



**EXPORT-OUTPUT CAUSALITY IN BARBADOS:
A COINTEGRATION APPROACH**

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ABSTRACT

This paper empirically tests export-output causality in the case of Barbados for the period 1970 to 1997, both at the aggregate and disaggregate level, utilizing cointegration theory and augmented Granger causality tests. Although no causal relationship was found between aggregate exports and GDP, disaggregated analysis revealed evidence of cointegrating relationships not only between output and export of services, but also output and sugar exports. Further analysis indicated that a bi-directional long-run relationship in the latter case.

I Introduction

Export led growth is now widely accepted as an essential development strategy for the Caribbean. History is a reminder that the well-being of the region depends on exports and the foreign exchange that it earns. Exports provide foreign exchange to support variety, and increase in consumption. It also encourages the acquisition of technology by intensifying international contacts and exploiting international production linkages. This can lead to efficiency gains through more competitive cost structures and productivity improvement.

Such benefits of export growth for economic growth and development in the Caribbean have been well discussed [Worrell, 1987, 1994, McIntyre 1995], and it has been frequently sited that export growth can generate positive externalities in other sectors of the economy through more efficient management styles and improved production techniques. Export, through this manner, promotes economic growth.

In this study, we propose to test the export-led growth hypothesis (ELG) in Barbados, for the period 1970-97 using both aggregate and disaggregated data. The methodology employed is an augmented Granger causality test within an error correction framework. The remainder of the paper is organised as follows. Section II offers a selective literature review of research on the export-led growth, in various countries. Section III and IV give an overview of the Barbadian economy, and outlines the econometric methodology, respectively. The data set is then discussed and results presented in Section V. Section VI concludes.

II Review of Literature on Export-Led Growth

A myriad of empirical literature, focusing on exports and growth is available, encompassing various techniques and methodologies applied to numerous countries worldwide. The following reviews the findings of a selection of papers, which used relatively similar analytical techniques. They have followed three basic steps to causality testing. The properties of the relevant time series are first tested using the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) or Zivot-Andrews unit root tests. Secondly, the existence cointegration is tested using Johansen Maximum Likelihood procedure by ordinary least squares (OLS) or seemingly unrelated regression (SUR). If cointegration is not found, the static Engle-Granger causality test may be used. If cointegration is found, an error correction model is incorporated (known also as augmented Engle-Granger). Finally, causal relationships may be determined using the Wald test. Some weaknesses in some of these methodologies have also been sited, including simultaneous-equation bias, causality versus exogeneity, accounting versus economic effects, controlling for imports, and the disaggregation of exports.

Kwan et al [1996] have sited that Granger non-causality could be considered as a precondition for strong exogeneity, thus the need to properly address the difference between causality and exogeneity was emphasized. They suggested the use of the Engle-Hendry procedure. If exogeneity exists, there can be no Granger causality. However, once it does not exist, the next step is to test for cointegration, which was done frequently by OLS regression. Unfortunately simultaneous-equation bias has been sited as one of its shortcomings, so to avoid invalidating results, Abhayaratne [1996] corrected for this problem by using the seemingly unrelated regression (SUR).

Attempts to distinguish between the accounting and economic effects of exports on growth have been made by Ghatak et al [1997] by looking at the relationship between real GDP and exports, and real non-export GDP¹ and exports respectively. However it was statistically

¹Real GDP less exports

proven by Atukeren [1994] that one variable cannot Granger cause another if the sole relationship is an accounting one, thus Granger-causality tests do not suffer from an accounting effect. This finding eliminates any need to net out exports from GDP before testing for causality.

Studies have also shown that the lack of a causal relationship between exports and GDP may be due to the fact that various components of exports may be canceling each other out, and so current research looks not only at aggregate exports, but also at its different components. Furthermore, there is a school of thought that believes that one should also control for imports, because growth of exports could cause the growth of imports, and thus affect the growth of output. Ghatak et al [1997] incorporated both such techniques in their research on Malaysia. Abhayaratne [1996] and Ghatak and Price [1997] also chose to include a variable for imports in their causal models, but neither found imports to be important.

Although recent years have witnessed various studies on the export and growth relationship, literature searches on export-led growth for the Caribbean revealed the lack of research focused on small, open Caribbean economies emphasizing the need for more regional research in the area. McIntyre [1992] was the only paper found which analysed the impact of exports in the development process of Caribbean economies. Using a Cobb-Douglas function form model, his findings in the Barbadian case supported the argument that foreign exchange flows had a positive effect on output over time. The model incorporated real GDP, capital stock, labour force, real imports, and real gross foreign exchange inflows² over the twenty period, 1968 to 1988. McIntyre, however, was cautious in his interpretation of the results, because of unreliable measurement of labour and capital.

Biswal et al [1998] found evidence of a bidirectional causality between exports and growth in Taiwan, for the period 1960 to 1990. Phillips and Perron unit root tests were first performed

²Gross exports of goods and services plus gross exogenous capital flows, deflated by import price index.

on the variables, which were found to be $I(1)$. Further analysis revealed that cointegration existed, and Granger causality was unveiled using the Engle-Granger error correction model. This analysis confirmed findings by Chow [1987], who used Sims' causality tests for the period 1960 to 1984. Kwan et al [1996] also tested the ELG hypothesis in the Taiwanese case by first using Engle and Headley procedures to test the joint hypothesis of weak and super exogeneity³ (which were rejected). The Zivot-Andrews (1992) modified unit root tests found the variables to be $I(1)$, but the Engle-Granger (1987) cointegration found no long run relationship existing during the period 1953 to 1988. The inconsistent findings may not only be due to the different econometric specifications and test procedures, but also the different time periods analysed.

Ghatak et al [1997] opted to test the ELG hypothesis both on the aggregate (1955-90) and disaggregate (1966-90) export level in the Malaysian case. Aggregated export analysis with the error correction model, supported the hypothesis both with real GDP and real non-export GDP aggregate analysis, using real GDP, real exports, and real non-export GDP. The application of the ADF test confirmed that all the relevant variables were $I(1)$ in levels, and $I(0)$ in first differences. Real non-export GDP series indicated a structural break, and to ensure the lack of a spurious unit root the Additive Outlier Perron test was used. The existence of one cointegrating vector was determined with the Johansen ML procedure (optimal lags chosen with Akaike's minimum FPE criterion), implying the use of the error correction model. Furthermore, the significance of the coefficients of the error correction terms indicated a long run relationship. Exports were then broken down into manufactured goods, fuel and non-fuel primary goods, and also included measures of physical and human capital, and further analysis revealed that the hypothesis was driven by the relative importance of non-traditional, manufactured exports in total exports.

Ghatak and Price [1997] went a step further when they analysed the Indian economy, by

³Granger non-causality is considered to be a precondition for strong exogeneity

controlling for imports (though it appeared to have no effect). Analysis suggested that real GDP growth Granger caused real aggregate export growth, but confirmed the hypothesis on the disaggregate level, indicating that nontraditional manufactured exports Granger caused output growth. Stationarity of the variables (all found to be $I(1)$) were tested using the Augmented Dickey-Fuller unit root test. The optimal lag length used in the test for serial correlation was determined by the Akaike Information Criterion, confirming its absence. The Engle-Granger cointegration regressions were by OLS, for both the aggregate and disaggregate models, and the error correction model was incorporated when cointegration was found.

Much of the methodology applied in this research paper is a combination of techniques used by Doyle [1998] and Abhayaratne [1996]. The former found that Irish data for 1953 to 1993 supported the hypothesis, finding that in the short-run exports Granger caused output, and that long-run common trends also existed. Doyle found variables of exports and GDP both had a unit root when applying the Augmented Dickey Fuller test for stationarity, and further analysis using the Johansen procedure found one cointegrating vector existed⁴. Using the augmented Granger causality tests with the error correction term, the direction of causality was then established using the Wald test, and the significance of the coefficient of the GDP error term indicated the long run relationship.

Abhayaratne [1996] found that the foreign trade (exports and imports) did not cause output growth for the period 1960 to 1992 in the Sri Lankan case. Using the (Augmented) Dickey-Fuller, the variables were found to be $I(1)$, and the Johansen Maximum Likelihood procedure, according to the Schwartz criterion, found no cointegrating relationships. Furthermore, estimations were made using a seemingly unrelated regression (SUR) model to improve the efficiency of the estimates. Finally, the direction of causality was determined using the Wald test.

⁴ The optimal lag length in the VAR was found using the Akaike Information Criterion (1990) and Akaike Final Prediction Error (1979)

III The Barbadian Perspective

The Barbadian economy (independent in 1966) has displayed a systematic movement from an agricultural to a service industry, and this movement can be seen through three phases of growth emerging after World War II [Worrell 1982]: agricultural (1946-62), transitional (1963-70), and export diversification (1971-97). Agricultural dominance was driven almost entirely by sugar, which required few imported goods, and accounted for about 33.3% of GDP in 1946. Such a mono-crop plantation society made Barbados vulnerable to fluctuations of price and output of sugar, and despite record levels during the fifties and sixties, problems at various stages of production, coupled with insufficient revenue to offset rising unit costs, resulted in dramatic declines and the threatening of industrial viability during the seventies. The industry is yet to regain the premier position previously held for almost three centuries.

Unlike sugar, tourism was in its infancy in the fifties, with the Commonwealth Caribbean, especially Trinidad and Tobago, and the Leeward & Windward Islands, as a major source of visitors (41% in 1956). The sixties however, marked extra-regional market growth, and the corresponding emergence of tourism as one of Barbados' two major exports (manufacturing being the second). The close proximity to the US and Canada, and its socio-political relationship with UK, were distinct competitive advantages over other destinations in the main markets. In 1964, the Board of Tourism launched a major advertising programme in Canada, and its success was reflected in sharp increase in Canadian visitors [Phillips 1982]. Further intensive marketing strategies, growth of incomes in more developed countries, as well as greater availability of air transportation further encouraged growth in US and Canadian markets during the period. In contrast to the previous decade, the seventies was a period of deterioration of the tourist market (recession of most western industrial economies), despite the establishment of air links and corresponding advertising campaigns in Europe markets earlier in the decade.

In the initial stages, import-substitution contributed to much of manufacturing output growth which was limited to food, beverage, soap and tobacco production for local consumption. Any

potential growth however, was restricted by population growth, once pre-war levels of per capita consumption was restored. Hence the introduction of new products with better export potential led to the increase of output realised in the late fifties and sixties. A corresponding decline in the contribution of import-substitution occurred, as various stages of production of condiments, beer, and milk were added in 1958, 1961, and 1964 respectively [Cox 1982]. The expansion of the sector also comprised clothing, pharmaceuticals, paints, furniture and ceramics, lead acid batteries, and industrial gas production. Moderate growth continued, slumping in the late sixties, and 1974. Initially, most were regional exports, and the establishment of the Caribbean Free Trade Association and Caribbean community (Caricom) in 1967 and 1973 respectively, further increased their importance. Despite this, extra-regional market exports had ultimately surpassed exports to other Caribbean countries by 1980.

Tourism and manufacturing industries, unlike sugar, had a significant impact on imports, and coupled with the improving standard of living, the demand for consumer, intermediate and capital goods strengthened. Although exports of goods and services were believed to have sustainable such economic activity, analysis by Codrington et al found no relationship between these changes and variation in GDP growth. In fact, the results suggested that the non-traded sectors made a larger contribution. The most important of these activities were those offered by the private firms, such as banking, real estate, accountancy, and insurance.

Fiscal incentives were first introduced in the sixties, to encourage development of such international business services, but a study by Ernst and Young [1994] suggested that it was not until the mid-eighties that rapid development occurred, offering insulation from external shocks, thus further stabilising the economy. This was attributed, in part, to improved monitoring of operations such as Shipping and Exempt Insurance Companies, Foreign Sales Corporations, and Offshore Banks. Estimates indicated that in the eighties the sector generated jobs for approximately 22% of the total number employed, and by 1996, this had risen to 31.3% [Central Bank of Barbados Annual Report 1996]. Despite the impact of this sector, analysis performed by Campbell and Downes [1997] implied that non-tourism

services⁵ a net foreigner exchange user.

IV Econometric Methodology

Recent research (G, 1988, Bahmaric-Oskooee and Alze, 1993) have indicated that cointegration tests are required to investigate causality since the presence of cointegration between variables invalidates the conclusions reached using the standard tests for causality. Outside the co-integration frame work, causality tests present evidence of simultaneous matters than causal reactions between such non-stationary variables. If the error-connection term is omitted from causality tests when the series are cointegrated, not only will the casual information be invalid, but no causation may be detected when it exists. The error-connection term provides an additional channel through which causality may be assessed. Therefore, we empirically test the export-led growth hypothesis within the cointegration framework.

Integration

Our first step is to determine the order of integration of the series using the Dicky-Fuller (DF) and Augmented Dicky-Fuller (ADF) tests for unit roots. The ADF Test is based upon the regression model:

$$\Delta LEXP_t = \alpha_1 + \beta_1 t + \delta_1 LEXP_{t-1} + \sum_{j=1}^J \gamma_j \Delta LEXP_{t-j} + \xi_t \quad (1)$$

$$\Delta LDGP_t = \alpha_2 + \beta_2 t + \delta_2 LGDP_{t-1} + \sum_{j=1}^J \alpha_j \Delta LGDP_{t-1} + W_t \quad (2)$$

where $LEXP_t$ represent the log of real exports and $LGDP_t$ represents the log of Gross

⁵Non-tourism services comprise transportation, government, and other services (insurance, communication, construction, financial, computer and information, and various other business services).

Domestic Product. J is chosen to be sufficiently large to ensure that the error term is free of significant serial dependence. When $J=0$ the DF test is obtained and $J>0$ defines the ADF test. The null hypothesis that the series follows a random walk is rejected if the coefficient on $LEXP_{t-1}$ ($LGDP_{t-1}$) is significantly negative.

Cointegration

The next step is to determine if real exports and output are cointegrated. Consider the following vector autoregressive model of the levels of X_t ,

$$B(L)X_t = \xi_t$$

Where $X = [LEXP, LGDP]'$. Applying the Beveridge-Nelson decomposition $B(L) = B(1) + (1-L)B^*(L)$ to the lag polynomial operation on X_{t-1} on the RHS, we obtain

$$\Delta Y_t = -B(1)X_{t-1} + \sum_{j=1}^{\infty} B \Delta X_{t-j} + \xi_t$$

where $B(1)$ is a matrices of long run multipliers and B the short-run dynamics coefficients. The rank, r , of $B(1)$ determines the number of cointegrating vectors that exist. If $B(1)$ is less than full rank, X_t is cointegrated and $B(1)$ can be expressed as

$$B(1) = \gamma\alpha'$$

where α is the matrix of cointegrating vectors and the coefficients in γ represent the speed of adjustment of the system to disequilibrium. Johansen (1990) suggest estimating the $B(1)$ matrix in an unrestricted form and the test whether one can reject the restriction implied by the reduced rank of $B(1)$. The test statistics in this decision are the trace statistic given by

$$Q_r = -T \sum_{i=r+1}^k \log(1 - \lambda_i)$$

for $r=0, 1, \dots, k-1$ and λ_i is the i -th largest eigenvalue; and by the maximum eigenvalue

statistics given by

$$Q_{\max} = -T \log(1 - \lambda_{T-1}) = Q_T - Q_{T+1}$$

The test in each case is $H_1(r)$ against $H_1(k)$. The critical value for the trace test and the maximum eigenvalue test can be found in Osterwald - Cenum (1992).

Causality on Error-Correction Models

A variable, W_t , is said to Granger cause another variable, Y_t , if lagged values of W_t help to forecast Y_t , from a forecast initially using the lags of Y_t alone. In the context of this study, exports can be said to Granger cause output, if the forecast of output is improved by using past values of exports, given that relevant information is totally contained in the past and present value of these variables. As noted earlier, the standard Granger-causality test is augmented with the error-correction term from the cointegrating equation. The augmented Granger causality test is therefore:

$$\Delta LEXP_t = \beta_0 + \sum_{i=1}^Z \beta_i \Delta LEXP_{t-i} + \sum_{i=1}^M \beta_{2i} \Delta LGDP_{t-i} + \delta ECT_{t-1} + \xi_t \quad (3a)$$

$$\Delta LGDP_t = \theta_0 + \sum_{i=1}^n \theta_{1i} \Delta LGDP_{t-i} + \sum_{i=1}^P \theta_{2i} \Delta LEXP_{t-i} + \gamma ECT_{t-1} + \xi_{2t} \quad (4a)$$

where ECT is the error correction term derived from the long-run cointegrating relationship, ie μ and/or η (whichever is found to be stationary) from

$$LEXP_t = \alpha + \phi_1 LGDP_t + \mu_t \quad (3b)$$

and

$$LGDP_t = \varphi + \phi_2 LEXP_t + \eta_t \quad (4b)$$

The ECT provides an extra channel through which causality can be observed. From equation

4, exports is said to Granger cause output not only if the θ_{2i} is jointly significant, but also if y is significant. The changes of the lagged independent variable describe the short-run causal impact where the error-correction term captures the adjustment of $\Delta LEXP_t$ and $\Delta LGDP_t$ to their long-run equilibrium [Jones & Joufaian (1991)]

To determine the optimum lag length for the equations 3a and 4a two criteria are considered. The Akaike information criterion [Harvey, 1994] and Schwarz criterion [Hsiao, 1979].

V Data and Empirical Results

Data

The data used in this study is obtained from the database of the Central Bank of Barbados. The data is of annual frequency and spans the period 1970 to 1997, due primarily to the fact that the export of services series started from 1970. For the analysis at the aggregate level we used the natural logarithms real GDP (LGDP), and real exports of goods and services (LEXP). The export of goods and services component is further disaggregated into real exports of goods (LEXP_G), real exports of services (LEXP_SER), real exports of sugar (LEXP_SUG) for further analysis.

In light of the economic methodology presented in the previous section, we first checked for the stationary properties of the series. The results are presented in Table 1. The results indicate that the null hypothesis of non-stationarity is not rejected at the 10% level of significance for all the levels of the variables. The null hypothesis of non-stationarity is rejected for the first differences at the 10% level of significance. Hence, we conclude that the variables are all $I(1)$.

Aggregated export Analysis

The next step in the analysis is to use the Johansen's ML procedure described in the previous section to test for cointegration. Table 2A reports the results. Both test statistics are well below the corresponding 5% critical values. Hence we conclude that there is no cointegrating relation between them (i.e. LGDP and LEXP are not cointegrated).

Since LGDP and LEXP are $I(1)$ and not cointegrated, estimation of the causality model given in equation 3a and 4a, excluding the error correction terms, is considered more appropriate. Further efficiency may be gained by estimating the model using seemingly unrelated regression (SUR). An optimal lag length of one is used according to the Schwarz criterion. A number of tests were carried out to determine the direction of causality and Table 2A (Causality Test Results) reports the Wald test-statistics calculated in the above tests. The Wald test statistic has an asymptotic $\chi^2(q)$ distribution where q is the number of restrictions under the null hypothesis. The p-value indicates the marginal significance level at which the null can be rejected.

These results provide no evidence to suggest that there exists any causal relation between total exports of goods and services and output. Hence, provides no empirical support for the export-led growth hypothesis at the aggregate level.

Some have argued the importance of controlling for imports in investigations of the export-led hypothesis, including Riezman et al (1995), reasoning that omitting imports may cause misleading influences about the effect of exports on income. The inclusion of imports did not change the above results although we did find that the exports of goods and services at the aggregate level did Granger cause imports of goods and services at the aggregate level.

Disaggregated Export Analysis

Total exports of goods and services are separated into exports of goods and exports of services and we examine the effects of each of them relative to output. The methodology applied is the same as in the previous section.

According to the Johansen test no cointegrating relation exists between exports of goods and output (referred to Table 2B). There is also no evidence of causality in either direction between the two variables.

Table 2C contains the summary results for the analysis between exports of services and GDP. The Johansen test for cointegration indicates that there exist a cointegrating relation between the two variables. In other words, output determines or Granger cause exports of services in the long-run. The results of the causality tests indicate that they exist no short-run Granger casual relationship between exports of services and GDP via the lagged differences of either variable because the coefficient on the lagged differences is not significant. Nevertheless, short-run Granger causality from GDP to exports of services occurs because of the significant equilibrium-correcting term. Furthermore, when GDP and exports of services are away from equilibrium, the exports of services responds to achieve equilibrium. These findings are not surprising and are in line with the writings of McClean (1993) and others who argue that exports, including exports of services, are determined at the supply end of the market, i.e. exports are an excess supply relation where output is determined first, and after local demand is satisfied, exports are the residual.

A similar analysis is carried out between exports of sugar and GDP, and the results are presented in Table 2D. The results are quite similar to those for exports of services but with one difference, we found bi-directional long-run Granger causality. Equations 3a and 4a are estimated with the equilibrium correcting term in each one. The coefficients on the equilibrium correcting terms are both significant and negative, that is, the long run relationship

between exports of sugar and GDP is such that either variable (in the ECM) can be the dependent variable (see equation 3b and 4b). Hence, in the long-run exports of sugar Granger causes GDP, and at the same time, GDP Granger causes exports of sugar. Hence, short-run Granger causality occurs only via the equilibrium correcting term, as with services. But in this case, when GDP and exports of sugar are away from equilibrium, both variables respond to achieved equilibrium.

VI Conclusion

In this study, our main purpose was to test the export-led economic growth hypothesis for Barbados using recent advances in time series econometric methodology. Our results indicate that there is no causal relationship in the aggregate between export growth and real GDP. At the disaggregated level we found some support for this hypothesis. Real GDP Granger causes both exports of services and exports of sugar. The relationship between exports of sugar and real GDP is bi-directional. No causal relationship exists between exports of goods and GDP. The failure to find anything at the aggregate level may be due to the effects from the different the components of exports canceling each out.

Table 1

SERIES	ADF		PP	
	No Trend	Trend	No Trend	Trend
LRGDP	-1.329280	-3.368113	-0.961364	-2.102542
5%	-2.9798	-3.5943	-2.9760	-3.6867
10%	-2.6290	-3.2321	-2.6266	-3.2279
D(LGDP)	-2.886004	-4.119163	-2.890874	-2.829676
5%	-2.9798	-3.6219	-2.9798	-3.6943
10%	-2.6290	-3.2474	-2.6290	-3.2321
LEXP	-1.527933	-2.692632	-1.689790	-2.159803
5%	-2.9760	-3.5943	-2.9760	-3.6867
10%	-2.6266	-3.2321	-2.6266	-3.2279
D(LEXP)	-4.457309	-4.347016	-3.775745	-3.665599
5%	-2.9907	-3.6118	-2.9798	-3.6943
10%	-2.6348	-3.2416	-2.6290	-3.2321
LEXP_G	-1.807340	-1.854056	-1.713246	-1.930021
5%	-2.9760	-3.6867	-2.9760	-3.6867
10%	-2.6266	-3.2279	-2.6266	-3.2279
D(LEXP_G)	-4.364005	-4.287633	-4.311780	-4.224674
5%	-2.9798	-3.6943	-2.9798	-3.6943
10%	-2.6290	-3.2321	-2.6290	-3.2321
LEXP_SER	-1.457882	-5.120459	-1.152994	-2.437938
5%	-2.9798	-3.6943	-2.9760	-3.6867
10%	-2.6290	-3.2321	-2.6266	-3.2279
D(LEXP_SER)	-4.407132	-4.316529	-3.250355	-3.217362
5%	-2.9907	-3.6118	-2.9798	-3.6943
10%	-2.6348	-3.2416	-2.6290	-3.2321
LEXP_SUG	-1.355899	-3.645465	-1.753970	-3.857650
5%	-2.9798	-3.6867	-2.9760	-3.6867
10%	-2.6290	-3.2279	-2.6266	-3.2279
D(LEXP_SUG)	-4.846861	-4.704242	-9.564824	-9.512517
5%	-2.8969	-3.6219	-2.9798	-3.6943
10%	-2.6281	-3.2474	-2.6290	-3.2321

The shaded region displays the Mackinnon Critical Values at the 5 and 10% levels.
D() represents the first difference of the variable

TABLE 2A

Johansen Cointegration Test		
Null hypothesis (r) about the number of cointegrating equation (LGDP, LEXP).		
	r = 0	r ≤ 1
trace statistic	0.272156	0.136210
Likelihood Ratio	(12.0664)	(3.8070)
Critical Values 5%	19.96	9.24
1%	24.60	12.97
Short Run Causality Test Results		
Test	P-value	
D(LEXP) => D(LGDP)	0.594860	
D(LGDP) => D(LEXP)	0.321012	

NB The critical values pertain to the likelihood ratio which rejects any cointegration at 5% significance level

TABLE 2B

Johansen Cointegration Test		
Null hypothesis (r) about the number of cointegrating equation (LGDP, LEXP_G).		
	r = 0	r ≤ 1
trace statistic	0.132568	0.049457
Likelihood Ratio	(5.016438)	(1.318769)
Critical Values 5%	12.53	3.84
1%	16.31	6.51
Short Run Causality Test Results		
Test	P-value	
D(LEXP_G) => D(LGDP)	0.963187	
D(LGDP) => D(LEXP_G)	0.790316	

NB The critical values pertain to the likelihood ratio which rejects any cointegration at 5% significance level

TABLE 2C

Johansen Cointegration Test		
Null hypothesis (r) about the number of cointegrating equation (LGDP, LEXP_SER).		
	r = 0	r ≤ 1
trace statistic	0.575025	0.241496
Likelihood Ratio	(29.43542)	(7.186591)
Critical Values 5%	25.32	12.25
1%	30.45	16.26
Causality Test Results		
Short Run Test	P-value	
D(LEXP_SER) => D(LGDP)	0.136641	
D(LGDP) => D(LEXP_SER)	0.904621	
Long Run Test	P-value	
ECT => D(LGDP)	0.000000	
ECT => D(LEXP_SER)	0.000781	

NB The critical values pertain to the likelihood ratio which rejects any cointegration at 5% significance level

TABLE 2D

Johansen Cointegration Test		
Null hypothesis (r) about the number of cointegrating equation (LGDP, LEXP_SUG).		
	r = 0	r ≤ 1
trace statistic	0.509190	0.050836
Likelihood Ratio	(19.86069)	(1.356516)
Critical Values 5%	15.41	3.76
1%	20.04	6.65
Causality Test Results		
Short Run Test	P-value	
D(LEXP_SUG) => D(LGDP)	0.227688	
D(LGDP) => D(LEXP_SUG)	0.501255	
Long Run Test	P-value	
ECT => D(LGDP)	0.003820	
ECT => D(LEXP_SUG)	0.006049	

NB The critical values pertain to the likelihood ratio which rejects any cointegration at 5% significance level

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