the whole sale price. It is expected to affect the quantity of imports inversely.

ln(IIP): Natural log of India's Index of Industrial Production relative to the wholesale price at base 1993 – 94. The monthly data on the Index of Industrial Production has been considered as a proxy variable for the GDP, since the monthly data of GDP are not available. It is expected to affect the quantity of imports favourably.

ln(EXR): Natural log of Exchange Rate of Rupee per unit of US $. It is expected to affect the quantity of imports inversely.

ln(FER): Natural log of Foreign Exchange Reserves in US $ million. It includes gold, SDRs and foreign exchange reserves. It is expected to affect the quantity of imports favourably.

ln(CSDT): Natural log of Custom Duty in US million $. The Custom Duty has been considered as a proxy variable in the absence of suitable data of tariff on imports of goods and services. It is expected to affect the quantity of imports adversely.

ECT: Error Correction term taken in one period lag. It is the estimated residuals in the regression of ln(IMP) on its determinants. Its coefficient is expected to be negative. The value of the coefficient of the **ECT** tells us to what extent the error due to the fact of being out of equilibrium is corrected. Its absolute value ensures the speed of adjustment to reach the equilibrium.

TIME: Measured in monthly unit.

PIMPACTDV: Policy Impact Dummy Variable, which takes the value '0' for weak liberalization period and '1' for strong liberalization period. The choice of the break point due to liberalization for structural shift in India's import demand has been confirmed by the tests of CUSUM and CUSUMSQ of the recursive residuals. Since we have used the semi-logarithmic model, the coefficient of **PIMPACTDV** should be interpreted by looking at the growth rate, which is calculated by the formula **((exp(Coefficient of PIMPACTDV) - 1)*100))%.**
$\mathbf{U_t}$ **=** Pure white noise with all standard classical assumptions.

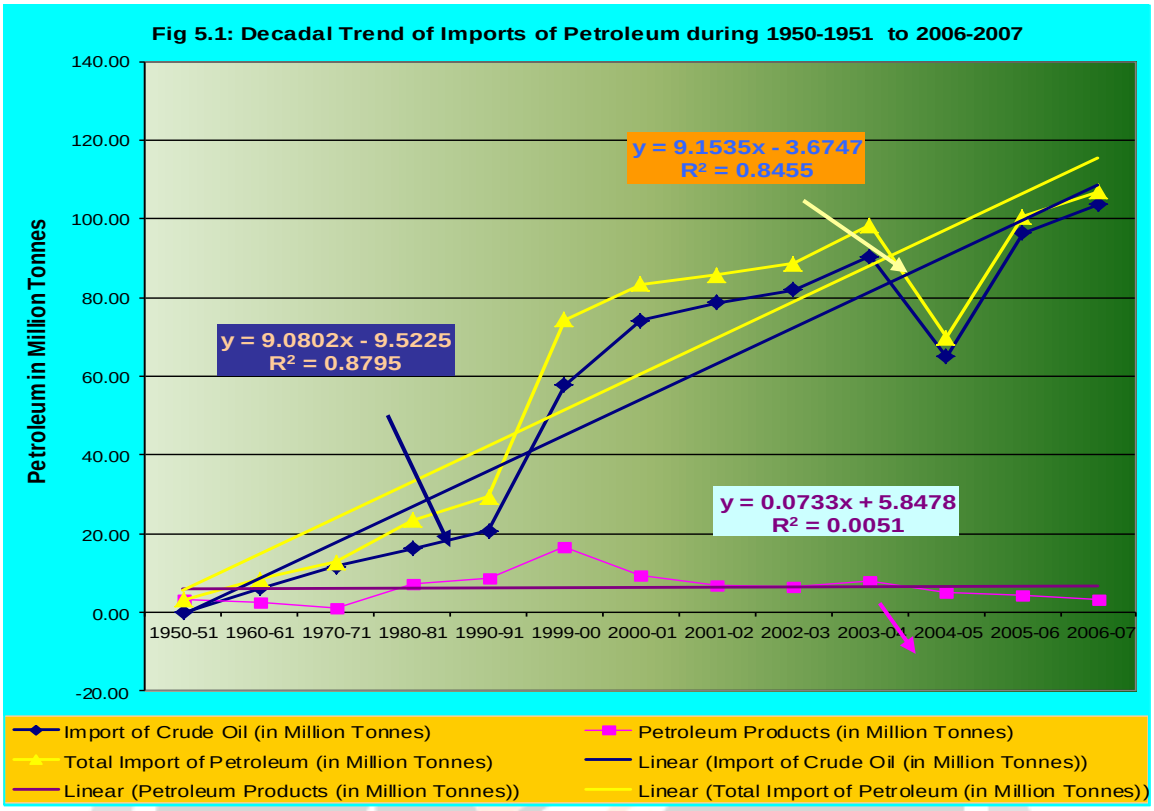
5. Results and Data Analysis

The growth rate of import of crude petroleum is seen to be comparatively higher to the growth rate of import of petroleum products. The growth rate of crude oil was as high as 179.23 per cent within 1999-00 to 2000-01, the period in which liberalisation measures had been initiated In recent years the growth rate of import of crude petroleum has been no less than 20 per cent to 40 per cent per year. On contrary to that the petroleum products have remained stagnant and very recently its growth rate has become negative. It may indicate to the set-up of domestic industries of petroleum by-products in our country.

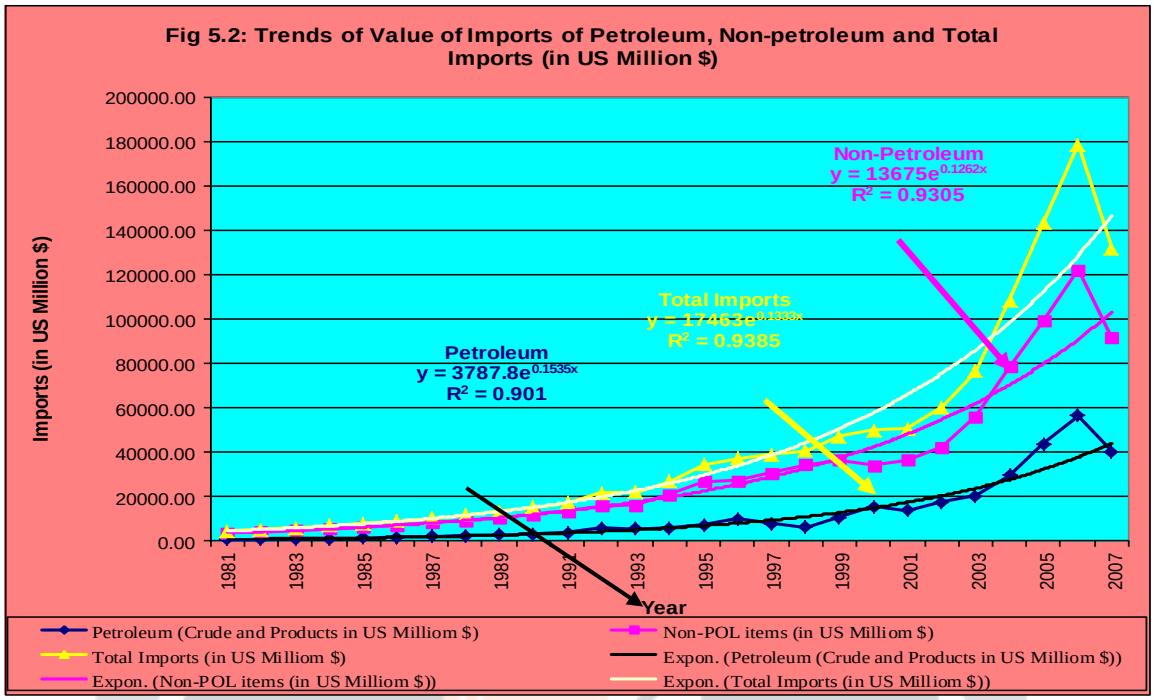
Table 1.

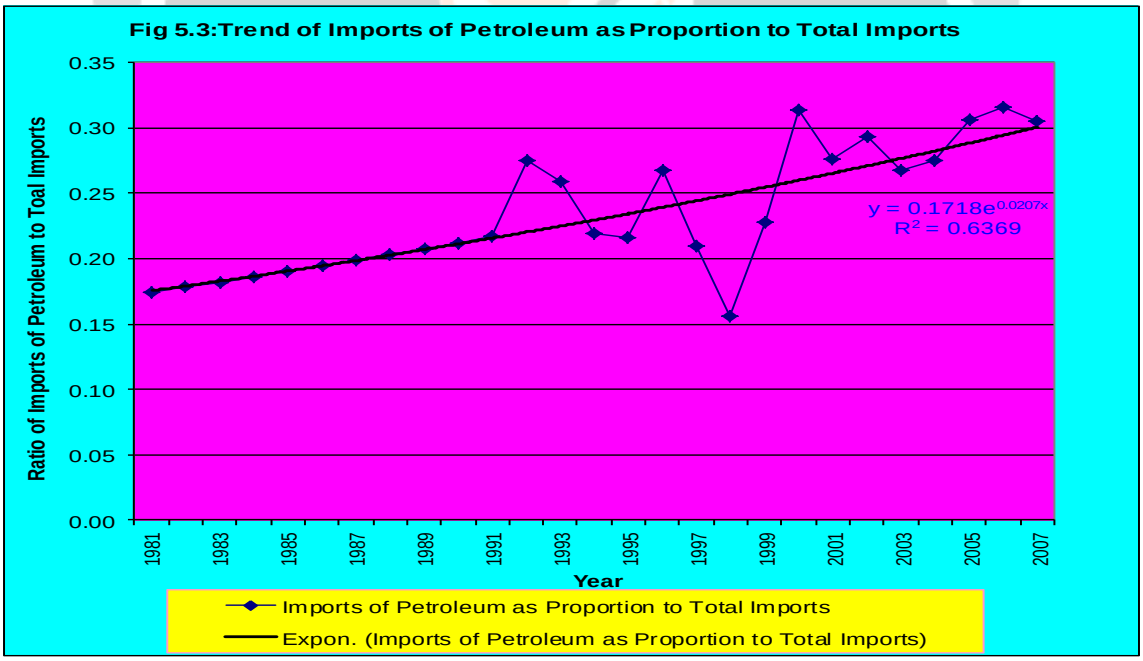
Decadal Growth Rate (%)			
Year	Import of Crude Oil	Petroleum Products	Total Import of Petroleum
1950-51	--	--	--
1960-61	N.A.	-19.35	174.19
1970-71	95	-56	50.59
1980-81	38.46	563.64	83.59
1990-91	27.78	19.18	25.11
1999-00	179.23	90.8	153.06
2000-01	28.2	-43.98	12.1
2001-02	6.21	-24.73	2.76
2002-03	4.19	-4.29	3.5
2003-04	10.24	17.91	10.82
2004-05	-28.21	-36.71	-28.89
2005-06	48.43	-14	43.96
2006-07	7.63	-25.83	6.2

When non-petroleum imported goods are compared to the petroleum imports the picture is such that the growth rate of petroleum import is 0.15 per cent per year whereas the growth rate of non-petroleum goods is 0.13 per cent per year and the overall growth rate is 0.13 per cent per year. It has been depicted in Figure 5.2 by using exponential trend line each for petroleum, non-petroleum imports and total imports.



Petroleum is regarded as one of the major imported item in India. The empirical support to this statement is clear from Figure5.3. The figure shows that exponential trend line of imports of petroleum relative to total imports has a positive slope implying that over time the share of imports of petroleum in total imports has risen on an average. It clearly justifies our current exercise of estimation of long-run petroleum import demand function for India. We have postulated that Petroleum import demand is a function of Petroleum import prices, index of industrial production (working as a proxy of national income variable), exchange rate, wholesale price index, Indian foreign exchange reserve, total import duty, time and a policy impact dummy variable where policy implies liberalization policies. For the purpose of estimation we use monthly time series data for relevant variables for the time span of 1981:04 to 2006:03. It is imperative that we filter the entire dataset before using it for the purpose of estimation. We take help of the sophisticated Hodrick-Prescott filtering tool to do this.





5.1 Test of Structural Stability

In this paper we anticipate that due to various policy implementations of liberalization under economic reform in India that was necessitated by the WTO era of globalization, import pattern must have entailed a structural shift. We will first use Chow Breakpoint test to locate the time point of structural change in petroleum import and taking the time point as the point of structural shift due to liberalization we will carry on standard time series analysis as before in order to check whether the time series data are stationary. If there exists long-run equilibrium relationship among the time series variables we are using in specifying the import demand function

for petroleum then we estimate the long-run import demand function and also go through the estimation of error correction model at the end.

Table-2. Chow Test for Structural Stability for Imports of Petroleum.

Chow Breakpoint Test: 1993:10			
F-statistic	591.018*	Probability	0.000000
Log likelihood ratio	619.342*	Probability	0.000000

Author's own calculation based on secondary data. * stands for significant at 1%. ** stands for significant at 5% and *** stands for significant at 10% level.

In Table-2 the Chow test results show that the point of shift in imports data for petroleum is detected to be at the end of the year 1993, i.e., at the 10th month of 1993. We shall take this as the time point of structural shift and carry on our other estimations. The Chow test confirms us that the structural breakpoint has really occurred at the tenth calendar month of the year 1993 with high level of confidence.

Table-3: The Phillips-Perron Tests for Unit Root at Levels and at First Differences across Different Phases of Liberalisationfor Imports of Petroleum

		ModerateLiberalisationPeri (1981:04 – 1993:09)			**Strong LiberalisationPeriod (1993:10 – 2006:03)**			**Entire Period (1981:04 – 2006:03)**		
Variable with Length of La (12)♥		**No Interce and No Trend**	**Intercep and No Trend**	**Intercep and Trend**	**No Interc and No Tren**	**Intercep and No Trend**	**Intercep and Trend**	**No Interc and No Tren**	**Intercep and No Trend**	**Intercep and Trend**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
At Levels	**lnIMPET**	6.102	3.066**	2.503	6.822*	-6.936*	-1.559	-8.156*	-0.776	-1.394
	lnIMPRPE	7.221	0.877	-2.717	5.079*	-0.340	-1.068	-7.281*	-1.486	-0.248
	lnIIP	16.229	-2.453	1.812	21.554*	0.096	-0.716	-23.684	-0.141	-1.091
	lnEXR	11.318	2.613**	0.266	3.964*	-3.838*	2.973	-6.300*	-3.927*	-2.291
	lnFER	-6.904	-9.006*	-4.651*	24.111*	3.852*	4.492*	-13.142	-3.486*	-3.231**
	lnCSDT	-3.152	-1.918	-4.249*	-2.267*	-0.868	-0.290	-1.263	-0.358	-1.837
	lnWPI	-29.028	-11.970	-4.741*	18.757*	-5.456*	-11.027	-18.582	-2.838**	-1.255
At First Difference	**lnIMPET**	-9.987	-12.000	-15.443	-6.207*	-11.183	-15.392	-11.528	-17.509	-17.697
	lnIMPRPE	-2.772	-3.018**	-4.080*	-2.907*	-3.380**	-5.330*	-3.679*	-4.493*	-4.829*
	lnIIP	-2.756	-3.538*	-4.180*	-2.165**	-3.682*	-5.739*	-3.025*	-4.758*	-4.732*
	lnEXR	-3.095	-3.722*	-4.467*	-2.265*	-3.056**	-4.920*	-3.594*	-4.444*	-4.910*
	lnFER	-2.624	-3.592*	-4.530*	-2.521**	-3.219**	-4.926*	-2.759*	-4.071*	-4.748*
	lnCSDT	-3.210	-3.873*	-4.710*	-2.904*	-3.985*	-5.013*	-2.916*	-4.202*	-4.838*
	lnWPI	-2.374*	-3.781*	-4.716*	-4.054*	-4.823*	-5.509*	-4.125*	-4.406*	-5.360*
Level of Significance		***MacKinnon Critical Values for Rejection of Hypothesis of a Unit Root.**								
		No Intercept and No Trend			**Intercept and No Trend**			**Intercept and Trend**		
	1%	-2.5728			-3.4549			-3.9935		
	5%	-1.9407			-2.8717			-3.4269		
	10%	-1.6162			-2.5722			-3.1364		

Author's own calculation based on secondary data. * stands for significant at 1%. ** stand s for significant at 5% and * stand for significant at 10% level. ♥ The length of lags has been confirmed by**

the AIC and SBC Criteria. (Newey-West suggests: 5). Lag truncation for Bartlett kernel: 5. Lag truncation for Bartlet-Kernel: 4 and (Newey-West suggests: 4) for the segmented Data.

Interesting is the result that under the PP test most of the series are stationary even at levels with as high as 99% level of confidence in each phase of liberalization and also for the entire period. It is because the ADF test is biased in acceptance of unit root in the presence of structural shift in data (see Enders, 1995).

6. Summary and Conclusion

In this paper our objective was to check whether there exists any long-run equilibrium relationship between the import variable and its proposed explanatory variables and if there is any then to estimate the long-run equilibrium relationship. On the basis of foregoing tests we may conclude that there exists a unique long-run stable or equilibrium relationship between the quantity of import demand and its proposed explanatory variables such as imports prices, income, exchange rate, foreign exchange reserve and wholesale price index based on the data for the time span of 1981:04 to 2006:03. Hence we estimate an aggregate import demand for India for the relevant time period. The major findings are now listed for convenience.

- Exchange rate affects the import demand in the strong liberalization period favourably. The seed of this favourable effect lies in increasing purchasing power of Indian rupee. If that trend is continued import demand is sure to flourish in future.
- Total import duty naturally discourages import demand. Though tariff and other trade barriers are to be reduced according to the IMF conditionalities, due to various unfavourable international political obstacles it cannot be done too hurriedly as that may harm our domestic industries (including agriculture) badly.
- The domestic price increase has positive impact on import demand; especially, after the norm of import liberalization has been implemented vigorously. Even if a slight change in domestic price induces the domestic buyers to trade off in favour of imported goods.

We also estimate two separate aggregate import demand functions relevant for the weak liberalization period and the strong liberalization period for this time span while taking 1993:10 to be the time point for structural shift in the import model due to the advent of strong liberalization regime in India. Major conclusion regarding the impact of change in the degree of liberalization on the import demand for petroleum is that import depends significantly on all the included variables but complete impact out of such policy regime is yet to come.

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