CAUSAL LINK BETWEEN LIBERIA'S RICE IMPORTS AND INCOME CHANGES

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Abstract

Liberia's inability to produce enough rice to feed its population has led to massive rice imports, a high import bill, a negative balance of payment, vulnerability to shock and political instability (such as the 1979 rice riot that degenerated into civil unrest and the current economic crisis), increased food insecurity and high rate of poverty, among other effects. However, the effect of these massive rice importations on the national income has not been established. This provoked the need to determine the casual link between the imported rice volumes and income. To achieve this, the study models secondary annual time series data on Liberia's agriculture subsector from 1979 to 2011. The Johansen cointegration technique, Error Correction Model (ECM) and the Granger Causality tests are used to determine the causal link between rice imports and income changes. Liberia's imported rice volumes are observed to be sensitive to income changes in both the short-run and long-run periods. Based on the causation between imported rice volumes and income changes, this study recommends that the domestic rice production be improved and commercialized.

Key words: Rice, Liberia, Income, Causality

1. Background

Rice (*oryza sativa*) is the most important cereal crop in the developing world and is the staple of over half of the world's population (Daramola, 2005). It is a primary commodity of Liberia and it represents over 33% of the food consumption; and accounts for approximately 50% of adult caloric intake. This implies the importance of the crop to the Liberian economy. However, the country spends 69% of her income on food imports (CFSNS, 2013), a greater portion of which constitutes rice imports, which could be because rice demand outweighs the domestic production. Food

accounts for about 24% of the country total import, of which rice accounts for 65.3% of food commodity importations (Broudic, 2008). By 2008, the country's import bill had increased steadily from US$25 million in 1990 to approximately US$200 million (MOA, 2009; Daybor, 2013).

Liberia as a low income country spends a large portion of her income (US$200 million) on imported rice (Daybor, 2013; CFSNS, 2013). The food insecure, majority of the population spends a higher share of their income (59%) on food, chiefly on imported rice (CFSNS, 2010). This amount is spent at the expense of developing a post-war country; and according to Daybor (2013), such expenditure on rice importation is a waste and a huge financial blow to an already struggling country that has about 41% of the total population living on an unacceptable food consumption level, while 13% are extremely poor, consumes only rice, roots and tubers (FAO, 2000). The importation of rice deprives Liberia of said amount that could be circulated in the country was she to produce her own rice. Such needed income that could be used for crucial infrastructure projects, such as schools, roads and hospitals and to address poverty related problems is consistently dedicated to meeting the country's food import bill (Daybor, 2013).

This can be partly attributed to the Liberian civil war that was fought between 1989 and 2003. During this period, income generating activities and prices of agricultural products among others were negatively impacted, especially when agricultural production stalled. While it is expected that the effects of the civil war still linger today, posing obstacle to rice self-sufficiency, it is not clear whether these effects on income are uniform across the economic climates that characterize Liberia for the 33 years period. In addition, it is not known whether income caused importation of the rice or importation of rice cause income changes. This study established the causality between imported rice and income changes across the three periods (before, during and after civil-war).

2. Contextual Framework and estimation procedure

Dynamics of international trade

Some of the expected benefits in free trade include increase in economic efficiency, increase competition among firms, economic growth acceleration, advancement in technology and increase in human welfare through the availability of better quality and wide variety of products at competitive prices (Dollar and Kraay, 2004). In order to achieve economic growth, it is imperative to trade across borders; trade integrates the nations' agriculture with the world agricultural economy (Kohls and Uhl, 1985).

Trade pessimists however, argue that free trade may be less beneficial or harmful for the developing nations and the poor in particular. Additionally, countries with very low wage are unlikely to use their production cost advantage in many circumstances. International trade is never costless, Rogers (2000) shows that a certain proportion of net importers' income will be spent on purchases of imports with a condition that higher income leads to higher imports. FAO (1995) asserts that globalization of agricultural trade could have undesirable consequences on the economy if the agricultural sector is exposed to international competition.

2.1 Imports sensitivity to Household Income

Income is an important factor in determining agricultural products importation (Honma, 1991). Least developed countries' imports demand relies on income as a major determinant (Dordonu and Sackey, 1998). This implies a positive significant relationship between imports and income of developing countries. Humpage (2000) shows a positive significant relationship between imports and income. Harvey and Sedegah (2011) declared that import demand changes based on changes in income, which means an increase in income leads to increase in imports demand.

A study on China's agricultural imports, established income as statistically significant in explaining the agricultural imports demand (Niemi and Niemi, 2008). According to Ramos (2001), Portugal's import is significantly related to economic growth. Again, studies conducted by Kogid *et al*. (2011) and Alexiou (2009) showed causality between economic growth and importation. Abbas (2012) studied Pakistan importation and showed causality direction between the variables of income and imports. There is a positive significant relationship between import demand and income changes in Pakistan (Chani, Pervaiz and Chaudhary, 2011). Nandakumar *et al.* (2010) noted that increase in income of India, China and some countries from South-East Asia have consequently increased the level of importation. Economic growth raises the per capita demand for all normal goods, which increases importation. Afzal (2001) found significant positive relationship between Pakistan imports and income.

Niemi and Niemi (2008) used the cointegration model to study China's growing importation and show imports as being responsive to income. Amiri and Gerdtham (2011) studied imports and economic growth of France and identified that cointegration exists between these variables. Hye (2008) proves the existence of cointegration between the variables of imports and income.

Other researches however, established a negative relationship between imports and income. Mushtaq *et al.* (2014) found a significant negative relationship between imports and income. In a study, Kogid *et al.* (2011) found out that import affects economic growth in both negative and positive ways. They observed bidirectional causality between economic growth and imports, which means that Malaysia's imports contribute towards its economic growth. In other words, Malaysia imports largely intermediates/agricultural inputs that are used for agricultural production.

By contrast, East-West (2008) noted that economic growth has no connection with importation. This assertion was supported by FAO and Earthscan (2010) study on Africa's importation, which show that an increase or decrease in income has never been a factor for rice importation in Africa. They noted that imported rice continues to flood local African market regardless of a decrease or increase in income.

2.2 Theories on Cointegration, Error Correction Model and Granger Causality Methods for data analyses

The cointegration technique is used to test for stationarity of the residuals generated from a long-run regression equation. The main purpose of cointegration analysis is to establish whether the series in the model trend together over time (Dlamini, Armstrong and Nxumalo, 2001). The

rejection of the null hypothesis of the cointegration test means that the residuals are non-stationary, which shows the existence of some cointegrating relationships. A time series is stationary if there is no systematic change in the mean variance (no trend) and if strictly periodic variations have been removed. Most of the time series and economic data face the problem of non-stationarity due to the presence of time trend.

According to Nielsen (2005), using ordinary least squares (OLS) method to analyze non-stationary data produces spurious results, and the regression results would be unreliable. Nielsen (2005) declares that cointegration occurs when the stochastic trends in variables are the same (common trend) so they cancel. Hence, cointegration technique is appropriate in eliminating the stochastic trends in the model to produce stationary residuals. Niemi and Niemi (2008) declared that there are two main advantages of using the cointegration techniques for data analysis: firstly, it clearly distinguishes between the short-run and long-run effects, and secondly, it directly and speedily estimates the long-run equilibrium. For example, does increase in rice import results into an increase in income or the other way round?

The Error Correction Model (ECM) and Cointegration Methods are increasingly becoming important in analyses that attempt to describe the short-run and long-run equilibrium relationships simultaneously. The ECM is used to test the short-run cointegration between variables (Mwansakilwa, Tembo and Mugisha, 2013). A significant coefficient of ECM with negative sign is considered as a further proof of the existence of short-run and stable long-run relationship (Banerjee, Dolado and Mestre, 1998). Nwachukwu and Egwaikhide (2007) noted that inspection of the order of integration of variables allows the ECM estimation procedure to thoroughly examine the characteristic of time series, helping to overcome the problem of spurious or meaningless regression results often associated with non-stationary historical data.

The Johansen Cointegration test proposed by Johansen (1988) and Johansen and Juselius (1990) is used to find long-run relationship among stationary variables of the same order. Similarly, the cointegration or fit cointegrating ECMs require specifying the number of lags to include. The ECM test is used to find the short-long relationship between the variables in the series. The maximum likelihood (ML) testing procedure is suggested to find out the number of cointegrating vectors in the VAR representation (Johansen, 1988; Johansen and Juselius, 1990). Engle and Granger (1987) were the first to put forward the concept of cointegration. They proposed two steps estimation approach where only one cointegrating vector can be found. The first step in cointegration analysis is to specify the number of lag orders. The current study builds on the work of Engle and Granger (1987) and Nielsen (2001) to determine the lag order, after which, the test for cointegration between the log of imported rice volumes and the log of income in the series were tested to establish the causal relationship between the two variables.

3. Data and Cointegration, Error Correction Model and Granger Causality Analysis

The time series data (1979 to 2011) for this study were collected using secondary sources: websites and databases. Data on imported rice volumes was taken from FAOSTAT. The data on income (GDP) was taken from the World Development Indicators (WDI) online database by World Bank.

To analyze the causal link between rice imports and income changes, this study used Johansen cointegration analysis, error correction techniques and granger causality model to analyze the causation between the volumes of imported rice and income changes. This study first sought to evaluate if the time series data has a unit root, which means that more than one trend is present in the series. The study used the ADF unit root procedure developed by Dickey and Fuller (1979) to test whether a variable has a unit root or equivalently, and to evaluate if the series or variable follows a random walk. The trend option with Dickey Fuller was used to include a constant and time trend in the generalized ADF. Thus, stationarity of these variables were achieved after carrying out first differencing and this result supported the use of imported rice volumes and income for time series analysis. Additionally, the post estimation specification and stationarity tests were performed to check the specification of the model. This was done by predicting the cointegrating equations by graphing them over time as indicated in figure 1. Again, the model specification was checked to establish whether the number of cointegrating equations was correctly specified. This test result showed that the *r* eigenvalues were strictly less than one and it was concluded that the equation was correctly specified. For the test of serial correlation in the residuals, the results indicated that there is no serial correlation in the residuals since all the p-values were insignificant. To assess the validity of the vector autoregressive (VAR) model, the stability and autocorrelation of the residuals were tested to examine the dynamic stability of the system and none of the eigenvalues was close to one, so the system is stable.

3.1 Empirical Model for Cointegration Equation

The general form of VAR is:

$$Y_t = \alpha + \beta_t Y_{t-1} \ldots\ldots + \beta_k Y_{t-k} + \varepsilon_t \quad \text{---------- 1}$$

Where:
Y_t is an (n×1) vector of variables that are integrated of order 1,
α is a (n×1) vector of constant terms,
$\beta_t \ldots\ldots \beta_k$ are parameters and
ε_t is an independent and identically distributed error term.

This VAR can also be written in the following alternative form of vector error correction model (VECM):

$$\Delta Y_t = \mu + \sum_{i=0}^{\rho-1} r\, \Delta Y_{t-i} + \pi Y_{t-1} + \varepsilon_t \quad \text{---------- 2}$$

Where:
Y_t (n×1) is column vector of ρ variables,
μ is a (n×1) vector of constant terms.
ε_t (N×1) is vector of usual error term,
Δ is difference operator and
r (Gamma) and π (Pi) represent coefficient matrices.

The coefficient matrix π is also termed as impact matrix and it describes the long-run relationship. Two types of likelihood ratio tests termed as trace test statistics and maximum eigenvalue test

statistics are used to find the number of cointegrating vectors. The representation of VECM with respect to the study variables is given as:

$$\Delta \text{lnImported Rice Volume} = \alpha + \sum_{i=0}^{\rho-1} \beta \Delta \ \text{lnIncome}_{t-I} + \varepsilon_t \quad ---------- \quad 3$$

The Johansen Cointegration normalization test is performed along with the error normality test. The assumption of the normality of the variables was achieved at 0.05 % significant level, hence, the variables are normally distributed. To determine if Liberia's income and rice imports affect one another over time, the Granger causality test was performed. This procedure tests all the pairs of variables in a VAR for causal link.

3.2 Empirical model for Augmented Dickey Fuller (ADF) test

Dickey and Fuller (1979) proposed the ADF test that has been used in this study to check the stationarity and difference for all the variables used for analyses. Using this test to difference the series, all the variables were lagged by 1 year. The empirical evidences of these tests indicate that the variables are non-stationary. This implies that the null hypothesis of unit root at level cannot be rejected for all variables. But at first difference, all the variables are stationary, which shows that the null hypothesis of unit root for all variables is rejected. Thus, the variables have same order of integration, integrated of one lag order I (1). The following regression equations are used for the application of the ADF test.

$$\Delta X_t = \alpha + \delta X_{t-1} + \sum_{j=1}^{q} \gamma_j \Delta X_{t-j} + \varepsilon_{1t} \quad ---------- \quad 4$$

$$\Delta X_t = \alpha + \beta t_1 + \delta X_{t-1} + \sum_{j=1}^{q} \gamma_j \Delta X_{t-j} + \varepsilon_{1t} \quad ---------- \quad 5$$

$$\Delta\Delta X_t = \alpha + \delta \Delta X_{t-1} + \sum_{j=1}^{q} \gamma_j \Delta\Delta X_{t-j} + \varepsilon_{1t} \quad ---------- \quad 6$$

$$\Delta\Delta X_t = \alpha + \beta t_1 + \delta \Delta X_{t-1} + \sum_{j=1}^{q} \gamma_j \Delta\Delta X_{t-j} + \varepsilon_{1t} \quad ---------- \quad 7$$

Where:
$\Delta X_t = X_t - X_{t-1}$;
q = number of lags;

The test hypotheses for checking stationarity states that zero value indicates that the tested variable (X_t) is nonstationary. While the nonzero value means that the variable (X_t) is stationary, hence rejecting the null hypothesis (H0: $\delta = 0$) against the alternative hypothesis (Ha: $\delta < 0$).

3.3 Determining the number of Lags order for the study

Although, the lag order of 1 is used to difference the time series as suggested by Dickey and Fuller (1979), the lag order 3 has been used to check if cointegration exists between the imported rice and income, and determine if there are long-run and short-run causal relationships between the two variables. This follows the suggestion from the lagging order selection test, where most of the tests recommend 3 orders as the maximum lag order. Beside the Schwarz Bayesian Information Criterion (SBIC) lag order that suggests 2 orders, the Likelihood Ratio, Akaike Information Criterion (AIC), Hannan-Quinn Information Criterion (HQIC) and Final Prediction Error (FPE) suggest an optimal lag length of 3 to be used.

4. Causality analysis

A series trend obtained by plotting rice imports and income show some form of trend in the series of the three periods as indicted in Figure 6.

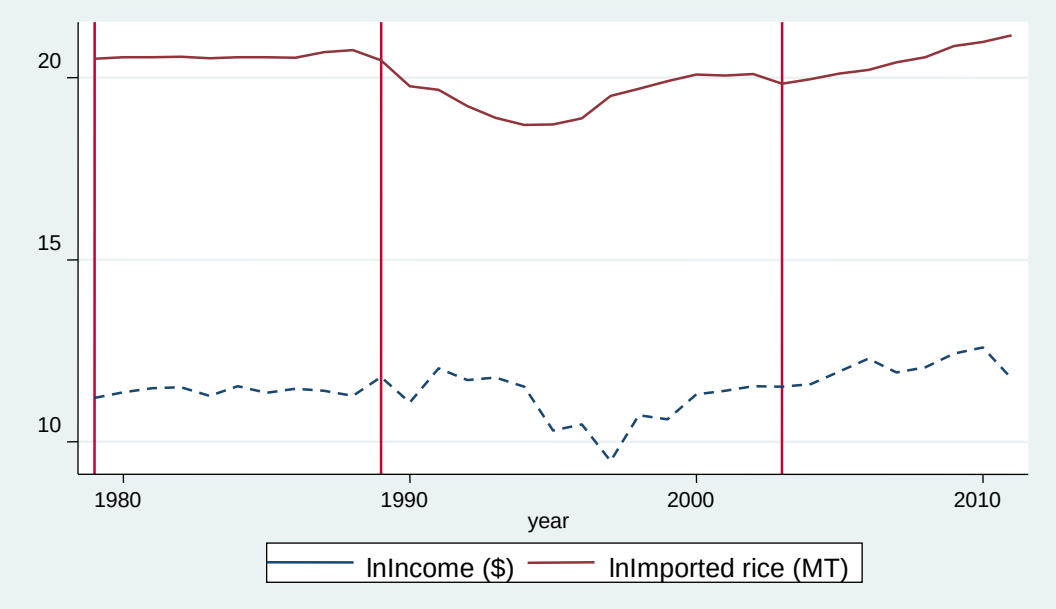

Figure 1: Trends of rice imports and income across three periods

In a competitive market, the current and past income contains all the information available, so tomorrow's imports will be a random walk from today's income. Except for the crash during the civil war, the volume of imported rice appears to be closely related to income. We therefore expect the series of imports to be cointegrated with the series of income or economic growth. As observed, something put a significant brake on rice imports between 1989 and the late 90s. Following the brake, there was a recuperation of imports, which implies that the country was severely affected by the war.

By the start of the war, total productivity in the country dropped and the corresponding effect is seen in the volume of imported rice (Figure 1). The empirical evidences depict that imports started

to increase in 1991, but income continuously fell during that time. This negative relationship during the civil war era can be attributed to food-aid, goodwill and the level of importance Liberian attach to rice consumption. This trend can be further tested using cointegration techniques comprising of the Johansen cointegration test, ECM and the Granger causality test.

Table 1: Results of the Johansen Cointegration test

Maximum Rank	Parms	LL	Eigenvalue	Trace Statistic	5% Critical Value
0	10	-9.70		11.32*	15.41
1	13	-4.42	0.30	0.76	3.76
2	14	-4.05	0.02		

"*" Trace statistic r = 0

The empirical evidences of the Johansen Cointegration test show that there is no unit root in all the variables after differencing at one lagged order. Thus, the null hypothesis of non-stationarity is rejected since the test-statistic is significantly different from the critical values. The Johansen Cointegration test results indicate less value for the trace statistics (r = 0 of 11.32) when compared to its critical value (15.41). The null hypothesis of the Johansen's method for testing cointegration states that the number of cointegrating relationships is equal to rank (r) and it is given in the "maximum rank" column of the output. The alternative provides that there are more than r cointegrating relationships. The null is rejected if the trace statistic is found to be greater than the critical value; otherwise, the null hypothesis will be accepted (Dickey and Fuller, 1979). This trace test result accepts the null hypothesis of no cointegrating equations between the rice imports and income changes. Similarly, because the trace statistic at (r =1 of 0.76) is less than the critical value (3.76), the null hypothesis that there is one or fewer cointegrating equation is accepted.

By employing the Johansen Cointegration technique, this study shows zero cointegrating vectors, implying that there exist no cointegration equation between the imported rice volume and income. This is contrary to Amiri and Gerdtham (2011), Rizvi and Shamim (2010) and Hye (2008) studies that show the existence of cointegration between imports and income in different countries. Although, the study establishes no cointegration between the two variables, there is a need to know which one of the variables affects the other in the short-run and long-run. Thus, ECM and Granger Causality Models are used to establish these effects or causal link. The ECM is used to analyze the speed at which the variables of income and rice imports respond to each other.

Table 2: Results of Error Correction Model (ECM)

Variables	Coefficient	Standard Error	Z	P-value
Income - Imported rice	-0.36	0.13	-2.66	0.01
Imported rice - Income	0.07	0.02	0.97	0.33

Table 2 contains the estimates of the short-run parameters along with its z-statistics and p-values. The coefficients are the parameters in the adjustment matrix alpha for this model. The estimated coefficient (-0.36) of imported rice volume implies that when rice imports are too high, they

quickly and significantly respond by adjusting towards income changes. Still in the same table, the estimated coefficient (0.07) of income indicates that the country income does not adjust towards imports at the same level and this effect is even statistically insignificant (Table 2). Hence, Liberia income is not significantly responsive to rice imports. The coefficient of income in the equation of rice imports is positive, which means an increase in income leads to an increase in rice imports.

This study establishes a negative significant values of the error correction term (ECT) coefficient (-0.36), which indicates that the imported rice volumes is responsive to income changes in the short-run. A significant ECT coefficient shows the speed at which the dependent variable adjusts to any deviations from the equilibrium position between itself and each explanatory variable, thereby confirming the existence of relationships between the variables in the short-run (Nwachukwu and Egwaikhide, 2007). The lagged order ECT coefficient describes the existence of short-run relationship (Mwansakilwa, Tembo and Mugisha, 2013). Its value and sign tells us about the speed and convergence or divergence to or from the long-run equilibrium. Thus, the negative value of the ECT indicates convergence, whereas its positive value indicates divergence. To determine the long-run causal relationship between the same variables, the Granger Causality test is performed (Table 3).

Table 3: Results of Granger Causality Wald test

Equation	Excluded	Chi2	DF	P-value
Imported Rice	Income	7. 65	2	0. 02
Imported Rice	All	7. 65	2	0. 02
Income	Imported Rice	1. 07	2	0. 59
Income	All	1. 07	2	0. 59

The Granger Causality Wald test results show overwhelming evidence that income helps in predicting rice imports (P = 0.02). This test confirms the error correction test that rice import is not a significant (P = 0.59) predictor of income. This is not surprising, in view of the fact that income encompasses all the output produced within the country. As such, the rise in output increases income that raises the purchasing power of consumers and in turn, the demand for imported rice increases significantly.

The study findings reveal that Liberia rice imports are significantly responsive to income changes. This confirms similar previous studies that asserted the causal relationship between imports and income. According to Abbas (2012), there is a causality direction between income and imports of Pakistan. Previous studies on Pakistan's importation (Harvey and Sedegah, 2011; Chani, Pervaiz and Chaudhary, 2011; Afzal, 2001; Rivera-Batiz, 1985), a study on Cote D'Ivoire (Constant, Bi and Yue, 2010) and a study on India, China and other country in Asia (Nandakumar *et al.*, 2010) show that importation is sensitive to income changes. Most of the studies declared that income has a positive and significant effect on importation. The dependence of Liberia's rice import on income indicates that increase in its GDP leads to an increase in consumption. Since food agricultural products are not among the leading income generating activities in the country, increase in income will lead to an increase in importation of agricultural products such as rice. By contrast, increase in domestic rice production results to reduction in rice imports.

5. Conclusions

The study shows no existence of cointegration between rice imports and income changes. Further analyses on the same variables using the ECM and the Granger Causality tests show that imported rice volume is reactive to income changes. This implies a significant causal relationship between imported rice volumes and income. The ECM establishes rice import as having causal link with income changes in the short-run and it has a stable long-run relationship. Similarly, the Granger Causality test proved the ECM results by establishing a positive long-run relationship between the rice imports and income changes, and the rice import volume is an insignificant predictor of income. Unpacking the time horizon based on the political occurrences in the country presents a clear picture that highlights the impact of the fourteen years civil strike.

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