An Aggregate Import Demand Function for Malaysia: A Cointegration and Error Correction Analysis

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This paper examines the long run relationship between Malaysia's aggregate imports and income and relative prices using Johansen cointegration analysis. Annual data for the period 1970 to 1998 were used. The estimated long run elasticities of import demand with respect to income and relative prices are 1.5 and -1.8 respectively. In the short run, growth in imports is influenced by growth in current income and relative prices. The insignificance of the lagged error correction term in the ECM implies that there is no disequilibrium in the long run relationship. As import demand is income elastic in the long run, economic growth may have negative implications on the balance of payments. The high long run cross price elasticity suggests that domestic inflation needs to be kept in check, as domestic inflation would increase the volume of imports.

Key words: cointegration, elasticities, error correction, equilibrium, import demand

Kertas ini mengkaji hubungan jangka panjang antara import agregat Malaysia dan pendapatan dan harga relatif menggunakan analisis kointegrasi Johansen. Data tahunan bagi tempoh 1970 hingga 1998 telah digunakan. Keanjalan jangka panjang yang dianggar bagi permintaan import terhadap pendapatan dan harga relatif masing-masing 1.5 dan -1.8. Dalam jangka pendek, pertumbuhan import dipengaruhi oleh pertumbuhan dalam pendapatan dan harga relatif. Ketaksignifikanan sebutan pembetulan ralat tertangguh dalam model pembetulan ralat (ECM) membawa makna tidak wujud ketakseimbangan dalam hubungan jangka panjang. Oleh kerana permintaan import adalah anjal terhadap pendapatan dalam jangka panjang, pertumbuhan ekonomi mungkin membawa implikasi negatif kepada imbangan pembayaran. Keanjalan harga silang jangka panjang yang tinggi bermakna inflasi dalam negeri perlu dikawal kerana inflasi boleh mengakibatkan peningkatan dalam volum import.

Kata kunci: kointegrasi, keanjalan, pembetulan ralat, keseimbangan, permintaan import

A major characteristic of the Malaysian economy is its openness. Since achieving Independence in 1957, the degree of openness has increased quite significantly. The value of gross imports of goods and non-factor services as a percentage of Gross National Product (GNP) has shown an upward trend. The import share increased steadily from 45.7 percent in 1970 to 57.1 percent in 1980 and 104.5 percent in 1995 (calculated from data in Bank Negara Malaysia, Quarterly Bulletin, various issues). During the same period the import structure has also changed dramatically. In 1970 the share of consumption goods, investment goods and intermediate goods to total imports stood at 28.5 percent, 25.2 percent and 35.3 percent respectively. The corresponding figures for 1995 were 14.2 percent, 40.5 percent and 44.7 percent (refer to Table 1). The figures show a significant increase in the import share of investment and intermediate goods imports.

The rapid increase in imports and changes to the import structure reflects the dynamic process of development experienced by the Malaysian economy. The shifts from import substitution industrialisation in the 1960s to export-oriented industrialisation in the 1970s, and industrialisation based on heavy industries in the 1980s, together with sound macroeconomic policies, enabled the economy to achieve rapid economic growth and significant structural changes. The economy has been transformed from an agriculture-based economy to a manufacturing based economy with export orientation. All these have implications on the import trend and structure. During the 1980-1996 period the overall balance of payments (current account and capital account combined) showed a surplus except for a few years (1981, 1982, 1983, 1988, 1994 and 1995). The strengths of the balance of payments come from the trade balance, which enjoyed a surplus (except for the years 1981, 1982 and 1983), and the capital account, which registered significant inflows of foreign direct investment. The magnitudes of the income elasticities and price elasticities of exports and imports would therefore influence the effectiveness of trade policies in relation to the balance of payments and development policies adopted. In this connection, empirical estimates of these parameters would help in the formulation of policies.

TABLE 1

Share of gross imports by economic function

Category	1970	1975	1980	1985	1990	1995
Consumption goods	28.5	22.2	18.2	20.3	16.4	14.2
Investment goods	25.2	31.7	30.0	31.1	37.5	40.5
Intermediate goods	35.3	41.3	50.1	47.7	45.4	44.7
Others	11.0	4.8	1.7	0.9	0.7	0.5
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: BNM Quarterly Bulletin. Various issues.

Many researchers have carried out empirical studies on the Malaysian import demand behaviour (Awang, 1988; MIER Annual Model, 1990; Mohammad, 1980; Semudram, 1982). The studies may be categorised as single equation studies or as part of macroeconometric models of the Malaysian economy. These studies generally estimated a traditional form for the demand function, that is, regressing the volume of imports on the level of real income and relative prices. The assumption made is that there is an underlying equilibrium relationship between the quantity of imports and the explanatory variables included in the model. The partial adjustment framework is used to model the adjustment of actual quantity of imports to its long run equilibrium value. If the underlying assumption that there exists a long run relationship is false, attempting to estimate the traditional formulation is invalid (Mah, 1994: 291). In addition, these studies were undertaken before it was fashionable to apply the methodology of cointegration and error correction modelling (ECM).

The primary objective of this paper is to estimate the Malaysian import demand function using cointegration and error correction modelling methods. Long run and short run import price and income elasticities will be estimated and their implications to policies spelt out. Recent advances in time series methodology allow us to test for the presence of an equilibrium relationship between the variables that appear in the import demand function. Engle and Granger (1987) have shown that even though an economic series may wander over time, there may exist a linear combination of the variables that converges to an equilibrium, that is, the variables are cointegrated. Examples of application of cointegration and ECM to import demand studies are found in Bahmani-Oskooee and Rhee (1997), and Mah (1993, 1994).

This study is justified by the following considerations. Firstly, by using recent advances in time series analysis, we can handle the problems that arise as a result of the presence of non-stationary data. Hence we can avoid the problems associated with 'spurious regression.'

Secondly, estimates of import price elasticities can be used to determine the efficacy of exchange rate policies for small open economies (such as Malaysia) which are dependent on imports of investment and intermediate goods. In 1972 these categories of imports constituted 68.5 percent of total Malaysian imports. The corresponding figure for 1995 is 85.3 percent. Awang (1988) found imports to be inelastic with respect to both income and relative price with short run elasticities of 0.29 and -0.28 respectively. The MIER Annual Model disaggregated imports into three categories: imports of primary commodities, imports of oil and imports of manufactures. Short run income and relative price elasticities of imports of manufactures are 1.35 and -0.912 respectively. The corresponding estimates of long run elasticities are 1.42 and -0.96. But these findings are based on non- stationary data. Heien (1968) has argued that the effectiveness of devaluation 'for any country a value of the price elasticity between -0.5 and -1.0 is necessary to ensure success of exchange depreciation.' A study by Gafar (1988) on import demand in Trinidad and Tobago estimated price elasticities in the range suggested by Heien, suggesting that exchange rate policies can be used to correct for balance of payments disequilibrium.

Thirdly, the Economic Crisis of 1997-1998 faced by East Asian economies including Malaysia has implications on import demand, especially with a view to 'control' imports in order to correct balance of payments disequilibrium. The current account of the balance of payments has consistently registered a deficit during the 1990s up to 1997, with the deficit peaking in 1995. The current account deficit in 1995 was RM21,647 million or 10.4 percent of Gross National Product (GNP). But in 1998, the current account registered a surplus of RM36,068 million or 13.7 percent of GNP. The sharp turnaround has been due to the slower growth of imports as a result of sharp decline in economic growth and the negative effect of the depreciated Ringgit on the demand for imports (Malaysia, 1999: 41). In recent years, the deficit in the current account of the balance of payments has been affected by a declining trend in the trade balance as a result of a steady increase in the imports of investment and intermediate goods. An important characteristic of Malaysian exports is the high import content, especially the exports of electrical and electronic goods. Both constitute a large percentage of total exports. This situation has its beginnings in the implementation of an import substitution strategy in the mid-1960s and the early 1970s. The 1970s saw the implementation of an export-led industrialisation strategy based on assembly type operations (see Feature Article 5 'Changing Structure of Malaysian Imports' in Economic Report 1991/92).

In mid-1997 the Government took several measures to reduce imports of goods and services, particularly lumpy imports. These measures included the postponement of projects with high import content, reduction of Government spending, promoting the use of domestic goods as well the imposition of high duties on construction materials and equipment, consumer durables and motor vehicles. The National Economic Recovery Plan (NERP) document has outlined several measures to strengthen the trade balance (Malaysia, 1998). The measures that are related to imports are:

1. To give priority to the development of resource-based industries. These industries are known to have low import content.
2. To accelerate the development of backward linkages for non resource-based industries in order to increase the utilisation of local inputs.

The results of this study can be used to evaluate the efficacy of exchange rate policies and to evaluate the effectiveness of Government policies to strengthen the trade balance.

The plan of the paper is as follows. Section 2 describes the method and data used in the analysis. The empirical findings are reported in Section 3. The final section gives a summary of the study and analyses its policy implications.

Method and Data

Traditional formulation of import demand equation relates the quantity of import demanded to domestic real income and the ratio of import prices to domestic prices. In this study we adopt the specification used in Gafar (1988) as shown in equation (1).

$$M_t^* = f[Y_t, (Pm_t / Pd_t)] \qquad (1)$$

where Mt* is desired quantity of imports demanded at period t, Yt is real Gross Domestic Product, (Pmt/ Pdt) is a relative price term (denoted as Pt henceforth) defined as the ratio of import price index Pmt to domestic price level, Pdt. Therefore, the traditional import demand function can be rewritten as:

$$M_t^* = f(Y_t, P_t) \qquad (2)$$

Both the linear and log-linear specifications have been used in empirical studies, with the latter being the most commonly adopted. In this study, we employed the log-linear formulation as it is deemed to be more appropriate than the linear one (see Doroodian, Koshal & Al-Muhanna, 1994). The use of the log-linear specification also avoids some estimation problems, particularly multicollinearity (Gafar, 1988). The log-linear model is specified as:

$$M_t^* = a + b_1 Y_t + b_2 P_t + e_t \qquad (3)$$

where e_t is the random error, assumed to satisfy classical assumptions. From economic theory, it is expected the signs of the coefficients to be as follows: $b_1 > 0$ and $b_2 < 0$.

All variables are in natural logarithmic form (ln). The data used in this study are annual from 1970 to 1998 obtained from the International Financial Statistics. Figure 1 below shows the long-run trend of the included variables. Both logarithms of imports and GDP show an upward trend. No discernible trend is observed in the logarithms of relative prices. No significant structural breaks are observed in the data series.

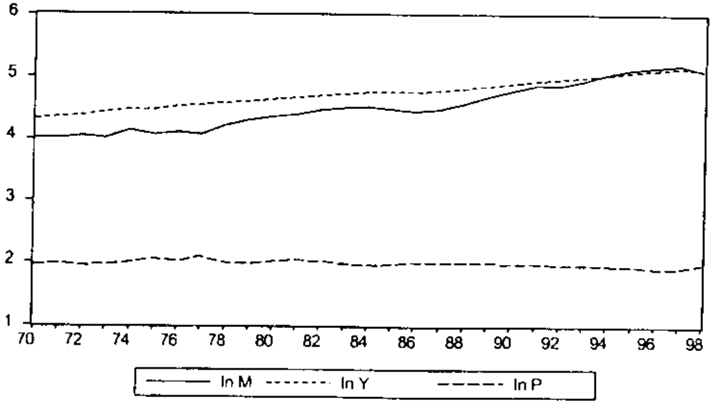

FIGURE 1. *Plot of log of Imports (ln M), Real GDP (ln Y), and Relative Price (ln P)*

We began by investigating the stability properties of the variables. According to Phillips (1987), regressions involving levels of variables that are I (1) but not cointegrated will yield spurious results. The implication of this is that only cointegrated variables are to be used in regressions that involve levels of the variables.

In Table 2 we report the results of the unit root tests. Both the Augmented Dickey Fuller (ADF) and the Phillips-Perron (PP) tests were conducted. The PP test was designed to be robust for the presence of autocorrelation and heteroscedasticity.

The regression equation for the ADF test (see Dickey & Fuller, 1979) is given as follows:

$$\Delta Y_t = a + bt + cY_{t-1} + \sum_{i=1}^{k} d_i \Delta Y_{t-i} + e_t \qquad (4)$$

where Δ is first difference operator, t refers to time trend, and k is additional terms in the first differences for the Augmented Dickey-Fuller (ADF) test et is the regression error assumed to be stationary with zero mean and constant variance. The Phillips and Perron test is also based on equation (4) but without the lagged differences. Both tests were carried out to reject the null hypothesis of a unit root ($c = 0$ for ADF, and $c = 1$ for PP). The results are presented in Table 2, which show that all variables, volume of import, real GDP, and relative prices are integrated of order one, I (1), i.e. stationary in their first differences.

TABLE 2

Test results for unit roots

Variable	ADF[1] Level	First difference	PP[2] Level	First difference
ln M	-2.330910	-2.447346	-2.475138	-4.686727*
ln Y	-2.684929	-2.781079***	-2.227597	-2.869864***
ln P	-2.767976	-4.099414*	-3.303193***	-6.67433*

*, **, and *** denoted rejection of a unit root hypothesis based on MacKinnon's critical value at 1 percent, 5 percent, and 10 percent.

Note:

(1) Constant and trend were included in level, and only constant in first difference (see Baghestani & Mott, 1997). In common practice, an augmentation of one or two, generally, appears to be sufficient to secure lack of autocorrelation of the error terms (Ghatak, Milner, & Utkulu, 1997). One augmented lag was used due to limitation of annual data (see Doroodian, Koshal, & Al-Muhanna, 1994: 912).

(2) The truncation lag of PP is three based on Newey-West Suggestion, q=4(T/100)^2/9.

The earlier studies on import demand employed a simple partial adjustment model to describe the short run adjustment of import demand to its long run value. However, the partial adjustment mechanism imposes "a highly restrictive lag structure on the regression equation which, if incorrect, would lead to dynamic misspecification and predictive failure" (Abbot & Seddighi, 1996: 1119).

Recent developments in applied econometrics allow us to investigate the existence of a long run relationship postulated by theory employing cointegration analysis. If a unique cointegrating vector is found, an error correction representation provides information concerning the short-run adjustment process, and an equation for short-run forecasting (Enders, 1995). Testing for cointegration using Augmented Dickey Fuller (ADF) statistic, has been found to be unreliable (Atesoglu,1997). In addition, Kim (1995) pointed out the difficulties associated with the ADF test for cointegration and how results can be altered when using Johansen method. The maximum likelihood framework involved is known to offer better properties than the traditional Engle and Granger approach (1987) which is residual based (Asafu-Adjaye & Chakraborty, 1999). The Johansen method applies the maximum likelihood procedure to determine the presence of cointegrating vectors in nonstationary time series. This method detects the number of cointegrating vectors and allows for tests of hypothesis regarding elements of the cointegrating vector (Johansen, 1988; Johansen & Juselius, 1990).

If a number of cointegrating vectors is found, a dynamic error correction model can be estimated by adopting the second step of Engle-Granger representation theorem (Engle & Granger, 1987) in order to examine the short-run behaviour of Malaysian aggregate imports. Finally, tests for parameter stability (see Zietz & Pemberton, 1993) by using CUSUM and Recursive Residuals tests are also carried out.

Empirical Results

The first step in applying Johansen method is to specify a lag length for the VAR. It is a crucial step in the Johansen procedure. Likelihood ratio (LR) test is used to choose an appropriate lag length for the VAR. Starting with a three-year lag length and observing that the results are not appreciably altered as lag length is reduced, lag length is kept as short as possible (Charemza & Deadman, 1992). The LR statistic rejects the hypothesis of 2 lags, but does not reject the hypothesis of 1 lag. The lag length is consistent with Atesoglu's (1997) study using annual data. Table 3 reports the trace test for cointegration analysis.

TABLE 3

Trace test for cointegrating vector

Test assumption: Linear deterministic trend in the data
Series: ln M ln Y ln P
Lags interval: 1 to 1

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesised No. of CE(s)
0.643484	38.8412	29.68	35.65	None **
0.295613	10.99402	15.41	20.04	At most 1
0.055178	1.532474	3.76	6.65	At most 2

*(**) denotes rejection of the hypothesis at 5 percent (1%) significance level.
L.R. test indicates 1 cointegrating equation(s) at 5 percent significance level.

The Likelihood Ratio statistic rejects the hypothesis of no cointegration but is unable to reject the hypothesis of at most one cointegration relation at 1 percent significance level. This means that there is at least one cointegrating vector among the three variables. The normalised cointegrating equation estimated is reported in Table 4.

TABLE 4

Normalised cointegrating coefficients

ln M	ln Y	ln P	C
-1.0000	1.4971	-1.7644	0.9278
(SE)	(0.0314)	(0.2232)	
(t-value)	(47.6559)	(-7.9064)	

Log likelihood = 231.0974

The coefficients of income, and relative prices exhibit the expected sign, and both are highly significant. The implied long run elasticities of import demand with respect to income and relative prices are 1.5 and -1.8 respectively.

A dynamic error correction model was estimated with a view to examine the short run behaviour of aggregate Malaysian imports. The methodology follows from the Engle-Granger representation theorem (Engle & Granger, 1987). The lagged residual from the cointegrating equation was incorporated in the general dynamic ECM. In addition, a variable for the rate of capacity utilisation was included to represent short run capacity constraints (Abbot & Seddeghi, 1996:1122).
The general equation for ECM with consideration of 1 lag length (based on minimum of Schwarz Criterion (SC) and LR test is given as follows:

$$\Delta \ln M_t = b_0 + b_{1i} \Delta \ln M_{t-1} + \sum_{i=0}^{n} b_{2i} \Delta \ln Y_{t-i} + \sum_{i=0}^{n} b_{3i} \Delta \ln P_{t-i} + \sum_{i=0}^{n} b_{4i} \Delta CU_{t-i} + b_5 EC_{t-i} + error\_term \quad (5)$$

where EC is residual error derived from the cointegrating vector, and CU is capacity utilisation (refer to Appendix I). The general model was tested downwards sequentially to arrive at a specific short-run data consistent equation. In selecting the specific model, all those variables that have relatively small absolute t-value (less than one) were dropped sequentially. The specific ECM is reported in equation (6).

$$\begin{aligned}\Delta \ln \hat{M}_t &= -0.6632\, EC_{t-1} + 0.575\, \Delta \ln M_{t-1} \\ (SE) &\quad (0.4158) \qquad (0.3965) \\ &+ 1.5224\, \Delta \ln Y_t + 1.029\, \Delta \ln Y_{t-1} \\ &\quad (0.5651)^{**} \qquad (0.8227) \\ &- 0.5775\, \Delta \ln P_t + 0.4255\, \Delta \ln P_{t-1} - 0.0565 \\ &\quad (0.3191)^{***} \qquad (0.3571)\end{aligned} \quad (6)$$

Note :** and *** denote significance of 5 percent, and 10 percent level. ( ) refers to probability value

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Period (adjusted) : 1972 - 1998
R-squared: 0.6137 Adjusted R-Sq: 0.4978 DW : 1.977
F-statistic: 5.2954 (0.002) RESET [1] : 0.0202 (0.887)
Breusch-Godfrey LM [2] : 2.1737 (0.3373)
ARCH [1] 0.2062 (0.6498)
White Heteroskedasticity: 16.94471 (0.1517)

The specific ECM shows that in the short run growth in imports appear to be primarily influenced by growth in current income and relative prices. Tests of the joint significance of the coefficients on lagged change in the logarithms of income and relative prices based on F tests are all positive. All the specification tests show model adequacy. The capacity utilisation variable, CU, dropped out from the ECM. The error correction term (ECt-1) has the correct sign (negative). Its magnitude indicates the speed of adjustment from short run disequilibrium towards the long-run equilibrium state. However, the error correction term is not significant at the 5 percent level. This implies that there is no disequilibrium in the long run relationship and that the model is specified correctly without the error term (see for example Ansari, 1993).

Table 5 summarises the long run and short run income and price elasticity of estimates of the import demand model.

Table 5
Elasticity of long run and short run import demand

	Long run	Short run
Y	1.4971	1.5224
P	-1.7644	-0.5775

Finally, Recursive Residuals and CUSUM tests found that the parameters of specific ECM remain stable over the sample period (refer to Figure 2).

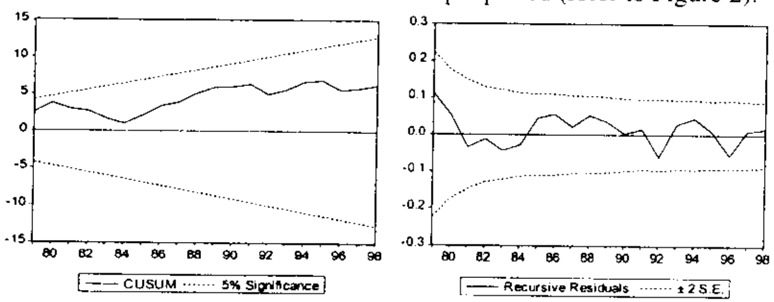

FIGURE 2. *Plot of Recursive residuals and CUSUM tests*

Summary and Conclusions

This study was motivated by the need to estimate an aggregate import demand function for Malaysia using cointegration and error correction modelling methods. We employed the Johansen procedure to examine the long run relationship between aggregate import demand and its determinants. Annual data for the period 1970-1998 were used. The results of the study may be summarised as follows.

First, the traditional formulation of the import demand function fits the data well. Estimated coefficients have the correct signs. Both real income and relative price variables are important determinants of import demand. Secondly, stability tests suggest no evidence of structural instability in the parameters during the sample period. Thirdly, the use of cointegration and error correction mechanism has yielded useful results. The quantity of import demand is found to be cointegrated with its determinants.

Let us look at the size of the elasticity estimates. The income elasticity in the long run was found to be elastic with a value of 1.50. The estimated short run income elasticity is 1.52. A high short run income elasticity may be defended given the importance of export, particularly manufactured exports, as a determinant of Malaysian economic growth (Ghatak, Milner, & Utkulu, 1997). Doraisami (1996) reported a long support for bi-directional growth between exports and output and a positive a long-run relationship between exports and growth. Shaaf and Ali Ahmadi (1999) also concluded that export policies played an effective and strategic role in the high economic growth and development achieved by Malaysia. The authors employed the neural network method and annual data from 1966 to 1994. Given the high import content of manufactured exports, economic growth driven by export demand will also lead to import growth. The converse also holds true. The results of the study also indicate a relatively large long run response of import volume to changes in relative prices. This is an indication that Malaysia has made some progress in developing import-substitute industries, a suggestion made by Melo and Vogt (1984). The estimated short run relative price elasticity is -0.58 (the coefficient is significant at the 10 percent level). An inelastic short run price elasticity is to be expected.

During the study period, Malaysia's current account of the balance of payments has consistently shown a deficit. The overall balance in general, has shown a surplus because of the strengths of the capital account and trade balance. The results of this study can shed some light on the efficacy of exchange rate policy to tackle balance of payments disequilibrium. Even though this study does not estimate export price elasticities, the estimated size of the import relative price elasticity suggests that the Marshall-Lerner condition is satisfied. The Marshall-Lerner condition indicates a stable foreign exchange market if the price elasticity of demand for imports and the demand for exports, in absolute terms, exceeds one (see for example, Salvatore, 1993: 465). Exchange rate policies can therefore be used to correct for balance of payments disequilibrium.

What other implications can be drawn from the study. First, as import demand is income elastic in the long run, economic growth may have negative implications on the balance of payments. Government strategies to give priority to the development of resource-based industries, which have low import contents, and to accelerate the development of backward linkages for non resource-based industries in order to increase the use of local inputs, should dampen the increase in import demand that is driven by economic growth. The development of domestic capital goods industries and also industries that produce intermediate goods that are competitive in terms of price and quality to imports will reinforce the previous strategies. Secondly, domestic inflation needs to be kept in check. The high long run cross price elasticity suggested by the results means that domestic inflation would increase the volume of imports. Both monetary and fiscal policies should be used judiciously so as to maintain internal and external balance.

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Appendix I: Data Definitions and Sources

Data used in this study covered the period from 1970 to 1998. All the variables are in natural logarithmic form (ln). Definitions of variables and data sources are given below:

1. Data on nominal imports (measured in RM million) are from Ministry of Finance's *Economic Report* (various issues). Nominal imports are deflated by the import price deflator (1978 = 100).
2. Gross Domestic Product (GDP) data are from Ministry of Finance's *Economic Report* (various issues). Nominal GDP is deflated by the GDP deflator (1978 = 100), obtained from International Financial Statistic Year book (various issues).
3. The relative price (P_t) variable is import price deflator (Pm) divided by GDP deflator (Pd), 1978 = 100.
4. The capacity of the country to produce and supply the goods itself, is essentially a short-run phenomenon. The capacity utilisation variable is defined as the residuals multiplied by 100 from the following regression: $\ln IP_t = a + b\ time + e$, where IP is an index of industrial production (1978 = 100), and e is residual. The data on industrial production index are obtained from International Financial Statistics [CD-ROM On-line).