E C O N O M I C S  B U L L E T I N

# Foreign direct investment (FDI) and the global food crisis. A study of the Windward Islands' agricultural sector.

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## *Abstract*

Using panel data unit root tests and Johansen Co-integration tests, as well as the Engle-Granger -correction model to test for causality, this study examines the effect of FDI on agriculture sector productivity (x6), market size (x2), macroeconomic performance (x3), infrastructure (x4), competitiveness (x5), financial performance (x7) and governance (x8), in a sample of five Caribbean countries over the period 1970-2006. According to UNCTAD (2008), FDI is defined as investment made from outside of the economy of the investor with the objective of acquiring a lasting interest in or effective control over an enterprise. The results suggest that in general when evidence of causality is observed it runs from FDI to (x4). No causality was detected in either direction for (x2), (x5), (x6) and (x8). However, causality runs from FDI to (x3). A major policy implication of the findings is that the agriculture sector does not impact significantly on the attraction of FDI in these countries.

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## 1. Introduction.

UNCTAD report (2001) noted that foreign direct investment (FDI) rose from $0.6 billion in 1990 to $5.2 billion in 1999 for the poorest countries. Factors contributing to this improvement were major efforts made by least developed countries (LDCs) to improve their investment climate through legislation which offers a wide range of guarantees and other measures to encourage investment. Although there was an increase in the FDI to poorest countries, the question still remains as to what accounts for the recent food crisis in the world? Several reasons have been suggested which include: change in diet that increases the overall demand for grains, the price of oil, bad weather and bad policy (Krugman 2008).

In this study, we examine the proposition that at least part of the explanation for the food crisis in the world, or more specifically in small developing countries, is based on the lack of agric-sector-specific investment, which in turn might be due to insufficiency of the marketing or communicating of investment opportunities in agriculture to the international business community. Put differently, the agriculture sector does not impact significantly on the attraction of FDI. According to UNCTAD (2008), recent global food crisis can be seen as a wake-up call, which highlights the systemic imbalances in global agricultural production and trade that may have contributed over the years to today's problems. For most agric-based developing countries, this can be turned into an opportunity to work closely with the international community, including foreign investors, to revitalize global agriculture production and trade. The rest of the paper is organized as follows: section 2 focuses on Foreign Direct Investment (FDI) and Small vulnerable States; section 3 gives the background to the study of the Windward Islands; the Econometric methodology and data used are presented in section 4; section 5 presents the empirical results; while section 6 concludes as well as provides some policy recommendations.

## 2. Foreign Direct Investment (FDI) and Small vulnerable States

Recent rising levels of food prices concern growing numbers of policymakers and members of the public in the Caribbean region. These concerns have sparked a new debate about the economic effect of foreign direct investment. A central issue in this debate has been the effect of FDI in agriculture sectors of their economies. For these economies, it has been natural to assume that FDI will enable economic growth and guarantee their survival in the global marketplace (World Bank, 2002). Additionally that it will help to mitigate against the negatives associated with small sized economies with the creation of forward and backward linkages, thus serving as a catalyst for economic growth (Read, 2001); while complimenting scarce domestic resources, transferring essential technological equipment and knowledge (Engelbrecht, 1997) and leading to marked improvements in competitiveness and facilitate integration into the global market. (Driffield, 1999). However, there is an absence of detailed empirical studies which makes it difficult to pass a definite judgment on the actual level of the

contribution which FDI has made to these economies and in particular the agriculture sector.

In terms of geographical focus, empirical studies in this specific area are relatively scarce; particularly with reference to the causal link between development factors (such as infrastructure, human capital (education), macro economic performance indicators (inflation, GDP and social and political stability) and FDI flows into developing countries. Again, this paucity is especially true for small island developing states such as the Windward Islands. Several researchers have investigated FDI and growth relationships for developing countries, favoring the continents of Africa and Asia. These include Salisu (2003) who focused on the oil industry of Nigeria, as he sought to establish any statistical relationships between corruption and growth. Also Obwona (1998) utilised a dual approach to research the factors that attract investment into Uganda; while Banga (2003) chose to investigate what if any differences occur in the factors which attract FDI from developed countries as opposed to developing countries. Agrawal (2000) investigated the impact of FDI flows on GDP growth rate for five main South Asian countries. Chen, et al (1995) looked at the regional locational determinants of FDI to China; while others such as Addison and Heshmati (2003) use panel data techniques to estimate FDI effects for large world groupings such as Latin America, East Asia-Pacific, South Asia, among others.

With a region-specific focus, therefore, this study seeks to fill the gap evident in the literature, based on empirical evidence from the Windward Islands as a sub-region of the Caribbean. It seeks to provide a distinct contribution to the body of empirical research that exists on the behavior of preconditions to FDI, by introducing this specific country group, within its particular context.

## 3. Background to the Study of the Windward Islands

The former UK colonies of the Windward Islands, as mentioned earlier, are a small group of islands in the Eastern Caribbean, made up of four independent states: St. Lucia, St. Vincent and the Grenadines, Grenada and Dominica. Traditionally, banana production was the main economic activity in these islands for a number of years, accounting for more than fifty percent (50%) of the income of the region and more than thirty percent (30%) of the workforce (Clegg, 2002). The banana industry was encouraged in the region as early as the 1950s as a means of diversification away from sugar production. This occurred with the help and support of the British government, as the change from sugar to bananas was intended to benefit both Caribbean producers and UK consumers. The banana is one of the crops which is most suitable for cultivation in the Windward Islands, and banana growing provided a regular weekly income for small farmers in the region.

With the growth of trade liberalisation and globalisation, the agricultural base of these economies has become under increasing threat, and therefore requires a more sustainable buttress. Myers (2001) points out that this prevailing international trading environment challenges small agrarian economies to survive in the face of powerful global players. In fact, when the WTO arbitration panel ruled that the EU's banana regime was inconsistent with WTO rules and that compensation in the amount of $191.4 million was due the United States for lost banana sales, the economies of the Windward Islands were severely

affected, and the call for diversification was heard (Hanrahan, 1999). Of the four Windward Islands, St. Lucia seems to have managed best after this period. This may be attributed to the input of FDI into the tourism industry. (Economic Commission for Latin America and the Caribbean, 2003).

Some researchers seem clear that these economies warrant at least a modified economic policy recipe, simply because of their 'special circumstances'. (Josling, 1998). We argue in this paper that FDI inflows may be the 'fuel' to drive this evidently mandatory and necessary re-structuring and diversification impetus needed in the Windward Islands. But we question whether the diversification should not be more agric-based related; thereby still maintaining a stock of agricultural outputs that may mitigate against a deepening food crisis in the region. Put differently, in this paper, we test the assumption that small vulnerable economies such as the Windward Islands may provide much needed insight into at least halting or reducing the impact of agric-based food crisis in the region.

Next, we test the relationship between FDI and several key variables that are considered to be significant for a stable economic environment and attractive investment climate. Note that one 'new' variable that is being tested in this study is that of 'sector productivity', proxy by the contribution of agriculture to GDP. Owing to the aforementioned sector-based pressures from trade liberalization particularly in the banana industry in the Windward Islands, which has had a shrinking effect on that sector's performance and potential, we postulate that sector productivity may significantly affect the inward flow of FDI in a negative way. While some researchers may have hinted at this position (Josling, 1998), the paper provides a statistical basis to indicate whether this postulate can be proven.

## 4. Econometric Methodology and Data

The econometric modelling used in this stage of the research was inspired by several researchers, including Pfaffermayr (1994) and Obwona (1998) who used Granger causality model to test for causality relationships between FDI (out) and exports; and FDI and economic growth respectively. Also Kolstad and Villanger (2008) who employed a panel data analysis of 135 countries for a twenty two year period, in order to determine region specific effects on FDI flows. Their conclusion was that the Caribbean is different as a region in regards to FDI. But that difference is still to be explored deeply. This paper seeks to segment the Caribbean further to isolate key preconditions which may lend some light to the question raised by Kolstad and Villanger (2008).

Following Johansen (1995) co-integration approach, we derive the equilibrium relationship between the foreign direct investment (FDI) and AGRI/GDP (agriculture as a fraction of GDP) for this group of Caribbean countries (Barbados, Dominica, Granada, St Lucia and St Vincent). Barbados is used as a control country for the inflow of FDI into the region. Table 1 gives the variable category, proxies, panel label and code.

The framework begins with a vector autoregressive (VAR) representation of the form:

$$y_t = \eta + \sum_{i=1}^{p} \Pi y_{t-i} + \varepsilon_t \qquad (1)$$

where $y$ is a $n \times 1$ vector of variables consisting of FDI and agri/gdp, $\eta$ is a $n \times 1$ vector of deterministic variables, $\Pi$ is a $n \times n$ coefficient matrix and $\varepsilon$ is a $n \times 1$ vector of disturbances with normal properties, i.e., the assumption of a normal distribution for the disturbance. If there exists a co-integrating relationship among the I(1) variables, Equation "(1)" may be re-parameterised into a vector error correction mechanism (VECM):

$$\Delta y_t = \eta + \sum_{i=1}^{p-1} \Phi_i \Delta y_{t-i} + \Pi y_{t-1} + \varepsilon_t \tag{2}$$

where $\Delta$ is the first difference operator, and $\Phi$ is a $n \times n$ coefficient matrix. The rank of $\Pi$ determines the number of co-integrating relationships. If the matrix $\Pi$ is of full rank, *n*, then a VAR in levels is appropriate. If the matrix $\Pi$ is of rank zero, then a VAR in first differences is suitable. However, if the rank of $\Pi$ is less than *n*, then there exist $n \times r$ matrices $\alpha$ (adjustment matrix) and $\beta$ (co-integrating vectors) such that $\Pi = \alpha\beta'$, Equation "(2)" provides the more appropriate framework. The $\beta$ vector allows one to examine the long-run relationship between FDI and productivity (agri/gdp).

The Trace statistic (*TR*) is used to test for the existence of co-integration, amongst the non-stationary variables.

The test statistic is derived from:

$$TR = T \sum_{i=r+1}^{N} \ln(1 - \hat{\lambda}_i) \tag{3}$$

and we test the hypothesis that there are at most $r$ co-integrating vectors. The $\hat{\lambda}_{r+1},...,\hat{\lambda}_n$ are the $N - r$ smallest squared canonical correlations between the $y_{t-k}$ and $\Delta y_t$ series.

The study exploits the panel data structure of the database to undertake panel unit root test since it has been shown that the power of unit root tests improves when one uses the extra information that can be derived from panel data (see Baltagi, 2005). The results from four panel unit root tests are presented: Levin, Lin and Chu (2002), Breitung (2000), Im, Pesaran and Shin (2003) and the Fisher-type ADF test attributed to Maddala and Wu (1999) and Choi (2001). The Levin, Lin and Chu and Breitung tests both assume that there is common unit root process while the Im, Pesaran and Shin and Fisher ADF assume the unit root process to vary across countries.

The study uses annual data over the period 1970 to 2006 and the data on FDI and CGDP,CPI, INF_TEL, OPENK AGRI/DGP, EXCH and REER (See Table 1 in the Appendix), were obtained from various sources, but essentially from the World Bank database, United Nations Statistics Division, Eastern Caribbean Central Bank; Caribbean Development Bank and individual country sources.
Descriptive statistics for all the variables are provided in Table 2 in the Appendix.

## 5. Relationship between FDI and CGDP,CPI, INF_TEL, OPENK AGRI/DGP, EXCH and REER

The panel unit root test results are given in Table 3 (panel with Barbados as control) and Table 4 (panel excluding Barbados). All statistics tests the null hypothesis of non-stationarity against the alternative of stationarity. The results show that all the series are stationary at classical levels of testing for the Im, Pesaran and Shin tests; as well as the ADF Fisher Chi-Square tests. However, under the Levin, Lin and Chu tests the results suggest that we accept the null hypothesis of non stationarity for the variables of Financial performance and Governance; while under the Breitung tests we accept the null hypothesis of non stationarity for Foreign Investment, Market Size and also Financial Performance. It is to be noted that all test results agree with the suggestion to reject the null hypothesis of a unit root for the key variable under investigation: Sector Productivity (agri/gdp), thereby suggesting that this variable is a stationary time series. By and large the inconsistencies identified above are not new in the empirical application of panel unit root or stationarity tests, as highlighted by Hlouskova and Wagner (2006). Contributing factors may include lag length employed, as well as underlying assumptions concerning unit root process across the countries.

Furthermore, an attempt was made to identify whether there exists a long-run co-integrating relationship between these variables of interest. Based on the Schwarz criterion, the lag length is set to two years and the Trace statistic, presented for each country, is used to establish the number of co-integrating relationships. Tables 5-9 provide test results. The null hypothesis that there are no co-integrating equations can be ruled out for the five countries. The evidence of co-integration implies that we can use the Engle-Granger – correction model to test for causality. Next we examine the direction of causality between FDI and the preconditions identified in this study. Table 10 presents the Granger causality test results of five countries, using a five percent level of significance. Several findings on these five islands are observed. In general, when evidence of causality is observed, it runs from FDI to Infrastructure. No causality was detected in either direction for Market Size, Competitiveness, Productivity and Governance. Only in the case of Macro-economic performance, causality runs from FDI to Macro-economic performance.

Finally, the relationship between FDI and the variables for each of the five countries is also examined in a panel framework and assumes homoskedastic variation of scale over countries and unique serial correlation for each panel of country. Table 11 shows the coefficients of Infrastructure, Competitiveness and Financial performance to be positively significant for this group of countries. Also the variables x2 (Market Access) and x6 (Productivity) are negatively insignificant.

## 6. Conclusions

Judging from the statistical evidence presented in this paper, a solid infrastructure alone; or a policy of openness alone obviously does not provide a compelling incentive for foreign investors to invest in the Windward Islands. We suggest instead that a sub-region-specific combination of key development factors, including infrastructure, openness, and good financial and monetary structure together with an effective sector-specific

marketing/communication program might provide more favorable (preconditions) climate for attracting inward FDI to the Windward Islands.

Our study indicates that Sector Productivity is not significant but negatively related to FDI. This may be explained by the fact that the proxy used here is Agriculture as a percentage of GDP. The results may mean that as the agriculture sector declines, it is less of an attraction to foreign investors. This may also be as a result of trade liberalization in this sector (particularly in the banana industry) which has attracted so much global attention that it may have warded off potential investors. Also, this result could represent the shift in emphasis from agriculture over the last three decades in the Caribbean in general and in the Windward Islands specifically, as far as governments' strategic direction is concerned.

We conclude that a partial explanation for the global food crisis is the basic fallacy hinged on the assumption that development goals can ever be divorced from agriculture. The implications, therefore, for FDI policy change or development are significant as these areas each lend themselves to further research and testing. We propose that the results of this research be used to foster further research forays into small vulnerable developing countries/islands like the Windward Islands and their FDI attraction policies and practices. However, the approach should be with a focus on sector-specific foreign and local investment; within the particular regional or sub-regional investment climate. In this paper we postulate that such an approach when targeted towards the agriculture sector may help to revitalize this 'backbone' of the economy and thus impact positively on the global food crisis, for the Windward Islands.

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## APPENDIX

**Table 1** **Variables for Panel Data Analysis**

| Variable Category | Proxies | Panel label | Code |
|---|---|---|---|
| Foreign Investment | FDI inflows | fdi | X1 |
| Market Size | GDP per capita | cgdp | X2 |
| Macroeconomic performance | Consumer Price Index (base=2000) | cpi | X3 |
| Infrastructure | Main telephones per 1000 | Inf_tel | X4 |
| Competitiveness | Openness | openk | X5 |
| Sector Productivity | Agriculture sector performance (% GDP) | agri/gdp | X6 |
| Financial performance | Exchange rate | exch | X7 |
| Governance | Real Effective Exchange rate (base=2000) | reer | X8 |

**Table 2** **Descriptive Statistics**

| | Mean | Maximum | Minimum | Std.Dev. | Observation |
|---|---|---|---|---|---|
| FDI | 10.07292 | 58.00000 | 0.000000 | 9.856064 | 180 |
| MARKET SIZE | 592.3542 | 2816.000 | 14.00000 | 781.3418 | 180 |
| MACRO-ECONOMIC PERFORMANCE | 64.90583 | 106.0700 | 11.49000 | 27.44330 | 180 |
| INFRASTRUCTURE | 195.0625 | 1239.000 | 0.000000 | 230.6009 | 180 |
| COMPETITIVENESS | 116.0519 | 148.1800 | 87.27000 | 14.51765 | 180 |
| SECTOR PRODUCTIVITY | 12.53448 | 30.67000 | 3.590000 | 5.927510 | 180 |
| FINANCIAL PERFORMANCE | 2.363683 | 2.700000 | 1.921278 | 0.350490 | 180 |
| GOVERNANCE | 107.9706 | 213.3500 | 8.730000 | 32.17599 | 180 |

**Table 3** **Panel Unit Root Test Statistics (with Barbados)**

| VARIABLE | LEVIN, LIN AND CHU | BREITUNG | IM, PESARAN AND SHIN | ADF FISHER, CHI-SQUARE |
|---|---|---|---|---|
| X1- fdi | -4.02652 [0.0] | -0.20668 [0.4181] | -8.10435 [0.0] | 75.4316 [0.0] |
| X2- cgdp | -1.93939 [0.0262] | -0.74022 [0.2296] | -2.81022 [0.0025] | 24.6127 [0.0061] |
| X3- cpi | -2.52626 [0.0058] | -3.28657 [0.0005] | -4.77109 [0.0] | 39.8851 [0.0] |

| | | | | |
|---|---|---|---|---|
| X4- infr. | | | | |
| X5- openk | -5.33573<br>[0.0] | -6.22667<br>[0.0] | -4.80665<br>[0.0] | 40.5310<br>[0.0] |
| X6- agri/gdp | -5.02887<br>[0.0] | -8.37455<br>[0.0] | -7.54740<br>[0.0] | 65.9123<br>[0.0] |
| X7- exch. | -1.31169<br>[0.0948] | 3.13545<br>[0.9991] | -4.85115<br>[0.0] | 50.2699<br>[0.0] |
| X8- reer | 2.53632<br>[0.9944] | -4.24675<br>[0.0] | -5.00326<br>[0.0] | 32.3608<br>[0.0] |

*Note: 1) All tests evaluate the null hypothesis of a unit root against the alternative of no unit root.*

*2) p-values given in square brackets below test statistics.*

**Table 4** **Panel Unit Root Tests Of W.I [excl. Barbados]**

| VARIABLE | LEVIN, LIN AND CHU | BREITUNG | IM, PESARAN AND SHIN | ADF FISHER, CHI-SQUARE |
|---|---|---|---|---|
| X1- fdi | -4.89235<br>[0.0] | -6.69245<br>[0.0] | -6.56163<br>[0.0] | 49.9076<br>[0.0] |
| X2- cgdp | -1.08077<br>[0.1399] | -0.144485<br>[0.4424] | -2.40960<br>[0.0080] | 19.1872<br>[0.0139] |
| X3- cpi | -1.76680<br>[0.0386] | -2.73022<br>[0.0032] | -4.10268<br>[0.0] | 30.6880<br>[0.0002] |
| X4- infr. | 8.85253<br>[1.0] | 6.51700<br>[1.0] | 7.05305<br>[1.0] | 6.78338<br>[0.5602] |
| X5- openk | -4.97000<br>[0.0] | -5.49616<br>[0.0] | -4.57476<br>[0.0] | 34.6368<br>[0.0] |
| X6- agri/gdp | -6.01759<br>[0.0] | -7.14749<br>[0.0] | -5.87997<br>[0.0] | 45.0856<br>[0.0] |
| X7- exch. | -3.75242<br>[0.0999] | 3.93653<br>[1.0] | -1.71950<br>[0.0428] | 15.0174<br>[0.0588] |
| X8- reer | 2.53632<br>[0.9944] | -4.24675<br>[0.0] | -5.00326<br>[0.0] | 32.3608<br>[0.0] |

*Note: 1) All tests evaluate the null hypothesis of a unit root against the alternative of no unit root.*

*2) p-values given in square brackets below test statistics.*

**Table 5.** **Johansen Co-integration Tests (Barbados)**

Unrestricted Co-integration Rank Test (Trace)

| Hypothesized No. of CE(s) | Eigen Value | Trace Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.995911 | 350.8554 | 125.6154 | 0.0000 |
| At most 1 * | 0.897589 | 174.8727 | 95.75366 | 0.0000 |
| At most 2 * | 0.723917 | 101.9523 | 69.81889 | 0.0000 |
| At most 3 * | 0.610354 | 60.76657 | 47.85613 | 0.0020 |
| At most 4 * | 0.448770 | 30.60603 | 29.79707 | 0.0403 |
| At most 5 | 0.288009 | 11.54673 | 15.49471 | 0.1800 |

Trace test indicates 5 co-integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

**Table 6.** **Johansen Co-integration Tests (Dominica)**

Sample (adjusted): 1970 2006
Included observations: 36 after adjustments
Trend assumption: Linear deterministic trend
Series: X1 X2 X3 X4 X5 X6 X7
Lags interval (in first differences): 1 to 2
Unrestricted Co-integration Rank Test (Trace)

| Hypothesized No. of CE(s) | Eigen Value | Trace Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.995911 | 350.8554 | 125.6154 | 0.0000 |
| At most 1 * | 0.897589 | 174.8727 | 95.75366 | 0.0000 |
| At most 2 * | 0.723917 | 101.9523 | 69.81889 | 0.0000 |
| At most 3 * | 0.610354 | 60.76657 | 47.85613 | 0.0020 |
| At most 4 * | 0.448770 | 30.60603 | 29.79707 | 0.0403 |
| At most 5 | 0.288009 | 11.54673 | 15.49471 | 0.1800 |
| At most 6 | 0.020923 | 0.676635 | 3.841466 | 0.4107 |

Trace test indicates 5 co-integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

**Table 7.** **Johansen Co-integration Tests (Grenada)**

Sample (adjusted): 1970 2006
Included observations: 36 after adjustments
Trend assumption: Linear deterministic trend
Series: X1 X2 X3 X4 X5 X6 X7
Lags interval (in first differences): 1 to 2
Unrestricted Co-integration Rank Test (Trace)

| Hypothesized | | Trace | 0.05 | |
|---|---|---|---|---|
| No. of CE(s) | Eigen Value | Statistic | Critical Value | Prob.** |
| None * | 0.957622 | 277.8083 | 125.6154 | 0.0000 |
| At most 1 * | 0.886349 | 176.6519 | 95.75366 | 0.0000 |
| At most 2 * | 0.770093 | 107.0640 | 69.81889 | 0.0000 |
| At most 3 * | 0.662160 | 60.02143 | 47.85613 | 0.0024 |
| At most 4 | 0.447526 | 25.29558 | 29.79707 | 0.1511 |
| At most 5 | 0.166588 | 6.308412 | 15.49471 | 0.6591 |
| At most 6 | 0.014800 | 0.477147 | 3.841466 | 0.4897 |

Trace test indicates 4 co-integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

**Table 8.** **Johansen Co-integration Tests (St. Lucia)**

Sample (adjusted): 1970 2006
Included observations: 32 after adjustments
Trend assumption: Linear deterministic trend
Series: X1 X2 X3 X4 X5 X6 X7
Lags interval (in first differences): 1 to 2
Unrestricted Co-integration Rank Test (Trace)

| Hypothesized | | Trace | 0.05 | |
|---|---|---|---|---|
| No. of CE(s) | Eigen Value | Statistic | Critical Value | Prob.** |
| None * | 0.988898 | 336.1782 | 125.6154 | 0.0000 |
| At most 1 * | 0.941885 | 192.1589 | 95.75366 | 0.0000 |
| At most 2 * | 0.809595 | 101.1084 | 69.81889 | 0.0000 |
| At most 3 * | 0.468014 | 48.03303 | 47.85613 | 0.0481 |
| At most 4 | 0.380057 | 27.83658 | 29.79707 | 0.0828 |
| At most 5 | 0.223908 | 12.53650 | 15.49471 | 0.1329 |
| At most 6 * | 0.129146 | 4.424989 | 3.841466 | 0.0354 |

Trace test indicates 4 co-integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

**Table 9.** **Johansen Co-integration (St. Vincent)**

Sample (adjusted): 1970 2006
Included observations: 32 after adjustments
Trend assumption: Linear deterministic trend
Series: X1 X2 X3 X4 X5 X6 X7
Lags interval (in first differences): 1 to 2
Unrestricted Co-integration Rank Test (Trace)

| Hypothesized | | Trace | 0.05 | |
|---|---|---|---|---|
| No. of CE(s) | Eigen Value | Statistic | Critical Value | Prob.** |
| None * | 0.988898 | 336.1782 | 125.6154 | 0.0000 |
| At most 1 * | 0.941885 | 192.1589 | 95.75366 | 0.0000 |
| At most 2 * | 0.809595 | 101.1084 | 69.81889 | 0.0000 |
| At most 3 * | 0.468014 | 48.03303 | 47.85613 | 0.0481 |
| At most 4 | 0.380057 | 27.83658 | 29.79707 | 0.0828 |
| At most 5 | 0.223908 | 12.53650 | 15.49471 | 0.1329 |
| At most 6 * | 0.129146 | 4.424989 | 3.841466 | 0.0354 |

Trace test indicates 4 co-integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

**Table 10.** **Granger Causality Tests**

Pairwise Granger Causality Tests
Sample: 1970 2006
Lags: 2

| Null Hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| X3 does not Granger Cause X1 | **157** | 6.08027 | 0.0029 |
| X1 does not Granger Cause X3 | | 0.99274 | 0.3729 |
| X4 does not Granger Cause X1 | **157** | 5.16142 | 0.0068 |
| X1 does not Granger Cause X4 | | 0.15970 | 0.8525 |
| X5 does not Granger Cause X1 | **157** | 2.78376 | 0.0650 |
| X1 does not Granger Cause X5 | | 0.78474 | 0.4581 |
| X6 does not Granger Cause X1 | **157** | 1.66167 | 0.1933 |
| X1 does not Granger Cause X6 | | 0.95947 | 0.3854 |
| X7 does not Granger Cause X1 | **157** | 1.28759 | 0.2789 |
| X1 does not Granger Cause X7 | | 3.35191 | 0.0376 |
| X8 does not Granger Cause X1 | **157** | 0.10986 | 0.8961 |
| X1 does not Granger Cause X8 | | 0.42652 | 0.6542 |

**Table 11.** **Panel Least Square Result**

Method: Panel Least Squares
Sample (adjusted): 1970 2004
Periods included: 34
Cross-sections included: 5
Total panel (unbalanced) observations: 164
White period standard errors & covariance (d.f. corrected)
Estimation settings: tol= 0.00010
Initial Values: C(1)=-0.01372, C(2)=0.15140, C(3)=0.04765, C(4)=0.11494
C(5)=-1.80147, C(6)=12.3977, C(7)=-17.7283, C(8)=0.00000

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| X2 | -0.007483 | 0.004923 | -1.519979 | 0.1305 |
| X3 | 0.156352 | 0.105553 | 1.481264 | 0.1406 |
| X4 | 0.059642 | 0.010923 | 5.460388 | 0.0000 |
| X5 | 0.192330 | 0.069132 | 2.782065 | 0.0061 |
| X6 | -1.101177 | 0.591496 | -1.861683 | 0.0645 |
| X7 | 22.02542 | 5.075470 | 4.339582 | 0.0000 |
| C | -66.51908 | 17.94575 | -3.706677 | 0.0003 |
| AR(1) | 0.739865 | 0.012727 | 58.13296 | 0.0000 |
| R-squared | 0.775321 | Mean dependent var | 18.40244 | |
| Adjusted R-squared | 0.765239 | S.D. dependent var | 21.82466 | |
| S.E. of regression | 10.57451 | Akaike info criterion | 7.602320 | |
| Sum squared resid | 17443.95 | Schwarz criterion | 7.753533 | |
| Log likelihood | -615.3902 | Hannan-Quinn criter. | 7.663706 | |
| F-statistic | 76.90344 | Durbin-Watson stat | 1.990957 | |
| Prob(F-statistic) | 0.000000 | | | |
| Inverted AR Roots | .74 | | | |