

**THE RELATIONSHIP BETWEEN IMPORTS  
AND GROWTH IN THE CARIBBEAN**

by

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Introduction

Recent studies appear to confirm that imports could be considered factors 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

$$Q = F_1(K, L, II) \quad (1)$$

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:

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

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  $0 < \lambda < 1$ .

Then equation (2) becomes

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

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

$$Q = F_1(K, L, (1 - \lambda)^{-1} MI_t) \quad (4)$$

Taking the time derivative of equation (4) an estimable equation (5) below may be derived.

$$\dot{Q} = \alpha_K \dot{K} + \alpha_L \dot{L} + (1-\lambda)^{-1} \alpha_{MI} \dot{MI} \quad (5)$$

In equation (5),  $\alpha_K$ ,  $\alpha_L$  and  $\alpha_{MI}$  represent the marginal productivities of capital, labour and intermediate imports, respectively. The dots over the variables denote their time derivatives. 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 (5) becomes

$$\dot{Q} = \alpha_I I + \alpha_L \dot{L} - (1-\lambda)^{-1} \alpha_{MI} \dot{MI} \quad (6)$$

Equation (4) 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 endogeneity of intermediate imports is explored in this paper.<sup>1</sup>

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:

$$MI = F_7(Q, RPMI) \quad (7)$$

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. Taking the time derivative of (7) leads to an estimable equation <sup>2</sup> of the form

$$MI = \gamma_Q Q + \gamma_{RP} RPMI \quad (8)$$

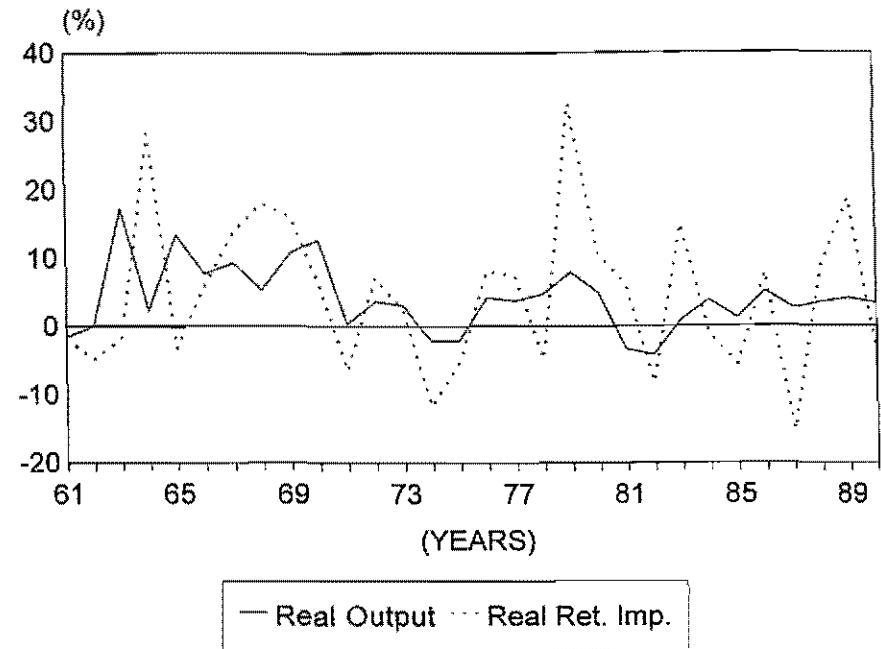
where  $\gamma_Q$  and  $\gamma_{RP}$  are positive coefficients. Equations (6) and (8) were estimated, with data spanning the period 1961 to 1990.

### Overview of Imports and Growth 1961-90

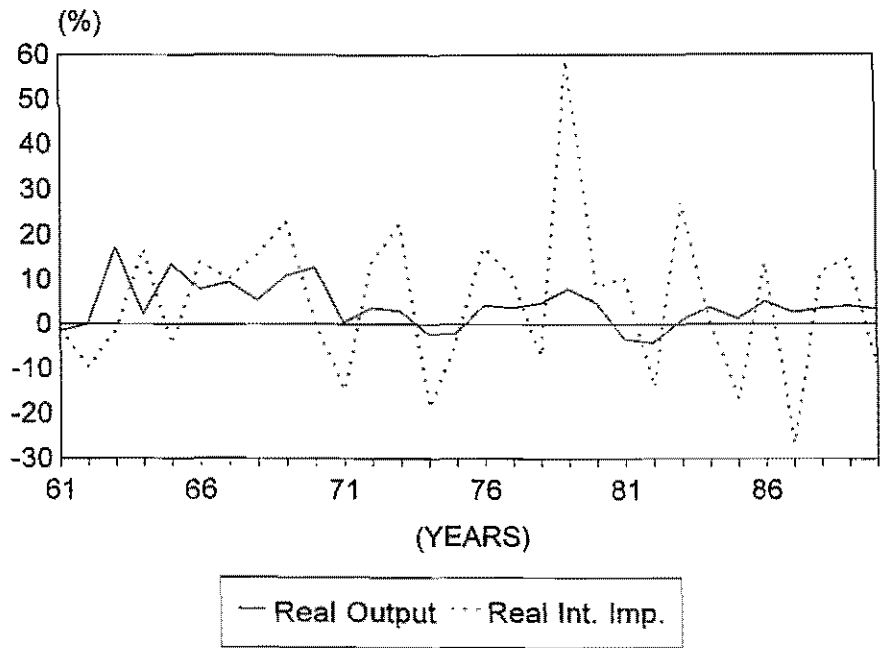
The historical data on the growth of real output (real gross domestic product (GDP) at factor cost) and real imports in Barbados suggest a strong positive association between the two growth rates over the past three decades. Over the three decades real output grew the fastest (5.6%) between 1961-70, 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.

Chart 1

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



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



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.

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

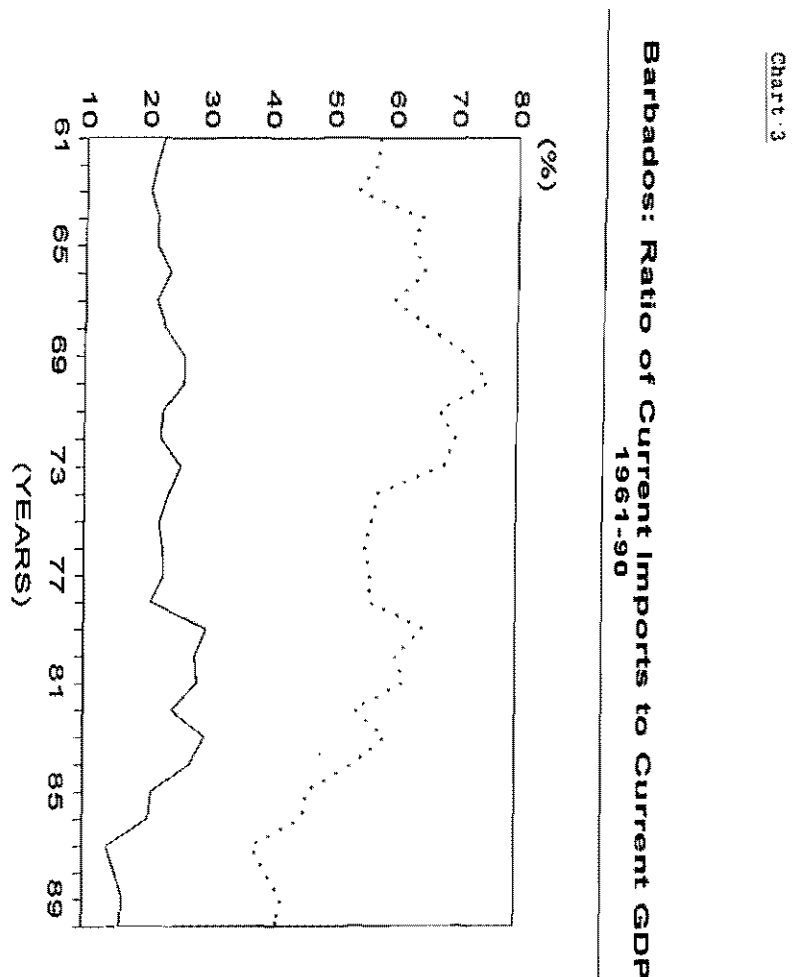
**Ratio of Current Imports to Current Output**

(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	61.4	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

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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 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.

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). Steady state cointegrating sets were found for real output and the lagged values of real investment and labour and real intermediate imports. 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 (6) and (8).

#### Real Output

$$\begin{aligned} \Delta \ln Q = & 0.002 \ln I & - 0.049 \Delta \ln L & + 0.101 \Delta \ln MI \\ & (1.254) & (-0.193) & (2.099) \\ & + 0.388 \Delta \ln Q_{-1} & - 0.141 \text{EC} \ln Q_{-1} & \\ & (2.400) & (-3.720) & \end{aligned} \quad (9)$$

$$\begin{aligned} R^2 = 0.421 \quad DW = 1.935 \quad F(5,25) & = 4.188 \\ \text{LMSC1 } [\chi^2(1)] = 0.025 \quad \text{LMSC2 } [\chi^2(2)] & = 0.363 \\ \text{LMN } [\chi^2(2)] = 0.816 \quad \text{ARCH1 } [\chi^2(1)] & = 0.231 \\ \text{RESET } [F(3)] = 1.401 & \end{aligned}$$

#### Real Intermediate Imports

$$\begin{aligned} \Delta \ln MI = & -0.046 + 1.883 \Delta \ln Q - 1.258 \Delta \ln RPMI \\ & (-1.368) \quad (3.517) \quad (-3.631) \\ & - 0.484 \text{EC} \ln MI_{-1} & \\ & (-3.048) & \end{aligned} \quad (10)$$

$$\begin{aligned} R^2 = 0.498 \quad DW = 1.882 \quad F(3,27) & = 7.935 \\ \text{LMSC1 } [\chi^2(1)] = 0.125 \quad \text{LMSC2 } [\chi^2(2)] & = 0.133 \\ \text{LMN} [\chi^2(2)] = 0.476 \quad \text{ARCH1 } [\chi^2(1)] & = 1.053 \quad \text{RESET } (F3)[F(\cdot)] = 0.469 \end{aligned}$$

In equations (9) and (10),  $\Delta$  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<sup>3</sup> 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 presumed feedback that real output have on real intermediate imports is also borne out by the highly significant coefficient of  $\Delta \ln Q$  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.

To investigate the fact that the output growth process may be characterised by increases in labour productivity, the growth equation is reformulated to fit the log of the output labour ratio (QLR) as the dependent variable. The explanatory variables for the steady state are the log-linear functions of the capital labour ratio (LR), the real intermediate imports per unit of employed labour (LMLR) and one period lag of the output labour ratio. The latter variable is used as a proxy for technical progress, as has been frequently done in similar studies for developing countries. (See e.g. Sengupta and Espana (1994) P. 49).

After transforming real output into the output labour ratio, the three remaining variables of the original production function (equation 4), ie  $\ln QLR$ ,  $\ln KLR$  and  $\ln MILR$  were all found to be integrated of order one, i.e.  $I(1)$ . A steady state cointegrating vector was found for  $\ln QLR$ ,  $\ln KLR$ ,  $\ln MILR$  and  $\ln QLR_{-1}$ . The results appear as equation A3 in the appendix.

The results of the error correction model for the dynamic function for the period 1964 to 1990 is reported as equation (11) below

#### Real Output-Labour Ratio

$$\begin{aligned} \Delta \ln QLR = & 0.060 \Delta \ln KLR + 0.125 \Delta \ln MILR \\ & (0.417) \quad (2.488) \\ & + 0.727 \Delta \ln QLR_{-1} \quad 0.885 E C \ln QLR_{-1} \quad (11) \\ & (2.520) \quad (-2.663) \end{aligned}$$

$$\begin{aligned} R^2 = & 0.466 \quad DW = 1.839 \quad F(4,21) = 6 - 106 \\ LMSCI [\chi^2(1)] & 0.189 \quad LMSC2 [\chi^2(2)] = 0.256 \\ ARCH1 [\chi^2(1)] & 0.210 \quad RESET(3) [F(\cdot)] = 1.152 \end{aligned}$$

The results reveal a strong positive influence of technical progress (proxied by  $QLR_{-1}$ ) both in the steady state and in the dynamic results of the labour productivity estimates. Changes in real intermediate imports per unit of employed labour also appear to exert a strong positive influence on changes in labour productivity. That changes in the capital labour ratio is not significant in explaining changes in labour productivity is surprising and may be attributed mainly to data deficiencies. The coefficient of the error correction term (0.885) indicates a relatively fast speed of adjustment towards the steady state.

### 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 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 seek to ration foreign exchange, perhaps in response to balance of payments difficulties, may have the unintended results of deepening recessionary tendencies, especially if such restrictive practices limit the flow of intermediate imports.

The results also point to the existence of a feedback mechanism between real growth rate and growth of real intermediate imports as real growth appear to have a strong positive impact on the growth of real intermediate imports. However, a definitive statement on the effective direction of causation, may

have to await a formal test, in the Granger (1988) sense, between the two variables.

Finally, the influence of human capital development cannot be discounted, to the extent that changes in labour productivity in the previous period appear to have a dominant impact on current period's productivity growth.

## ENDNOTES

1. The endogeneity of investment and of labour will be explored in the subsequent revision of the paper.
2. Lags may be introduced in the actual estimation of the steady state relationship to reflect the fact that changes towards the desired level of imported intermediate goods may not be instantaneous.
3. These estimates assume that  $\lambda = 0$  in equation 8. In other words, all intermediate goods are imported. The results for various values of  $\lambda$  will be reported in subsequent revision of the paper.

## APPENDIX

The steady state estimates of models (9) (10) and (11) in the text are reported below.

### Real Output

$$\ln Q = 4.432 - 0.070 \ln I + 0.031 \ln MI + 0.592 \ln L_{-1}$$

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

### Real Intermediate Imports

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

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

### Real Output Labour Ratio

$$\ln QLR = 0.457 + 0.097 \ln MT - 0.035 \ln KLR + 0.79 \ln QLR_{-1} \quad (A.3)$$

$$R^2 = 0.955 \quad DW = 1.928 \quad DF = -5.581$$

\* In equations A1, A2 and A3 the DF and ADF represent, respectively, the Dickey Fuller and Augmented Dickey Fuller statistics for the error terms of the respective equations.

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