# eExports, Imports, and Economic Growth in Liberia: Evidence from Causality and Cointegration Analysis

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*This paper revisits the highly debated export-led growth hypothesis in a number of different ways using Liberia as a case study. First, the hypothesis is tested in terms of how exports can affect or be affected by GDP growth. Considering the impact of imports on GDP serves a similar purpose. This paper investigates the Granger-Causality between exports, Imports, and Economic growth in Liberia over the period 1970 – 2011. The role of the import variable in the investigation of exports and output causality is emphasized, enabling one to test for the cases of direct causality, indirect causality, and spurious causality between export growth and output growth.*

## INTRODUCTION

An important policy strategy for assessing growth and development in developing economies is to ascertain economic relationships between economic growth and the trade sector for a particular economy. The intuitive rationale is that the trade sector is the "engine of growth" for these economies which, to a large extent, are characterized by unit-modal production processes. Additionally, it is the "cash cow" for most developing economies that allows them to purchase goods and services in the international community. The following analysis provides opportunities to develop strategies, which can lead to the growth and development of these economies by increasing the value-added and/or value chain of their export products.

There is an extensive range of empirical literature on the relationship between the trade sector and economic growth in developing economies, on the one hand, and emerging economies with respect to export-led growth on the other. The competing strategy is import substitution, which focuses on protecting local "infant industry" markets from competing international markets. Import substitution was the predominant strategy in the 1950s and 1960s when policy instruments were chosen to protect developing economies' domestic industries (Kruger, 1984; Todaro and Smith, 2012). The success of East Asian economies, for example, provided a basis for the adoption of export-led growth (Hossain et al., 2009). However, it is felt that import substitution has the potential to be an effective strategy only for limited period of time (Aghion and Howitt, 2009). The choice of strategy for economic growth depends on developing a long-term strategy, which may consist of utilizing both approaches: import-substitution initially in the short-run and export-led growth for the long run (Perkins et al., 2006). Supporting this view is Uddin et al. (2010) and Paul (2011); however, the latter promotes both export promotion and import liberalization for emerging economies which aspire to grow fast but, at the same time, confront issues associated with economic openness.

There is also a long and continually growing body of literature on the relationship between foreign trade and economic growth with a significant number of these studies suffering from the omission of the import variable. Hossain et al. (2009) point out that studies which include imports establish the validity of the export growth hypothesis. In other words, if one wants to investigate the "growth-export" paradigm it is necessary to include imports as part of the determinants thus developing a tri-variate approach, especially when modelling in the context of a vector autoregression model (VAR). Most recent studies take this approach, since VARs impose few restrictions in the estimation process and are particularly adept at identifying internal and external shocks (Garrett et al., 2012; Amoateng and Amoako-Aju, 1996). VARs are extremely appropriate for modeling the Liberian economy, since Liberia has been subjected to two major internal shocks and one recent external financial shock.

There are two ways in which one can examine long-run relationships between economic variables in an economy. First, there is the well-known Granger Causality which tests the hypothesis that some variables do not "Granger cause" some other variables (Granger, 1969). For example, a variable X is said to be Granger causal to another variable Y if Y can be predicted with greater accuracy, all other information being identical, if current and past values of X are used (Kirchgassner, 2013). In this context, Granger Causality is used if at least n-1 of the series are integrated of order zero.

Second, cointegration is used when there are common stochastic trends significant relationships between variables of interest are integrated of order zero (Lutkepohl, 2004, p. 89). It is a measure of the amount required to adjust to equilibrium between two or more variables when using an error correction model, which requires the variables under analysis to be integrated of order 1; that is I(1), or stationary. If the variables are not stationary the regression results are considered spurious and the estimation results appear to be statistically relevant when they are not and without any economic meaning (Enders, 2015, p. 195).

This paper develops a model for examining long-run relations between exports, imports and output growth for the economy of Liberia. The approach used here is well documented in the literature both in terms of methodology, modeling approach, and the number of countries studied. We also examine causality between trade sector variables and economic growth in the Liberian economy. Our model follows Shazi and Munap (2005); Frankel and Romer (1999); Amoateng and Amoaka-Adu (1996); and Arestis and Demetriades (1991) in developing a tri-variate model, since bivariate models tend to omit the import variable, which has be shown to adversely affect the statistical results. The importance of understanding these relationships is through the specification process by determining direction of causality between imports, exports, and economic growth. In particular, we utilize the concepts of causality and cointegration to say something about the choice of development strategy by examining the growth path of the Liberian economy over the period 1970 – 2011.

**Imports, Exports, and the Growth Relationships for Liberia**

The country of Liberia continues a path to recovery from substantial internal shocks due to two ethno-political conflicts and an external global financial shock. According to the 2nd Annual Progress Report by the Government of Liberia to the IMF, the main engines for growth will result from natural resource-based activities of mining, timber production, rubber and other plantation products (GoL, 2011). Most of these commodities are earmarked for exports indicating an export-led growth strategy. Export-led growth (EL) growth and import-substitution (IS) strategies are a common policy approach for emerging and developing economies using VARs. For example, similar studies were developed for Pakistan (Rahman and Shabbaz, 2011); and Korea (Hwang 1998; Glasure and Lee, 1999) using bivariate VAR models. Dar et al. (2013), using a wavelet time scales model of exports and growth (measured by industrial production) found exports and output growth not to share any short-run co-movement relationships at lower dimension time scales between 2 – 8 months. They did, however, find positive relationships between export and output growth at higher time dimensions scales in the medium and long-run between 8-64 months, verifying ELG as a long-run phenomenon for India. More importantly, their results indicated a uni-directional relationship between exports and growth in the medium run and a bi-directional relationship in the long-run. However, each incorporate endogenous growth model concepts

and consider either Granger causality or cointegration in modeling causality among long run relationships. The objective of this paper is to examine causality between trade sector variables and economic growth in the Liberian economy. This paper adds to the literature by statistically ascertaining which development strategy Liberia is adopting: export-led, import-substitution, or both. Thus, understanding the direction of causality is critical for the policy analyst, as it provides opportunities for developing long-run planning procedures which can lead to a diversified production economy. This is important as Liberia moves forward towards gaining the growth and maturity it so adequately demonstrated prior to the major civil war shocks and to regain its leadership position in the West African region.

## MODELING LONG-RUN RELATIONSHIPS

Recent developments of causality and cointegration in time series econometrics have introduced a number of methodologies for analyzing long-run economic relations between aggregate economic variables. The examination of causality or the link between key economic aggregates, as represented by the work of Granger (1969) is at the heart of most macroeconomic theories. The concept of cointegration describes the long-run equilibrium relationship two or more economic variables share with common stochastic trends, and identify persistent but random long-term co-movements (Hamilton, p. 572; Stock and Watson, p.778). Therefore, causality and cointegration suggests a linear correlation between two or more variables which allow them to move together in the long run. The significance of Granger Causality is direction of causality, a common problem in economics and long-run stability of equilibrium. Both concepts provide interesting information on the dynamics of models for policy makers in developing short, medium, and long run policy prescriptions.

The reason for our concern with causality is that export growth is thought to be a primary determinant of output and employment growth in an economy in the context of (1) export-led growth, (2) GDP driven exports, and (3) the existence of a feedback mechanism between trade variables and GDP growth. The importance of understanding the direction of causation allows for the development of policy prescriptions that will enhance the production capability of the Liberian economy.

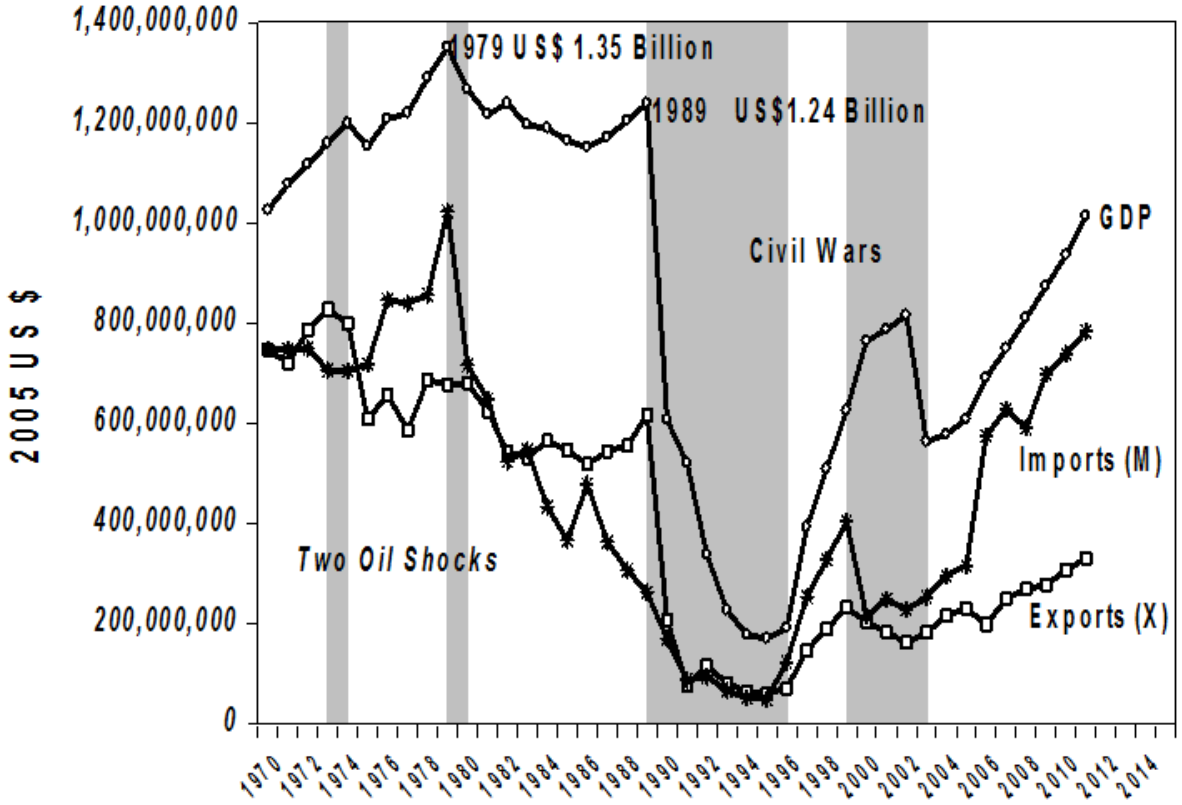
## DATA

In this paper we use annual data for Liberia's exports, imports, and gross domestic product (GDP) in real terms with a base year of 2005 for the period 1970 – 2011. The source of the data is the UN Database. Plots of the series are presented in Figure 1, which demonstrates the impact of external shocks on the Liberian economy of the period of analysis and also co-movements of the three series. These data include the two oil shocks in the 1970s and early 1980s, shocks associated with the country's two civil wars in the 1980s and 1990s, and the financial crisis (or Great Recession), which occurred between 2007 and 2009.

The oil shocks had relatively mild impact on the country's economy relative to the two civil wars, which had deleterious effects on the country and for a substantial period of time. For example, real GDP fell from USD 1.24 billion to 190 million USD or 84% during the first civil war. While the second civil war seems to have had a lesser impact on the economy, the impact on physical and social capital was much more devastating. The global financial crisis also resulted in a decline in Liberia's investment in the mineral sector, however, the sector experienced a strong recovery in 2011 with a real growth rate of 12% (GoL, 2011). Imports have steadily increased since 2000 but with net exports increasing the trade deficit. Thus, areas in which the economy has competitive advantages appear not to have positively impacted areas of the economy where import-substitution could make a difference. The critical question is to determine the direction of causality between imports, exports, and GDP. Understanding this tri-variate relationship provides the basis for developing planning procedures that have a direct effect on the economic outlook and long-term growth of the economy.

The fact that the three series exhibit co-movements implies the series are cointegrated. Testing for stationarity of these series are problematic due to the presence of major structural breaks suggest. Stationarity refers to the property of time series data where the mean and variance depend on time, violating one of the key assumptions of the classical linear regression model that such series have the property of mean reversion. The use of nonstationary economic series in time analysis generates estimation results defined in the literature as spurious results. The solution to this problem is to determine the degree of integration of each series; that is, how many times each series must be differenced in order to achieve stationarity.

**FIGURE 1**
**EXPORTS, IMPORTS, AND GROSS DOMESTIC PRODUCT (GDP)**




*Source:* UN Database (Data Zoa)

This is achieved by applying the Augmented Dickey-Fuller (ADF) unit root test and we evaluate the unit roots in logarithms of each series. However, since there is more than one major structural break, ADF tests are unable to reject the null hypothesis of the presence of a unit root even in the presence of a large sample size (Kirchgassner, 2013; Perron, 1989). This requires the examination of unit roots in the presence of structural breaks. While the ADF test is widely used for the stability of its critical values as well as its power over different sampling experiments, Phillips and Perron (1989, 1999) have shown that a structural break may bias the ADF test towards non-rejection of the hypothesis of a unit root (Udin et al., 2010, p. 3). Therefore, we perform ADF and Phillips Perron Tests, along with additional unit root tests with the results presented in Table 1 (see Appendix for Tables). The Phillips-Peron tests for each series indicate stationarity in first differences for exports, imports, and GDP. Since detecting unit roots are sensitive to the lag structure, the Perron-Phillips test adjusts for changes in the mean of a stationary

variable. The results in Table 1 indicated that each variables is integrated of order one, our VAR will be modeled in first differences.

## COINTEGRATION AND CAUSALITY TESTS

We now investigate the concept of cointegration, which essentially says there is a long-run relation tying the three series together represented by a linear combination and suggesting a long-run relationship in log differences for imports, exports and GDP (Hamilton, p. 572). The Johansen Cointegration results are presented in Table 2, where we used 9 lags to determine our results. Both the Johansen Trace (JT) Test and the Maximum Eigenvalue (ME) Test, indicate 1 cointegrating equation at the 0.05 level, while the Log Likelihood Tests indicates 2 cointegrating equations. Enders (p.380) notes that when there are conflicting results regarding cointegration tests, the Max-Eigen (ME) statistic has the sharper alternative hypothesis test and is preferred for "pin[ing] down" the number of cointegrating vectors. In this case, the result, which is robust, yields one (1) cointegrating equation at the 5% marginal significance level.

## MODEL ESTIMATION

A method that can resolve both causality and the long-run relationships among output, import, and export structure of Liberia is the estimation via a Vector Autoregression (VAR) with three variables. A VAR is a commonly used method for analyzing the dynamic structure of a system of variables. Testing and analyzing cointegration in a VAR is superior to the Engle-Granger (1987) single equation method; however, there are some strict requirements that must be satisfied in order to utilize the model (Charnmza and Deadman, 1992, p.178). These restrictions were satisfied in the previous section. In addition, the VAR model structure can now be used to model each variable as the dependent and independent variable in a simultaneous equation framework. The VAR is also a dynamic specification, including different time period specifications and lagged variables. Thus, the VAR provides a modeling specification which addresses all of the aforementioned problems associated with modeling time series data. It also provides an additional contribution by generating impulse response functions which show how a shock due to one variable proceeds through the system of equations and provides an indication of its short- and/or long-run persistence in the system. This is of particular interest to Liberia, as a country which has experienced three major shocks to its economy during the period of analysis.

We specify an unrestricted VAR system with one period lags given as:

$$\begin{aligned} \log GDP_t &= a_{11}\log GDP_{t-1} + a_{12}\log X_{t-1} \_ a_{13}\log M + c_1 + \varepsilon_{1t} \\ \log X_t &= a_{21}\log GDP_{t-1} + a_{22}\log X_{t-1} \_ a_{23}\log M + c_2 + \varepsilon_{2t} \quad , \\ \log M_t &= a_{31}\log GDP_{t-1} + a_{22}\log X_{t-1} \_ a_{33}\log M + c_3 + \varepsilon_{3t} \end{aligned} \tag{1}$$

where log GDP, log X, and log M are the natural logarithms of Gross Domestic Product, Exports, and Imports. In addition, $a_{ij}$ and $c_{ij}$ represent the parameters to be estimated and $\varepsilon_{ij}$, the disturbance term for each equation. The VAR is unrestricted in the sense that there are no prior designation values for parameters estimated by the regression. The lag specification is one lag for the endogenous and exogenous variables as determined by six (6) lag model specification tests, as shown in Table 3.

The importance of the VAR estimation method is that it allows for the simultaneous estimation of the system in Eq. (1) and can be used to examine both Granger-Causality and cointegration in the same specification. Granger-Causality can be examined by specifying restrictions on the cointegration relationships using Wald tests. The regression output for Liberia in a simultaneous context is presented in Table 4. The results indicate that all one-period lagged series are strong determinants of their respective series, with first period lags for imports and exports inversely related to GDP. We would expect inverse relationships for imports but for a one period lag in exports to reduce GDP is not something we would

expect. Moreover, each function exhibits decreasing returns to scale in the model. This may be problematic because a shock of one unit of the highly correlated regressor may very well impact the other regressors causing them to move by one unit shock and not remain unchanged. This may have been cause for previous researchers choosing bivariate VARs. Unless there is evidence of low correlation between regressors there may be a problem with the standard errors of the respective independent variables. The square root of the variance inflation factor $\left(1/\sqrt{1-R^2}\right)$ for the system is 3.804, which shows some multicollinearity exists but not be serious enough to significantly affect other regressors in the model (Heij, et al., p. 160). Even with VIF values that greatly exceed the 10 point rule, one can often confidently draw conclusions from regression analyses (O'Brien, 2007, p. 681).

We present results of pairwise Granger Causality tests in Table 5. The theory behind Granger Causality is based on measuring whether current and past values are used to determine future values; that is, can a scalar y forecast two other scalars x and z? If this is not possible, then we can say that y cannot Granger-Cause x and z (Tong et al., p. 309). The critical issue is selection of the lag order, which should be based on the belief of the longest time period exports, imports, and GDP can influence one of the other variables. In this case, we chose a lag value of 10, which represents a 10-year span of the data and which appears adequate for the Liberian economy with its long-period shocks. The results are presented in three panels representing pairwise tests for three (3) series. Based on the marginal significance levels (p-values), we find, in the first panel, that we can reject the hypotheses that imports do not Granger cause GDP and GDP does not Granger cause imports. In the second panel, we find that we cannot reject the hypothesis that exports do not Granger cause GDP and that GDP does not cause Exports. Finally, we cannot reject the hypothesis that exports do not Granger cause imports but we can reject the hypothesis that imports do not Granger cause imports. Thus the import/GDP relationship is bi-directional, while import/export relationships are uni-directional. This provides evidence that over a 10 year period of Liberia as an Import-Led economy.

Next, we analyze how a one period shock (or innovation) traces out the response of the dependent variable in the model to shocks to each of the other variables in the model. From Table 6, the shock of GDP and exports (column 2) to imports does not die away quickly indicating a long-run adjustment to a shock in GDP on imports. All other relational shocks have a short-run adjustment. This points to the sensitivity of imports to the overall economy of Liberia; in essence, the key determinant to long-term sustained growth lies with paying close attention to the composition of imports into the economy, which implies the need for an IS national strategy in the long run and short run attention to exports in the short run.

Finally, we examine the variance decomposition of our VAR estimation, which examines the importance of each variable's contribution to the forecast error variance for x-periods ahead. Here each dependent variable can be explained by innovations in each independent variable. The variance decomposition results are presented in Tables 7A-C. The variance decomposition of GDP (7-A) shows that it accounts for 100% of the immediate reaction in which the innovation occurs in period 1, while imports (M) and exports (X) account for 0%, respectively. While the variance decreases for GDP over time, the importance of both imports and exports increase so that by 15 years out, imports and exports account for 81% and 2.4% of the variance decomposition, respectively. GDP starts to influence both exports and imports in the second period but by approximately 15% and 16%, respectively. Imports become increasingly stronger by year 4 accounting for 56%.

In Tables 7-B and C, in the initial period, imports accounts for 83% of the variance decomposition. In years 4-15, it is mainly imports that impacts both GDP and exports. The impact of exports on both GDP and imports is relatively small but increasingly more importantly to imports after year 4. Thus, imports are strong in each variance decomposition and shows strong influence over the 15 period span, providing additional corroboration that imports are the key driver of the Liberian economy. This supports the view that an EL strategy is not an approach which should be considered for the long-run growth of the Liberian economy. Rather, focus should be on an IS strategy for the long-run and an EL strategy for the short-run.

## SUMMARY

In this paper we have analyzed the relationship between exports, imports, and GDP in the context of the Liberian economy. For this purpose we have used the framework of a structural vector auto regression model. The period of analysis was from 1970 to 2011, a time interval in which there was comparable data for the country's imports, exports, and GDP. The focus of the research was to determine which variable were Granger Cause of economic growth; that is, was the "engine of growth" led by (1) exports or (2) GDP. An unrestricted VAR was used to investigate these relations in terms of Granger Causality. We have found that imports Granger cause both GDP and Exports. In addition, we found that major ethno-political and financial shocks may have increased the likelihood of introducing decreasing returns to scale in production and causing an inverse relationship between exports and GDP growth, when the opposite would be expected.

Overall, the results confirm the bi-directional causation between GDP and Imports and uni-directional causation between exports and GDP and exports and imports. Moreover, our analysis does not suggest that Liberia is driven by exports alone but rather a mixture of exports and imports, with the latter having a long-run impact. Therefore, planning procedures geared to using EL strategies in the short-run and IS strategies in the long-run can be regarding as providing an optimal strategy that would positively impact the local and export market economies.

## POLICY IMPLICATIONS

From 1979 to 1990 exports were the engine of growth for the Liberian economy. However, with a new data horizon from 1970 to 2011, imports are now a dominant aspect of the Liberian economy indicating the country's strategy is currently about equally weighted on imports as exports, even though the present policy has experienced strong "export-led growth" due to strong growth in mineral and resource exports. Because of the significant impact of two civil wars and the experience of an international financial crisis, domestic stabilization is more dependent on exports than developing an import substitution strategy. The implication of our results is to use this knowledge in planning the macro structure of the present Liberian economy.

According to the World Bank Group, the average annual growth rate for GDP was 7.1% in 2009, down from 9.4% in 2007. According the US State Department, GDP growth was 7.9% in 2011 and estimated at 8.7% in 2013, ranking 11$^{th}$ in the international economy; however, 2014 growth was only 0.5 percent (The World Factbook). The ratio of Exports to GDP, one-half the component to the Globalization Index (exports plus imports divided by GDP) was 31.1 in 2008 and showing an average annual increase of 11.15% since 1998. Given the large component of the Globalization Index and its substantial growth rate, it appears the economy has the potential to provide the growth needed for sustainable development. Based on our research, greater attention should focus on increasing the emphasis on a dual strategy of "Import Substitution (IS)" and "Export-Led (EL)" strategies, with the former focused on the agriculture sector and the latter on the mineral resource sector. Earlier in our analysis it was indicated that Liberia should adopt an import substation strategy in the short-run and pursue an export-growth led strategy as the economy matures. What we observe from the data is a different approach for Liberia, which is to develop a dual approach incorporating both export-led and import substitution growth strategies. A dual approach allows the country to impact local markets, especially the agriculture sector, and the export market, the source for foreign exchange.

What can our results say about the present structure of the economy? Given that the economy will continue to demonstrate export-led growth, the focus should be to increasingly focus on reducing imports that impact employment in the private and agricultural sectors. That is, imports that compete with locally produced goods, especially those in the agricultural sector, should be minimized and focus directed to increase protection of local produce, which can compete with foreign imports. Concentration on domestic agricultural production, especially in rice, should provide the opportune moment to focus on increasing domestic produce. Thus, a good "rule of thumb" policy rule would be to use export earnings to increase

productivity in agricultural production in the short-run, while developing the private sector in both the short- and long-run.

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**APPENDIX**

**TABLE 1**
**ADF AND PHILLIPS-PERRON TESTS FOR UNIT ROOT BY SERIES**

| | **Imports** | **Imports** | **Exports** | **Exports** | **GDP** | **GDP** |
|---|---|---|---|---|---|---|
| **I(1)** | ADF (1) | PP(1) | AD(F1) | PP(1) | ADF(1) | PP(1) |
| | t-Statistic | Adj. t-Stat | t-Statistic | Adj. t-Stat | t-Statistic | Adj. t-Stat |
| **CV** | -4.6326 | -4.6326 | -4.8923 | -5.44512 | -3.79112 | -7.64041 |
| **P-value** | 0.0033 | 0.0033 | 0.0016 | 0.0003 | 0.0275 | 0.0000 |
| | | | | | | |
| **1%** | -4.2050 | -4.2050 | -4.2050 | -4.205 | -4.205 | -4.205 |
| **5%** | -3.5266 | -3.5266 | -3.5266 | -3.52661 | -3.52661 | -3.52661 |
| **10%** | -3.1946 | -3.1946 | -3.1946 | -3.19461 | -3.19461 | -3.19461 |

ADF: Adjusted Dickey Fuller Tests

## TABLE 2
## JOHANSEN COINTEGRATION TESTS WITH LIBERIA'S GDP, EXPORTS, AND IMPORTS

Sample (adjusted): 1975 2011
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: L_GDP L_M L_X
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.510349 | 45.45303 | 42.91525 | 0.0273 |
| At most 1 | 0.361173 | 19.03273 | 25.87211 | 0.2788 |
| At most 2 | 0.064129 | 2.452254 | 12.51798 | 0.9342 |

**Trace test indicates 1 cointegrating eqn(s) at the 0.05 level**
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

| Hypothesized No. of CE(s) | Eigenvalue | Max-Eigen Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.510349 | 26.42030 | 25.82321 | 0.0417 |
| At most 1 | 0.361173 | 16.58048 | 19.38704 | 0.1221 |
| At most 2 | 0.064129 | 2.452254 | 12.51798 | 0.9342 |

**Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level**
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

| L_GDP | L_M | L_X | @TREND(71) |
|---|---|---|---|
| -16.06890 | 0.189401 | 12.70003 | 0.188590 |
| -0.425743 | 4.350544 | -5.715265 | -0.096801 |
| 3.900718 | 1.990645 | -5.217521 | -0.176633 |

Unrestricted Adjustment Coefficients (alpha):

| | | | |
|---|---|---|---|
| D(L_GDP) | 0.057564 | 0.060421 | 0.015610 |
| D(L_M) | 0.012951 | 0.115551 | -0.029785 |
| D(L_X) | -0.041483 | 0.116089 | 0.019471 |

| | | |
|---|---|---|
| 1 Cointegrating Equation(s): | Log likelihood | 55.87025 |

**Table 2, continued.**

Normalized cointegrating coefficients (standard error in parentheses)

| L_GDP | L_M | L_X | @TREND(71) |
|---|---|---|---|
| 1.000000 | -0.011787 | -0.790348 | -0.011736 |
| | (0.06419) | (0.08152) | (0.00245) |

Adjustment coefficients (standard error in parentheses)

| | |
|---|---|
| D(L_GDP) | -0.924988 |
| | (0.43798) |
| D(L_M) | -0.208106 |
| | (0.75640) |
| D(L_X) | 0.666587 |
| | (0.70979) |

**2 Cointegrating Equation(s): Log likelihood 64.16049**

Normalized cointegrating coefficients (standard error in parentheses)

| L_GDP | L_M | L_X | @TREND(71) |
|---|---|---|---|
| 1.000000 | 0.000000 | -0.806763 | -0.012012 |
| | | (0.03046) | (0.00206) |
| 0.000000 | 1.000000 | -1.392639 | -0.023426 |
| | | (0.15253) | (0.01031) |

Adjustment coefficients (standard error in parentheses)

| | | |
|---|---|---|
| D(L_GDP) | -0.950712 | 0.273765 |
| | (0.38852) | (0.10525) |
| D(L_M) | -0.257301 | 0.505162 |
| | (0.65003) | (0.17610) |
| D(L_X) | 0.617163 | 0.497194 |
| | (0.59394) | (0.16090) |

## TABLE 3
## VAR LAG ORDER SELECTION CRITERIA

Endogenous variables: L_GDP L_M L_X
Exogenous variables: C
Sample: 1970 2015
Included observations: 39

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -60.13819 | NA | 0.005114 | 3.237856 | 3.365822 | 3.283769 |
| **1** | **25.03316** | **152.8716*** | **0.000103*** | **-0.668367*** | **-0.156502*** | **-0.484714*** |
| 2 | 31.03716 | 9.852729 | 0.000121 | -0.514726 | 0.381038 | -0.193334 |
| 3 | 41.66652 | 15.80777 | 0.000114 | -0.598283 | 0.681379 | -0.139151 |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

**TABLE 4**
**VAR (1, 1) REGRESSION ESTIMATE RESULTS**

Sample (adjusted): 1971 2011
Included observations: 41 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| | L_GDP | L_M | L_X |
|---|---|---|---|
| L_GDP(-1) | 0.482575 | -0.370148 | -0.167706 |
| | (0.12042) | (0.21173) | (0.19878) |
| | **[ 4.00743]** | [-1.74822] | [-0.84366] |
| L_M(-1) | 0.332243 | 1.199350 | 0.360267 |
| | (0.06382) | (0.11221) | (0.10535) |
| | **[ 5.20612]** | **[ 10.6887]** | **[ 3.41982]** |
| L_X(-1) | 0.042056 | -0.047521 | 0.712710 |
| | (0.08952) | (0.15740) | (0.14778) |
| | [ 0.46978] | [-0.30190] | **[ 4.82276]** |
| C | 3.214754 | 4.574160 | 1.929629 |
| | (1.03783) | (1.82477) | (1.71320) |
| | **[ 3.09756]** | **[ 2.50671]** | [ 1.12633] |
| R-squared | 0.930982 | 0.890580 | 0.896456 |
| Adj. R-squared | 0.925386 | 0.881708 | 0.888060 |
| Sum sq. resids | 0.940686 | 2.908066 | 2.563334 |
| S.E. equation | 0.159449 | 0.280350 | 0.263210 |
| **F-statistic** | **166.3630** | **100.3824** | **106.7782** |
| Log likelihood | 19.20523 | -3.931758 | -1.345081 |
| Akaike AIC | -0.741719 | 0.386915 | 0.260736 |
| Schwarz SC | -0.574541 | 0.554093 | 0.427913 |
| Mean dependent | 20.45715 | 19.70859 | 19.53742 |
| S.D. dependent | 0.583727 | 0.815125 | 0.786700 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 6.82E-05 |
| Determinant resid covariance | 5.01E-05 |
| Log likelihood | 28.45364 |
| Akaike information criterion | -0.802616 |
| Schwarz criterion | -0.301083 |

## TABLE 5
## PAIRWISE GRANGER CAUSALITY TESTS

Sample: 1970 2015
Lags: 10

| Null Hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| L_M does not Granger Cause L_GDP | 32 | 3.42096 | 0.0277 |
| L_GDP does not Granger Cause L_M | | 3.48945 | 0.0259 |
| L_X does not Granger Cause L_GDP | 32 | 0.51052 | 0.8503 |
| L_GDP does not Granger Cause L_X | | 1.19739 | 0.3841 |
| L_X does not Granger Cause L_M | 32 | 4.03271 | 0.0155 |
| L_M does not Granger Cause L_X | | 1.19210 | 0.3867 |

## TABLE 6
## IMPULSE RESPONSE FUNCTIONS

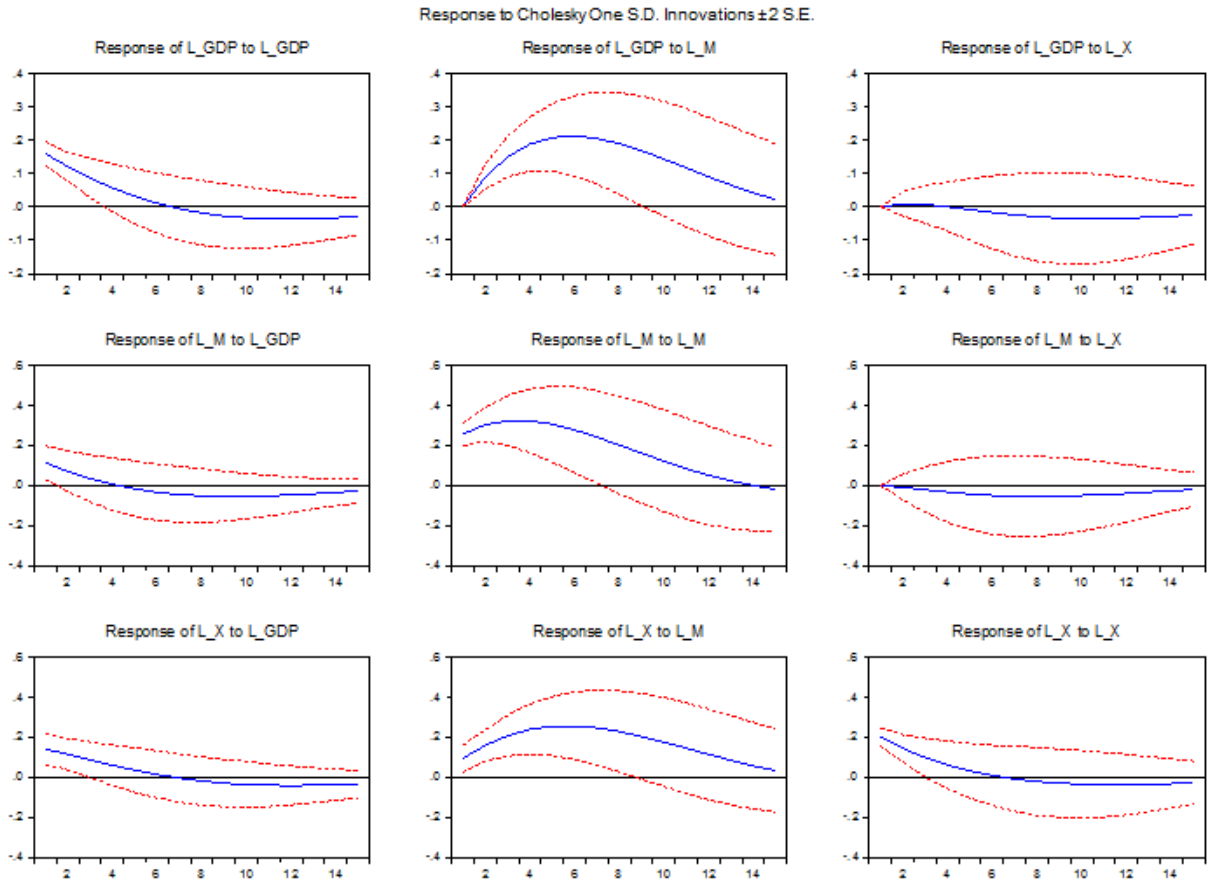

**TABLE 7A**
**VARIANCE DECOMPOSITION OF GDP**

| Period | S.E. | Log(GDP) | Log(M) | Log(X) |
|---|---|---|---|---|
| 1 | 0.159449 | 100.0000 | 0.000000 | 0.000000 |
| 2 | 0.219023 | 83.30086 | 16.54872 | 0.150420 |
| 3 | 0.279444 | 60.72990 | 39.11559 | 0.154519 |
| 4 | 0.341857 | 43.33647 | 56.56019 | 0.103340 |
| 5 | 0.401464 | 32.04351 | 67.83930 | 0.117190 |
| 6 | 0.454581 | 25.04965 | 74.72212 | 0.228230 |
| 7 | 0.499313 | 20.77535 | 78.80032 | 0.424331 |
| 8 | 0.535143 | 18.20263 | 81.11660 | 0.680762 |
| 9 | 0.562484 | 16.70956 | 82.31862 | 0.971821 |
| 10 | 0.582321 | 15.90966 | 82.81618 | 1.274160 |
| 11 | 0.595939 | 15.55240 | 82.87994 | 1.567661 |
| 12 | 0.604723 | 15.46744 | 82.69664 | 1.835921 |
| 13 | 0.610002 | 15.53494 | 82.39822 | 2.066844 |
| 14 | 0.612942 | 15.67019 | 82.07658 | 2.253226 |
| 15 | 0.614486 | 15.81574 | 81.79125 | 2.393015 |

**TABLE 7-B**
**VARIANCE DECOMPOSITION OF IMPORTS**

| Period | S.E. | Log(GDP) | Log(M) | Log(X) |
|---|---|---|---|---|
| 1 | 0.280350 | 16.39051 | 83.60949 | 0.000000 |
| 2 | 0.418884 | 10.16873 | 89.77876 | 0.052506 |
| 3 | 0.530437 | 6.762203 | 93.04081 | 0.196986 |
| 4 | 0.621284 | 4.936127 | 94.63809 | 0.425783 |
| 5 | 0.693523 | 4.026064 | 95.25509 | 0.718841 |
| 6 | 0.749010 | 3.664048 | 95.28264 | 1.053308 |
| 7 | 0.789910 | 3.634255 | 94.95893 | 1.406811 |
| 8 | 0.818661 | 3.800972 | 94.44048 | 1.758545 |
| 9 | 0.837787 | 4.072736 | 93.83733 | 2.089938 |
| 10 | 0.849721 | 4.384751 | 93.22973 | 2.385517 |
| 11 | 0.856645 | 4.690734 | 92.67526 | 2.634004 |
| 12 | 0.860380 | 4.959478 | 92.21121 | 2.829308 |
| 13 | 0.862333 | 5.173250 | 91.85579 | 2.970956 |
| 14 | 0.863492 | 5.326216 | 91.61014 | 3.063647 |
| 15 | 0.864466 | 5.422067 | 91.46202 | 3.115913 |

**TABLE 7C**
**VARIANCE DECOMPOSITION OF EXPORTS**

| Period | S.E. | Log(GDP) | Log(M) | Log(X) |
|---|---|---|---|---|
| 1 | 0.263210 | 28.51306 | 12.59908 | 58.88785 |
| 2 | 0.358236 | 25.57610 | 26.48605 | 47.93785 |
| 3 | 0.434100 | 21.40034 | 40.88606 | 37.71360 |
| 4 | 0.502800 | 17.35920 | 53.07029 | 29.57051 |
| 5 | 0.565543 | 14.10103 | 62.21866 | 23.68031 |
| 6 | 0.621139 | 11.73477 | 68.61615 | 19.64908 |
| 7 | 0.668416 | 10.13876 | 72.87509 | 16.98615 |
| 8 | 0.706877 | 9.138531 | 75.57932 | 15.28215 |
| 9 | 0.736750 | 8.574013 | 77.18993 | 14.23605 |
| 10 | 0.758841 | 8.315263 | 78.04972 | 13.63501 |
| 11 | 0.774321 | 8.260648 | 78.41061 | 13.32874 |
| 12 | 0.784532 | 8.331496 | 78.45875 | 13.20975 |
| 13 | 0.790820 | 8.467642 | 78.33189 | 13.20047 |
| 14 | 0.794409 | 8.624610 | 78.12992 | 13.24547 |
| 15 | 0.796317 | 8.771863 | 77.92128 | 13.30686 |