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Testing Long Run Relationship between Exports and Imports: Evidence from Ghana

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Abstract: This study examines the long-run relationship between exports and imports for the Ghanaian economy for the period of 1948 to 2010. Empirically, we find that Ghana's exports and imports are cointegrated using Granger and Engle (1987) two-step procedure. However, the slope coefficients from the cointegration equations were not statistically equal to 1 and the equilibrium relationship further indicates that the economy of Ghana imports more than 1 dollar to get 1-dollar exports revenue. Conclusively, the sustainability of Ghana's foreign deficit is doubtful.

Keywords*: Foreign deficit, sustainability, exports, imports, co integration*

1. Introduction

The analysis of the relationship between export and imports of countries has been the focus of recent research. This is underpinned by the fact that export and import are two important elements of the balance of payments of any country. Fundamentally, unsustainable trade deficits mean violation of international budget constraints over time. Baharumshah et al, (2003) asserts that due to long - run deficits, domestic interest rates will be excessively high and such an economy, in the course of time, will turn into a heavily debt-ridden one resulting in poor standard of living. In effect, the long-run relationship between exports and imports is desirable to all countries and has to be investigated with empirical data. Little is known about the relationship between the imports and exports of Ghana. This prompts the need to investigate the import and export relationship, provide empirical evidence and possible policy implications in the case of Ghana. Against this background, this study examines whether the foreign deficit of Ghana is sustainable or not. First, we examined whether there is a cointegration relationship between imports and exports or not. Second, we tested whether the slope coefficients obtained from the cointegration equations derived from exports and imports series is statistically equal to 1 or not. The remainder of the paper is organized as follows. Section two reviews related literature. Section three discusses the data used for the study and the data analysis techniques. Section four discusses the empirical findings. Finally, section five presents the conclusion of the paper.

2. Literature Review

Some studies have investigated the cointegration relationship that exists between imports and exports. Further, this phenomenon has been tested empirically by researchers to ascertain whether trade deficits are present only in the short or long run. Husted (1992) studied quarterly US trade data between 1967 to 1989 and finds a long-run relationship between US export and imports pointing that its trade deficit has been a short run phenomenon. Similarly, Fountas and Wu (1999) studying US data ranging between1967 and 1994, concluded that the US trade deficit was not sustainable and rejected the earlier findings of Husted (1992). Narayan and Narayan (2005) investigate whether there is a long-run relationship (cointegration) between exports and imports for 22 least developed countries (LDCs). They analyzed this issue using the bounds testing approach to cointegration and found that exports and imports are cointegrated only for six out of the 22 countries, and the coefficient of exports is less than one. Bahamani-Oskooee and Rhee (1997) empirically examined the link between exports and imports in the case of Australia. He found cointegration among the variables and suggested that macroeconomic policies are efficient in the sample period because the cointegration coefficient value is near one. Arize (2002) used quarterly data for the period 1973–1998 from

50 OCED and developing countries to examine the same question. He found that for 35 of the 50 countries there was evidence of cointegration between exports and imports; and 31 of the 35 countries had a positive export coefficient. Upender (2007) has demonstrated that India's nominal exports and imports were cointegrated by employing data for the period 1949-50 to 2004-05.

Similarly, Erbaykal and Karaca (2008) examined whether the foreign deficit of Turkey is sustainable and finds that although there is a cointegration relationship between imports and exports, the slope coefficients obtained from the equations derived from exports and imports series is not equal to one. They conclude that it is doubtful that the foreign deficit of Turkey is sustainable. The foregoing discussion suggests that the existence of a cointegration relationship between imports and exports is not enough to state clearly that the foreign deficit is sustainable. In order to derive an absolute conclusion about this matter, while there is a cointegration relationship between imports and exports series, it is also sufficiently required that the slope coefficients obtained from the equations derived from these series should be statistically equal to 1.

3. Methodology

The methodology describes the time series data and the econometric techniques employed in the study. Econometric techniques such as unit root test, cointegration analysis and Husted econometric model are emphasized.

Data: This study used nominal annual time series data for the period of 1948 to 2010. The datasets were obtained from the statistics database of World Trade Organization WTO that provides searchable time series data on international trade in both merchandise and commercial services. Specifically, total merchandise imports and exports data (measured in US$ value) of Ghana were used for the study. All the variables are transformed into natural log form prior to the estimation process.

Data Analysis Techniques: Numerous tests have been developed and applied to time series data in order test for the existence of a unit root. This section discusses commonly used test for stationarity such as the Augmented Dicky Fuller test and the Phillips-Perron statistic. In addition, the Granger and Engle (1987) co integration test is presented and sequentially utilized to model the export and import series for further examination. We conclude with the Husted econometric model that is adopted for this study.

Unit Root Testing: Within the empirical framework of time series econometric analysis, the issue of stationarity of series remains an essential consideration. This is because it provides much fundamental guidance for the choice of estimation technique or regression model to adopt, specifically, for cointegration or long-run relationship analysis. A series is considered non-stationary if it follows a unit root process, that is, it exhibits time varying characteristics (e.g. mean, variance and covariance). On the other hand, a stationary series is one that does not follow a unit root process. Testing for stationary of a series is therefore accomplished using unit root tests. A number of unit root tests have been developed and used extensively for modeling stationarity in statistical and economic literature. Commonly used is the Augmented Dicky Fuller test, hereafter referred to as ADF test. Following Dicky and Fuller (1981), the ADF setup is specified as:

[1] $$\Delta \mathrm{x}_t = \delta_t + \eta \mathrm{t} + k\mathrm{x}_{t-1} + \sum_{k=1}^{n} \beta_k \Delta \mathrm{x}_{t-k} + \varepsilon_t$$

Where: $\Delta \mathrm{x}_t$ is the first-differenced (variable growth overtime) value, $k\mathrm{x}_{t-1}$ is the first-lagged value and $\sum_{k=1}^{n} \beta_k \Delta \mathrm{x}_{t-k}$ corresponds to the first to nth-lagged of first-differenced values of the series, x_i. ε_t is white noise error term. Another commonly used unit root test that overcomes the possible weaknesses of the ADF test is the Phillips-Perron statistic or test, hereafter referred to as PP test. The PP test is similarly computed as:

[2] $$\mathrm{x}_t = \delta_t + \eta_0 \mathrm{x}_{t-1} + \eta_1 \Delta \mathrm{x}_{t-1} + \ldots + k\Delta \mathrm{x}_{t-k} + u_t$$

Co integration Analysis: The notion of cointegration is important in analyzing the long-run equilibrium relationships between economic time series variables. In this study, we adopted two-step Engle-Granger (1987) approach to examine cointegration between the export and import series. To operationalize this, consider an ordinary least squares cointegration regression in the form:

[3] $$\mathrm{y}_t = \alpha + \beta \mathrm{x}_t + v_t$$

Moreover, the residuals from this cointegration regression, defined by:

[4] $$\hat{v}_t = \mathrm{y}_t - (\hat{\alpha} + \hat{\beta}\mathrm{x}_t)$$

Where: β is the equilibrium parameter, α is intercept and v_t is the error term or residual. Cointegration is examined by testing the stationarity of the error terms in the same fashion as ADF unit root test but in this case, without trend term. The error equation here is defined as:

[5] $$\Delta \mathrm{v}_t = k\mathrm{v}_{t-1} + \sum_{k=1}^{n} \beta_k \Delta \mathrm{v}_{t-k} + \varepsilon_t$$

The null hypothesis for this residual based test is that the error terms are nonstationary, and a rejection of this hypothesis indicates that the imports and export series are cointegrated. The statistical inferences are based on MacKinnon (1991) critical values.

Husted's Econometric Model: In order to account for possibly conditions required to examine the sustainability of Ghana's foreign deficits, much theoretical insights were drawn from Husted (1992). Husted (1992) formulated a model that shows the long run relationship between imports and exports. First, a current budget constraint for a country is given by:

[6] $$C_o = Y_o + B_o - I_o - (1+r)B_{-1}$$

Where: Y_o, C_o, B_o, I_o and $(1+r)B_{-1}$ are output, consumption, foreign borrowing, investment and the accumulated past debt at current rate of interest, r respectively. Based on the budget constraint equation, Husted (1992) developed a test hypothesis model as:

[7] $$\mathrm{Export}_t = a + b\mathrm{Import} + e_t$$

Following Arize (2002), equation (7) can be rewritten as:

[8] $$\mathrm{Import}_t = a + b\mathrm{Export} + e_t$$

According to this model, two conditions must be met for an economy to maintain inter-temporal budget constraint: a cointegration relationship must exist between the import and export series; the slope coefficients from the cointegration equations should also be statistically equal to 1 (Erbaykal & Karaca, 2008).

4. Results and Discussion

In this study, we used both the ADF and PP tests to model stationarity of the import and export series. The selection of the optimum lag length was done using the Akaike Information Criterion AIC and Newey-West, as this requires model selection criteria.

Table 1: Unit Root Tests Results

ADF test

Variable	***Original Series***		***First Difference***	
	with Trend	***without Trend***	***with Trend***	***without Trend***
Exports	-0.944 (2)	1.129(2)	-6.620*(1)	-6.398*(1)
Imports	-1.697(2)	0.531(2)	-7.503**(1)	-7.461*(1)

PP test				
Variable	***Original Series with Trend***	***without Trend***	***First Difference with Trend***	***without Trend***
Exports	-2.123{3}	1.033{3}	-10.470*{3}	-10.260*{3}
Imports	-3.315{3}	0.326{3}	-11.877*{3}	-11.709*{3}

An"*" indicates significance at both1%, 5% and 10% levels. Values in { } & ( ) indicate optimum lag length based on Newey-West & AIC respectively. Mackinnon (1991) critical values (*with trend models*): 1%= -4.128, 5%= -3.490 & 10%= -3.174 and (*without trend models*): 1%= -3.566, 5%= -2.922 & 10%= -2.596

The empirical results of the ADF and PP tests are presented in Table 1. We fail to reject non-stationarity at 1, 5 and 10 percent levels for both series considered, since the test statistics are greater than the corresponding Mackinnon critical values. Similarly, we examined the stationarity of the first differenced series and found stationarity, as the test statistics are less than corresponding critical values at 1, 5 and 10 percent significant levels. These results suggest that the variables are individually integrated of order one, $x_{i,t} \sim I(1) \text{ for } i = 1, 2$. Subsequently, we proceed to examine cointegration between the import and export series because all the variables are individually integrated, $x_{i,t} \sim I(1) \text{ for } i = 1, 2$. The results for the cointegration tests are presented in Table 2.

Table 2: Cointegration Test Results

Model	R^2	*ADF Without Trend*
Residual *i*. Exports = f(Imports)	0.95	-4.056*
Residual *ii*. Imports = f(Exports)	0.95	-4.242*

An "*" indicates significance at 1% , 5% & 10% levels.

Clearly, the ADF test statistics for both error equations are less than the corresponding critical values. The Mackinnon (1991) critical values are -3.563, -2.920 and -2.595 for 1, 5 and 10 percent significance levels respectively. This leads to the rejection of non-stationarity of the residuals, I(0). Hence, we suggest that both export and import series are cointegrated. Specifically, in both equations the exports and imports are cointegrated of order (1, 1). Graphically, equivalent stationarity results can be seen from the plots of residuals from these cointegration regressions (see Figures 3 and 4 of appendix). These results are consistent with other authors (Bahamani-Oskooee and Rhee ,1997; Arize , 2002; Narayan and Narayan, 2005; Upender , 2007) who found export and import relationship to be cointegrated.

Table 3 presents the results of Wald test that was used to examine whether the slope coefficients are statistically equal to one. The magnitude of the slope coefficients from [7] and [8] i.e. either $\hat{b} > 1$ or $\hat{b} < 1$ show how much a country imports per dollar unit of export and vice versa.

Table 3: Cointegration Equations and Wald Test Results

Equation	*Coefficient* $\hat{\beta}$	*Null Hypothesis*	*F Statistic*
i. E(I): *ex* = 4.41+ 0.78*im*	0.78	$H_o : \hat{\beta}_{ex} = 1$	98.72**
ii. I(E): *im* = -4.42 + 1.22*ex*	1.22	$H_o : \hat{\beta}_{im} = 1$	40.83**

"**" indicates significance at 1% level

The F statistics lies within the rejection region of 1 percent significance level. This leads to the rejection of the null hypothesis that the each slope coefficient for both cointegration equations is statistically equal to 1. Looking at Table 3, the slope coefficient of [8] is greater than [7]. This means that Ghana imports more than 1 dollar to get 1-dollar exports revenue. Similar findings were found in Turkey's imports and exports relationship by Erbaykal & Karaca (2008), as well as in the study by Narayan and Narayan (2005).

5. Conclusion

This study investigates the long-run relationship between nominal exports and imports for the Ghanaian economy for the period of 1948 to 2010. Both ADF and PP tests were used to examine stationarity of the export and import series whiles two-step Engle-Granger approach was used to analyze cointegration of the time series. The results of the study suggest that the natural logarithm transformed nominal export and import series (in US$) are individually integrated of order one, $x_{i,t} \sim I(1)$. The Engle-Granger cointegration test reveals that imports and exports of Ghana are cointegrated of order $(1,\ 1)$ for each of the cointegration regressions with cointegrating vectors (1, -0.78) and (1, -1.22). This shows that Ghana's exports and imports have a long-run equilibrium relationship.

In the sense of Erbaykal & Karaca (2008), it is doubtful that Ghana's foreign deficit or balance of trade is sustainable since we found the slope coefficients from the cointegration regressions to be statically not equal to 1, although the necessary condition of cointegration has been established. In addition, the economy of Ghana imports more than 1 dollar to get 1-dollar exports revenue, which could explain why the sustainability of Ghana's foreign deficit is doubtful. Even though Ghana's foreign, economic policies have been effective in bringing its imports and exports into a long run equilibrium, economic measures that would widen the current foreign account deficits can lead to serious economic crisis since the sufficient condition was not met in the period investigated. Directions for future research will be to investigate the stability of the import export relationship using error correction modeling.

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APPENDIX
Figure 1: Plots of raw data series

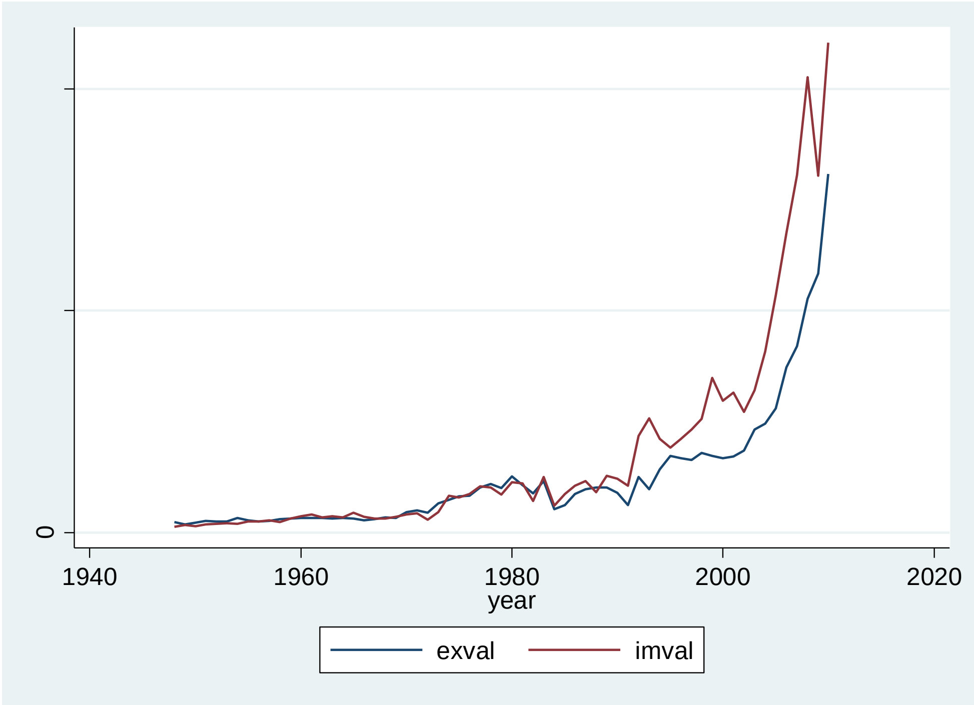

Figure 2: Plots of natural log transformed data series

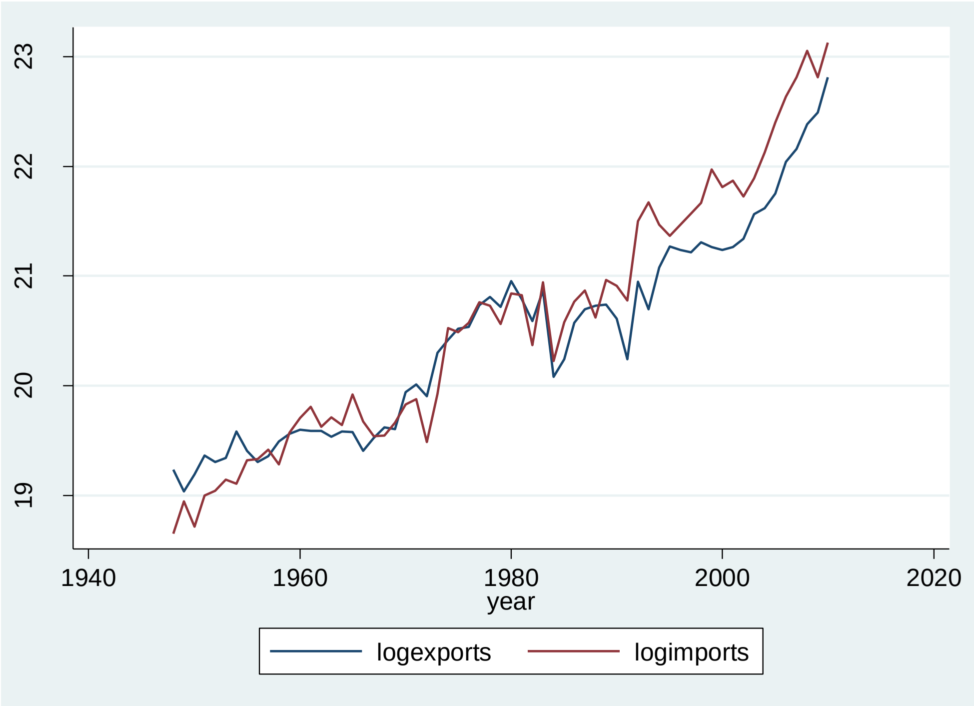

Figure 3: Residuals Plot from Equation *i*: Export = f(Imports)

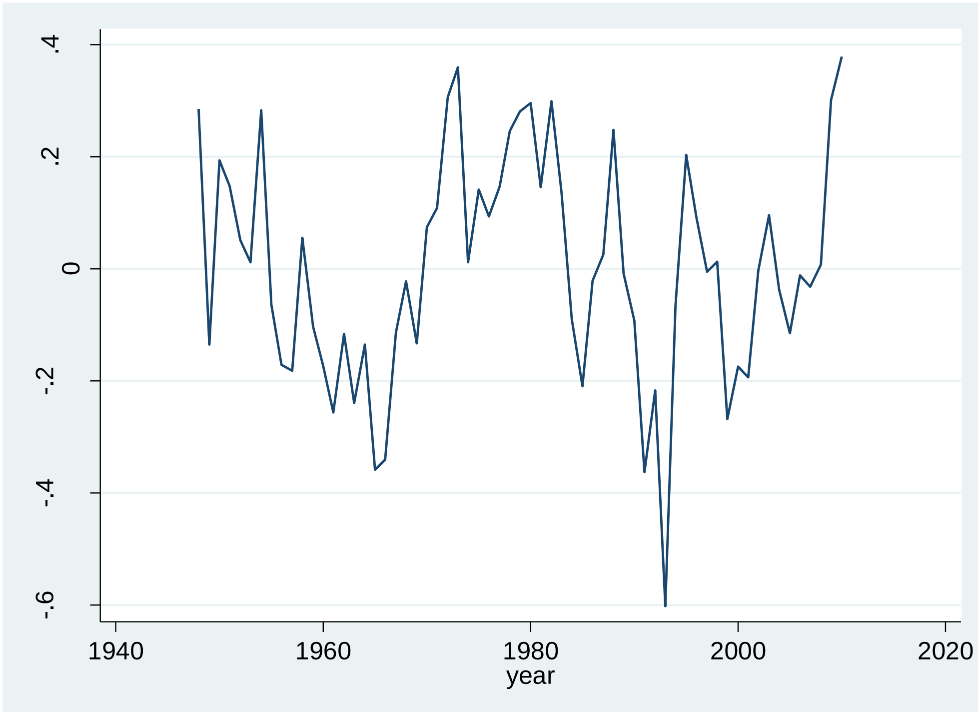

Figure 4: Residuals Plot from Equation *ii*: Imports = f(Exports)