

Applied Econometrics and the Determinants of Economic Growth

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DOI: 10.6007/IJAREMS/v6-i2/2783 URL: <http://dx.doi.org/10.6007/IJAREMS/v6-i2/2783>

Abstract

The purpose of the current research was the exploration of macroeconomic determinants of economic growth in post-conflict Sierra Leone for the period, 2002-2013, and whether the association between the determinants and economic growth is long-term and short-term. The research methodology was quantitative, and the dataset was time series with 48 observations and 7 variables. Applying the $AR(2)$ model, the findings revealed foreign direct investment, gross capital formation, inflation, real interest rate, real exchange rate, population growth rate, and trade openness were significant determinants of economic growth. In addition, applying the Phillips-Ouliaris cointegration model, the findings revealed a statistically significant long-run association between economic growth and its determinants ($Rho = -16.456$, $Tau = -3.240$, $p < .05$). Furthermore, the error correction model (errorECM1) applied to determine the short-run deviation from the long-run had the expected sign, but was statistically insignificant ($\beta_{errorECM1} = -.1646$, $SE = .1331$, $t = -1.24$, $p = .2237$), indicating the adjustment towards equilibrium occurred in the same period under review. However, the research was limited to 12 post-conflict years (2002-2013), which may be insufficient to realize the complete determinant of economic growth. Subsequent studies must include additional years and variables to realize a comprehensive impact on growth.

Keywords: Applied Econometrics, Macroeconomic Variables, Economic Growth, Real Exchange Rate, and Real Interest Rate

1. Introduction

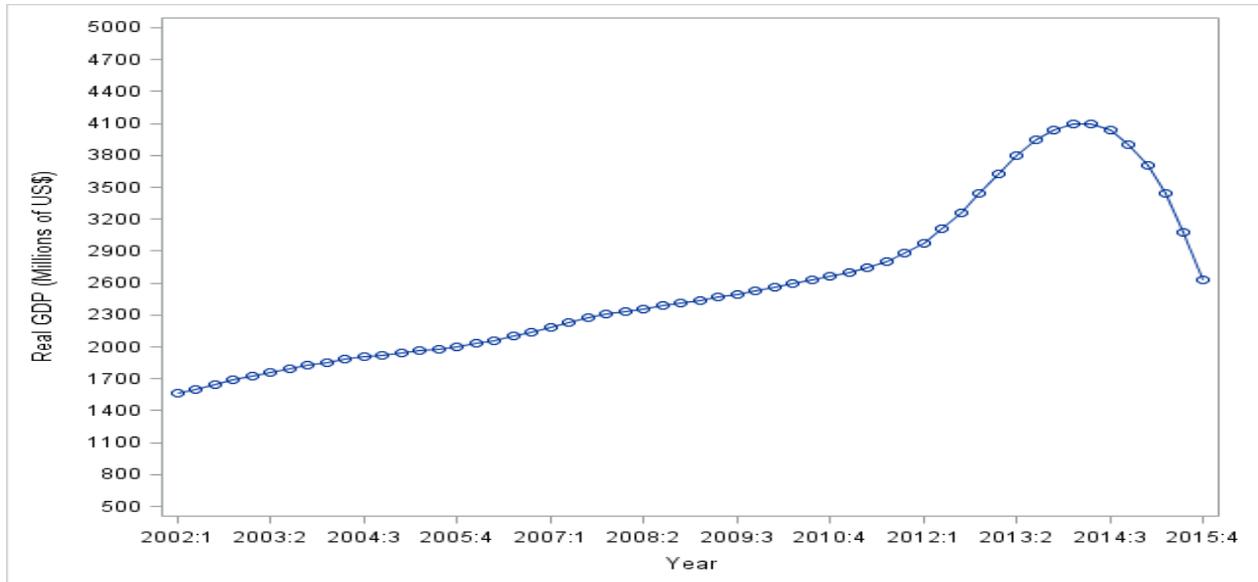
Economic growth is a major macroeconomic axiom; it is an essential concept in the expansion of a country's development, and has been a significant theme in many nations of the world. Arguably, while many western countries have realized progressive economic development since the 1960s, the same is untrue for several African nations. Since the 1960s, many African nations have only realized lackluster economic development and greater degree of severe insufficiency, even in the existence of mineral deposits productivity (Nsiah, Fayissa, & Wu, 2016). In addition, Nsiah et al. (2016) noted the motives behind this development

encompassed the internal policies espoused by the African nations, including macroeconomic concerns like inflation, and exchange rate instability, inter alia.

Academics, over the years, have applied distinct factors, including macroeconomic elements like interest rate, inflation, and exchange rate, among others, alongside the application of theoretical models in the determination of the economic growth of a country. Earlier theoretical models on the determinants of economic growth included the neoclassical growth model, with its foundation on the Solow (1956) growth model, and the endogenous growth theory, apparently developed by Romer (1986), for example. In the determinant of economic growth, the neoclassical theory, for instance, noted the significance of the rates of savings and investment in the short-run. Even with the seemingly endless journals on the determining elements of economic growth, including political permanence and domestic capital realization, Kagochi, Nasser, and Kebede (2013) argued many emerging nations, including Sub-Saharan Africa, have failed to recognize these elements. The reason for this seemed that, many of these nations' residents existed in insufficient survival stages (Neelankavil, Stevans, & Roman, 2012). Despite Sierra Leone is a Sub-Saharan African country, for example, its characteristics may be different from the subsistence levels postulated by Neelankavil, et al. (2012), especially in its post-conflict years of 2002 and beyond, in which it experienced an upsurge in economic growth.

Thus, Sierra Leone offers a contemporary case study because, after its internal war, which abates in the first quarter of 2002, the country experienced an expansion in economic activities. The World Bank (2016), for example, noted the gross domestic product (GDP) growth rate (a proxy for market growth) for Sierra Leone in 2010 was about 5.4%. This figure was about 20.5% in 2013 (World Bank, 2016). This essentially implies Sierra Leone's economy grew at about 14.9% between 2010 and 2013. Correspondingly, the World Bank (2016) reported the net inflows of foreign direct investment as a percentage of GDP into Sierra Leone in 2009 was 4.43%, but this value was upped 18.75% in 2012, an increase of about 14.32%. Similarly, the annual inflation rate for Sierra Leone was about 16.2% in 2011, but this figure was about 7.3% in 2014 (World Bank, 2016), a decrease of approximately 8.9% within a three-year period. It is obvious Sierra Leone experienced a post-conflict surge in economic growth, even as its population grew from approximately 4.87 million in 2004 to about 6.32 million in 2014 (World Bank, 2016), hence potentially increasing the size of its market for likely domestic and foreign investments. However, even with these increased economic activities, information is

Figure 1
Real GDP Trend in Post-Conflict Sierra Leone



Source: Author's computation.

imperfect in the current literature relating to the determinants of economic growth in post-conflict Sierra Leone, or the likely association between macroeconomic elements and economic growth in post-conflict Sierra Leone; and, whether this association is long-term or short-term. This offers the support to explore the theoretical and empirical foundations of the possible determinants of economic growth in Sierra Leone subsequent to the abatement of its internal conflict in 2002.

Now, Figure 1 on page 3 is a graph showing the trend-line of the real GDP in millions of US\$ for the post-conflict years in Sierra Leone. Consistent with the graph, the real GDP was approximately \$1647 million in the third quarter of 2003, a year following the conclusion of the country's internal conflict. Consequently, there was a progressive surge in the real GDP growth in the subsequent years, which peaked in the first quarter of 2014 at approximately \$4095 million. Notwithstanding the augmented trend in the real GDP, the growth weakened sharply to about \$2635 million in the fourth quarter of 2015 for reasons, which are beyond the current research objectives.

Given all this, the purpose of the current research is the empirical exploration of a few selective macroeconomic determinants of economic growth in post-conflict Sierra Leone, with the application of econometric models. Agalega and Antwi (2013), for example, researched the impact of macroeconomic variables on the gross domestic product of Ghana. Applying the multiple linear regression model on time series data for the period, 1980 to 2010, Agalega and Antwi found a positive and significant relationship between GDP and inflation rate, and that the GDP and inflation rate together performed or progressed in identical path. In addition, Agalega and Antwi realized an inverse association between GDP and interest rate, thus implying the GDP and interest rate both progressed in differing path. The implication here is that, an

increase in the interest rate reduces GDP expansion. The current research applied a macroeconomic approach similar to Agalega and Antwi's (2013) economic growth determinants, though the two studies differed in their research methodologies and the scope of investigation.

Concluding, Sierra Leone is obviously at an emerging phase of economic development following the upshots of its conflict, and is deficient in needed information on the post-conflict effect of macroeconomic variables on economic growth. This deficiency helped to reinforce the significance of an empirical study on the determinants of economic growth in post-conflict Sierra Leone. The research is noteworthy because it is anticipated to fill the existing gaps in economic growth determinants in post-conflict Sierra Leone, in addition to providing the leading prospect of exploring the upsurge of economic progression and its influencing macroeconomic elements of a Sub-Saharan specific-country, which has only just appeared from a distressing ten-year internal conflict. The results hold applied inferences for policy makers, administrations, and financiers, as well as adding a novel knowledge to the seemingly unending journals on economic growth.

2. Literature Review

Solow (1956) and, later, Romer (1986) earlier developed an interest in the determinants of economic growth. Solow (1956) was the pioneer of the neoclassical growth model (also called the Solow-Swan growth model). A practical analysis of the Solow-Swan model of economic growth appears to hypothesize an uninterrupted production utility connecting productivity to the inputs of capital and labor, which induces steady state stability of the economy. However, the steady state growth relied on technology advancement and population growth, which were both exogenous in the model and in the nonexistence of technological advancement, the growth of steady state *per capita* productivity was nonrealistic (Ghura & Hadjimichael, 1996). In addition, Ghura and Hadjimichael (1996) surmised a significant assumption in the neoclassical growth was that output stages of nations with comparable technologies ought to converge to an agreed stage in a steady state, but current research studies equally exposed the unrestricted convergence assumption was irregular with the empirical revelation.

Because of the inadequacy of the neoclassical theory, which relied on the exogenous technological progress, Romer (1986) developed the endogenous economic growth theory, in the effort to generate a long-run connection between growth and public policies. The endogenous growth model underscored technical development as the consequence of the degree of speculation, the scope of the capital accumulation, and the accumulation of human resources. There are several other postulated economic growth models after Romer's (1986) endogenous model, including the resource curse hypothesis, but there is barely any comprehensive agreement among the distinct growth models regarding the true determinants of economic growth in a country. This is because not two countries have the same characteristics, and a feature that may be effective in determining the economic growth of a country may be insignificant in the economic growth determinant of another country. Thus, there are several elements, including foreign direct investment (FDI), gross capital formation,

inflation, interest rate, and exchange rate, among others (Adeleke, Olowe, & Fasesin, 2014; Andraz & Rodrigues, 2010; Eregha, 2015; Lo, Lin, Chi, & Joseph, 2013; Rachidi & Saidi, 2011), featured in the current journals in determining the economic growth of a nation.

Lo et al. (2013), for example, acknowledged the part of FDI as a significant determinant of economic growth. The authors argued that FDI was a derivative of the neoclassical growth theoretical model and, thus, it was theoretically conceivable that FDI can enhance growth through the transportation of outward investment, cutting-edge technology, and improved administration in organizations in the host nation. Owing to its possible spillovers, FDI ought to wield compelling positive influence on growth, including augmenting the economic environment of the host nation (Lo et al., 2013). Li and Ng (2013), and Babatunde (2011) also acknowledged the role of FDI as a significant determinant of economic growth. In his research on trade openness, FDI, and growth in Sub-Saharan African countries, Babatunde (2011), for instance, realized FDI was positive and statistically significant in enhancing economic growth in the selected nations.

At the present, while FDI appears to be a significant economic growth determinant in some journals, Nsiah et al. (2016), alternatively found the effect of FDI on Sub-Saharan African economies as positive, but statistically insignificant. The reason for this, among others, was the recognition that, FDI inflows into Sub-Saharan Africa were largely focused on the mining and export of raw materials, progressing to negligible benefit to the national economy (Nsiah et al., 2016). Likewise, Leshoro (2014) realized a complete negative association between FDI and GDP in his vector autoregression model approach, to explore the impacts of foreign capitals inflow and savings on the economic growth of South Africa. Therefore, notwithstanding the comprehension of a rising sign of the influence of FDI on the economic growth of host nations, the review also showed no decisive agreement to this statement. This is because; supplementary studies have unveiled negative, or no association between FDI and economic growth in some host nations.

Equally, the gross capital formation has also become a noteworthy macroeconomic element applied in determining the economic growth of a country, and is ubiquitous in the current literature (Adeleke, 2014; Akram, Manzoor, Hassan, Farhan, & Alam, 2011; Freckleton, Wright, & Craigwell, 2012; Havi, Enu, Osei-Gyimah, Attah-Obeng, & Opoku, 2013; Javed, Nawaz, & Gondal, 2014). Eregha (2015) accentuated the importance of the gross capital formation as a determinant of economic growth in his research on FDI inflow, volatility, and domestic investment in West Africa. Applying the panel data model on the Economic Commission of West African States (ECOWAS), Eregha realized the real growth rate significantly and positively influenced the increase of domestic investment (gross capital formation) in the ECOWAS region. Correspondingly, Adekele (2014) also affirmed the significance of gross capital formation as a determinant of economic growth, in his research on FDI-growth nexus in Africa. Applying the panel data model on 31 Sub-Saharan African countries, Adekele found that gross capital formation was significant and positively associated with economic growth in all the three statistical techniques employed in the panel data model. Similarly, Javed et al. (2014), in their research on the volatility effect of macroeconomic variables on economic growth,

correspondingly found that gross capital formation had a positive association with GDP, with a statistically significant coefficient value of .084115.

Concerning the exchange rate as a supplementary determinant of economic growth of a country, Alemu and Lee (2015) had argued that, in theory, the devaluation of the national currency exchange rate against the US dollar ought to epitomize the prospect of advancing exports. Alemu and Lee surmised that devaluation and an exchange rate stability had a positive relationship with economic growth. The exchange rate has also been a noteworthy macroeconomic element in some empirical studies on the determinants of economic growth of a country (Adeleke, 2014; Javed et al., 2014; Kogid, Asid, Lily, Mulok, & Loganathan, 2012; Kunle, Olowe, & Oluwafolakemi, 2014). Kogid et al. (2012), for example, had maintained that international exchange rates were an essential gauge of the inclusive condition of the economy. Applying the autoregressive distributed lag model in their research on the effects of the exchange rates on Malaysia's economic growth, Kogid et al. found the nominal and real exchange rates had positive long-run impacts on growth, even when the nominal exchange rate impact was insignificant. Meanwhile, Adeleke (2014) recognized in his research on FDI-growth nexus in Africa that, the exchange rate was negatively associated with economic growth, and this was especially significant since currency devaluation inclined to stimulate growth. Adeleke's (2014) findings were consistent with Alemu and Lee's (2015) argument that, devaluation of the national currency exchange rate against the US dollar encouraged the possibility of improved exports. Javed et al. (2014) equally realized exchange rate had a negative effect on economic growth, in their research on the effect of macroeconomic elements on the economic growth of Pakistan, though this effect was insignificant. Thus, exchange rate seems to hold varied results in its effect on the economic growth of a country in the current literature.

Inflation has similarly been a significant macroeconomic element often applied in empirical investigations to determine the economic growth of a country (Agalega & Antwi 2013; Ajide & Lawanson, 2012; Akram et al., 2011; Anyanwu, 2014; Babatunde, 2011; Mbulawa, 2015; Ngongang, 2015; Odhiambo, 2013). Akram et al. (2011), for instance, noted the importance of the macroeconomic element of inflation in economic growth determinant, and reasoned that more inflation exemplified an extraordinary degree of concern related to the economy. As such, inflation appears to determine the stability of the economy of a country. Therefore, in the current literature, the association between economic growth and inflation appears to be negative (Akram et al., 2011). This view is consistent with Anyanwu's (2014) postulation when he noted inflation was a determinant of economic growth since it assessed price instability, including the superiority of fiscal and monetary strategies and, therefore, macroeconomic stability. However, Odhiambo (2013) posited it was the instability of the inflation rate rather than the degree of inflation, which negatively influenced growth. Even so, Odhiambo (2013) alternatively noted other academics had argued there was a point under which a modest upsurge in inflation rate essentially stimulated growth, but beyond which additional surges in the inflation rate truly hindered economic growth.

Akram et al. (2011), however, realized inflation had a negative relationship with economic growth, in their research on the determinants of economic growth in the Southern

Asian Association for Regional Corporation (SAARC) countries. Other academics have similarly recognized the negative and significant association between inflation and economic growth (Adeleke, 2014; Ristanović, 2010; Saqib, Masnoon, & Rafique, 2013). In the interim, Agalega and Antwi (2013), in their research on the impact of macroeconomic elements on the gross domestic product of Ghana found inflation and GDP were positively associated, though this association was insignificant. Babatunde (2011) similarly recognized a positive but insignificant association between inflation and economic growth in his research on trade openness, FDI, and growth in Sub-Saharan African countries. The review seems to acknowledge the realization that, the effect of inflation on economic growth appears mixed in the current literature.

Arguably also, trade openness has been one of the primary stimulating macroeconomic elements, regularly applied in empirical investigations on economic growth (Hamad, Mtengwa, & Babiker, 2014; Idris, Yusop, & Habibullah, 2016; Ismaila & Imoughele, 2015; Kakar & Khilji, 2011; Majeed, 2010; Nowbutsing, 2014; Razmi & Refaei, 2013; Yusoff & Nuh, 2015; Zeren & Ari, 2013). Regarding the significance of trade openness, Idris et al. (2016), for instance, argued that, several nations had unlocked their economies for the reason of economic expansion and development. The authors furthered that in recent past, growth in global trade had risen to about 6% annually. Hamad et al. (2014) also added the objective of every single nation was to augment economic growth, and thus nations got onboard prevalent economic policies, which permitted a decrease and elimination of trade barriers, including tariffs, quotas, and import regulations, inter alia. Razmi and Refaei (2013) appeared to reaffirm the significance of trade openness on economic growth by noting the relevance of international trade. Razmi and Refaei posited that, international trades were hugely beneficial to the residents and organizations of a nation, and by focusing in the production of goods and services, progressed to a complete expansion of welfare, which correspondingly caused production and allocation efficacy. The implication of all this seems to give the appearance that an open economy realizes an advanced economic growth rate in comparison to a closed economy (i.e., no admittance to open trade).

Other academics similarly recognized that trade openness had a positive and significant relationship with economic growth in their research findings (Idris et al., 2016; Nowbutsing, 2014; Razmi & Refaei, 2013; Yusoff & Nuh, 2015; Zeren & Ari, 2013). Notwithstanding the argument for trade openness, Nowbutsing (2014), for example, argued that even when free trade advanced to several gains, nations were hardly equipped to permit a comprehensive free trade. This is because many nations espoused protectionism procedures like tariffs barriers and non-tariff barriers for dissimilar motives (Nowbutsing, 2014), which may obstruct economic growth. Yusoff and Nuh (2015) had similarly researched FDI, trade openness, and economic growth in Thailand and recognized that trade openness, among others, had a long-run association with economic growth. Supplementary research findings, have, however, recognized negative or positive but weak associations between trade openness and economic growth (Bibi, Ahmad, & Rashid, 2014; Eris & Ulasan, 2013). Eris and Ulasan (2013) even acknowledged the realization that, contrary to previous cross-state growth research studies, his findings did not support the principle that trade openness had a strong and direct association with economic growth in the long-term.

The role of human capital in determining the economic growth of a country is also noteworthy, even if variation exists in the type of human capital applied in the determinant of growth (Adeleke, 2014; Alemu & Lee, 2015; Ali, Ali, & Amin, 2013; Dao, 2012; Guga, Alikaj, & Zeneli, 2015; Sethy & Sahoo, 2015; Tchereni & Sekhampu, 2013; Thuku, Paul, & Almadi, 2013; Wako, 2012). Alemu and Lee (2015), for example, noted that the endogenous theory regarded human capital as the primary determinant of economic growth. The authors argued that, preceding the second half of the 1990s, the performance of human capital had a relationship with education, even though some academics had already realized the significance of supplementary factors like health. Freckleton et al. (2012) similarly applied secondary school enrolment as a proxy for human capital in their research on economic growth, FDI, and corruption in developed and developing countries.

Tchereni and Sekhampu (2013), alternatively, regarded the human capital of population growth rate as an efficient determinant of economic growth, and superior population growth rates inferred augmented consumption market, which may boost production. Equally, Guga et al. (2015) were concerned about the human capital of total population growth rate, among others, and its effect on the economic growth of Albania. The authors contended that human capital progression and economic growth were associated and, that economic growth shaped the circumstances for human growth, and human development created openings for economic growth. Therefore, applying the log-log regression model on the time series data for the period, 1990 to 2014, Guga et al. (2015) found that the total population growth rate, among others, had a positive and significant effect on the economic growth of Albania. Ali et al. (2013) also realized population growth had a long-run positive effect on economic growth, in their research on population growth and economic development in Pakistan, even though the short-term effect of population growth on economic growth was negative. Alternatively, other academics have realized a negative association between population growth and the economic growth of a country (Dao, 2012; Wako, 2012). Dao (2012), for example, realized a negative association between population growth (human capital) and economic growth, in his research on population and economic growth in developing nations. Concluding, the significance of population as a proxy of human capital in determining the economic development of a country likewise appears mixed in this review.

Meanwhile, the use of interest rate in empirical studies, to determine the economic growth of a country is ubiquitous in the current literature (Agalega & Antwi, 2013; Akiri & Adofu, 2007; Balassa 1989; Ghatak, 1997; Imoisi, Chika, & Moses, 2012; Koka, Bozdo, & Çuçi; 2013; Mashamba, Magweva, & Gumbo, 2014; Obamuyi, 2009; Ristanović, 2010; Saymey & Orabi, 2013; Waty, 2014). Imoisi et al. (2012), for example, had argued that the real interest rate was a significant determining factor of the savings and speculation comportment of family unit and businesses and, therefore, of strategic significance regarding cyclical change and long-term economic development. Agalega and Antwi (2013) also explored the influence of macroeconomic variables, including interest rates, inflation, and exchange rates on Ghana's GDP. Applying the linear regression model, Agalega and Antwi found that the interest rate had a negative effect on Ghana's GDP. This essentially implies a growth in the interest rate would decrease the GDP. Saymeh and Orabi (2013) also applied the regression and cointegration

models, in their research on the effect of interest rate, and others, on the economic growth of Jordan, and recognized that interest rate had a negative influence on economic growth. Saymeh and Orabi's (2013) findings were consistent with the additional findings on interest rate and economic growth by some academics (Agalega & Antwi, 2013; Ristanović, 2010; Waty, 2014). However, in his research on the influence of bank savings and bank credits on Nigerian economy, Anthony (2012) noted the interest rate spread had a positive and statistically significant relationship with economic growth, which is inconsistent with the findings of Waty (2014), for example.

3. Methodology

The methodology for the current research is quantitative design and the data are secondary time series. The methodology is inclusive of a few model specifications, and model estimation.

3.1. Model Specification: The current research assumes the macroeconomic variables of FDI, gross capital formation, exchange rate, inflation, trade openness, human capital, and interest rate significantly affect the economic growth of post-conflict Sierra Leone. Thus, given the macroeconomic determinants of economic growth, hypothesizing a growth model generates the following formula:

$$GDPgrowth = f(FDI, GCF, INF, INT, EXR, POP, TOP)$$

where the *GDPgrowth* (GDP growth - proxy for economic growth) is a function of *FDI* = Foreign Direct Investment; *GCF* = Gross Capital Formation; *INF* = Inflation; *INT* = Interest Rate; *EXR* = Exchange Rate; *POP* = Human Capital; and, *TOP* = Trade Openness.

The leading econometric model is a log-log (Guga et al., 2015; Wooldridge, 2013) autoregression, to determine the relationship between economic growth and the selected macroeconomic variables. The log stochastic autoregression equation appears as:

$$LGDPgrowth_t = \alpha_0 + \alpha_1 LGDPgrowth_{t-1} + \alpha_2 LGDPgrowth_{t-2} + \dots + \alpha_q yt-q + et \quad (1)$$

where

L = natural logarithm; *LGDPgrowth_t* = the log of *GDPgrowth_t*; α_0 = a constant; $\alpha_1 LGDPgrowth_{t-1}$ = one lag values of log *GDPgrowth*; $\alpha_2 LGDPgrowth_{t-2}$ = two lag values of log *GDPgrowth*; $\alpha_q yt-q$ = the rest of the predictors and their lag values; *et* = the error term, projected as independent and identically dispersed.

The model is a multiple regression but with lagged values of *LGDPgrowth_t* as predictors. The addition of the subscript *t* to the variables is to stipulate they are time series data. Furthermore, the addition of the multiple lagged values of *LGDPgrowth_t* as predictors is to decide how associated is the GDP growth at time *t* to its previous values. Converting all the elements utilized in the current research into natural logarithm is noteworthy, since it diminished the series of its values, thereby allowing the regression approximations to be less vulnerable to outliers (Wooldridge, 2013). Correspondingly, the *a priori* expectation of the coefficient estimate for the individual variables in the model includes the following:

$$\alpha_{FDI} > 0, \alpha_{GCF} > 0, \alpha_{INF} < 0, \alpha_{INT} < 0, \alpha_{EXR} > 0, \alpha_{POP} > 0, \alpha_{TOP} > 0$$

In addition to the determination of a relationship between economic growth and the selected macroeconomic variables, is the notion of a possible long-run relationship between economic growth and the macroeconomic elements under review. Thus, the model specification for determining the long-run relationship among the variables of interest is the Phillips-Ouliaris cointegration model (Larbi, 2013; Shin, 1994), which has similarities with the Engle-Granger cointegration model (Ahmed & Pulok, 2013; Wooldridge, 2013). The cointegration analysis indicates estimating the econometric equation:

$$\Delta LGDPgrowth_t = \alpha_0 + \alpha_1 \Delta LFDI_{t-1} + \alpha_2 \Delta LGCF_{t-2} + \dots + \alpha_q \Delta yt-q + et \quad (2)$$

where

$\Delta LGDPgrowth_t$ = changes in the log of $GDPgrowth$ at time t ; α_0 = a constant; $\Delta LFDI_{t-1}$ = changes in the log of $FDIgrowth$ at time t ; $\alpha_q \Delta yt-q$ = changes in the rest of the predictors in logarithms at t times; et = error term. The *a priori* expectation of the cointegration test discloses a long-term relationship between GDP growth and the macroeconomic determinants.

In addition, consistent with the Phillips-Ouliaris, and Engle-Granger cointegration models, when variables are cointegrated, there ought to be an error correction model (ECM) that outline the short-run concealed impulses or adjustments of the cointegrated variables toward the path of their equilibrium values (Akhtar, Khan, & Hussain, 2013). Therefore, drawing from Wooldridge (2013), the model specification is a simple error correction model, and is applicable to determine the short-run association between GDP growth and its determinants:

$$\begin{aligned} \Delta w_t &= \beta_0 + \beta_1 \Delta w_{t-1} + \lambda_0 \Delta z_t + \lambda_1 \Delta z_{t-1} + \vartheta v_{t-1} + \varepsilon \\ &= \beta_0 + \beta_1 \Delta w_{t-1} + \lambda_0 \Delta z_t + \lambda_1 \Delta z_{t-1} + \vartheta(w_{t-1} - \beta z_{t-1}) + \varepsilon_t \end{aligned} \quad (3)$$

where $E(\varepsilon_t | I_{t-1}) = 0$, and I_{t-1} have numbers on Δz_t and all preceding statistics of z and w . Furthermore, $\vartheta(w_{t-1} - \beta z_{t-1})$ is the error correction term, and is merely an example of an error correction model. The *a priori* expectation of the error correction model discloses a short-run association between GDP growth and its determinants.

3.2. Model Estimation. The applicable model in the current research is the autoregression model. The application of the autoregression model is significant because of the nature of time series data, which often convey the presence of serial correlation within the series. The autoregression model seems to solve the serial correlation complication by complementing the regression design with an autoregressive structure for the random error, thus explaining for the autocorrelation of the errors (Peiris, 2014; SAS, 2016). Additionally, because of the characteristic nature of time series, it is essential to examine the stationarity of the data by applying the Augmented Dickey Fuller (ADF), and the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) tests for unit root (Eita, 2012; Kwiatkowski, Phillips, Schmidt, & Shin, 1992; Silvia, Iqbal, Bullard, Watt, & Swankoski, 2014; Woolridge, 2013) on each variable before applying Equation (2). The regression result may, perhaps, be spurious in the probable occurrence the time-series are non-stationary (Akhtar et al., 2013). Differencing the data will correct this issue.

Thus, drawing from Wooldridge (2013), the general ADF formula appears to represent the following equation:

$$\Delta w_t = \alpha_0 + \vartheta w_{t-1} + \lambda_1 \Delta w_{t-1} + \varepsilon_t \tag{4}$$

where w = a time series; t = a time trend; Δ = a first difference operative; α_0 = a constant; ε_t = an error term; and, $|\lambda_1| < 1$. Following Wooldridge’s (2013) argument, given this format, the null hypothesis, $H_0: \vartheta = 0$, $\{\Delta w_t\}$ appears to trail a steady AR(1) model, while in the alternative hypothesis, $H_1: \vartheta < 0$, seems to indicate that $\{w_t\}$ tails a steady AR(2) model. To explain the undercurrents in the unit root procedure, the addition of q lags of Δw_t in Equation (4) is an option, and this comprehensive form of the Dickey-Fuller test is the ADF, since the lagged modifications were augmented with the regression (Wooldridge, 2013), Δw_{t-q} .

The inclusion of the KPSS unit root test, to supplement the ADF test, is to confirm the accuracy of the ADF test, because both tests hold distinct null hypotheses. Silvia et al. (2014) similarly affirmed that the KPSS differed from the ADF because its null hypothesis emphasized no unit root (stationary), while its alternative hypothesis underscored unit root (nonstationary). Taking directly from Silvia et al. (2014), the KPSS unit root test has two forms of statistics:

1. The foundation of the statistic rests on the residual from the regression of y_t on the exogenous elements x_t' :

$$y_t = x_t' \delta + \varepsilon_t \tag{5}$$

where

x_t' = possible exogenous elements, which may comprise a constant, or a constant and a trend, and δ parameters selected for assessment
 ε_t = the error term, which is a white noise

2. It also has a Lagrange Multiplier (LM) statistic described as:

$$LM = \sum_{t=1}^T S_t^2 / (T^2 f_0)$$

where

$S(t)$ = a collective residual utility; and, f_0 = a rule of the residual range at zero rate of recurrence. The application of the KPSS is to help confirm the accuracy of the ADF unit root test.

4. Data

The selected data for the current research are annual time series on the preferred variables, to determine the economic growth of post-conflict Sierra Leone. The data include the gross domestic product growth rate, the inward movement of foreign direct investment stock, gross capital formation, exchange rate, inflation, trade openness, human capital, and interest rate. The data analysis is for the period, 2002 to 2013. The period appears significant in determining the economic growth in the post-conflict years of Sierra Leone.

The data sources for the research include the World Development Indicators (WDI) of the World Bank, and the United Nations Conference on Trade and Development (UNCTAD). The UNCTAD is the source for the foreign direct investment (FDI), inflation rate, and the exchange rate variables. The crucial operationalized variable under the FDI is the net inward FDI stock in millions of current US dollars, transformed into real FDI inflow through dividing FDI

by the host nation's consumer price index (CPI, 2005 = 100), after the model of Li, Liu, and Jiang (2015). The inward stock data gradually shelters the formation of flows in the host nation-state, and are less unbalanced than flows (Gwenhamo, 2011; Júlio, Pinheiro-Alves, & Tavares, 2013; Kerner & Lawrence, 2014). FDI is one of the determinants of economic growth in the current research. The applicable inflation rate (INF) determinant in the research is the country's average consumer price index (2005 index based), following a similar concept by Adeleke (2014). The exchange rate (EXR) determinant is the country's real effective exchange rate, with the application of the 2005 CPI based index, following a similar concept by Kogid et al. (2012). The World Bank (2016) described the real effective exchange rate as the nominal effective exchange rate divided by a price deflator or consumer price index.

The WDI of the World Bank is the data source for the macroeconomic variables of gross domestic product growth rate (GDP growth), gross capital formation, trade openness, human capital, and interest rate. The GDP growth is the real annual GDP growth rate, and serves as a proxy for economic growth. The utilization of the GDP growth is essential, to capture real growth (Javed et al., 2014; Musonera, Nyamulinda, & Karuranga, 2010). The gross capital formation (GCF) utilized in the current research is the gross capital formation as a percentage of GDP, following a similar application by Adeleke (2014). The applicable trade openness (TOP) variable is a measurement of the sum of the export of goods and services (constant 2010 US\$) and the import of goods and services (constant 2010 US\$) as a proportion of GDP at market prices (constant US\$), following a similar concept by Nsiah et al. (2016). Due to the unavailability of adequate data on secondary and primary school enrollment in Sierra Leone, the use of the country's annual average growth rate of the total population becomes the proxy for the human capital (POP) element in the current research. Obviously, Guga et al. (2015) had previously realized the significance of population growth in economic development, when they noted a population upsurge signified an augmented participation of the labor force. The real interest rate (INT) is the macroeconomic variable applied in the current research, following similar applications by Obamuyi (2009), Imoisi et al. (2012), and Inam and Umabong (2015). The real interest rate is the nominal interest rate adjustment for inflation. Since the original variables in the dataset are low frequency annual time series, converting them into high frequency quarterly time series is important, to undertake condensed and supplementary detailed short-range analyses (Pavia-Miralles, 2010), and policy assessment in the present research.

5. Results

The results of the current research included a preliminary descriptive analysis (e.g. mean, maximum, minimum, etc.), to disclose any possible disparity and dispersion among the variables of interest. Table 1 is the summary descriptive statistics of the entire variables of interest in their level forms, and is self-explanatory. From Table 1, the mean for FDI inflow (FDI) ($M = 4.51$, $SD = 1.68$), for example, appeared reduced than the mean for GDP growth (GDPgrowth) ($M = 9.77$, $SD = 7.41$). Table 2 is equally the descriptive statistic results of the

Table 1

Summary of Macroeconomic Growth Variables in their Level Forms

Variable	N	Mean	Maximum	Minimum	SD
GDPgrowth	48	9.77	38.56	4.011	7.41
FDI	48	4.51	8.15	1.95	1.68
GCF	48	16.52	42.76	6.74	10.61
INF	48	130.95	270.56	73.15	60.79
INT	48	10.82	46.33	1.064	7.63
EXR	48	101.36	149.88	68.66	20.95
POP	48	3.18	4.998	2.22	1.081
TOP	48	.57	1.33	.32	.25

variables of interest in the current research, after transformation of the variables into logarithms, to help balance the variances of the series (Lütkepohl & Xu, 2012). Therefore, The mean for the log of the real interest rate (LINT) ($M = 2.16, SD = .72$), for example, was easily comparable to the mean for the log of the gross capital formation (LGCF) ($M = 2.65, SD = .52$), in part because both variables had a similar logarithm-measuring element. In addition, the preliminary data exploration also helped resolve the regression issues on random selection, normal distribution, linearity, and multicollinearity of the data. The data were time series and Table 2

Summary of Macroeconomic Growth Variables in their Logarithm Forms

Variable	N	Mean	Maximum	Minimum	SD	SE	Skewness	Kurtosis
LGDPgrowt	4	2.079	3.65	1.39	.59	.086	.96	-.13
h	8	1.44	2.098	.67	.37	.053	.076	-.56
LFDI	4	2.65	3.76	1.91	.52	.075	1.026	-.21
LGCF	8	4.79	5.60	4.29	.41	.059	.76	-.78
LINF	4	2.16	3.84	.062	.72	.10	-.80	1.58
LINT	8	4.60	5.01	4.23	.20	.030	.068	-.56
LEXR	4	1.10	1.61	.80	.32	.047	.49	-1.53
LPOP	8	-.64	.28	-1.13	.37	.053	1.12	.036
LTOP	4							
	8							
	4							
	8							
	4							
	8							
	4							
	8							

trailed the stochastic procedure of randomly chosen (Wooldridge, 2013), thus fulfilling the subject of the random selection of the data.

The values of the skewness and kurtoses in Table 2 for the totality of the variables of interest were also inside the established range of +/-2 largely considered as normal distribution (George & Mallery, 2016; Gravetter & Wallnau, 2014; Lomax & Hahs-Vaughn, 2012). In addition, based on the expected presence of serial correlation in time series, the autoregression model was the appropriate technique in the current research, which augmented the regression procedure with an autoregressive procedure for the random error, thus making an allowance for the autocorrelation of the errors (Larbi, 2013; SAS, 2016). Therefore, the ultimate model applied in Equation (1) was the autoregression maximum likelihood (ML) estimation method with two lags $AR(2)$ of the parameters, which resolved any concerns of autocorrelation, and the confirmation of the homogeneity of the variances of the variables of interest:

$$LGDPgrowth_t = \alpha_0 + \alpha_1 LGDPgrowth_{t-1} + \alpha_2 LGDPgrowth_{t-2} + \dots + \alpha_q y_{t-q} + et \quad (1)$$

Where α_0 was a constant and et was a white noise. The model mirrored a multiple regression though with lagged values of $LGDPgrowth_t$ as predictors. Table 3 is the results of the $AR(2)$ model. The bottom-half of the table showed the autoreg procedure after autocorrelation improvement, and had many ML estimations ($SSE = .054$, $MSE = .001$, $Root\ MSE = .038$, $SBC = -144.39$, $AIC = -163.10$, $Reg.\ R^2 = .871$, $Tot.\ R^2 = .997$, $DW = 2.3$), which were noteworthy in the determination of the goodness-of-fit of the model. For example, SSE is the sum of square error, and MSE is the mean square error. The $Root\ MSE$ indicated the mean deviation of the

Table 3

Parameter estimates of the AR(2) Model

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > t
Intercept	1	-1.7435	1.5384	-1.13	.2642
LFDI	1	.6796	.1410	4.82	<.0001
LGCF	1	.3038	.1321	2.30	.0270
LINF	1	-2.9007	.5324	-5.45	<.0001
LINT	1	.2749	.0445	6.18	<.0001
LEXR	1	4.0280	.4724	8.53	<.0001
LPOP	1	-2.2096	.4343	-5.09	<.0001
LTOP	1	1.1610	.2319	5.01	<.0001
AR1	1	-1.7642	.0460	-38.37	<.0001
AR2	1	.9602	.0435	22.08	<.0001
SSE		.054			
MSE		.001			
Root MSE		.038			
SBC		-144.39			
AIC		-163.10			
MAE		.026			
MAPE		1.278			
Reg. R-square		.871			
Tot. R-square		.997			
Durbin-Watson		2.30			

evaluated GDP growth from the tangible GDP growth (response variables). In addition, the *Regress R²* (*Reg. R² = .972*) specified the converted *R²*, a valuation of adequacy of the fundamental portion of the design after conversion for the autocorrelation. The computation of the *Total R²* (*Tot. R² = .994*) was from the autoregressive model residuals, which mirrored the enhanced fit from the usage of previous residual, to support the forecast of the ensuing GDP growth value. In the table, the *Total R²* and the *Regression R²* had distinct values, which is a signal of autocorrelation adjustment. Also, the *Durbin-Watson* (*DW = 2.3*) autocorrelation result indicated the absence of autocorrelation. This is consistent with the arguments of Sangi, Win, Shirvani, Namazi-Rad, and Shukla (2015), and Haery, Bahrami, and Haery (2013). Prusty, (2010) had similarly argued *DW* statistics between the values of 1.5 and 2.5 practically connoted no autocorrelation. In total, the *AR(2)* model was the best-fit design for the current research.

The upper-half of Table 3 is the coefficient estimates. The realized results were from the combined evaluation of *AR* and regression parameters. The results indicated the statistical

significance of the predictors in their association with GDP growth (response variable). As expected, the *AR*(2) statistics were also significant in the model. It thus seemed from Table 3 that, all the predictors, excluding the intercept, were statistically significant at the 5% level, and had relationships with GDP growth and, in combination, can forecast economic growth in post-conflict Sierra Leone. In addition, in Table 3, FDI inflow (LFDI), for instance, had a positive association with economic growth (LGDPgrowth), and the association was statistically significant ($\beta_{LFDI} = .6796$, $df = 1$, $se = .141$, $t = 4.82$, $p < .0001$). This principally indicated a 1% increase in the inward movement of FDI resulted in approximately .68% upsurge in economic growth, implying FDI was a good predictor of economic growth. Similarly, gross capital formation (LGCF) had a positive and statistically significant relationship with GDP growth (LGDPgrowth) ($\beta_{LGCF} = .3038$, $df = 1$, $se = .132$, $t = 2.30$, $p = .027$). This implied a 1% upsurge in gross capital formation caused an increase of around .31% economic growth in Sierra Leone. However, inflation (LINF) appeared to hold a negative relationship with economic growth ($\beta_{LINF} = -2.901$, $df = 1$, $se = .532$, $t = -5.45$, $p < .0001$). The implication here is that, a 1% increase in the inflation rate of the country resulted in approximately 2.9% reduction in economic growth. This is also true of the population growth rate variable (LPOP – proxy for human capital), which had a negative effect on economic growth ($\beta_{LPOP} = -2.2096$, $df = 1$, $se = .434$, $t = -5.09$, $p < .0001$). Meanwhile, the supplementary macroeconomic variables, including real interest rate (LINT), real exchange rate (LEXR), and trade openness (LTOP), altogether had positive and statistically significant associations with the economic growth variable (LGDPgrowth). In totality, the macroeconomic variables applied in the current research had relationships with economic growth and significantly influenced growth in post-conflict Sierra Leone.

Since the results exhibited a relationship between economic growth and its determinants, the ensuing segment is the determination of whether the relationship is a long-term association. However, prior to the determination of a long-term relationship, the selected variables would have to be examined for unit roots, that is, whether the variables are stationary. If variables have unit roots, or appears at the level form of $I(1)$, it suggests the application of the cointegration models in place of the ordinary least square method (Silvia et al., 2014). Thus, the use of the Augmented Dickey-Fuller (ADF), and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests were important, to test for stationarity. There was a preliminary differencing of the variables in their level forms, to solve the problem of unit root, and the ADF unit root test, for example, assumed the following formula:

$$\Delta m_t = \beta + \vartheta m_{t-1} + \gamma_1 \Delta m_{t-1} + e_t$$

where the time series was m , the trend line was t , the first difference operator was Δ , the constant was β , and the random error term was e_t . Table 4 is the ADF and KPSS unit root results for the individual variables in the current research after first difference, to establish their stationarities. In Table 4, the ADF results included the *Rho* and *Tau* columns, which presented the Ordinary Least Square t -values, and the corresponding $Pr < Rho$ and $Pr < Tau$ columns presented the probabilities related to these t -values (Silvia et al., 2014). The *Rho* and *Tau* and their associated probability levels presented the results used to reject or not to reject the existence of a unit root in the distinct variables of interest. The null hypothesis for the ADF

infers the existence of a unit root (nonstationary), while the alternate hypothesis specifies no unit root (stationary). The rejection level for the null hypothesis for the ADF test was at $p < .05$ (Silvia et al., 2014). Concurrently, Table 4 also displays the KPSS results for the stationarity test. The *Eta* was the coefficient estimate for each variable under consideration and its related probability level ($Pr > Eta$) applied to reject the null hypothesis. Distinct from the ADF, the KPSS null hypothesis for the unit root test suggests the variable is stationary (non-unit root). A rejection of the null hypothesis is a signal the variable is not stationary (has unit root).

All the parameters of interest in Table 4 were in their first difference. Per the table, the ADF unit root test for the GDP growth variable (DGDPgrowth), for example, was statistically

Table 4

ADF, and KPSS Unit Root (Stationarity) Test

Parameter	ADF				KPSS	
	Rho	Pr < Rho	Tau	Pr < Tau	Eta	Pr > Eta
DGDPgrowth	-20.406	.005	2.629	.095	.425	.062
DFDI	74.528	.9999	5.122	.0002	.073	.733
DGCF	696.604	.9999	3.670	.008	.085	.662
DINF	-24.732	.001	1.790	.381	.152	.383
DEXR	589.430	.9999	6.903	.0001	.242	.1997
DINT	-66.765	.0003	3.903	.004	.208	.253
DPOP	-6.237	.079	2.075	.038	.1497	.391
DTOP	-6.994	.062	2.135	.033	.232	.214

significant for the *Rho* test ($Rho = -20.406, p = .005$) but not for the *Tau* test ($Tau = -2.629, p = .095$). However, the KPSS unit root test result ($Eta = .425, p = .062$) of no unit root in the GDP growth had similarities with the *Rho* test result ($Rho = -20.406, p = .005$) in rejecting the null hypothesis of the presence of a unit root in the GDP growth variable. Thus, the GDP growth variable in first difference (DGDPgrowth) was stationary. In addition, the remaining variables of interest in Table 4 individually showed the absence of a unit root in first difference with the joint utilization of the ADF and KPSS unit root tests. Altogether, the entire variables in Table 4 seemed stationary at the 5% level of significance after first difference and, hence, helped endorse the assumption of the nonexistence of a unit root in the current data after first difference. Because the entire variables were at the level $I(1)$ after first difference, the

cointegration methodology was apposite in determining the long-run association between GDP growth and its determinants.

The ensuing phase is the analysis of the long-run causal association among the variables, utilizing the Phillips-Ouliaris (PO) cointegration test. The long-run association is a cointegration assessment, and the null hypothesis for the PO cointegration test is that, there is no cointegrating association between GDP growth and its determinants. The alternate hypothesis indicates that there is at least one cointegrating association between GDP growth and its determinants. It is also noteworthy to indicate the preliminary analysis for unit root exposed trending with time on some of the variables of interest in their level forms. First differencing the variables helped perfect the unit root and detrended the data, since the stringent method of cointegration entails that there not be a trend (Wooldridge, 2013). Moreover, the addition of the maximum of two lags on the autoregression model appeared significant, which is consistent with the Akaike Information Criterion (AIC) recommending two lags model (Goh & Wong, 2011). Tables 5 and 6 reveal the PO cointegration test results, applying the autoregression model with two lags. In Table 5, the *Rho* statistical *p*-value for the PO cointegration test was -16.4562, and the *Tau* statistical *p*-value was -3.2403. Comparing these values to the PO cointegration test standard critical values ($p = .05$) available in Falk et al. (2012), the *Rho* (-16.456), and *Tau* (-3.240) statistics in Table 5 were below the test standard critical values for the *Rho* (-15.64), and *Tau* (-2.76) statistics at the 5% probability level. Thus,

Table 5
Phillips-Ouliaris Cointegration Test

<i>Rho</i>	<i>Tau</i>
-16.456	-3.240

the rejection of the null hypothesis of no cointegration association between GDP growth and its determinants was comprehensive for both the *Rho* and *Tau* test statistics, indicating that, at least, one determinant had a long-term (cointegration) relationship with GDP growth.

Table 6 includes the parameter estimations and the *t*-values of the individual variables in the PO cointegration procedure, together with its ordinary least square regression estimations. The long-run parameter estimates of the PO cointegration test in their first difference encompassed the upper portion of Table 6. In the table, FDI (DFDI), for example, had a positive long-run association with GDP growth, which was significant ($\beta_{DFDI} = .5145, SE = .0516, t = 2.91, p < .0001$). Principally, holding all other variables constant, a one-unit increase in FDI inflow caused about .54% upsurge in economic growth in post-conflict Sierra Leone in the long-term, for the extent of the sampled period. Equally, inflation (DINF), for example, had a negative long-run association with GDP growth, which was significant ($\beta_{DINF} = -3.6982, SE = .9023, t = 5.50, p = .0002$). Principally, holding the other elements in the model constant, a one-unit increase in inflation caused about -3.70% decline in the economic growth of post-conflict

Sierra Leone in the long-term, for the sampled period under review. Similarly, in Table 6, trade openness (DTOP) had a negative long-run association with GDP growth, but the association was insignificant ($\beta_{DTOP} = -.9272, SE = .5106, t = -1.82, p = .077$). In addition, the gross capital formation (DGCF), including the real interest rate (DINT) and the real exchange rate (DEXR) all had positive and significant long-run relationships with GDP growth for the period under review. However, even when the total population (DPOP) had a positive long-run association with GDP growth, this relationship was insignificant ($\beta_{DPOP} = 1.8558, SE = 1.1304, t = 1.64, p = .1087$). All embracing, the PO cointegration tests specified the existence of a long-run equilibrium association between GDP growth and at least one determinant applied in the current research.

Nevertheless, time series infrequently deviate from this long-term relationship to short-run dynamics. Thus, the ensuing purpose is to explore whether the diversion from the long-term association is statistically important, inter alia. Consequently, the Error Correction Model (ECM) was apposite, to determine the possible short-run dynamics, given the *p*-value for the null hypothesis at .05. Table 7 displays the outcome of the ECM test. The upper section of the

Table 6
The Phillips-Ouliaris Cointegration Coefficient Result Estimates

<i>Parameter Estimates</i>					
<i>Variable</i>	<i>DF</i>	<i>Estimate</i>	<i>SE</i>	<i>t Value</i>	<i>Approx Pr > t </i>
Intercept	1	.1503	.0516	2.91	.0059
DFDI	1	.5145	.0935	5.50	<.0001
DGCF	1	.4181	.1367	3.06	.0040
DINF	1	-3.6982	.9023	-4.10	.0002
DINT	1	.4077	.0501	8.13	<.0001
DEXR	1	4.1829	.6892	6.07	<.0001
DPOP	1	1.8558	1.1304	1.64	.1087
DTOP	1	-.9272	.5106	-1.82	.0771
SSE		.210			
MSE		.005			
Root MSE		.073			
SBC		-90.053			
AIC		-104.854			
Reg. R-square		.787			
Tot. R-square		.787			

table is the coefficient estimations of the ECM test. Regarding the short-run dynamics, the regression coefficient estimations for the ECM model for the GDP growth testified in Table 7 had several remarkable facets. The errorECM1 variable in the table is the lag of the residual

ECM independent element included in the regression model, to evaluate the short-run dynamics. The coefficient value of errorECM1 was negative, as anticipated (Andraz & Rodrigues, 2010; Havi et al., 2013), and established the presence of a cointegrating relationship between the dependent variable and its determinants (Ismaila & Imoughele, 2015). Moreover, the negative errorECM1 merely specified how quickly the reestablishment of the equilibrium was after the ECM model had been out of equilibrium (Ahmed & Pulok, 2013). However, the coefficient estimates of the errorECM1 indicated the short-run divergence from the long-run was not statistically significant, indicating the adjustment towards equilibrium occurred in the same period under review. This is consistent with the argument of Ahmed and Pulok (2013) who noted that if the ECM coefficient was insignificant, it implied the adjustment occurred in the same era. Therefore, the coefficient estimates of the errorECM1 (-.1646) in Table 7

Table 7
The Result Estimates of Autoreg Procedure of ECM

<i>Parameter Estimates</i>					
<i>Variable</i>	<i>DF</i>	<i>Estimate</i>	<i>SE</i>	<i>t Value</i>	<i>Approx Pr > t </i>
Intercept	1	.0825	.0750	1.10	.2781
DFDI	1	.4490	.1069	4.20	.0002
DGCF	1	.3430	.1488	2.31	.0267
DINF	1	-2.3849	1.3894	-1.72	.0942
DINT	1	.3841	.0533	7.20	<.0001
DEXR	1	3.1282	1.0935	2.86	.0068
DPOP	1	.8326	1.3946	.60	.5540
DTOP	1	-.3644	.6813	-.53	.5958
errorECM1	1	-.1646	.1331	-1.24	.2237
	SSE	.326			
	MSE	.009			
Root MSE		.095			
	SBC	-57.878			
	AIC	-78.230			
Reg. square	R-	.651			
Tot. square	R-	.651			

principally inferred that, after the model diverged from the equilibrium, it adjusted at about 16% in the same period under review.

In addition, many of the variables in Table 7 had the anticipated coefficient estimate symbols, which is consistent with the results of the cointegration model. Foreign direct investment (DFDI) ($\beta_{DFDI} = .4490$, $SE = .1069$, $t = 4.20$, $p = .0002$), for example, had a positive and significant association with GDP growth in the short-run, which is consistent with its long-run association with GDP growth. This principally implied, holding the other predictors constant, a one-unit increase in foreign direct investment, for example, resulted in about .45% increase in GDP growth in the short-run, assumably in the thirteenth quarter of the period sampled.

Similarly, the gross capital formation (DGCF) ($\beta_{DGCF} = .3430$, $SE = .1488$, $t = 2.31$, $p = .0267$), for example, had a positive and significant relationship with GDP growth in the short-run, which is consistent with its long-run relationship with GDP growth. Thus, holding the other predictors constant, a one unit increase in gross capital formation, for example, resulted in about .34% increase in GDP growth in the short-run. Equally, the real interest rate (DINT) ($\beta_{DINT} = .3841$, $SE = .0533$, $t = 7.20$, $p < .0001$), and the real exchange rate (DEXR) ($\beta_{DEXR} = .31282$, $SE = 1.0935$, $t = 2.86$, $p = .0068$), for example, also experienced positive and significant associations with GDP growth in the short-run, which is consistent with the results of the cointegration model in Table 6. Nevertheless, the total population determinant (DPOP) ($\beta_{DPOP} = .8326$, $SE = 1.3946$, $t = .60$, $p = .5540$) had a positive but insignificant short-run association with GDP growth, and is consistent with the results of the cointegration model in Table 6. Regarding the remaining determinants, inflation (DINF) ($\beta_{DINF} = -2.3849$, $SE = 1.3894$, $t = -1.72$, $p = .0942$), for instance, had a negative but insignificant association with GDP growth in the short-run. This result contrasted the cointegration result in Table 6 where inflation had a negative but significant long-run relationship with GDP growth. Furthermore, trade openness (DTOP) ($\beta_{DTOP} = -.3644$, $SE = .6813$, $t = -.53$, $p = .5958$), for example, similarly had a negative but insignificant short-run association with GDP growth, and is consistent with the cointegration results in Table 6.

Additionally, the bottom part of Table 7 is the Ordinary Least Square (OLS) estimations of the autoregressive process of the ECM. Table 7 had several OLS estimations ($SSE = .326$, $MSE = .009$, $Root\ MSE = .095$; $SBC = -57.878$, $AIC = -78.230$, $Reg. R^2 = .651$, $Tot. R^2 = .651$), which were important in assessing the goodness-of-fit of the model. For example, SSE was the sum of square error, and MSE was the mean square error. The $Root\ MSE$ displayed the mean deviation of the expected GDP growth from the tangible GDP growth (dependent variable). The R^2 values (both Total and Regress) of .651 were noteworthy, demonstrating that the predictors in the regression procedure described about 65.1% of variances in the response variable. Ultimately, the high R^2 values aided confirmation of the goodness-of-fit of the model.

6. Analysis of Results

The current research focuses on the macroeconomic determinants of economic growth in post-conflict Sierra Leone. The inclusive results of the established models, to examine the determinants of economic growth display the existence of an association between economic growth and its determinants, including foreign direct investment, gross capital formation, real interest rate, and real exchange rate, among others, as expected. This appears to agree with the model specification of the current research.

The uniformity of the research outcomes with the model specification and the literature becomes more seeming in the results of the *AR(2)* model in Table 3. The results of the *AR(2)* model in Table 3 specify the elements, including foreign direct investment, gross capital formation, inflation, real interest rate, and real exchange rate, among others, together are significant predictors of economic growth in post-conflict Sierra Leone, which is consistent with the model specification. Furthermore, the findings on economic growth are also consistent with the literature review. For example, the model specification indicated foreign direct investment was a function of economic growth. Therefore, the *a priori* expectation of foreign direct investment (FDI) is a positive impact on economic growth (GDP growth). Given this, the contemporaneous FDI (LFDI) in Table 3 has a positive and significant impact on economic growth at the 5% level of significance. This is consistent with the anticipation that, the additional inflow of FDI aid in promoting investment and, therefore, in enhancing economic growth. The implication of all this is that FDI is a major macroeconomic predictor of economic growth in post-conflict Sierra Leone. This positive and significant impact of FDI on economic growth is equally consistent with some of the discoveries in the literature (Babatunde, 2011; Li & Ng, 2013; Lo et al. 2013). The coefficient estimate of FDI, therefore, conforms to the *a priori* anticipation of a positive association with economic growth.

The results in Table 3 similarly indicate the contemporaneous gross capital formation (LGCF) has a positive and significant impact on economic growth at the 5% level of significance, which is consistent with the *a priori* expectation. This principally implies a 1% increase in gross capital formation will lead to about .31% increase in the economic growth of Sierra Leone. The findings support the recognition that, enhancing the scope of investment improves output, which has a run over impact on economic realization. The positive and significant impact of gross capital formation on economic growth is consistent with some of the findings in the literature (Adekele, 2014; Eregha, 2015; Javed et al., 2014). Furthermore, the *AR(2)* results in Table 3 also indicate the contemporaneous inflation element (LINF) has a negative and significant impact on economic growth at the 5% level of significance. This principally implies a 1% rise in inflation leads to a decrease of about 2.90% in Sierra Leone's economic growth. The implication is that rising prices create instability in the Sierra Leone economy and, hence, affects growth. The findings underpin the recognition that, inflation is a noteworthy determinant of economic growth because it assesses price instability, including the superiority of fiscal and monetary strategies and, hence, macroeconomic stability of a country. The negative and significant impact of inflation on economic growth is consistent with some of the findings in the literature (Akram et al., 2011; Anyanwu, 2014; Odhiambo, 2013). The coefficient estimate of inflation consequently conforms to the *a priori* expectation of a negative relationship with economic growth.

The results in Table 3 further indicate the contemporaneous real interest rate (LINT) has a significant and positive impact on economic growth at the 5% level of significance. This essentially implies a 1% increase in the real interest rate leads to about .27% increase in Sierra Leone's economic growth. However, the findings are inconsistent with the *a priori* expectation of a negative relationship between real interest rate and economic growth, because a surge in interest rate depresses investment, which sequentially induces a contraction in economic

growth (Imosi et al., 2012). Nevertheless, a feasible intuition concerning the positive association between interest rate and economic growth postulated by Keynes (as cited in Imosi et al., 2012) and Mackinnon (as cited in Akiri & Adofu, 2007) is that, an upsurge in the real interest rate will have robust positive impacts on savings. The authors furthered that investment may exploit the increased savings, as individuals with surplus liquidity will be stimulated to save because of the high interest rate and, therefore, banks will hold surplus liquidity for investment loaning purposes to financiers, thus increasing the size of productive speculation. Therefore, the positive and significant association between interest rate and economic growth is likely the result of excess liquidity in the banks for investment purposes created in part by increased savings due to increased interest rate on savings. The positive and significant effect of the real interest rate on economic growth is consistent with some of the findings in the literature (Balassa 1989; Ghatak, 1997; Mashamba et al., 2014), even with an inconsistent *a priori* expectation.

The AR(2) results in Table 3 equally show the contemporaneous real exchange rate (LEXR) has a positive and significant impact on economic growth at the 5% level of significance. This suggests a 1% rise in the real exchange rate leads to an increase of about 4.03% in Sierra Leone's economic growth. By implication, as the real exchange rate rises, the Leones (Sierra Leone local currency) appear to depreciate relative to the US dollar, for example, causing the local prices of goods to be far cheaper than imported goods. The effect could see a rise in the export demand for local goods because of falling prices, which may ultimately enhance Sierra Leone's GDP growth. The positive and significant effect of the real exchange rate on economic growth is consistent with the findings of Kodig et al. (2012), and the *a priori* expectation of the current research. The results in Table 3 further indicate the contemporaneous total population growth rate (LPOP) as a proxy of human capital has a negative and significant effect on economic growth at the 5% level of significance, which is inconsistent with the *a priori* expectation of a positive association with economic growth. The *a priori* expectation of a positive association is that, superior population growth rates induce increased consumption market, which may advance production and economic growth. A probable reason for the negative association between population growth rate and economic growth inferred from Wako's (2012) research findings is that, advanced rate of population growth impedes the degree of *per capita* income and, consequently, impedes economic growth. In addition, the contemporaneous trade openness (LTOP) has a positive and significant effect on economic growth at the 5% level of significance. This suggests a 1% rise in trade openness leads to an increase of about 1.16% in Sierra Leone's economic growth. By implication, trade liberalization is significant in growing the economy of post-conflict Sierra Leone. The result is consistent with some of the findings in the literature (Hamad et al., 2014; Nowbutsing, 2014; Razmi & Refaei, 2013), and the *a priori* of the current research.

Table 6 is the partial results concerning the possible long-run relationship between economic growth and its determinants in their first difference. The PO cointegration model, applied to examine the long-run relationship, affirms there is at least one cointegration between economic growth and its determinants. The implication here is that, the selected variables shared a mutual stochastic trend, and will mature proportionately. The findings are

consistent with the model specification of the existence of cointegration among the variables. The findings are also consistent with some of the cointegration results in the literature (Andraz & Rodrigues, 2010; Havi et al., 2013; Ismaila & Imoughele, 2015; Mbulawa, 2015). Moreover, Table 6 also shows that foreign direct investment (DFDI), gross capital formation (DGCF), real interest rate (DINT) and real exchange rate (DEXR) individually have positive and significant long-run impacts on economic growth. A 1% increase in foreign direct investment, for example, leads to an increase in Sierra Leone's economic growth of about .51% in the long-run. This is consistent with the result estimates in the *AR(2)* model in Table 3. The inflation (DINT) result in Table 6, however, holds a negative and significant relationship with economic growth in the long-run, an indication that price instability will persist in the long-run, and this may have a negative effect on the economic growth of Sierra Leone. The total population growth rate (DPOP) result in Table 6 shows a positive relationship with economic growth, but this relationship is insignificant in the long-run. This clearly indicates that the population growth rate may not be a significant macroeconomic determinant of economic growth in Sierra Leone in the long-run. Additionally, the trade openness (DTOP) result in Table 6 shows a negative but insignificant impact on economic growth in the long-run. This essentially implies trade liberalization will have a negative but insignificant effect on the economic growth of Sierra Leone in the long-run. This is inconsistent with the *AR(2)* model in Table 3 where trade openness had a positive and significant effect on economic growth.

Following the existence of a cointegration relationship between economic growth and its determinants, it is apparent time series sporadically deviate from this long-run relationship to short-run dynamics. Therefore, Table 7 is the findings of the short-term dynamic of the relationship between the coefficient estimates of economic growth and its selected determinants, applying the ECM model. The results in Table 7 show the coefficient value of the lagged error term, errorECM1, is negative, as anticipated (Andraz & Rodrigues, 2010; Havi et al., 2013), and confirms the presence of a cointegration association between economic growth and its determinants (Ismaila & Imoughele, 2015). Furthermore, the negative errorECM1 simply detailed how promptly the restoration of the equilibrium was after the ECM model had been out of equilibrium (Ahmed & Pulok, 2013). Nevertheless, the coefficient estimate of the errorECM1 demonstrates the short-run deviation from the long-run is not statistically significant, an indication the adjustment towards equilibrium happens in the same review period. This is consistent with Ahmed and Pulok's (2013) argument when they said if the ECM coefficient was insignificant, it signified the adjustment happened in the same epoch. Thus, the coefficient estimates of the errorECM1 (-.1646) in Table 7 primarily means that, after the model deviates from the equilibrium, it adjusts at about 16% in the same period under review.

Table 7 also shows that, foreign direct investment (DFDI), gross capital formation (DGCF), real interest rate (DINT), and the real exchange rate (DEXR) determinants have positive and significant short-run relationships with economic growth. This is consistent with the cointegration model in Table 6, where the same elements held positive and significant long-run relationships with economic growth. This essentially suggests the determinants positively affect economic growth in Sierra Leone, even in the short-term. Simultaneously, the inflation (DINF) and trade openness (DTOP) determinants in Table 7 hold negative but insignificant

relationships with economic growth in the short-run. This practically suggests that, price instability and trade liberalization negatively affect the economic growth of Sierra Leone in the short-term, but the impact is non-significant. However, the short-term inflationary outcome, for example, is inconsistent with the cointegration model in Table 6, which held that inflation had a negative and significant impact on the economic growth of Sierra Leone in the long-run. Meanwhile, the result on trade openness outlined in Table 7 is consistent with the findings on trade openness in Table 6.

7. Conclusion

The objective of the current research was the determination of economic growth in post-conflict Sierra Leone, applying selective macroeconomic variables. The selected variables were time series, and the leading econometric model was the log-log autoregression. A preliminary descriptive analysis was significant, to disclose disparity and dispersion among the variables of interest. In addition, the application of the autoregression model was significant because it helped resolve the problem of serial correlation often dominant in time series data. Resolving the concern of serial correlation resulted in an $AR(2)$ log-log leading econometric model applied to resolve Equation (1). Table 3 is the findings of the $AR(2)$ model for Equation (1), which noted the variables, including foreign direct investment, gross capital formation, real interest rate, and real exchange rate, among others, had significant effects on the economic growth of post-conflict Sierra Leone. The selected macroeconomic variables were, therefore, good predictors of economic growth in Sierra Leone. Table 3 also showed that foreign direct investment, gross capital formation, real interest rate, real exchange rate, and trade openness had positive and significant relationships with economic growth. Therefore, enhancing these determinants will lead to increased GDP growth. Conversely, in Table 3, inflation and population growth rate had negative but significant associations with economic growth. The negative inflation was an indication of rising prices and, hence, economic instability, which may affect growth. Meanwhile, the negative population growth rate signified that, the advanced population growth hindered the level of *per capita* income and, hence, hindered the level of economic growth. Therefore, lowering the level of rising prices and the population growth rate will help enhance economic growth.

Additionally, a supplementary focus of the current research was the long-run and short-run associations between economic growth and the selected macroeconomic determinants. After the correction for unit root and the application of the cointegration model, the findings suggested that, at least, one determinant had a long-run relationship with economic growth (see Tables 5 and 6). Moreover, Table 6 also showed that foreign direct investment, gross capital formation, real interest rate, and real exchange rate individually had positive and significant long-run relationships with economic growth, an indication that long-term growth will persist with the enhancement of these determinants. Thus, foreign direct investment, gross capital formation, real interest rate, and real exchange rate are the positive and significant long-run determinants of economic growth in post-conflict Sierra Leone. However, in the short-term, after the model deviated from its long-term equilibrium, it adjusted only about 16% in the same period under review. In addition, foreign direct investment, gross

capital formation, real interest rate, and real exchange rate had positive and significant short-term relationships with economic growth. Consequently, foreign direct investment, gross capital formation, real interest rate, and real exchange rate are similarly significant determinants of short-term economic growth in Sierra Leone. Given this analysis, the following are the recommending policies for a possible sustainable economic growth in Sierra Leone:

- Foreign direct investment and gross capital formation had positive and significant relationships with economic growth in all three models. Therefore, policy makers in Sierra Leone should engender policies that would sustain these macroeconomic elements, by applying development alignment and sustainable policies to stimulate development.
- In addition, policy makers should engender policies (e.g. business tax breaks, etc.) to augment the latitude of investment in Sierra Leone, which can increase production because this has an overspill effect on economic attainment.
- Moreover, because of the significance of foreign direct investment in the current research, policy makers in Sierra Leone should engender policies to attract added financiers into the country, to secure resourceful labor at economical cost to upsurge its employment.
- The real interest rate had a positive and significant association with economic growth. Keynes (as cited in Imosi et al., 2012), and Mackinnon (as cited in Akiri & Adofu, 2007) noted that an upsurge in real interest rate induced high bank savings and surplus bank liquidity for investment loans. Therefore, the engendering of monetary policies to include high interest rate on savings may induce additional savings and additional bank liquidity for investment loans, and subsequent growth development.
- A surge in the real exchange rate is an indication that policy makers in Sierra Leone should engender policies to increase export demands for locally produced goods because of falling prices, which may ultimately enhance economic growth.
- The negative and significant impact of inflation on economic growth in the current research is an indication of the presence of price instability, which may create macroeconomic instability in the country. Policy makers in Sierra Leone should stimulate monetary and fiscal policies to curb rising prices. These may include raising the interest rates and income taxes, and reducing the budget deficit, among others.
- The total population growth rate as human capital in the current research was positive but insignificant in the long-run and short-run models. Policy makers in Sierra Leone should stimulate policies to improve the education and work skills to make its population more efficient, because superior population growth rates induce increased consumption market, which may enhance production and economic growth.

- Trade openness in the current research was positive and significant in the *AR(2)* model, but negative and insignificant in the long-term and short-term models. Nowbutsing (2014) had argued that even when free trade stimulated several gains, many nations continued espousing protectionism procedures, like tariff barriers, for example. Thus, policy makers in Sierra Leone should engender policies to promote global trade, such as dropping tariff rates, etc. Sierra Leone should also promote the export of a variety of high quality products, to enhance growth.

Even with these policy recommendations, the research is not without its limitations. In particular, the research was limited to 12 post-conflict years (2002-2013), which may be insufficient to realize the complete determinants of economic growth. However, subsequent research explorations must include additional years and supplementary macroeconomic variables to comprehend their complete impact on economic growth. In addition, there was no attempt to investigate the possibility of exogenous shock (e.g. the 2014 Ebola episode) and its impact on the economy, including the role of money supply, and government budgetary balance in economic growth. Still, the research exploration was robust and conclusive. It helped fill the imperfect information in the current literature relating to the determinants of economic growth in post-conflict Sierra Leone with theoretical and empirical underpinnings. The results also held applied inferences for policy makers, administrations, and financiers. Concluding, the findings recognized will supplement a new knowledge of a country-specific research on the determinants of economic growth with applied econometrics and generalizability practicalities.

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