THE RELATION SHIP BETWEEN IMPORT AND GDP GROWTH IN ETHIOPIA: AN EMPIRICAL ANALYSIS

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Abstract

In this study, the effect of GDP growth on import, and the contribution of imported intermediate and capital goods to economic growth during the period 1960/61-1999/2000 in Ethiopia is studied. Cointegration and error correction mechanisms are used so as to separate the long run and short run relationship between import and GDP. The effect of imported intermediate and capital goods on economic growth (measured by real GDP) is also studied using the same procedure.

The estimated cointegrating vectors using Johansen's cointegrating approach indicates that the long run elasticity of imports with respect to real GDP is positive but it is insignificant at 5 percent level of significance. On the other hand, real international reserve is found to affect imports positively and significantly. However, the short run elasticity of imports with respect to real GDP is positive and significant. The policy implication of the short run high-income elasticity of imports is that policies of aggregate demand or stabilization may improve the balance of payment position.

The results of the estimation of imported intermediate and capital goods on economic growth indicate that in the long run imported intermediate goods positively and significantly affect real GDP growth. Similarly, in the short run, the change in imported intermediate goods before one year has a positive and significant effect on the change in current real GDP growth. On the other hand, imported capital goods have a negative effect on real GDP growth. This indicates that there is inefficient utilization of these goods in the production of goods and services.

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1. INTRODUCTION

The purpose of this paper is to explore the role of economic growth (measured by real GDP growth) on import and the contribution of imported capital[2] and intermediate goods[3] to economic growth in Ethiopia. A large number of studies have looked at the role of economic growth on import in estimating import demand model. However, no studies looked at the role of imported capital and intermediate goods on economic growth in Ethiopia.

Economists have debated the role of economic growth on import. Some researchers argued that economic growth does not have role on import (See Hemphill, 1974). Others are contrary to this (Moran, 1989).

The theoretical notion for the second view is that when income increases, people will have more money and the purchasing power rises so that they tend to buy more domestic and foreign goods and services. Therefore, real GDP growth and import have a positive relationship. On the other hand, it may be negative theoretically if imports are lower in consumption as income increases (Egwalkahide, 1999:13-14).

Empirical evidence on Ethiopian cases showed mixed result. Some researcher documented the positive influence of economic growth on imports (see Solomon (2000), Girma (1982), and Tura (2001)). However, others have found evidence to the contrary (see Muluneh (1982) and Alem (1995)). Therefore, it is difficult to conclude the effect of real GDP growth on imports from these studies; further research is required.

As pointed out earlier, no studies examined the role of imported capital and intermediate goods on economic growth.

There are two channels of connections between imported capital and intermediate goods to economic growth. These are growth oriented and innovation-oriented approach (Baark, 1988). The first is that capital goods help to achieve new manufactured goods and affect the three main sectors of the economy, namely, agriculture, industry and transport.

[2] Capital goods are defined as produced commodities, which serve as inputs in the production of other commodities (Baark, 1988). Capital goods consist of three main goods namely transport, agriculture and industrial equipment.
[3] Intermediate goods are composed of raw materials, semi-finished goods and fuel.

The second is an innovation-oriented approach, which considers the importance of capital goods as supply of new technology to the manufacturing sector. The import of capital goods supplies efficient machines that occupy new technology, which is obtained from the research and development in developed countries. Thus, diffusion of embodied technology to domestic industry from developed country is important to increase productivity growth throughout the economy and this raises domestic output, in turn, leading to growth of GDP.

Similarly, intermediate goods are input for the production of other commodities. Imports of these goods from developed countries bring new technology to developing countries, which in turn enhance the productivity of factors and leads to the growth of output (Coe, *et al*, 1997).

As indicated above, the empirical evidences made so far are inclusive about the role of economic growth on imports. This paper minimizes the debate about the role of economic growth on imports. More importantly, it provides empirical evidence about the role of imported capital and intermediate goods on economic growth in Ethiopia. It is organized as follows. In part II, empirical literature will be revised. In part III, model will be specified. In part IV, the empirical results are discussed. In part V draws conclusions and policy implications.

2. EMPIRICAL LITERATURE REVIEW

In this section we review the empirical literature mainly focusing on Ethiopia regarding the effect of GDP growth on imports, and the contribution of imported intermediate and capital goods growth to economic growth.

Ram (1990) studied explicitly the relationship between growth rate of import and growth rate of real GDP in many developing countries using an augmented production function approach. The result suggests that imports have a positive influence on economic growth for some countries. According to his result, import of capital goods can promote economic growth for an LDC; however, inefficient utilization of imported capital goods may not always help economic growth.

Coe and Helpman (1995) examined the contribution of foreign research and development to economic growth. They conducted a study on productivity of foreign research and development on a pooled data set of 22 countries during the period 1970-1990. In his model, the measure of foreign research and development capital stock was import share-weighted average of trade partners' domestic research and development. This means technology is gained by buying foreign goods. The result suggests that foreign R &D (measured by import flow) for developing country has influential effect on domestic productivity and; it is much stronger if the economy is more open to foreign trade. But, unlike developing countries for a developed country, the domestic research and development is stronger than foreign research and development.

Coe ***et al*** (1997) investigated the effect of foreign research and development on productivity based on data for 77 developing countries over the period 1971-90. The result showed that imports of machinery and equipment from industrial countries positively and significantly affect total factor productivity in developing countries.

Connolly (1998) showed that high technology imports from developed country have a positive influential effect on real per capita growth than domestic technology. According to this study, the contribution is greater for developing countries than for developed countries. His study was based on forty countries during the period 1970 - 1985.

Keller (2000) conducted a study on productivity of imports of intermediate goods that embody new technology using industry-level data for eight OECD countries (Sweden and G-7 countries) during the period 1970-1991. The result showed that productivity of foreign research and development (measured by import of intermediate goods) is less for developed countries.

As pointed out earlier, there is a vast body of empirical evidence about the effect of economic growth on imports and the focus here is only Ethiopian studies.

Girma (1982) estimated value of import as a function of GDP only in Ethiopia during the period 1970 to 1978, based on OLS estimation method. In his result, GDP is significantly and positively affect import of goods. The major shortcoming of this empirical study is that it ignored the capacity variable and relative import price which may lead to misleading result.

Muluneh (1982) extended Girma's work by including foreign exchange reserve and estimated import demand in Ethiopia during the period 1965-1980, based on OLS estimation method. The results showed that income elasticity of aggregate import is negative and significant. The reason presented for this negative relation was "the nature of Ethiopian economy where there is no free market operating on its own and the quantity and quality of imports is determined by the government at the central level". The weaknesses in the above two studies are that they used small sample, and they did not test stationarity of the data. Small sample size may give biased results while using non-stationary data may give highly significant result, which is spurious (Gujarati, 1995).

Alem (1995) has shown the impact of income (real GDP) on import using generalized import model during the period 1969-1991, based on Engle-Granger cointegration method. In his result, income elasticity of imports is negative and weakly significant (at 10 per cent) in the long run but it is not significant in the short run. The weakness in this model is that he used small sample data, which as indicated above may give biased result. Also the Engle-Granger method used in the study does not test if there are more than one cointegration relationships, which may result simultaneity bias.

On the other hand, Solomon (2000) estimated import demand based on Engle-Granger and Johansen estimation procedures for the period 1960-1995 in Ethiopia. In his result, real income is positively and significantly affects aggregate import both in the short and long run.

Tura (2001) estimated the generalized import demand for Ethiopia, using the recent estimation technique Johansen Cointegration estimation procedure during the period 1970/71-1999/2000 based on quarterly data. The result indicates that real income does not have a significant effect on imports in the long run although it has a positive influence on imports. He reasoned out that whenever income increases most people increase spending on domestic goods to satisfy their basic needs, as the Ethiopian economy is highly subsistent. The study shows that in the short run real income positively and significantly affects imported goods. The result is mixed as shown in the above studies.

3. ECONOMETRIC ANALYSIS

3.1. Model Specification

The early theoretical import demand models showed that the main determinants of imports are real activity variables such as GNP or industrial output, and relative prices (the ratio of unit value of imports of the country to domestic price level). However, for most less developed countries, the effect of foreign exchange is a very important factor in the determination of imports. In addition, these countries employ trade and exchange restrictions either due to inward oriented policies or lack of capacity to import that would directly affect both the relative price and the volume of imports (Hemphill, 1974). Thus, foreign exchange reserves and foreign exchange inflows should be included in the determinants of import (Hemphill, 1974 and Moran, 1989). Hence, the import model of Hemphill (1974) excludes the relative price and real activity variables such as GNP or industrial output. According to Hemphill (1974), the change in relative prices and real economic activity can be measured by the change in foreign exchange reserves since changes in imports cannot be fully explained by changes in relative price and real economic variables in the presence of import and exchange restrictions. However, in real world, developing countries' import depends on both capacity and demand factors (Moran, 1989).

The Moran (1989) model which is used here incorporates all the variables that the traditional and Hemphill (1974) model identified as determinants of import (See Appendix 1). The traditional model ignores the capacity variables such as international reserve and foreign exchange receipts. While the Hemphill (1974) model ignores the demand side factors. Thus, omission of important variables gives biased and inconsistent estimates (Ogbu (1994) cited in Tura (2001)).

The model is specified in the log linear form:

$$Lnm_t=b_o+b_1lnF_t+b_2lnR_{t-1}+b_3lnm_{t-1}+b_4ln\ (P_{m/}P)_t+b_5ln\ y_t+e_t$$

Where m_t is real value of imports; y_t is real GDP, F_t real foreign exchange receipts; e_t is white noise errors; R_{t-1} is lagged real international reserve (see descriptions of the variables in the Data Appendix).

A separate model is also considered to see the effect of imports on economic growth (measured by real GDP). Among the wide category of imports emphasis is given to intermediate and capital goods.

The role of capital and intermediate goods in production is well known. As discussed earlier, capital goods affect output both through their direct contribution and effects on knowledge (Romer, 2001). Imported intermediate goods are inputs in production, which also have a similar effect on production. To analyze the effect of imported capital and intermediate goods on economic growth, the Solow type growth model can be employed. The Solow growth model is represented as below.

$$Y=f(X, t) \text{---------------------------} (1a)$$

Where Y is output; X is vector of different inputs used in production; t is time and is used to measure technology. In most empirical work, equation (1a) is approximated by a Cobb-Douglas type of technology (see Deverjan, 1993, and Baffers and Shah, 1993).

The model used in this study to test the effect of imported intermediate and capital goods traces its roots to Solow type growth model. It is stated that research and development (R&D) expenditure creates new intermediate and capital goods in developed economies, and if these goods are imported to developing countries, they increase productivity in developing countries in turn leading to economic growth (Keller, 2000). To see this effect, two categories of capital, imported and local capital, are included in addition to labor input in equation (1a); Intermediate goods are also introduced as input in addition to the above. Active labor force is used instead of population growth.

In the usual notation the production function can be written as follows:

$$y=f(L_t, dk_t, int_{t-1}, kap_{t-1}) \text{---------------------} \qquad (2a)$$

Where y_t is gross domestic product (GDP); L_t is active labor force (age group 15-60); dk_t is domestic capital which is approximated by gross capital formation(investment) less lagged imported capital goods since there is no data for domestic capital ; int_{t-1} and kap_{t-1} is lagged imported intermediate and capital goods respectively. Imported intermediate and capital goods are lagged by one period since the current import of these goods may not directly used in the production process due to lag of time. All the variables are in real terms (see Data appendix).

We assume the production function to be an extended Cobb-Douglas function:

$$Y=A_t L_t^{\delta 1} dk_t^{\delta 2} kap_{t-1}^{\delta 4} int_{t-1}^{\delta 3} e_t \text{----------------------------} \qquad (3a)$$

Where e_t is white noise error term, A_t is level of technology.
Taking log of equation (3a) we have the following regression equation:

$$Lny=c+\delta_1 lnL_t+\delta_2 lndk_t+\delta_3 lnint_{t-1}+\delta_4 lnkap_{t-1}+\delta_5 t+u_t$$

Where u_t is an error term assumed to be a white noise, the δ_i's (i=1..4) are output elasticities with respect to the variables and are expected to have positive signs.

The weakness of this model is that it uses a Cobb-Douglas type of technology, which assumes fixed returns to scale. Although a translog production function solves these problems, the sample size does not allow estimating cointegration using the Johansen method since there are large parameters to be estimated and this significantly reduces the degree of freedom. Therefore, in this paper, the Cobb-Douglas type of production function is applied.

3.2. Data and Methodology

3.2.1 Data Source

Yearly data covering the period 1960/61-1999/2000 are used in this study. The data were obtained from the annual and quarterly bulletin of the National Bank of Ethiopia; Statistical Abstract published by Central Statistical Authority, the current Ministry of Finance and Economic Development, and Ethiopian Custom Authority.

One of problems in data collection is that some sources use different calendar year. Since it is difficult to compare different calendar year data, effort has been made to convert data from different calendar years into the same calendar year. The other problem is that data like import unit price index after 1980 is not available from domestic source. Thus, import unit price index is calculated using the formula of Fishers index (See Data Appendix). There is no data for capital stock in Ethiopia and therefore investment as a proxy for capital stock is taken by following Salisu and Sapsford (1999), and Netsanet (1997). Accordingly, the local capital stock is approximated by investment less lagged imported capital goods.

3.2.2 Methodology

The first step in time series regression analysis is to test stationarity of each variable. The need to test stationarity of the variables arises because estimating regression using non-stationary variables based on ordinary least squares (OLS) leads to spurious and inconsistent result (Gujarati, 1995). In addition, if variables are non-stationary, it is difficult to conduct hypothesis testing as the classical assumptions on the property of the error term, namely that it has zero mean, constant variance, and is non-auto correlated is violated (Rao, 1994). Therefore, stationarity test is important. There are different ways of testing stationarity. In this paper, the two widely applicable (and most available in statistical software) tests of unit root, namely the Dickey–Fuller (DF) and Augmented Dickey –Fuller (ADF) are used.

A) Dickey-fuller (DF) – the null hypothesis of this test is that a variable is non-stationary. This test is based on the following three different regression equations.

(i) $\Delta y_t = by_{t-1} + U_t$, (ii) $\Delta y_t = \mu + by_{t-1} + U_t$, (iii) $\Delta y_t = by_{t-1} + \mu + ¢t + U_t$

Where y_t shows the variable to be estimated; μ shows constant; ¢ is the trend coefficient; U_t is normally distributed random variable and t is a time trend.

The null hypothesis is expressed as:

$$Ho: b=0 \text{ against } H_1: b<0$$

The critical values of this test statistic are obtained from the Dickey-Fuller distribution table. If the null hypothesis is rejected, then we say that y_t is stationary. The weakness in the Dickey-Fuller test is that it assumes that the error term is an independently and identically distributed random variable with mean zero and constant variance. The limiting distributions and critical values obtained by Dickey and Fuller cannot be assumed to hold if this assumption fails, however, this problem is solved by running ADF regression (Rao, 1994).

B. Augmented Dickey-Fuller (ADF)- The null hypothesis is similar to DF. The model needed to test the null hypothesis of non-stationary against the alternative of stationary is as follows. P-1

$$\Delta y_t = \mu + cy_{t-1} + \Sigma_{I=1} d^i \Delta y_{t-i} + at + e_t$$

Where p is selected so the e_t is white noise, μ, c and d are parameters to be estimated. If the null hypothesis is rejected, then a variable is stationery if c is negative and significantly different from zero. The weakness in this test is that the power of the test may be adversely affected by misspecifying the lag length (Rao, 1994).

It is known that most time series variables are non-stationary at level. Differencing the respective variables and running regression on the same can handle the non-stationarity problem. However, this method, suffers from the problem that information about the long run relationship between the variables is lost, since in the long run, first difference of these variables are zero (Yuan and Kochhar, 1994). The concept of cointegration analysis suggested a way to improve this problem. Cointegration means that despite being individually non-stationary, a linear combination of two or more time series variables can be stationary. Cointegration of two (or more) time series variables suggests that there is a long run, or equilibrium, relationship between the variables (Rao, 1994).

C. Approches of Testing Cointegration

The two widely employed approaches for testing cointegration relationships are the Engle-Granger (1987) two-step procedure and Johansen (1988) maximum likelihood approach. In the Engle-Granger approach the first step is to estimate the cointegrating regressions and then to test whether the residual obtained from the cointegrating regressions is stationary or not; if the residual is stationary, then the independent and dependent variables have long run relationships (Rao, 1994). The drawback of this procedure is that it is difficult to determine the number of equilibrium relationships if the variables are more than two. In addition to this, it needs priori information that the dependent variables are endogenous and the independent variables are weakly exogenous. In cointegration relationship estimating a single equation is potentially inefficient since information is lost unless each endogenous and weakly exogenous variable is clearly identified (Harris, 1995). In this paper, the Johansen Maximum likelihood procedure is used in testing for cointegration since it offers solutions for the above problems.

Johansen procedure starts by defining a general polynomial distributed k-lag model of a vector of variable y (Hall, 1989).

$$y_t = \Pi_1 y_{t-1} + \ldots + \Pi_k y_{t-k} + \Phi D_t + e_{t,\ t=1\ldots T}$$

Where y is a vector of N variables of interest; Π_i is an (NxN) matrix of parameters; and e_t is assumed an independently identically distributed N dimensional vector with mean zero and vector of variance Σ.

i.e. e_t ˜IN (0, Σ). The deterministic term D_t shows a vector of a constant, various dummies and other regresses that are fixed and non-stochastic.

This model can be reformulated into a vector error-correction (VECM) as:

$$\Delta y_t = \Gamma_1 \Delta y_{t-1} + \ldots + \Gamma_{k-l} \Delta y_{t-k+1} + A y_{t-1} + e_t$$

Where $\Gamma_{i=}-(I- \Gamma_{1-\ldots-}\Gamma_i)$, (I=1,…,k-1), and $A=-(I- \Pi_1-\ldots-\Pi_k)$. Δy_t is assumed to be I (0) vector. I is NxN identity matrix; the A matrix contain information about the long run relationships; while the estimate Γ_i shows the short run adjustment. Therefore, the number of distinct cointegrating vectors, r, is given by the rank of A (NxN matrix). In general, if y is integrated of order one or I (1) variable, then the number of cointegrating relations, r, is not more than N-1 i.e $r \leq N-1$. In this case, we can decompose A in two matrices α,β both of which are Nxr such that $A= \alpha\beta'$ (Hall, 1985). Where α represents the speed of adjustment to disequilibrium while β is a matrix of long run coefficients that makes $\beta' y_t$ stationary although y_t is non-stationary.

The two widely used test statistic to test the number of cointegration vectors in the Johansen procedure are the λ-trace test and λ-max test (Harris, 1995). The λ-trace test statistic for the hypothesis that there is at most r cointegrating vector is

$$\lambda\text{-trace}(r) = -T \sum_{l=r+1}^{n} \log(1-\hat{\lambda}_l) \quad r=0,1,2,..,n-2, n-1$$

The maximal test statistic for the hypothesis that there are r cointegration vectors against the alternative that r+1 exist is

$$\lambda\text{-}_{max}(r) = -T \log(1-\hat{\lambda}_{r+1}), \quad r=0,1,2,\ldots,n-2,n-1$$

Where λ_i's is eigenvalues[4] obtained from the estimated A matrix; T is the number of observations. The weakness of the Johansen procedure is that it over-rejects the null hypothesis if the sample size is small when the null is true (Harris, 1995). However, Reimers (1992) recommended a way to improve this weakness. Therefore, he recommends considering the number of parameters to be estimated in the model and making an adjustment for the degree of freedom by replacing T in the above test statistics by T-nk, where T is the sample size, n is the number of variables in the model and k is the lag-length.

[4]Let M be a pxp matrix. We let |M| be the absolute value of the determinant of M, and let I be an identity matrix. The eigen values of M are the solutions to the equation $|\lambda I-M|=0$

4. ESTIMATION RESULTS

The stationarity of each variable are tested using DF and ADF test and the results of the test statistics are reported in Appendix 2. The results from this test show that the null of a unit root or non-stationarity is not rejected for all the natural logarithmic variables.

The DF and ADF statistics of the natural logarithmic first difference of these variables are significantly high, thereby rejecting the null hypothesis that their first difference is non-stationary. Therefore, the variables are stationary (I (1) series[5]).

Given that all the variables in the model are I(1), the Johansen maximum likelihood procedure which is superior to Engle-Granger method as discussed earlier , is applied to determine cointegrating relationship between the dependent and independent variables.

4.1. The Effect of real GDP growth on import

A) Determination of the Lag Length

After the order of integration is determined, the next step in estimation of the long run relationship using the cointegration technique based on Johansen's estimation technique is to determine the appropriate lag[6] length which gives white noise residuals, as the Johansen estimation technique is based on the assumption of white noise errors (Rao, 1994). The issue of setting the appropriate lag-length is that there are variables that only affect the short run behavior of the model and if they are omitted will become part of the error term and this leads to residual misspecification problem (Harris, 1995). Thus, the levels systems were estimated with an initial choice of lag 2 and the long run model is estimated based on the level. The sample size is small to increase the lag-length to three or higher and therefore the additional lags are not tested. An intercept term is included since non-zero drift is believed to be present in the systems. As shown in Appendix 3, the null hypothesis that information at period t-i is not significant in determining the current period value of the dependent variable is tested based on the F-test. The results of F-test indicate that the second-period lag is significant in the real import and real relative price in explaining imports. Therefore, the significant information in the model is contained principally at the

[5] I(1) means integrated of order one(stationary after being differenced once).
[6] Indicates the past value

second lag and cointegration analysis requires the model to have a common lag-length, and hence lag-length 2 is appropriate in our cointegration analysis.

Lag-length 2 is confirmed by performing diagnostic test of residual as shown in Appendix 4. The results proved that there is no residual auto correlation as shown by AR test, absence of heteroscedasticity as shown by the F-test; and the residuals are approximately normally distributed at 1 percent level of significance as indicated by the normality test. Therefore, our choice of lag-length 2 is acceptable (See Appendix 4).

B) Estimation of cointegrated model

Having determined the lag-length, the next step is to determine the number of cointegrating vectors by using the two likelihood ratio tests of cointegration such as maximal eigenvalue test (λ_{max}), and trace test. The test statistics are summarized in Appendix 5 and Appendix 6. As shown in Appendix 5, the maximal eigenvalue test indicates that the null hypothesis that there are no cointegration vectors(r=0) against the alternative the one(r=1) is rejected since the test statistic (30.49) is greater than the 95 percent critical value (27.1), and it concludes that there is at least one cointegrating vector. The null hypothesis of $r \leq 1$ against r=2, however, cannot be rejected, suggesting that there is a unique cointegrating vector.

As shown in Appendix 6, the trace tests indicates that both the null of r=0 against $r \geq 1$ and the null of $r \leq 1$ against $r \geq 2$ are rejected. However, the null of $r \leq 2$ against $r \geq 3$ cannot be rejected indicating that there are at most two cointegrating vectors. However, the trace test is less powerful than the maximal eigenvalue test and therefore we conclude that there is one cointegrating vectors among the variables based on the most powerful test of maximal eigen value test (Yuan and Kochar, 1994, Tura, 2001). This means among the variables real import, real international reserve, real income, foreign exchange receipts there is one long run relationships. The long run elasticity of the cointegrated vectors is presented in Table 4.1 a.

Table 4.1: Output of Cointegrating Analysis for Aggregate Imports (from PCFIML)

(a) Standard β' Eigenvectors

lnm	**lny**	**lnfx**	**lnpc**	**lnres$_{t-1}$**
1.00	-0.681	-0.036	-1.11	-0.363

(b) Standard α-coefficients

lnm	-0.46	0.51	-0.29	_0.022
Lny	-0.006	-0.07	-0.042	-0.055
Lnfx	-0.195	1.05	-0.45	-0.10
Lnpc	0.26	-0.35	0.295	-0.19

Number of lags 2, variable entered unrestricted: constant and variable $\ln R_{t-1}$ entered restrictively.

Now, we have found that there is one cointegrating vector; the next step is to impose restriction on the first column of the α-matrix to identify which entries of the first column of α-matrix is statistically zero. This helps us to identify weakly exogenous variables in the system and can enter on the right hand side of VAR. Thus, there is no loss of information by modeling weak exogenous variables (Harris, 1995).

Table 4.2: Tests for Zero restrictions on α-coefficients for import model

	Lny	Lnfx	lnpc
α-Coefficients	-0.006	-0.195	-0.26
Lr-test x^2 ($\approx$1)	0.0602	0.639	3.435
P-value	0.806	0.42	0.063

It is clear from Table 4.2 that the null hypothesis of weak exogeneity is not rejected for all the variables. Thus, it is possible to normalize cointegrating vector by choosing lnm conditioning on the other variables. The normalized long-run import demand from Table 4.1 (a) is:

$$Lnm = 0.68\ln y_t + 0.036\ \ln F_t + 1.11\ln(p_m/p)_t + 0.36\ \ln R_{t-1} \text{-----------------------} 1b$$

The coefficient of equation (1b) has the natural interpretation as the long run effect of the independent variables on the dependent variable. Before discussing the coefficient of the long run equation, it is important to discuss the speed of adjustment coefficients (α_{11}= -0.46) at this stage. It shows that the adjustment towards the long-run equilibrium, has a negative sign as theoretically expected. Its interpretation is that economic agents adjust by about 46 percent to their long-run steady state whenever there is a shock in the system. The absolute value of the speed of adjustment indicates that in about two years the long run disequilibrium will be fully adjusted.

The next step is to test the significance of the long-run coefficients β in order to identify the unique cointegrating vector. These tests are summarized below in Table 4.3.

Table 4.3: Tests for Zero restrictions on Long run coefficients for import Model

	lny	**lnfx**	**lnpc**	**$Lnres_{t-1}$**
β coefficient	-0.68	-0.036	-1.11	-0.36
[7]LR test $X^2(1)$	0.87	0.0048	7.057	12.596
P-Value	**0.35**	**0.94**	**0.007****	**0.0004****

** Rejection at 1% level of significance

* Rejection at 5% level of significance

As shown in Table 4.3 above, the relative price and international reserves are significant in the import model. The sign of long run coefficient of import with respect to relative price is positive and statistically significant at 1 percent level of significance contrary to expectation. This result is similar to the result of Solomon (2000) and Alem (1995), and they found positive price elasticity of import. This result suggests that in the long run devaluation[8] of local currency may not reduce import demand because most of Ethiopia's import goods consist of capital and intermediate goods, which is important for domestic industry. Real GDP has the expected sign that is, positively affect import in the long run, but it is statistically insignificant at 5 percent level of significance. The long run elasticity of import demand with respect to foreign exchange receipts is statistically insignificant although it has the expected positive sign. In the long run, elasticity of imports with respect to one period lagged real international reserve is positive and statistically significant. This result indicates that a decrease past year (lagged one period) level of real reserve leads to a decrease in current period imports, with the assumptions of other things constant. Thus, the result suggests that, in the long run, import depend positively on the value of real international reserve since in the long run imported intermediate and high investment capital goods may be financed from the reserve.

Vector Error Correction Model

Having determined the long run relationship among the variables, the next step is to determine the coefficients of the short run dynamics. The short–run dynamics is estimated through the estimation of a general to specific model selection technique to obtain vector error correction model (VECM).

[7]The likelihood ratio (LR) test used to test zero restrictions on α- coefficients takes the form (Harris, 1995)

$-2 \log (Q) = T\Sigma^{r}_{I=1} \log \{(1-\lambda_I^*)/(1-\lambda_I)\}$, where Q =(restricted MLE/ unrestricted MLE), T is number of observations, λ_i and λ_I^* are eigenvalues as defined before for unrestricted and restricted model respectively and r is rank.

[8] Devaluation is a reduction in the exchange value of a currency of a country.

The results of the short-run dynamic import equation from PC-FILM are presented in appendix 7. The policy dummy variable defined in the data appendix was used to capture trade liberalization policy of the period.

A testing down procedure is used in which insignificant lags are dropped and the following parsimonious result is obtained:

$$\Delta \ln m_t = -0.008 + 1.38\Delta \ln y_t + 0.32\Delta \ln F_t - 0.59\Delta \ln p_{m/}p_t - 0.25VECM_{t-1} + 0.011D_{t1}$$

(0.80) (0.006) (0.000) (0.000) (0.038) (0.77)

R^2=0.87,DW=2.25, Rss=0.414
AR (2,29)=0.44(0.6451), ARCH 1(1,29)=0.345(0.56),
Normality X^2 (2)=3.34(0.188), RESET F (1, 30)=0.7907(0.38)

Where Δ denotes difference, the figures in parentheses denotes P-values. $VECM_{t-1}$ denotes the error correction term

The adequacy of the model is approved by the various diagnostic tests as shown above. The coefficient of vector error correction term ($VECM_{t-1}$), which measures the average at which import equation adjust to changes in equilibrium conditions, has a negative sign as expected and statistically significant at 5 percent level of significance. Thus, our model is correctly specified.

In the parsimonious model, the lagged international reserve is dropped since it is insignificant. The coefficients of the remaining variables show that the short run import model elasticities having the expected sign and statistically significant. The results indicate that in the short run elasticity of import with respect to real GDP is positive and statistically significant. One percent change in real GDP leads to 1.38 percent change in imports. The change in relative price and import demand has negative relationship and statistically significant at 1 percent level of significance, but it is inelastic. The other important variable that determines import demand in the short run is foreign exchange receipts and the elasticity of import demand with respect to foreign exchange receipts is 0.32, which is statistically significant at 1 percent level of significance. A one percent change in current real foreign receipts leads to 0.32 percent change in current imports. Trade liberalization policy measured by dummy variable has a positive sign but it is not statistically significant.

4.2. The Effect of Imported Capital and Intermediate Goods on Real GDP Growth

As shown in Appendix 2, the order of integration tests indicate that the variables real GDP, real value of imported intermediate goods, real value of imported capital goods and local capital goods are I (1). Thus, the next step is to determine the lag length. The level system was estimated with an initial choice of lag 2. An intercept and trend is included. As shown in Appendix 8, the second lag of real GDP, real local capital, imported capital and trend is significant based on F-test. Thus, the lag-length 2 matters in the cointegration analysis. The vector multivariate tests show that there is no problem of auto correlation, and non-normality of residuals at 1 percent level of significance. But, the sample size is small for testing heteroscedasticity.

Considering the use of the likelihood ratio tests of Johansen the number of cointegration relationships among the variables is tested. The tests results for the number of cointegrating relationships are presented in Appendix 9.

On the basis of the maximal eigenvalue and trace tests, it is possible to accept that there are two cointegration vectors since in both tests the null hypothesis of one cointegrating vector is rejected but the null hypothesis of two cointegrating vectors is not rejected at 1 per cent level of significance (see Appendix 9). However, using both Reimers (already discussed in section 3.2.2C) adjusted trace and maximal eigenvalue statistics could not reject the null of one cointegration. Thus, we conclude that there is one cointegrating vector since the sample size is small and the Johansen procedure over rejects the null hypothesis when the null is true (Harris, 1995).

After we know the number of cointegrating vector, the next step is to estimate the β-coefficients. Table 4.4 below shows the long run β-coefficients or long run elasticity and α- coefficients.

Table 4.4: Output of Cointegrating Vector

(a) Standardized β' Eigen vectors

lny	lnL	Lnint	lnkap	lndk	Trend
1.00	0.43	-0.12	0.046	-0.012	-0.032

(b) Standardized α- coefficients

	lny	lnL	Lnint	lnkap	lndk
Lny	-0.53	-0.36	-0.017	0.017	0.011
LnL	-0.061	-0.19	-0.012	0.004	-0.003
lnint	1.22	-6.1	-0.18	-0.13	0.05
Lnkap	-2.81	3.77	-0.25	-0.21	-0.015
lndk	-2.44	-5.43	0.188	-0.03	0.019

Number of lags used in the analysis: 2, variable entered unrestricted: constant and dummy(d) variables entered restricted: Trend

Now, we have found that there is one cointegrating vector. The next step is to impose restriction on the first column of α-matrix to identify which entries of the first column of α-matrix is statistically zero. The test of weak exogeneity (restriction of the first column of α-matrix) shows that all variables are weakly exogenous (Table 4.5). Therefore, it is possible to express real income as a function of the rest of the variables. The normalized long run relationships from Table 4.4 (a) is:

$$Lny_t=-0.43lnL_t+0.12lnint_t-0.046ln\ kap_t+0.012lndk_t+0.03Trend$$

Table 4.5: Tests for zero-restrictions on α and β coefficients.

	LnL	Ln int	lnkap	lndk	Trend
β-Coefficients	0.43	-0.12**	0.046	-0.012	-0.03
LR-test:$x^2(\approx 1)$	0.432	7.545	2.53	0.075	3.2806
P-value	0.51	0.006	0.116	0.783	0.070
α Coefficients	-0.061	1.22	-2.81	-2.44	
LR-test:$x^2(\approx 1)$	1.62	1.34	3.15	2.76	
P-value	0.202	0.24	0.07	0.096	

** denotes rejection at 1 percent level of significant

The long run results indicate that imported intermediate goods have positive and significant effect on real GDP growth at 1 percent level of significance. A one percent increases this goods leads to 0.12 percent increase in real GDP growth. Imported capital goods have negative and insignificant effect on real GDP growth. One possible implication of this is that there is inefficient utilization of these goods over longer period of time. The local capital goods have a positive effect on real GDP growth as theoretically expected but it is statistically insignificant. Active labor force is negatively and insignificantly affects real GDP growth. The possible implication of this is that labor is unproductive. This is because about 85% percent of labor forces live in the rural area at static land size and majority of them use backward cultivating system.

Vector error correction model

Given that the variables are I(1) and they are cointegrated, the next step is to estimate the short run dynamics through the estimation of a general-to-specific model selection technique to obtain vector error correction model (VECM). In estimating the vector error correction model dummy for war is introduced (see data appendix). The result of short-run dynamic equation is presented in Appendix 10.

After dropping insignificant lags, we found the following parsimonious results. The values in brackets are p-values.

$$\Delta \ln y_t = 0.08 + 0.60\Delta \ln y_{t-1} - 0.87\Delta \ln y_{t-2} - 1.66\Delta \ln L_{t-1} + 0.06\Delta \ln int_{t-1} - 0.064\Delta \ln kap_t$$

(0.000) (0.016) (0.000) (0.006) (0.034) (0.002)

$$-0.038\Delta \ln kap_{t-1} + 0.11\Delta \ln dk_{t-2} - 0.81 VECM_{t-1} - 0.08d$$

(0.096) (0.003) (0.034) (0.000)

$R^2 = 0.69$, $F(9,24) = 6.06(0.000)$, DW=1.70
AR1-2F(2,22)=0.53
(0.59),ARCH1F(1,22)=1.32(0.26),Normality$x^2(2)$=0.95(0.62),RESET

F(1,23)=0.28 (0.59)
The result has passed the various diagnostic tests as shown above. The test results indicate that there is no problem of autocorrelation, normality, heteroscedasticity and misspecification. The coefficient of vector error correction term (VECM) has a negative sign as expected and statistically significant at 5 percent level of significance. Thus, our model is correctly specified. The results of the short run model indicate that the change in imported intermediate goods before one year (lagged one period) has a positive and significant effect on the current change in real GDP growth at 5 percent level of significance. A one percent change in this goods leads to 0.06 percent change in real GDP growth. The current and lagged one period change in real imported capital goods have negative and significant effect on the current change in real GDP growth at 1 and 10 percent level of significance respectively. However, the change in lagged two periods local capital goods has a positive and significant effect on the current change in real GDP growth at 1 percent level of significance. The change in lagged one period active labor force is negatively and significantly affects the current change in real GDP at 1 percent level of significance. The drought measured by dummy variable has a negative and significant effect on the current change in real GDP as theoretically expected. This shows that the drought has retarded economic growth.

5. CONCLUSIONS

This paper has examined the effect of GDP growth on imports and the effect of imported intermediate and capital goods on economic growth (real GDP growth) in Ethiopia. The first model used in this study relates import with real GDP growth, relative prices, foreign exchange receipts and international reserves during the period 1960/61-1999/2000. This model is that of Moran (1989). The models are estimated using the Johansen's cointegration and vector error correction method. Based on the Johansen's procedure and maximal test indicates that there exists one cointegrating vector with the expected sign except relative price. Quantitative evidence indicates that short run coefficient of real GDP is higher than the long run coefficient, reflecting that import substitution is lower in the short run. The possible reason for this result is that as the economy expands most people spend their income on domestic goods in the long run since the Ethiopian economy is highly subsistent (Tura, 2001).

The regression result also indicates that imports do not depend on real income in the long run, but on international reserve. In the short run, import depends positively on real GDP growth and foreign receipts, and negatively on relative price.

This study has also examined the effect of imported intermediate and capital goods on real GDP growth. The model specification used here relates real GDP with real local capital, real imported intermediate, real imported capital and active labor force. The regression result indicates that imported intermediate goods positively and significantly influences real GDP growth in the long run. In the short run, the change in imported intermediate goods before one year has a positive and significant effect on the change in current real GDP growth. The results also indicate that there is a negative relationship between imported capital goods and economic growth in both short run and long run, reflecting that there is inefficient utilization of these goods. In line with this, under capacity utilization of manufacturing industries in Ethiopian can be a good example. In these sectors, the installed machineries produced much below the full capacity[9]. This under capacity utilization leads to high cost of production and in turn reduces productivity of the industries. Moreover, majority of imported vehicles (92 percent) in Ethiopia are manufactured before 15 years ago according to government official report[10], which results in high maintenance cost and in turn reduces the productivity. The impact of drought measured by dummy variable has a negative and significant effect on real GDP growth in the short run.

Policy Implications

The results of this study have the following policy implications. The short run high-income elasticity of import is indicating that economic growth is likely to worsen Ethiopian's balance of payments difficulties, under ceteris paribus assumptions. This is because increased growth will likely result in a substantial increase in imports. This shows that a certain proportion of an increase in income will be spent on purchases of imports and given the low level of consumption and investment goods produced domestically; the higher demand may lead to higher imports. The policy implication of the short run high-income elasticity of imports is that policies of aggregate demand or stabilization may improve the balance of payment position. In the short run, the price elasticity of import is less than one (inelastic) suggests that policies to solve balance of payment problem such as devaluation of the local currency may not work when there is low level of industrialization and import substitutes (Ghei and Pritchett, 1999). The price inelasticity of import demand can be explained by the fact that the majority of Ethiopian's imports are essential goods such as capital and intermediate goods, for which there exists few domestic substitutes. Another important policy implication from the result is that reduction of foreign exchange receipts may reduce import demand keeping the other factor constant. From the results, it can, therefore, be

[9] Central Statistics manufacturing Industries varies years surveys
[10] Source: The Ethiopian Amharic Reporter published on April 17, 2004.

inferred that the availability of sufficient amount of importation of intermediate goods is important for economic growth. In addition to this, it is important to use efficiently imported capital goods in the production of goods and services in order to be beneficial.

Data Appendix

y_t = real GDP (nominal GDP deflated by GDP deflator). Data were obtained from the current Ministry of Finance and Economic Development for the Period 1960/61-1999/2000.
p_m =Import unit value index. This data was collected from international financial Statistics for the year 1960-1963 and for the remaining years calculated based on disaggregated import data obtained from National Bank of Ethiopia Quarterlly Bulletin using Fisher's index formula (See Gupta 1981:400).

The formula is specified as:
Fisher's= $\sqrt{((\sum p_n q_o / \sum (p_o q_o)) x (\sum p_n q_n / \sum (p_o q_n)))}$

Where **p_n**=the current unit value, p_o=base year unit value q_n=the current quantity, **q_o**=base year quantity
p_t =GDP deflator calculated by dividing nominal GDP by real GDP.
m_t= real value import (nominal value of import deflated by import unit value index).
Data were obtained from two sources. For the period 1960-1970, quarterly data are Collected from Ethiopian Custom Office and converted in to Ethiopian Fiscal year.
For the remaining periods, data in Ethiopian fiscal year are collected from National Bank of Ethiopia Quarterly bulletin
$_{Ft}$=real foreign exchange receipts (nominal foreign exchange receipts deflated by import price index).It is defined as the sum of exports of goods and services, net transfer, net factor income and net capital inflow and obtained from National Bank of Ethiopia Balance of payment table
R_t= real international reserve (deflated by import unit value index), obtained from the National Bank of Ethiopia Quarterly bulletin
Kap_t and **int_t**= real value of capital and intermediate goods import (both deflated by Import unit value index). Data were obtained from National Bank of Ethiopia Quarterly bulletin. From the period 1960 to 1970, the series was changed into Ethiopian fiscal year using the following formula.

Value of Kap_t in fiscal year=<u>value of kap_t in Gregorian year</u> X Total import in Ethiopian fiscal year

Total import in Gregorian year

$$\text{Value of Int}_t \text{ in fiscal year} = \frac{\text{value of int}_t \text{ in Gregorian year}}{\text{Total import in Gregorian year}} \times \text{Total import in Ethiopian fiscal year}$$

L_t =active labor force from age 15-60 is obtained from World Development indicators CD-ROM 2000 for the period 1960/61-1998/99. For the period 1999/2000 is estimated based on growth rate of the previous period.

dk_t = local capital goods is proxied by gross capital formation(investment) less one period lagged imported capital goods.

$D1_t$=policy dummy variable which takes one for the period 1992/93-1999/2000, zero otherwise.

d_t=dummy variable for the drought which takes one for 1973/74 and1984/85, zero otherwise

The data like foreign exchange receipts, international reserve and import unit value index were not available in Ethiopian fiscal year from the period 1960-1970.These data have been converted in to Ethiopian fiscal year by taking the average of two years.

Appendix 1

The theoretical import demand model modified by Moran (1989), which is used here, incorporates both the traditional and Hemphill (1974) models

The Moran (1989) model, which is used here, begins by assuming that the main objective of economic authorities is to minimize the costs of deviating from the actual and desired levels of both imports and international reserves, which is stated in a quadratic cost function as (see Hemphill ,1974:651 and Moran ,1989:281).

(1) $$C_t=\phi_1(m_t-m_t^*)^2+\phi_2(R_t-R_t^*)^2+\phi_3(m_t-m_{t-1})^2+\phi_4(m_t-m_t^d)^2$$

Where m_t and m_t* show actual and long-run import volume at time t respectively; R_t and R_t^* represent current and desired level of real international reserves respectively; m_t^d is short-run notional or desired level of import volumes, and C_t represent cost of deviation from actual and desired level of both imports and international reserves; and the $\phi i_{'s}$ are all expected to be positive. All nominal variables are deflated by the import prices in order to consider determinants of real imports. In the long run steady state, it is expected that the current, the long run and desired levels of import will equal to the long-run foreign exchange receipts (Moran, 1989), that is, $m_t^*=F^*_t=m^d_{t}= m_t$.

Where F^*_t is the long run level of foreign exchange receipts.

In the short-run, however, the actual and desired volume of imports may not be equal because of the presence of past or current shock.

The argument suggests that economic decision-makers tend to minimize the cost of adjustment to the long-run level of imports by employing reserves to smooth imports.

It is further hypothesized that the desired level of international reserves is an increasing function of the long-run import level, so that:

(2) $$R_t^*=B_o+B_1m_t^*,\ 0\leq B_1\leq 1$$

In the long run, $F^*=m^*$; however, both variables are related through the balance of payments identity in the short run as:

(3) $$\Delta R_t=F_t-m_t$$

Where Δ is the first difference operator and F_t is the current level of (real) foreign exchange receipts.

The aggregate import demand function that relates imports with relative prices and real gross domestic product can be expressed as

(4) $m_t^d = \alpha_o + \alpha_1 (P_{m/}p)_t + \alpha_2 y_{t;}\ \alpha_1 \leq 0;\ 0 \leq \alpha_2$

Where m_t^d is demand for real imports, P_m is the import prices, which includes domestic taxes (tariff and non tariff barriers): P_t is an aggregate price index of domestic goods (the GDP deflator); y_t is real GDP; α_1 and $\alpha 2$ are the price and income elasticities of imports.

To get the model, an explicit assumption is required about the long-run level of foreign exchange receipts, F_t*. According to Moran (1989), it is specified as

(5) $F_t^* = F_t + \Lambda \Delta F_t$

Where Λ shows how the authorities perceive changes in foreign exchange receipts. According to Moran (1989), if the value of Λ is positive, then the changes in foreign exchange receipts are supposed to be permanent; but if the changes in foreign exchange receipts are transitory, then the value of Λ is negative. For simplicity, and following Moran (1989), the current level of foreign exchange earnings is equated with the long run receipts; this shows that Λ=0.

Moran (1989) derived import demand model by substituting equations (2) and (4) in to equation (1) and minimizing equation (1) subject to the constraint imposed by available foreign exchange (equation 3) and remembering that $m_t^* = F_t^* = F_t$

The result becomes

(6) $m_t = b_o + b_1 F_t + b_2 R_{t-1} + b_3 m_{t-1} + b_4 (P_{m/}P) + b_5\, y_t$

Where $0 \leq b_{1;}\ 0 \leq b_{2;}\ b_3 \leq 1;\ b_4 \leq 0;\ 0 \leq b_5$

Appendix 2: Tests of stationary of the variables

Variable	ADF								
	Lag 1				Lag 2				
	With out drift	With drift	With drift and trend	Without drift	With drift	With drift and trend	Without drift	With drift	With drift and trend
Lny	3.66	-0.17	-2.40	3.05	-0.18	-2.72	4.46	-0.03	-1.61
Lnm	0.83	-1.53	-3.12	1.53	-0.14	-1.62	1.79	0.36	-1.07
LnR	-0.04	-1.70	-1.71	-0.14	-2.18	-2.14	-0.21	-2.79	-2.73
LnF	0.55	-2.15	-3.41	0.92	-1.22	-2.59	1.19	-0.66	-1.95
Ln(p_m/p)	-2.49	-3.02	-3.70	-1.83	-2.26	-2.81	-1.46	-1.75	-2.03
Lnint	0.94	-1.5	-2.71	1.50	-0.62	-1.75	1.72	-0.28	-1.41
LnKAP	0.49	-2.02	-3.31	1.09	-0.66	-1.85	1.21	-0.42	-1.64
LnL	11.82	-.47	-1.99	5.82	-0.50	-1.66	3.66	-0.52	-1.93
lndk	-0.23	-2.58	-2.99	0.07	-2.52	-2.95	0.20	-2.04	-3.45
∆Lny	-4.40	-5.78	-5.71	-4.05	-6.74	-6.64	-1.79	-3.19	-3.14
∆Lnm	-8.49	-8.78	-8.81	-5.34	-5.79	-5.91	-3.66	-4.19	-4.35
∆LnR	-5.08	-5.01	-4.97	-3.35	-3.30	-3.29	-3.41	-3.36	-3.35
∆LnF	-7.83	-7.88	-7.86	-5.82	-5.99	-6.01	-4.15	-4.39	-4.37
∆Lnpc(p_m/p)	-8.14	-8.02	-7.95	-6.44	-6.36	-6.34	-5.29	-5.23	-5.23
∆Lnint	-7.87	-8.18	-8.10	-5.06	-5.49	-5.48	-3.63	-4.13	-4.16
∆LnL	-2.06	-6.97	-6.90	-0.89	-4.24	-4.20	-0.67	-4.04	-3.95
∆Lndk	-10.74	-5.58	-5.99	-6.63	-3.52	-3.95	-5.87	-3.04	-3.55
∆Lnkap	-9.14	-9.25	-9.24	-5.27	-5.46	-5.52	-3.82	-4.06	-4.12
Critical value (1%)	-2.62	-3.62	-4.23	-2.62	-3.62	-4.23	-2628	-3.62	-4.23
Critical value (5%)	-1.95	-2.94	-3.539	-1.95	-2.94	-3.539	-1.95	-2.94	-3.539

Appendix 3: Test statistics for lag length in the VAR

Lag length	Real value of import	Real GDP	Real foreign receipts	Relative price	One period lag Real international reserve
2	2.99(0.03)*	1.73(0.17)	0.891(0.48)	3.55(0.02)*	
1	2.285(0.089)	5.92(0.0018)**	3.526(0.021)*	3.167(0.03)*	4.33(0.0089)**

** Rejects null hypothesis at 1 per cent significance level; * rejects null hypothesis at 5 per cent significance level. The values in parenthesis are probabilities

Appendix 4: Test Statistics for diagnostic test

Diagnostic test	Statistics
AR	**F_{ar}(32,64)= 1.1607[0.3038]**
Normality test	**x^2 (8)= 15.305[0.053]**
Heteroscedasticity test	F_{het}(180,20)= 0.336[0.999]

Appendix 5: Tests for the number of cointegrating vectors based on maximal eigenvalue test

H_o:rank=r	H_1	n-r	Eigen value	Test statistic	95% critical value
r=0	r=1	4	0.536	30.49*	27.1
r≤1	r=2	3	0.124	17.22	21.0
r≤2	r=3	2	0.069	8.376	14.1
r≤3	r=4	1	0.0013	4.921*	3.8

Appendix 6: Tests for the number of cointegrating vectors based on trace test statistics

H_o:rank=r	H_1	n-r	Eigen value	Test statistic	95% critical value
r=0	r≥1	4	0.536	61.01**	47.2
r≤1	r≥2	3	0.124	30.52*	29.7
r≤2	r≥3	2	0.069	13.3	15.4
r≤3	r≥4	1	0.0013	4.92*	3.8

Note: r denotes the number of cointegrating vectors
** denotes rejection at 1% level of significance
* denotes rejection at 5% level of significance

Appendix 7: The short run dynamic equation for import Dependent variable Δlny_t

Variable	Coefficient	t-value	P-value
Constant	-0.053	-0.910	0.373
Δlnm_{t-1}	-0.059	-0.340	0.737
Δlnm_{t-2}	0.211	1.108	0.281
Δlny_{t-1}	1.147	2.003	0.058
Δlny_{t-2}	-0.589	-0.934	0.361
ΔlnR_t	-0.003	-0.063	0.950
ΔlnR_{t-1}	0.081	1.722	0.100
ΔlnR_{t-2}	0.117	2.480	0.020
ΔlnF_t	0.270	3.155	0.005
ΔlnF_{t-1}	0.095	-0.899	0.379
ΔlnF_{t-2}	-0.065	-0.591	0.561
$\Delta L(P_m/p)_t$	-0.616	-5.509	0.000
$\Delta L(P_m/p)_{t-1}$	-0.304	-1.961	0.063
$\Delta L(P_m/p)_{t-2}$	0.247	1.494	0.150
D_{t1}	0.073	1.515	0.145
$VECM_{t-1}$	-0.445	-3.151	0.005

R^2=0.94804, F(16,20)=22.807(0.000), DW=1.87, Rss=0.1749

Appendix 8 Test statistics for lag length in the VAR

Lag length	Lny	lnL	Ln int	Ln kap	lndk	Trend
2	11.77(0.000) **	2.69(0.051)	0.50(0.767)	3.281(0.025) *	4.62(0.005)**	
1	4.70(0.0053) **	4.73(0.005)	0.816(0.551)	2.41(0.072)	1.21(0.338)	
						6.00(0.001) **

** denotes rejection at 1 per cent level of significance

* denotes rejection at 1 per cent level of significance

Vector AR 1-2F(50,44)=1.1408(0.329), Vector normality $X^2(10)$=9.9449(0.445)

Variables entered unrestricted: constant and dummy (d)

Variables entered restricted: trend

The figures are the F-value and P-value in parenthesis.

Appendix 9: Tests for the number of cointegrated vectors based on maximal statistics

(a) Maximal eigenvalue test statistic

Ho:rank=r	H1	n-r	Eigenvalue	Test statistic unadjusted	Adjusted Maximal test	95% critical value
r=0	r=1	5	0.83	66.19**	48.3*	37.5
r≤1	r=2	4	0.68	42.85**	31.27	31.5
r≤2	r=3	3	0.47	23.8	17.37	25.5
r≤3	r=4	2	0.20	8.33	6.083	19.0
r≤4	r=5	1	0.05	2.05	1.50	12.3

** denotes rejection at 1 per cent level of significant

(b) Trace test

H_0	H_1	n-r	Eigenvalue	Test statistic	Adjused trace	95%critical value
r=0	r≥1	5	0.83	143.2**	104.5**	87.3
r≤1	r≥2	4	0.68	77.04**	56.22	63
r≤2	r≥3	3	0.47	34.19	24.95	42.4
r≤3	r≥4	2	0.20	10.39	7.58	25.3
r≤4	r≥5	1	0.05	2.058	1.50	12.3

Appendix 10 the short run dynamic equation

Dependent variable Δlny_t

Variable	Coefficient	t-value	P-value
Constant	0.12	2.19	0.048
Δlny_{t-1}	0.60	1.17	0.26
Δlny_{t-2}	-0.79	-2.13	0.05
ΔlnL_t	-0.84	-0.96	0.35
ΔlnL_{t-1}	-2.1	-2.40	0.03
ΔlnL_{t-2}	-0.24	-0.21	0.83
$\Delta lnint_t$	0.024	0.46	0.65
$\Delta lnint_{t-1}$	0.056	1.06	0.30
$\Delta lnint_{t-2}$	0.043	1.034	0.32
$\Delta lnkap_t$	-0.078	-2.20	0.047
$\Delta lnkap_{t-1}$	-0.048	-1.04	0.31
$\Delta lnkap_{t-2}$	-0.012	-0.35	0.72
$\Delta lndk_t$	0.0009	0.013	0.98
$\Delta lndk_{t-1}$	-0.05	-0.69	0.50
$\Delta lndk_{t-2}$	0.098	1.24	0.23
VECM	-0.90	-1.16	0.26
d_t	-0.09	-2.24	0.04

R^2=0.80, F(21,12)=2.29(0.07), DW=2.04

AR(2,10)=0.285(0.75),ARCH1F(1,10)=3.3087(0.098),Normalityx^2(2)=0.498(0.779),RESET F(1,11)=0.018(0.89)

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