THE RELATIONSHIP BETWEEN IMPORTS AND GROWTH IN THE CARIBBEAN

by

Daniel Boamah
Central Bank of Barbados

July 1995

THE RELATIONSHIP BETWEEN IMPORTS AND GROWTH IN THE CARIBBEAN

Introduction

Recent studies appear to confirm that imports could be considered a factor of production, distinct and separate from the traditional factors of capital and labour in the production process in developing countries. Works by Mohabbat, Dalal and William (1984) on India and Henry (1989) on Pakistan found that the three inputs are substitutable, with significant substitution elasticities. Boamah and Craigwell (1993) confirmed this for Barbados using a translog cost function. The estimated elasticities of substitution ranged between 1.08 and 1.21 for imported inputs and labour and between 0.07 and 0.23 between imported inputs and the standing capital stock.

This study relies on a growth accounting model to analyse the relationship between output and imported imports in a simultaneous equation framework.

Previous analysis of growth within a macro-production framework have relied on a modified production function in which total imports enter alongside the capital stock and labour (see for instance Ram (1990)) and Cardoso and Fishlow (1989). This study adopts a similar approach; the main difference is that our study employs intermediate imports, as distinct from total imports, in order to minimise possible estimation bias which may arise from double counting imported capital goods in a framework where total imports and capital goods enter as determinants.

Theoretical Framework

We start with an extended production function of the form

$$Q = F_1 (K_t, L_t, II_t) \qquad (1)$$

where **Q** is real gross output, K, L, II are aggregate inputs of capital, employed labour and intermediate goods, respectively, defined at time period **t.**

By definition:

$$II_t = MI_t + ID_t \qquad (2)$$

where MI represents Imported Intermediate goods and ID those intermediate goods produced locally. It is further assumed that domestically produced intermediate goods is a constant proportion of total intermediate goods, such that $ID_t = \lambda II_t$

where $o < \lambda < 1$.

Then equation (2) becomes

$$II_t = MI_t/(1-\lambda) \qquad (3)$$

Then the general production function in equation (1) becomes (4), ie

$$Q_t = F_4 (K_t, L_t(1-\lambda)^{-1}MI_t) \qquad (4)$$

It is assumed that the imputs bear a multiplicative relationship with each other such that the real output function may be explicitly defined as a Cobb-Douglas form.

$$Q_t = \alpha_o K_t^{\alpha k} L_t^{\alpha L} MI_t^{\phi_{MI}} U_t \qquad (5)$$

where $\phi_{MI} = \alpha_{MI}\,(1-\lambda)^{-1}$. Taking the logs of (5) yields an estimable long run relationship for real output.

$$lnQ_t = \gamma_o + \alpha_k \ln K_t + \alpha_n \ln L_t + \Phi_{MI} \ln MI_t + U_t \qquad (6)$$

where $\gamma_o = \ln\alpha_o$ and **U** is an error term that is presumed to satisfy the usual classical assumption of zero mean and constant or unvarying variance. First differencing (5) and using the notation $\Delta lnQ_t = lnQ_t - \ln Q_{t-1} \equiv \frac{\Delta Q}{Q}$, yields the short run relationship:

$$\Delta \ln Q_t = \gamma_o + \alpha_k \Delta \ln K_t + \alpha_L \Delta \ln L_t + \phi_{MI} \Delta \ln MI_t + \eta_t \qquad (7)$$

where $\eta_t = \ln U_t - \ln U_{t-1}$. In equation (7), α_K, α_L and α_{MI} represent output elasticities of capital, labour and intermediate imports, respectively. All the coefficients are expected to be positively signed, a priori. By definition the change in capital stock may be approximated by real gross capital formation (I). Hence equation (7) becomes

$$lnQ_t = \gamma_o + \alpha_I I_t + \alpha_L \Delta \ln L_t + \phi_{MI} \Delta \ln MI + \eta_t \qquad (8)$$

Equation (8) establishes a technological link between the level of real output, real intermediate imports and the other factors, with an implied assumption that an increase in any of the factors should influence output positively. The reverse would also hold to the extent that economic expansion may give rise to higher investment rates, employment and hence increased demand for intermediate goods. However, our main interest is in the investigation of the likely effect of intermediate imports on economic expansion and vice versa. Therefore only the endogeniety of intermediate imports is explored in this paper.[1]

In addition to the likely positive influence of increased real output on increased intermediate imports, there is a possibility that domestic firms could engage in the substitution of domestic goods and of labour for imported

intermediate goods both in the short term and in the long term. These considerations lead to the following relationship for the demand for intermediate goods:

$$MI = F_9\ (Q_{-1}\, RPMI) \qquad (9)$$

where RPMI represents the relative price of intermediate imports defined as RPMI = PMI/P, with PMI and P denoting the price index for imported intermediate good and the domestic price deflator, respectively. An implied assumption here is that current values of real imports of intermediate imports is not determined by current real output but rather the previous period's output. Assuming a convenient Cobb-Doublas form and first differencing the log transformation of (9) leads to an estimable equation of the form

$$\Delta lnMI = \gamma_c + \gamma_Q \Delta lnQ_{-1} + \gamma_{RP}\ \Delta \ln\ RPMI + \theta_t \qquad (10)$$

where γ_Q and γ_{RP} are positive coefficients and θ_t is an error term. Equations (8) and (10) were estimated, with data spanning the period 1961 to 1990.

Overview of Imports and Growth 1961-90

The historical data on the growth of real output (real gross domestic product (GDP) at factor cost) and real imports in Barbados suggest a strong positive association between the two growth rates over the past three decades. Over the three decades real output grew the fastest (5.6%) between 1961-70, followed by a decade of moderate growth averaging 3.0% (1971-80). Economic activity slowed to a trickle (1.2%) in the third decade ending in 1990. The first decade encompasses the period when there was rapid expansion in tourism-related activities while the third decade marked a period of declining profitability in the tourism and export-agriculture sectors.

The behaviour of real retained imports over the three decades was similar to that of real output (except that the rate of which growth in retained imports slowed in the last two decades was much more pronounced). During the first decade (1961-70) real retained imports grew at an average of 8.2%, slowed to an average growth rate of 4.5% in the decade (1971-80) before declining further to 1.3% in the period (1981-90).

Real intermediate imports did not follow the exact pattern, mainly because of the emergence and dominance of the electronics sub-sector in 1979. Growth rate of real intermediate imports rose to an average 9.2% in the decade 1971-80, from an average growth of 6.5% in the 1961-70 period. During the third decade 1981-90, growth rate of real intermediate imports declined by an average of 1.4%, mainly due to the closure of INTEL, the largest electronic firm in 1985. When the electronic sub-sector became prominent in 1979, real intermediate imports rose sharply by 59% over the 1978 figure. Between 1971 and 1978 real intermediate imports grew modestly at an average annual growth rate of 3.1%. This compares with an average growth of 0.13% for total retained imports and 2.1% for real aggregate output.

The relative importance of tourism services and the non-traded services sector is reflected in the declining share of retained imports in overall output of goods and services. In general, nominal retained imports as a proportion of nominal GDP at factor cost declined from an average 63.2% in the 1961-70 period to 48.2% in the 1981-90 decade (table 2). Spurred by the sharp increase in intermediate imports for the electronic sub-sector, the share of

Chart 1

Barbados: Growth Rates of Real Output and Real Retained Imports
1961-90

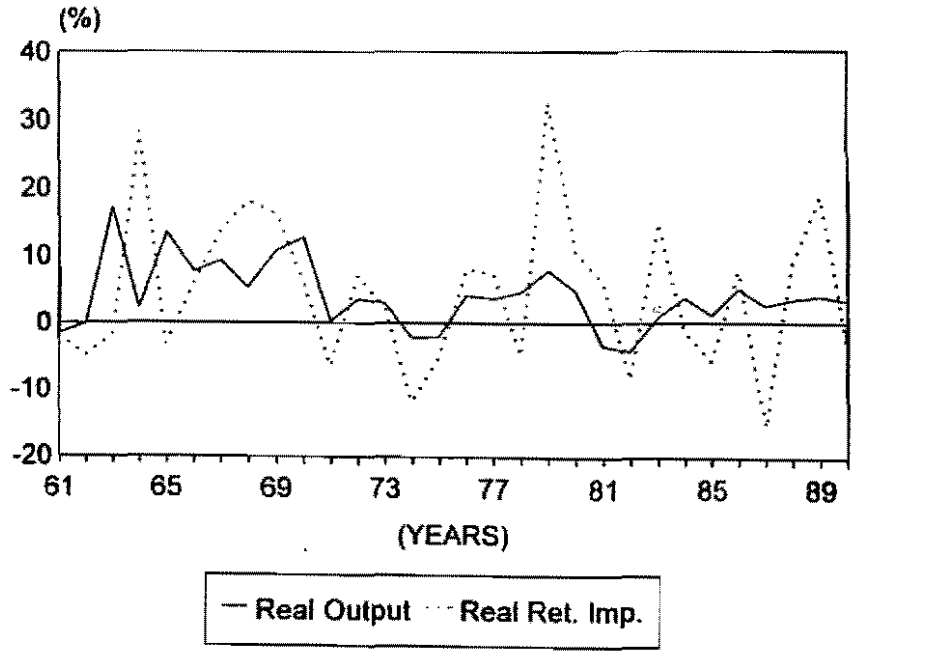

Chart 2

Barbados: Growth Rates of Real Output and Intermediate Imports
1961-90

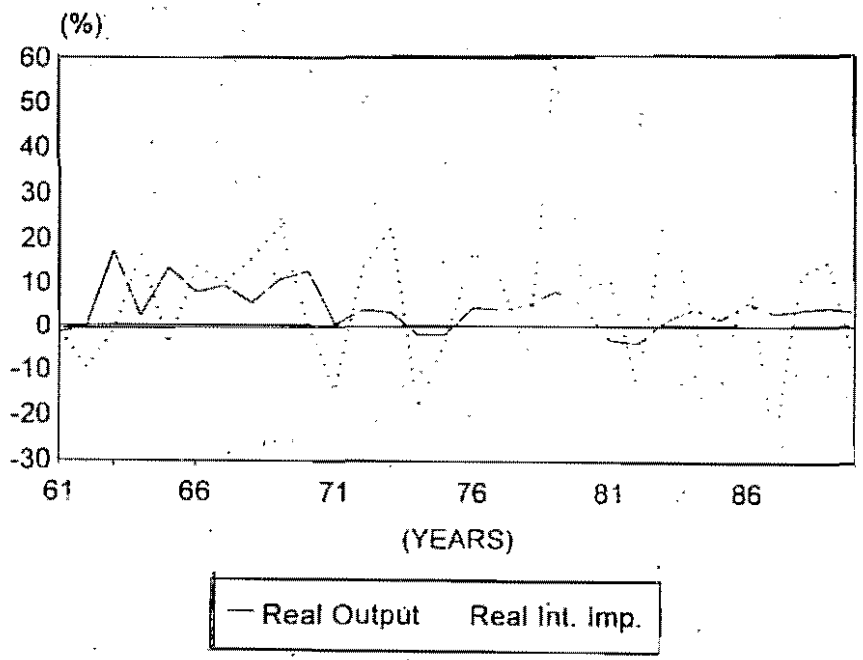

Chart 3

Barbados: Ratio of Current Imports to Current GDP
1961-90

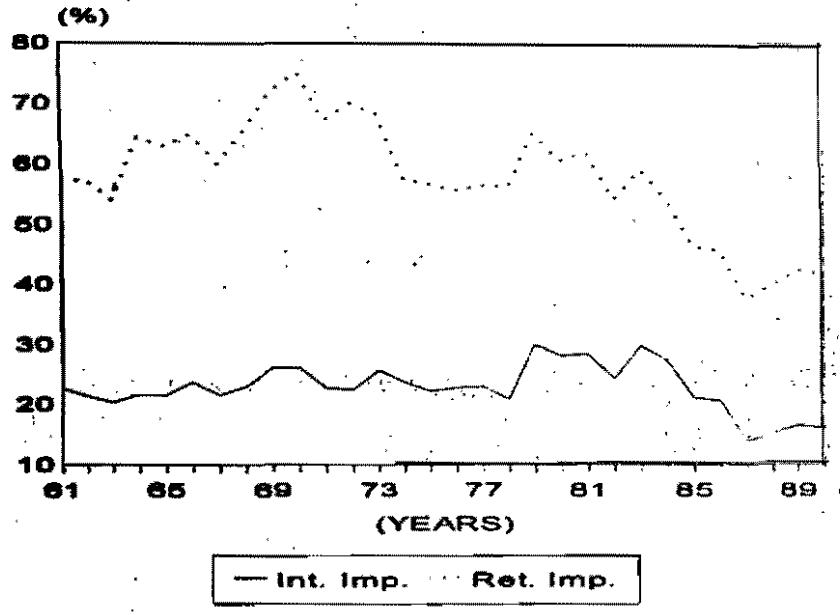

Table 1 **Growth Rates of Real Output and Imports**

(Percentage Averages)

	1961-65	1966-70	1971-75	1976-80	1981-85	1986-90	1961-70	1971-80	1981-90
Real Output	7.9	9.5	0.5	5.3	0.4	1.2	8.6	3.0	1.2
Retal Retained Imports	3.8	13.4	-2.1	10.6	-0.4	1.3	8.2	4.5	1.3
Real Intermediate Imports	-0.2	11.9	2.2	15.3	2.1	-4.1	6.5	9.2	-1.4

Source: Central Bank of Barbados

Table 2 Ratio of Current Imports to Current Output

(Percentage Averages)

	1961-65	1966-70	1971-75	1976-80	1981-85	1986-90	1961-70	1971-80	1981-90
Retained Imports	58.8	67.6	64.0	65.6	55.1	41.3	63.2	61.[illegible]	48.2
Intermediate Imports	21.5	24.1	23.7	24.9	26.2	16.5	22.8	24.3	21.3

Source: Central Bank of Barbados

intermediate imports rose to 24.3% in the period 1971-80 from 22.8% in the decade 1961-70 before declining to 21.3% in the period 1981-90.

Data, Estimation and Empirical Results (Barbados)

Data

The data for the empirical analysis spans the period 1961 to 1990. Current values of National Investment (I), defined as gross capital formation, imports of intermediate goods (MI) real output (Q) and employed labour (L) were obtained from various issues of the Annual Statistical Digest of the Central Bank of Barbados.

The real values of I, MI and Q were obtained by a simple deflation of the nominal series by the respective price indices, also obtained from published and unpublished sources at the Central Bank of Barbados. In addition, the capital stock variable (K) and the price index of capital goods (used to deflate investment) were obtained from Boamah (1984), subsequently revised and updated.

Estimation

With output, investment, imports and, to a lesser extent, labour growing over time in a growing economy like Barbados, the time series data are likely to be non-stationary. In such a situation, simple OLS or TSLS estimations of the production and the intermediate import functions will not be suitable as steady state or long run equilibrium relationship between the dependent variables and the vector of inputs may not exist. This is because basic classical assumptions of zero mean and constant or unvarying variance may be violated.

The error correcting methodology developed by Granger (1986) and extended by Engle and Granger (1987) becomes the appropriate vehicle for estimating such regression models where the variables are non-stationary. According to Engle and Granger, if a set of cointegrated variables exist from a linear combination of a set of otherwise non-stationary variables, then there exists a corresponding error correcting representation of those (cointegrated) variables which is capable of estimating the short run dynamics inherent in the data.

In short the error correction model (ECM) states that changes in the dependent variable depend not only on changes in the independent variables but also on the extent of disequilibrium between the levels of the dependent and independent variables.

In the particular case of Barbados, unit root tests of the variables suggested that real output, real intermediate imports, real investment, labour and the relative price of intermediate imports were all integrated of order one i.e. I(1) with the exception of real investment which appeared to be I(o), steady state cointegrating sets were found for real output, real investment, real intermediate imports and labour. Similarly real intermediate imports cointegrated with lagged values of real output and relative price of intermediate imports.

Empirical Results

The results of the cointegration tests for the two sets of equations are given as equation A1 and A2 in the appendix. Reported below are the results of the error correction representations of equations (8) and (10).

Real Output

$$\Delta \ln Q = \underset{1.254}{0.002I} - \underset{(-0.193)}{0.049}\,\Delta \ln L + \underset{(2.099)}{0.101}\,\Delta \ln MI + \underset{(2.400)}{0.388}\,\Delta \ln Q_{-1} - \underset{(-3.720)}{0.141}\,ECln Q_{-1} \qquad (11)$$

$R^2 = 0.421$ DW = 1.935 F(5,25) = 4.188
LMSC1 [$\chi^2(1)$] = 0.025 LMSC2 [$\chi^2(2)$] = 0.363
LMN [$\chi^2(2)$] = 0.816 ARCH1 [$\chi^2(1)$] = 0.231
RESET [F(3)] = 1.401

Real Intermediate Imports

$$\Delta \ln MI = \underset{(-1.368)}{-0.046} + \underset{(3.517)}{1.883}\,\Delta \ln Q - \underset{(-3.631)}{1.258}\,\Delta \ln RPMI - \underset{(-3.048)}{0.484}\,ECln MI_{-1} \qquad (12)$$

$R^2 = 0.498$ DW = 1.882 F(3,27) = 7.935
LMSC1 [$\chi^2(1)$] = 0.125 LMSC2 [$\chi^2(2)$] = 0.133
LMN[$\chi^2(2)$] = 0.476 ARCH1 [$\chi^2(1)$] = 1.053 RESET (3)[F(.)] = 0.469

In equations (9) and (10), Δ is the first difference operator, LMN is the Jarque-Bera normality test, LMSC1 and LMSC2 represent the Lagrange multiplier test for first and second order serial correlation, ARCH1 is the test for auto regressive conditional heteroskedasticity for one period lag and RESET represents Ramsey's test for model specification error.

All the stated diagnostics suggest that the residuals in both equations are white noise so that the equations can be considered adequate representation of the data generating process.

In both equations, the Lagrange multiplier tests for both first and second order serial correlations are not significant, satisfying a necessary condition for the residuals to be white noise; the Jarque-Bera test also suggest that the residuals are normal. The ARCH test suggest that the basic assumption of the variance of the residuals being homoskedastic cannot be rejected.

The fact that the coefficient of real intermediate imports is significant at conventional levels in equation (9) lends credence to the strong positive influence of real intermediate imports[2] on real output growth. The implied elasticity of 0.1, while small, is generally consistent with results obtained by Ram (1990) and Hentschel (1992) for developing countries.

The strong influence thatm lagged real output have on real intermediate imports is also borne out by the highly significant coefficient of $\Delta \ln Q_{-1}$ in equation (10). The implied income elasticity of demand is 1.9 while the

relative price elasticity of demand is 1.26. The results also indicate a relatively slow speed of adjustment in both equations, as indicated by the coefficients of the error correction terms. Only 14.1% of adjustment towards the steady state takes place each period with regards to the real output equation compared with a relatively faster speed of adjustment (48.4%) for the real intermediate import equation.

Although positively signed, the investment variable is not significant while the labour variable is insignificant and wrongly signed. Two factors may account for this. First, there is no direct measure of capacity utilisation of the standing stock of capital. Second, only physical unit of labour is available but, with the generally high skill level of the Barbadian labour force, the employment data need to be adjusted to account for human capital development.

Accounting for Human Capital

In the literature, three main approaches have been utilised to represent human capital in empirical studies. Early attempts made use of literacy rates and school enrolment ratios. To the extent that literacy rates capture a general level of education but ignores the fact that some people are better educated than others, it is not a satisfactory measure of human capital. Similarly school enrolment ratios measure future rather than present or past human capital. Therefore in this paper an incomes-based approach has been adopted to get an estimate of human capital.

Briefly, three educational levels for the population aged 14 years and over were identified: those with educational level up to the primary school (L_1), those with secondary/technical/vocational level and those with tertiary level of education (L_2). Then median salaries from the schedules of enrolments for the country's civil servants were estimated for the three educational classes identified. A deflated series of the sum of the yearly incomes of the three categories of adult group by education was taken as a rough estimate of human capital for the period 1963 to 1992.[3]

To incorporate the concept of human capital into the production function, an assumption was made that the human capital index (HK) enters as a multiplicative index with labour.

Thus, the production function (5) becomes

$$Q_t = \gamma_o K_t^{\alpha_K} MI_t^{\phi_{MI}} (HKL)_t^{\alpha_{HK}} U_t \qquad (13)$$

From (12) the short run relationship becomes

$$\Delta lnQ_t = \gamma_o + \alpha_K I_t + \phi_{MI} \Delta \ln MI_t + \alpha_{HK} \Delta \ln HKL_t + \eta_t \qquad (14)$$

Despite the fact that lnHKL was found to be integrated of order 1, a cointegrating nector could not be obtained for $\ln Q_t$, I_t, $\ln MI_t$ and $\ln HKL_t$. As a result, the error correction methodology for estimating equation (14) could not be adopted[4]. Nevertheless exploratory estimates for the long run relationship suggest a fairly strong influence of the human capital variable on real output (see the appendix).

Summary and Conclusions

The paper sets out to determine to what extent imports may be considered one of the main sources of economic growth in the Caribbean. A dynamic production function in which real intermediate imports enter as a separate factor of production is utilised in the analysis.

Preliminary results with data for Barbados appear to support the view that real intermediate imports and, to some extent, real investment are the main sources of growth in the country over the period 1961-90. This finding seems to support the generally held hypothesis that a liberal trade policy helps economic growth. Therefore the adoption of restrictive commercial policies that limit the flow of intermediate imports could lead to unintended results of deepening recessionary tendencies.

The results also indicate that growth of real intermediate imports appear to be determined largely by real output lagged one period, although relative prices also seem to exert some influence.

Finally, the influence of human capital development cannot be discounted, although time constraint did not allow for a detailed examination of its effect on real output. Some studies (e.g. Romer, 1986) attribute the existence of increasing returns in economic growth to the influence of human capital and specify a non-linear function between that variable and capital and labour. Therefore some further work needs to be done to explore the

inter-relationship between the human capital index we have developed and the other factors, especially labour.

Endnotes

1. The endogeneity of investment and of labour will be explored in the subsequent revision of the paper.

2. These estimates assume that $\lambda = 0$ in equation 8. In other words, all intermediate goods are imported. The results for various values of λ will be reported in subsequent revision of the paper.

3. See Boamah (1995) for a detailed account of how the series on human capital was derived.

4. The exact relationship between the human capital index and the employment variable may need to be explored further.

Appendix

The steady state estimates of models (11) (12) and (14) in the text are reported below.

Real Output

$$\ln Q = 4.432 - 0.070\ln K + 0.031\ln MI + 0.592\ln L$$

$R^2 = 0.986$ DW = 1.844 ADF = -4.169 (DF = -27.5) (A1)

Real Intermediate Imports

$$\ln MI = -1.031 + 1.210\ln Q_{-1} - 0.355\ln RPMI \quad (A2)$$

$R^2 = 0.905$ DW = 1.870 DF = -4.758

Real Output (with Human Capital)

$$\begin{aligned} \ln Q = {} & 0.620 + 0.348\ln K + 0.036\ln MI + 0.075\ln HKL \\ & (2.381) \quad (1.068) \quad (0.985) \quad (1.941) \\ & + 0.795\ln Q\text{-}1 \\ & (14.656) \end{aligned} \quad (A3)$$

$R^2 = 0.986$ Dw = 1.967

* In equations A1 and A2, the DF and ADF represent, respectively, the Dickey Fuller and Augmented Dickey Fuller statistics for the error terms of the respective equations. The variables in brackets in equation A3 are the t-ratios.

References

Boamah, Daniel, (1984, "The Stock of Fixed Capital in Barbados, 1958-81: Some exploratory Estimates", Economic Review, Central Bank of Barbados, XI, 8-20.

Boamah, Daniel and Craigwell, Roland (1993), "Substitution Possibilities between Imports and Traditional Factors of Production", The North American Journal of Economic and Finance, 4:2, 48-59.

Boamah, Daniel (1995), An Approach Towards the Measurement of Human Capital in Barbados, Review Seminar, Central Bank of Barbados.

Cardoso, Eliana and Fishlow, Albert (1989), Latin American Economic Development, 1950-1980 NBER Working Paper NO. 3161, Cambridge, Mass.

Engle, Robert F. and Granger, Clive W. J. (1987), "Cointegration and Error Correction: Representation, Estimation and Testing", Econometrica 55, 251-276 (March).

Granger, Clive, W. J. (1986), "Developments in the Study of Cointegrated Variables", Oxford Bulletin of Economics and Statistics, 48, 213-228 (August).

Henry, Michael C. (1989), "An Econometric Analysis of Substitution Possibilities Between Domestic and Imported Factors of Production in

Pakistan (1970-1987): A Translog Cost Approach", Working Paper No. 4771, University of the West Indies, St. Augustine, Trinidad.

Hentschel Jesko (1992), "A Note on the Relationship Between Imports and Growth", Weltwirtschaetliches Archiv 128:2, 339-345.

Maddala, G.S. (1988), Introduction to Econometrics, MacMillan, London.

Mirakhor, Abbas and Montiel, Peter (1987), "Import Intensity of Output Growth in Developing Countries , 1970-85", Staff Studies for the World Economic Outlook, International Monetary Fund, 59-97.

Mohabbat, K., Dalal A. and Williams, M. (1984), "Import Demand for India: A Translog Cost Function Approach", Economic Development and Cultural Change, 32, 593-605.

Ram, Rati (1990), "Imports and Economic Growth: A Cross-Country Study", Economia Internazionale, 43, 45-66.

Romer, Paul M. (1986), "Increasing Returns and Long-Run Growth", Journal of Political Economy, 94 (5), 1002-1037.

Sengupta, Jati, K. and Espana, Juan R. (1994), "Exports and Economic Growth in Asian NICs: An Econometric Analysis for Korea", Applied Economics, 26, 41-51.