Growth Impacts of Income Inequality: Empirical Evidence From Nigeria

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Abstract

The debate on whether income inequality promotes, restricts, or is independent of economic growth has been widely studied and discussed in development economics discourse. However, a careful reading of this extensive extant and burgeoning literature suggests that, other than the ambivalent nature and the fact that the bulk of these studies relied heavily on cross-section/-country/panel econometric analysis, empirical studies examining the nexus in the context of less developed economies, particularly, African countries, has received less attention, as most of the extant studies predominantly focused on developed economies. This current study, thus, attempts to examine the impact of inequality on growth in Nigeria spanning between the period 1970 and 2018. It also examined the theoretical predictions of some of the distinct transmission channels through which inequality impacts growth. Time series econometrics were applied. The results obtained consistently revealed that inequality hurts long-run growth in Nigeria. Also, the results obtained revealed that inequality in income increases relative redistribution and fertility, but lessens investment, gross enrollment ratio, and property rights protection in Nigeria, which may in turn impede growth.

Keywords: income inequality, economic growth, Gini Coefficient, Autoregressive Distributed Model, Nigeria

1. Introduction

Over the years, on the theoretical front, three distinct contentious and divergent views assessing the macroeconomic implications of inequality in the distribution income on economic growth have evolved markedly in development economics discourse, viz.: the classical, neoclassical and modern perspective theories. The classical expositions, whose ideas were grounded in the theories of economic growth put forward by Kaldor (1955) and Rostow (1959), on the one hand, posited that a certain degree of inequality in the distribution of income is essential, vital and beneficial to growth as well as overall economic performance (Aghion, Caroli, and Garcia-Penalosa, 1999; Panizza, 2002; Leoni and Pollan, 2003; Ehrhart, 2009; Galor, 2009). According to this body of literature, since the marginal propensity to save increases with wealth, inequality of income distribution channels resources towards individuals whose marginal propensity to save is higher (Galor, 2009), thereby trigger an increase in aggregate savings, and by extension raise capital accumulation, and correspondingly productivity growth (Leoni and Pollan, 2003; Delbianco, Dabus, and Caraballo, 2014; Kandek and Kajling, 2017; Njindan Iyke and Ho, 2017; Kennedy, Smyth, Valadkhani, and Chen, 2017; Joshi, 2018).

On the other hand, the neoclassical paradigm, which subsequently dominated the field of macroeconomics, implicitly dismissed the classical economists' viewpoint (Galor, 2009). Intrinsically, unlike the classical model, the neoclassical economists, whose standpoint can be traced to Kuznets' (1955, 1963) pioneering works of the inverted U-shaped curve nexus between economic growth and income inequality, vied that the study of inequality of income distribution has no significance in the understanding of growth process (Galor, 2009; Oded, 2011). Put differently, this strand of literature suggested that income inequality itself does not determine a country's economic growth course. Rather, it is economic growth that impacts income inequality, even more so than the latter affects the former (Oded, 2011; Joshi, 2018). Of late, in contrast to the predictions of the neoclassical and classical paradigms respectively: the modern perspective theory, initiated by Galor and Zeira (1989, 1993), reasoned that income distribution does, in fact, have a significant impact on economic growth (Galor and Zang, 1997; Dahan and Tsiddon, 1998; Ehrhart, 2009; Galor, 2009; Oded, 2011). Besides, unlike the classical standpoint, which highlighted the beneficial impacts of inequality for growth, the modern expositions underscored the potential adverse impacts of inequality on economic growth (Aghion and Bolton, 1992, 1997; Banerjee and Newman, 1993; Galor and Zeira, 1993; Pikketty, 1997; Galor, 2009).

On the empirical side, a replete of important empirical studies have attempted to assess the empirical implications of these three propositions. While some studies (Galor and Zeira, 1989, 1993; Alesina and Rodrik, 1994; Persson and Tabellini, 1994; Keefer-Knack, 1995; Birdsall, Ross, and Sabot, 1995; Perotti, 1994, 1996; Alesina and Perotti, 1993, 1996; Deininger and Squire, 1996, 1998; Knell, 1999; Mo, 2000; Barro, 2000; Rehme, 2002; De La Croix and Doepke, 2003; Banerjee and Duflo, 2003; Pagano, 2004; Knowles, 2005; Easterly, 2007; Sukiassyan, 2007; Noh and Yoo 2008; Lin, Huang, Kimz, Chih-ChuanYeh, 2009; Castelló-Climent, 2010; Chambers and Krause, 2010; Shin, 2012; Herzer and Vollmer, 2012; Wahiba and El Weriemmi, 2013; Fawaz, Rahnama, and Valcarcel, 2014; Cingano, 2014; Ostry, Berg, and Tsangarides, 2014; Darma and Ali, 2014; Bagchi and Svejnar, 2015; Njindan Iyke and Ho, 2017; Lahouij, 2017) lent credence to the modern perspective expositions which highlighted the potential negative impacts of inequality on growth process; in contrast, some other studies (Partridge, 1997; Li and Zou, 1998; Tanninen, 1999; Deininger and Olinto, 1999; Forbes, 2000; Balisacan and Fuwa, 2003; Iradian, 2005; De Dominicis, Florax and De Groot, 2008; Halter, Oechslin, and Zweimuller, 2014; Chletsos and Fatouros, 2016; Majeed, 2016a, 2016b; Naguib, 2017; Jauro, 2017; Joshi, 2018, etc.) have also reiterated the classical expositions which underscored the virtues of inequality of income distribution for economic growth.

Several other studies (Barro; 2000; Chang and Ram, 2000; Thornton, 2001; Panizza, 2002; Huang, 2004; Lin and Weng, 2006; Jalil, 2009; Chambers and Dhongde, 2011; Cheema and Rehman, 2014; Onaran and Oyvat, 2015; Vo, Nguyen, and Tran, 2019) are also quite supportive of the predictions of the neoclassical paradigm, particularly, with regard to the influence of growth on inequality. Still, a large number of studies (for instance, Furman and Stiglitz, 1998; Wan, Lu and Chen, 2006; Grijalva, 2011) found no clear relationship, different relationships at different time horizons (Partridge, 1997; Halter, Oechslin, and Zweimüller 2014; Malinen, 2013), or different relationships at different parts of the income distribution (Voitchovsky, 2005; Fallah and Partridge, 2007; Lin and Yeh, 2009; Assa, 2012; Tiwari, Shahbaz and Islam, 2013; Delbianco et al, 2014; Madsena, Islamb, and Doucouliagosc, 2016; Chen, 2018). Discursively, in accord with the theoretical discrepancies, even empirical evidences and literature, more often than not, still remain divided on the subject.

In Nigeria, as is the case in other parts of sub-Saharan Africa, income inequality, as measured by the widely-used Gini index, has grown up dramatically over the years. As of 1970, it was estimated at 0.0598 (World Income Inequality Database, WIID, 2018). Between 1978 and 1988, it rose from 0.0681 to 0.4025 (Awe and Ojo, 2012). Further, premised on the details published by the Standardized World Income Inequality Database (SWIID) of Solt (2016), it worsened from 0.4290 in 1990 to 0.4340 in 1995 before plummeted to 0.4220 in 2003 and remained unchanged till 2004. Regrettably, however, it deteriorated from 0.4174 in 2006 to 0.4810 in 2017 (Ewubare and Okpani, 2018). As evidenced in National Bureau of Statistics (2018) data set, it currently stands at 0.4870. In particular, it is projected to continue to rise over the next several decades (Mayah, Mariotti, Mere, and Odo, 2017). In this regard, the critical question is this: what are the growth implications of such rapid increase in income inequality in Nigeria? More precisely, as the gap between the haves and have-nots is increasingly widening with no end in sight in the country, what direction will the growth implications of inequality go? Explicitly, will an upsurge in inequality be beneficial/harmful for growth in Nigeria?

Although, as of date the literature hold a plethora of important empirical contributions on the subject, however, other than the ambivalent nature of these empirical findings and the fact that the bulk of these studies predominantly focused on developed countries and in addition provide little or no information about the distinct transmission channels through which inequality impacts growth, most of these extant studies examining the nature of the nexus relied heavily on cross-section/-country/panel econometric analysis. The problem with such discourse, as argued in Siddiqui and Ahmed (2009), besides the general methodological flaws relating to model specification and econometric procedure, is the homogenous assumption across the countries, which is unrealistic because of difference in culture, institutional, economic and social conditions. Given immense difference among countries with respect to nature and quality of data, cross-country comparison is fraught with danger (Siddiqui and Ahmed, 2009). In view of these, undoubtedly, there is the need not only to shed light on the existing contradiction-prone evidence but also to examine the subject from country-specific perspective. In the case of Nigeria, while there is a sizeable literature on income inequality and their economic implications as section two highlights, however, there is the dearth of econometric evidence examining the precise nexus linking inequality to growth and channels through which inequality impacts growth. This study, thus, will fill this gap.

Following the introduction, the other sections of the paper is arranged as follows: section two depicts a review of the relevant literature on this theme, section three focuses on the model specification, data and methodology adopted in achieving the objectives of the study. In section four, the empirical results and discussions were presented. Finally, the fifth section presents the summary of the findings.

2. Literature Review- A Synoptic View

In spite of the extensive extant and burgeoning literature, the debate on whether income inequality promotes, restricts, or is independent of economic growth has remained a subject of controversy and yet to find a clear consensus in development economics discourse. Broadly speaking, there are three distinct contentious theoretical views to this debate, namely; the classical, neoclassical and modern perspective theories. The classical paradigm, on the one hand, argued that a certain degree of inequality of income distribution is essential, vital and beneficial to economic growth (see figure 1 in Appendix I). They (the classical economists) reasoned that since the marginal propensity to save increases with wealth, inequality channels resources towards individuals whose marginal propensity to save is higher (Galor, 2009), thereby trigger an increase in aggregate savings which can be channeled into investments that are conducive to growth (Cingano, 2014; Gründler and Scheuermeyer, 2015). In contrast to the classical standpoint, the neoclassical economists, inspired by the Kuznets' (1955, 1963) pioneering works of the inverted U-shaped curve nexus between growth and inequality, on the other hand, advanced the proposition that the study of income inequality has no significance in the understanding of growth process (Galor, 2009). Basically, this strand of literature implicitly interpreted the observed relationship between inequality and economic growth as capturing the effect of growth process on the distribution of income (Oded, 2011).

Of late, contrary to the predictions of the neoclassical and classical propositions respectively: the modern perspective theory, in contrast to the neoclassical expositions, advanced the novel standpoint that inequality of income distribution does, in fact, have a significant impact on economic growth (Galor, 2009; Oded, 2011). Also, unlike the classical paradigm which underlined the beneficial impacts of income inequality on growth, the modern expositions highlighted the potential adverse impacts of inequality of income distribution on growth (Bernstein, 2013; Stiglitz, 2016). Discursively, the strand of literature suggests four distinct transmission channels (see figure 1 in Appendix I) through which income inequality adversely impacts growth (Majeed, 2016a, 2016b). Firstly, as advanced by Galor and Zeira (1989, 1993), in the presence of credit market imperfections and fixed costs associated with the acquisition of education, inequality of income distribution may be detrimental to human capital formation and economic growth (Galor, 2009; Gründler and Scheuermeyer, 2015; Islam, 2017).

Secondly, in societies that are characterized by income inequality, distributional conflict may bias political decisions in favour of appropriation and may thus lessen investment and economic growth (Galor, 2009). Thirdly, as underscored by Alesina and Perotti (1996), "income inequality increases social discontent and fuels social unrest; the latter, by increasing the probability of coups, revolutions, mass violence or, more generally, by increasing policy uncertainty and threatening property rights, has a negative effect on investment, and, as a consequence, reduces growth" (Leoni and Pollan, 2003). Lastly, premised on a novel line of reasoning put forward by Becker and Barro (1988), a worsening in the inequality of wealth jointly generates an increase in the fertility rate and a drop in the rate of investment in human capital of most of the households which are poor and less educated, and this in turn hampers growth (Ehrhart, 2009).

On the empirical front, a replete of studies have attempted to assess the empirical implications of these three propositions. For the purpose of comprehension and simplicity, an overview and synopsis of more recent cross-country/-section/panel and time-series studies on the impact of income inequality on economic growth is presented in Table 1 (in Appendix II). As can be seen from the table, it evident that the macroeconomic implications of inequality on growth has been widely discussed. However, in spite of the large and burgeoning discourse on the nexus, empirically, studies have failed to suggest an overall dominance of one view over the other. While some studies lent credence to the modern perspective paradigm view which highlighted the potential negative impacts of inequality on the growth process, however, some other studies also reiterated the classical proposition which underscored the virtues of inequality of income distribution for economic growth. Several other studies are also quite supportive of the predictions of the neoclassical paradigm, particularly, with regard to the influence of growth on inequality. Still, a large number of studies found no clear relationship, different relationships at different time horizons, or different relationships at different parts of the income distribution. Besides, premised on the review depicted in the table, other than the ambivalent nature of the empirical findings, it is also apparent that the bulk of these studies predominantly focused on developed countries and regress growth on inequality without providing any pertinent information about the distinct transmission channels through which inequality impacts growth.

Apart from these, as can be observed from the table, most of these empirical studies examining the exact nexus linking inequality to growth has relied heavily on cross-section/cross-country/panel econometric analysis. The problem with such discourse, as argued in Siddiqui and Ahmed (2009), aside the general methodological flaws relating to model specification and econometric procedure, is the homogenous assumption across the countries, which is unreasonable because of difference in culture, institutional, economic and social conditions. Given immense difference among countries with respect to nature and quality of data, cross-country comparison is fraught with danger (Siddiqui and Ahmed, 2009). Cross-country regressions are infamous for problem such as omitted variables bias, endogeneity, and so on. In the case of Nigeria, while there is a sizeable literature (Odedokun and Round, 2001; Akinbobola and Saibu, 2004; Dauda, 2004; Isere, Ibrahim and Agu, 2010; Awoyemi, and Omonona, 2011; Akpoilih and Farayibi, 2012; Awe and Ojo, 2012; Kolawole and Omobitan, 2015; Ogbeide and Agu, 2015; Adinde, 2017; Aigbokhan, 2008, 2017; Odusanya and Agboola, 2017; Ewubare and Okpani, 2018; Nwosa, 2019) on income inequality and their economic implications, however, there is the dearth of econometric evidence examining the precise nexus linking income inequality to economic growth and channels through which inequality impacts growth. This paper, thus, aims to fill this gap as there is the need not only to shed light on the existing contradiction-prone evidence but also to examine the subject from Nigeria perspective, a country that is characterized by high level of income disparities.

3. Data, Model Specification and Methodology

3.1 Sources of Data

The study made use of annual time series secondary data spanning between the period 1970 and 2018 sourced majorly from the publications of Central Bank of Nigeria Statistical Bulletin (2019), World Development Indicators (2019), United Nations Statistics Division National Accounts Main Aggregates Database (2019), Penn World Table 9.0, the Standardized World Income Inequality Database (SWIID, 2019), Economic Freedom of the World Index (Fraser Institute's Legal structure and security of property rights index), and United Nations University World Income Inequality Database WIID 3.4 (2019). The specific source and measurement as well as the description and justification for each variable employed in the study are depicted in Table 2 in Appendix II. In instance, where there are some missing observations, the study, following Ogbeide and Agu (2015), filled the missing gap using 4-year moving average, a widely accepted method of extrapolation.

3.2 Econometric Model

In order to obtain an econometric model used in examining whether income inequality has growth-promoting or growth-dampening impacts in Nigeria, this study draws on the theoretical framework of neoclassical growth model (though augmented by certain improvements and extensions taking into cognizance the objective of the study) and specifies a Cobb-Douglas production function of the form:

$$Q = \phi K^{\alpha} L^{1-\alpha} \qquad 0 < \alpha < 1 \tag{1}$$

where Q, K, L, ϕ and α are aggregate output, physical capital stock, labour force, technological progress (i.e. total factor productivity) and elasticity of output with respect to capital respectively. Notice that technological progress that enters in this fashion is known as *Hicks-neutral.* Following the literature (for instance, Bloom, Canning and Malaney, 1999), suppose the endogenous processes which generate total factor productivity (TFP hereafter) and physical capital accumulation converge to a steady state, this leads us to specify equation (1) in an intensive form {by dividing both sides of equation 1 by L } as follows

$$\left(\frac{Q}{L}\right)^{*} = \phi\left(\frac{K^{*}}{L}\right)^{\alpha} \Rightarrow q^{*} = \phi k^{*\alpha} \tag{2}$$

where * depicts the variable's steady state value. Suppose this steady-state value $\left(q^{*}\right)$ is determined by a set of factors, Z, (that is a matrix of variables) that may affect physical capital accumulation and TFP. That is,

$$q^{*} = Z\beta \tag{3}$$

Given the model (3), the regression equation derived from this model assumes that the actual level of income per worker will adjust slowly from its initial level to this steady-state level as follows:

$$g_{(q)} = \lambda\left(q^{*} - q\right) \tag{4}$$

where $g_{(q)}$ denotes growth rate of income per worker, q^{*} depicts natural log of the steady state of income per worker, q is the natural log of the initial income per worker and λ represents the rate of convergence. The empirical implementation of equation (4) suggests that a country's rate of growth is directly proportional to the initial distance from its steady-state income level q^{*}. As such, the poorer a country is with respect to its steady state, the faster such country is expected to grow (Bloom *et al*, 1999). By substituting equation (3) into equation (4)

$$g_{(q)} = \lambda\left(Z\beta - q\right) \tag{5}$$

where β is a vector of parameters. By combining equation (4) {i.e. the steady-state equation} with equation (5) {i.e. the adjustment process} and adding a random error ε yields the following equation whose parameters can be estimated.

$$g_{(q)} = \lambda Z\beta - \lambda q + \varepsilon \tag{6}$$

Equations (1-6) provide the theoretical underpinnings of most recent empirical studies of the sources of economic growth. Since income per capita instead of income per worker is usually used for growth regressions, the relationship between working-age population, total population, and labour force needs to be taken into account. Using the fact that

$$q = \frac{Q}{N}\frac{N}{L} = \hat{q}\frac{N}{L} \tag{7}$$

$$q = \hat{q}\frac{N}{L} \tag{8}$$

$$\hat{q} = q\frac{L}{N} \tag{9}$$

where $\hat{q}$ represents income per capita, and N denotes to total population. By combining equations (6) and (9) in order to obtain an expression for income per capita:

$$g_{\left(\hat{q}\right)} = g_{(q)} + g_{(L)} - g_{(N)} \tag{10}$$

$$g_{\left(\hat{q}\right)} = \lambda\left(Z\beta - q\right) + g_{(L)} - g_{(N)} + \varepsilon_{2} \tag{11}$$

where $g_{\left(\hat{q}\right)}$, $g_{(L)}$ and $g_{(N)}$ are growth rates of income per capita, labour force and population respectively. By simplifying, thus, an econometric representation of the expression in equation (11):

$$g_{\left(\hat{q}\right)} = \rho_0 + \rho_1 q + \rho_2 g_{(L)} + \rho_3 g_{(N)} + \rho_4 Z + \varepsilon_3 \tag{12}$$

The empirical implementation of equation (12) suggests, thus, that the growth rate of income per capita depends on initial income per worker, growth rates of labour force and population and a set of factors, Z, that determined the steady state level of income respectively. To close the model there is the need for covariates variables in vector Z to be defined. In the theoretical and empirical literature on the analysis of macroeconomic determinants of economic growth, econometric literature points to a number of robust and potential important long-term variables. For simplicity, this study follows Islam (2017) in the selection of the covariates variables included in Z. These variables are the financial deepening, human capital accumulation, and trade openness.

Regarding the impact of financial deepening on economic growth, Jalilian and Kirkpatrick (2005) emphasized the intermediation role performed by financial institutions in bridging the information asymmetries between borrowers and savers, thereby performing the functions of savings mobilization, capital fund allocation, monitoring of the use of funds, and managing risk, which together support the economic growth process (Levine, 1997; Jalilian and Kirkpatrick, 2005). Human capital accumulation, as argued in Benhabib and Spiegel (1994), does not only enhance the ability of a country to develop its own technological innovation, but also increases its ability to adapt existing knowledge which is one of the robust determinants of growth (Islam, 2017). Keho (2017) reasoned that trade openness can potentially enhance economic growth by providing access to goods and services, achieving efficiency in the allocation of resources and improving total factor productivity through technology diffusion and knowledge dissemination (Rivera-Batiz and Romer, 1991; Barro and Sala-i-Martin, 1997). Finally, in order to examine whether inequality has growth-promoting or growth-dampening impacts in Nigeria, the study incorporate Gini coefficient of income distribution. Hence, in line with these arguments, an econometric representation of equation (12) is then specified as follows:

$$\partial \ln \hat{q}_t = \lambda_0 + \lambda_1 \ln q_t + \lambda_2 \left(\partial \ln L_t\right) + \lambda_3 \left(\partial \ln N_t\right) + \lambda_4 \ln F_t + \lambda_5 \ln H_t + \lambda_6 \ln T_t + \lambda_7 \ln G_t + \mu_t \tag{13}$$

where $\partial \ln \hat{q}, \ln q_t, \left(\partial \ln L_t\right), \left(\partial \ln N_t\right), \ln F_t, \ln H_t, \ln T_t, \ln G_t,$ and μ_t are the growth rate of income per capita, income per worker, growth rate of labour force, growth rate of population, financial deepening, human capital accumulation, trade openness, Gini coefficient, and white-noise error term respectively. λ_i (for $i = 1,...,7$) are the shares of these inputs in the aggregate output, λ_0 is the constant term, t denotes time, $\ln$ is the natural logarithm operator. The variables are transformed to their natural logarithm form to remove or lessen considerably any heteroskedasticity in the residuals of the estimated model.

One of the limitations of equation (13) is that it does not permit policymakers to differentiate and separate the short-run contribution of the covariates variables, to the overall growth process, from the long-run contribution. Whereas growth policies are targeted toward achieving long-run results, production decisions take into account the short-run impact of the determinants of production (Njindan Iyke and Ho, 2017). Besides, it also takes time before policies such as the structural reforms actually affect the lives of the poor and growth. As a result, there may possibly be long lags between the time policies are implemented and their impacts on economic variables (Agyemang, 2014). Hence, by neglecting the short-run dynamics of the determinants to the overall growth process, vital key insights are lost. As well, Beck and Katz (1996) reasoned that the inclusion of lag dependent variable as a regressor in the model is also a parsimonious way to account for the continuing effect of explanatory variables in the past (Agyemang, 2014). Hence, in order to allow for some degree of persistence in the data generating process, equation (13) is then modified as a dynamic Autoregressive Distributed Lag (ARDL) to include the lag dependent and independent variables as follows:

$$\Delta\left(\partial \ln \overset{\Lambda}{q}_t\right) = \theta_0 + \sum_{i=1}^{a} \theta_{1i} \Delta\left(\partial \ln \overset{\Lambda}{q}_{t-i}\right) + \sum_{i=0}^{b} \theta_{2i} \Delta \ln q_{t-i} + \sum_{i=0}^{c} \theta_{3i} \Delta\left(\partial \ln L_{t-i}\right) + \sum_{i=0}^{d} \theta_{4i} \Delta\left(\partial \ln N_{t-i}\right) + \sum_{i=0}^{e} \theta_{5i} \Delta \ln F_{t-i} + \sum_{i=0}^{f} \theta_{6i} \Delta \ln H_{t-i}$$
$$+ \sum_{i=0}^{g} \theta_{7i} \Delta \ln T_{t-i} + \sum_{i=0}^{h} \theta_{8i} \Delta \ln G_{t-i} + \delta_1\left(\partial \ln \overset{\Lambda}{q}_{t-1}\right) + \delta_2 \ln q + \delta_3\left(\partial \ln L_{t-1}\right) + \delta_4\left(\partial \ln N_{t-1}\right) + \delta_5 \ln F_{t-1} + \delta_6 \ln H_{t-1} + \delta_7 \ln T_{t-1} \quad (14)$$
$$+ \delta_8 \ln G_{t-1} + \mu_{1t}$$

Notice that the terms with summation signs are used to model the short-run dynamics structure. Equation (14) is *ARDL* of order (a,b,c,d,e,f,g,h) which holds that economic growth is predisposed to be determined by its own lag, the lag values of initial income per worker, growth rate of labour force, growth rate of population, financial deepening, human capital accumulation, trade openness, and Gini coefficient. The $\delta' s$ denote the long run dynamics whereas $\theta' s$ depict the short-run dynamics of the model. In addition, Δ represents the first difference operator, θ_0 is the drift component and, u_{1t} is white noise residual.

Further, Majeed (2016a, 2016b) argued that, in an attempt to conduct the estimation of econometric model (14), it is likely that income inequality specified in the model captures the impact of poverty on growth. As such, there is the need to assess the exclusive impact of income inequality on economic growth. Thus, following Majeed (2016a, 2016b), this study controls for poverty incidence in a separate regression. Hence, in equation (15), $\ln P$ (a measure for poverty incidence proxied by headcount ratio) is incorporated as an additional term in order to capture the true growth impacts of income inequality.

$$\Delta\left(\partial \ln \overset{\Lambda}{q}_t\right) = \theta_0 + \sum_{i=1}^{a} \theta_{1i} \Delta\left(\partial \ln \overset{\Lambda}{q}_{t-i}\right) + \sum_{i=0}^{b} \theta_{2i} \Delta \ln q_{t-i} + \sum_{i=0}^{c} \theta_{3i} \Delta\left(\partial \ln L_{t-i}\right) + \sum_{i=0}^{d} \theta_{4i} \Delta\left(\partial \ln N_{t-i}\right) + \sum_{i=0}^{e} \theta_{5i} \Delta \ln F_{t-i} + \sum_{i=0}^{f} \theta_{6i} \Delta \ln H_{t-i}$$
$$+ \sum_{i=0}^{g} \theta_{7i} \Delta \ln T_{t-i} + \sum_{i=0}^{h} \theta_{8i} \Delta \ln P_{t-i} + \sum_{i=0}^{j} \theta_{9i} \Delta \ln G_{t-i} + \delta_1\left(\partial \ln \overset{\Lambda}{q}_{t-1}\right) + \delta_2 \ln q + \delta_3\left(\partial \ln L_{t-1}\right) + \delta_4\left(\partial \ln N_{t-1}\right) + \delta_5 \ln F_{t-1} + \quad (15)$$
$$\delta_6 \ln H_{t-1} + \delta_7 \ln T_{t-1} + \delta_8 \ln P_{t-1} + \delta_9 \ln G_{t-1} + \mu_{3t}$$

It is expected *a priori* that the growth rate of labour force, financial deepening, human capital accumulation, initial income per worker and trade openness will enhance the growth rate of income per capita. Expectedly, the relationship between these explanatory variables and economic growth is positive, while the poverty incidence is detrimental to growth, thus, the expected *a priori* is negative. Income inequality and the growth rate of population may or may not benefit economic growth, as such the expected *a priori* is either positive or negative respectively.

Additionally, in order to strengthen the robustness of this analysis, an attempt is also made to examine the classical economists and modern expositions predictions of some of the distinct transmission channels (viz., the investment, fertility, schooling, fiscal policy and socio-political instability channels) through which inequality (might positively or adversely) impacts growth. Regarding the investment channel, the classical economists submitted that income inequality stimulates economic growth by fostering aggregate saving and investment (Gründler and Scheuermeyer, 2015). In contrast to the classical standpoint, the modern expositions paradigms reasoned that investment will be adversely affected by inequality in the presence of credit market imperfections and fixed costs associated with investment (Islam, 2017). As regards socio-political instability channels, Alesina and Perotti (1996) argued that "income inequality increases social discontent and fuels social unrest; the latter, by increasing the probability of coups, revolutions, mass violence or, more generally, by increasing policy uncertainty and threatening property rights, has a negative effect on investment, and, as a consequence, lessens growth" (Leoni and Pollan, 2003).

In relation to fertility and schooling channels, De La Croix and Doepke (2003) vied that fertility and education decisions are interdependent: countries with higher income inequality tend to experience a higher fertility differential and lower average education which in turn lessen the future growth rate (De La Croix and Doepke, 2003; Ehrhart, 2009; Islam, 2017). With reference to fiscal policy channel, Alesina and Rodrik (1994) and Persson and Tabellini (1994) maintained that higher inequality in income and wealth in a democratic society may result in higher taxation and redistributive economic policies that decrease investment and subsequently economic growth (Islam, 2017). Progressive taxation and fiscal redistribution create a general disincentive to work and invest, hence the rich will lobby against the implementation of efficient redistribution policies (Benabou, 2002; Acemoglu and Robinson, 2008; Islam, 2017).

Hence, in line with these aforementioned arguments, in order to provide an insight on some of the distinct transmission channels through which inequality might impact growth, this study (following Islam, 2017; Lahouij, 2017), considered investment rate (INV, the ratio of fixed investment to RGDP), total fertility rate (FER), property rights protection (PRP), human capital accumulation (HCA), and relative redistribution (RED, calculated as the ratio of the difference between market Gini and net Gini to the market Gini) and specified the following unrestricted error correction (UECM) ARDL models:

$$\Delta(\partial \ln IN_t) = \alpha_0 + \sum_{i=1}^{a} \alpha_{1i} \Delta(\partial \ln IN_{t-i}) + \sum_{i=0}^{b} \alpha_{2i} \Delta \ln F_{t-i} + \sum_{i=0}^{c} \alpha_{3i} \Delta \ln H_{t-i} + \sum_{i=0}^{d} \alpha_{4i} \Delta \ln T_{t-i} + \sum_{i=0}^{e} \alpha_{5i} \Delta\left(\partial \ln \hat{q}_{t-i}\right) + \sum_{i=0}^{f} \alpha_{6i} \Delta \ln G_{t-i} +$$
$$\beta_1 (\partial \ln IN)_{t-1} + \beta_2 (\ln F)_{t-1} + \beta_3 (\ln H)_{t-1} + \beta_4 (\ln T)_{t-1} + \beta_5 \left(\partial \ln \hat{q}_{t-1}\right) + \beta_6 (\ln G)_{t-1} + \varepsilon_{0t} \quad (16)$$

$$\Delta(\partial \ln FR_t) = \delta_0 + \sum_{i=1}^{p} \delta_{1i} \Delta(\ln FR_{t-i}) + \sum_{i=0}^{q} \delta_{2i} \Delta \ln F_{t-i} + \sum_{i=0}^{r} \delta_{3i} \Delta \ln H_{t-i} + \sum_{i=0}^{s} \delta_{4i} \Delta \ln T_{t-i} + \sum_{i=0}^{t} \delta_{5i} \Delta\left(\partial \ln \hat{q}_{t-i}\right) + \sum_{i=0}^{u} \delta_{6i} \Delta(\partial \ln MR_{t-i})$$
$$\sum_{i=0}^{v} \delta_{7i} \Delta \ln G_{t-i} + \rho_1 (\partial \ln FR)_{t-1} + \rho_2 (\ln F)_{t-1} + \rho_3 (\ln H)_{t-1} + \rho_4 (\ln T)_{t-1} + \rho_5 \left(\partial \ln \hat{q}_{t-1}\right) + \rho_6 (\partial \ln MR)_{t-1} + \rho_7 (\ln GIN)_{t-1} + \varepsilon_{1t} \quad (17)$$

$$\Delta \ln H_t = \eta_0 + \sum_{i=1}^{q} \eta_{1i} \Delta \ln H_{t-i} + \sum_{i=0}^{w} \eta_{2i} \Delta \ln F_{t-i} + \sum_{i=0}^{e} \eta_{3i} \Delta \ln FR_{t-i} + \sum_{i=0}^{r} \eta_{4i} \Delta \ln T_{t-i} + \sum_{i=0}^{t} \eta_{5i} \Delta\left(\partial \ln \hat{q}_{t-i}\right) + \sum_{i=0}^{y} \eta_{6i} \Delta \ln G_{t-i} +$$
$$\gamma_1 (\ln H)_{t-1} + \gamma_2 (\ln F)_{t-1} + \gamma_3 (\ln FR)_{t-1} + \gamma_4 (\ln T)_{t-1} + \gamma_5 \left(\partial \ln \hat{q}_{t-1}\right) + \gamma_6 (\ln GIN)_{t-1} + \varepsilon_{2t} \quad (18)$$

$$\Delta \ln RD_t = \partial_0 + \sum_{i=1}^{j} \partial_{1i} \Delta \ln RD_{t-i} + \sum_{i=0}^{k} \partial_{2i} \Delta \ln F_{t-i} + \sum_{i=0}^{l} \partial_{3i} \Delta \ln H_{t-i} + \sum_{i=0}^{m} \partial_{4i} \Delta \ln T_{t-i} + \sum_{i=0}^{n} \partial_{5i} \Delta\left(\partial \ln \hat{q}_{t-i}\right) + \sum_{i=0}^{o} \partial_{6i} \Delta \ln G_{t-i} +$$
$$\varphi_1 (\ln RD)_{t-1} + \varphi_2 (\ln F)_{t-1} + \varphi_3 (\ln H)_{t-1} + \varphi_4 (\ln T)_{t-1} + \varphi_5 \left(\partial \ln \hat{q}_{t-1}\right) + \varphi_6 (\ln G)_{t-1} + \varepsilon_{3t} \quad (19)$$

$$\Delta \ln PR_t = \ell_0 + \sum_{i=1}^{g} \ell_{1i} \Delta \ln PR_{t-i} + \sum_{i=0}^{h} \ell_{2i} \Delta \ln F_{t-i} + \sum_{i=0}^{j} \ell_{3i} \Delta \ln H_{t-i} + \sum_{i=0}^{k} \ell_{4i} \Delta \ln T_{t-i} + \sum_{i=0}^{x} \ell_{5i} \Delta\left(\partial \ln \hat{q}_{t-i}\right) + \sum_{i=0}^{z} \ell_{6i} \Delta \ln G_{t-i} +$$
$$\sigma_1 (\ln PR)_{t-1} + \sigma_2 (\ln F)_{t-1} + \sigma_3 (\ln H)_{t-1} + \sigma_4 (\ln T)_{t-1} + \sigma_5 \left(\partial \ln \hat{q}_{t-1}\right) + \sigma_6 (\ln G)_{t-1} + \varepsilon_{4t} \quad (20)$$

where IN is investment rate, F is financial deepening, H is human capital accumulation, T is trade openness, $\partial \ln \hat{q}$ is growth rate of income per capita, G is Gini coefficient, FR is fertility rate, MR is infant mortality rate, RD is relative redistribution, PR is property rights protection; while the $\beta's$, $\rho's$, $\gamma's$, $\varphi's$, and $\sigma's$ depict the long-run impacts, the $\alpha's$, $\delta's$, $\eta's$, $\partial's$, and $\ell's$ capture the short-run elasticities of the models. Also, Δ denotes the first difference operator, α_0, δ_0, η_0, ∂_0, and ℓ_0 are the drift components and, ε_{it} (for $i = 0,...4$) is white noise residual.

3.3 Techniques of Estimation and Method of Data Analysis

Discursively, in order to estimate the short-run and long-run elasticities coefficients of equations (14-20), a four-stage procedure was followed. In the first stage, the order of integration of the variables were determined using Augmented Dickey-Fuller (ADF) and the Phillips Perron (PP) unit root tests to avoid spuriousness of the empirical findings. In the second stage, following the literature, the structural lags were determined on the basis of Hannan-Quinn information criteria (HQ), the Akaike information criteria (AIC), the Schwarz information criteria (SIC), the Log Likelihood (LL) and the Final Prediction Error (FPE). This is important since, under parameterization would lead to a biased result and similarly, over-parameterization reduces the power of the tests. Following the suggestion of Granger (1988), in the third stage, a test of possible cointegrating relationship among the series was conducted. In the literature, several techniques are available for conducting cointegration tests. Generally used techniques comprise the residual based Engle-Granger (1987) test, Gregory and Hansen (1996), Johansen (1988), and Johansen-Juselius (1990). Of late, the proposed autoregressive distributed lag (ARDL) approach, developed by Pesaran and Shin (1995, 1998), Pesaran, Shin and Smith (1996, 2001) has become popular (Verma, 2007).

Basically, this study, following Hundie (2014), adopts the ARDL Bounds Testing Approach. This technique is based on the estimation of an Unrestricted Error Correction Model (UECM) which enjoys several advantages over the conventional type of cointegration techniques. Firstly, it can be applied irrespective of the order of integration (and in small samples) while other cointegration techniques require all variables be of equal degree of integration (and large samples) (Verma, 2007). Secondly, given the nature of interrelation among the growth rate of capital per worker, the growth rate of effective labour force, the growth rate of population, human capital accumulation, financial deepening, trade openness, and Gini coefficient, which are included in our models, the Bounds Testing Approach is suitable to address possible endogeneity problems. Thirdly, as noted by Pesaran and Shin (1998), appropriate modification of the orders of the ARDL model is sufficient to simultaneously correct the residual serial correlation and the problem of endogenous regressors (Samantaraya and Patra, 2014). Finally, the bounds testing is more robust and perform better for small sizes.

Hence, having estimated our UECM-ARDL models (14-20), the presence of cointegrating relationship among the variables was evaluated by testing for the joint significance of the estimated coefficients of the lagged levels of the variables in the equations (14-20) using the Wald test based on the standard F-statistic. The F-statistic values derived from this test were compared with two sets of critical values (lower and upper bound) for a given level of significance reported in Pesaran, Shin and Smith (2001) and Nayaran (2005) for large samples and small sample sizes, respectively. Notice that the upper bound values assume that the variables are I(1) while the lower bound values assume that all variables in our ARDL models are I(0). Thus, if the computed F-statistic is less than the lower bound value, the null hypothesis of no cointegrating is not rejected. On the contrary, if the computed F-statistics is greater than the upper bound value, it implies existence of long-run relationship among the variables. Finally, if the computed F- statistics lies between the lower bound and upper bound, long run association between the variables becomes inconclusive. Under the inconclusive cases, following Kremers, Ericsson and Dolado (1992) and Bannerjee, Dolado and Mestre (1998), the error correction term will be a useful way of establishing cointegration (Verma, 2007).

Once a long-run cointegrating relationship has been confirmed, hereafter in stage four, the long-run and short-run parameters associated with the ARDL models (14-20) were estimated. In addition, a variety of diagnostics and stability tests which will enhance the credibility of the ARDL models were carried out. In particular, in order to ensure that the models possess the desirable BLUE properties, different post-estimation diagnostic tests were carried out, including the Breusch-Godfrey serial correlation LM test, the ARCH heteroskedasticity test, the Jacque-Bera normality test and the Ramsey RESET specification test. The cumulative sum of recursive residuals (CUSUM) and the cumulative sum of recursive residual squares (CUSUMSQ) were also plotted to determine if the models are stable.

4. Empirical Results and Discussion

4.1 Descriptive Statistics, Unit Root, Optimal Lag Length Selection and Bounds Test Results

As a preliminary examination, before the detailed analysis and estimation of the ARDL models (14-20) were undertaken, the study analyzed the descriptive statistics of the variables under consideration. This is done in order to ascertain the statistical properties of the variables. The results obtained are presented in table 3 (in Appendix II). As it is depicted in the table, the mean and the median of all the variables in the data set displayed a high consistency as their mean and median values are within the minimum and maximum values of the series. Besides, all the data series have the values of their mean and median almost the same. This shows that the distribution is nearly symmetrical.

This is in line with the position of Karmel and Polasek (1980) that when a distribution is perfectly symmetrical, the mean, median and the mode must converge. Moreover, the low standard deviation of nearly all the data series indicates that the deviations of actual data from their mean values are very small. Further, the skewness statistic (a measure of asymmetry of the distribution of the series around the mean), kurtosis statistic (a measure of thickness of the tail of the distribution) and Jarque-Bera (JB) statistic which is used to test the null hypothesis where each variable is considered to have a normal distribution showed that all the variables are normally distributed. The normality is further buttressed by the nearness of the mean and median values for these series.

Following the examination of the descriptive statistics of the variables employed, in order to avert spurious results and also ensure that none of the variables are integrated of order two I(2), the study established the stationarity status of the employed variables. To this end, the study applied two types of formal tests, viz.: the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests to determine the order of integration of the series under consideration. The choice of these two tests statistics is informed by the fact that both tests control for higher-order autocorrelation. Both tests statistics were done for two alternative specifications at 10 percent, 5 percent and 1 percent level of significance. At the outset, it was tested with intercept but no trend, and then it was tested with both intercept and trend. The estimated results of the ADF and PP tests statistics are depicted in tables 4 and 5 (in Appendix II) respectively. As can be observed from the tables both tests consistently revealed that other than the growth rate of income per capita, growth rate of labour force and investment rate which are stationary at level, all other variables (income per worker, growth rate of population, financial deepening, human capital accumulation, trade openness, Gini Index, poverty incidence, fertility rate, mortality rate, relative redistribution and property rights protection) become stationary when converted to first differences, suggesting that each is integrated of order one, denoted as I (1), at 5 percent level of significance.

Having investigated the descriptive statistics and order of integration of the series, the study proceeded to determine the appropriate lag length incorporated for each variable in the ARDL models (14-20) on the basis of Hannan-Quinn information criteria (HQ), the Akaike information criteria (AIC), the Schwarz information criteria (SIC), the Log Likelihood (LL) and the Final Prediction Error (FPE). The results obtained are presented in table 6 (in Appendix II). To choose the appropriate lag length, Liew (2004) reasoned that the Akaike Information Criterion (AIC) and Final Prediction Error (FPE) are superior than the other criteria under study in the case of small sample (60 observations and below), in the manners that they minimize the chance of under estimation while maximizing the chance of recovering the true lag length. Hence, given that there were 49 observations, the optimal lag lengths 2 (for models 14-18) and 1 (for models 19-20) were carefully chosen.

Hereafter, with these maximum lag lengths setting, during the analysis 4,374 different ARDL models specifications for equation 14; 13,122 different ARDL models specifications for equation 15; 486 different ARDL models specifications for equation 16; 1,458 different ARDL models specifications for equation 17; 486 different ARDL models specifications for equation 18; 32 different ARDL models specifications for equation 19; and 32 different ARDL models specifications for equation 20 were considered and the most suitable model ARDL (2,0,2,1,0,0,0,0) for equation 14, ARDL (1,1,0,1,0,2,2,1,1) for equation 15, ARDL (2,0,2,2,2,1) for equation 16, ARDL (2,0,0,0,0,0,0) for equation 17, ARDL (1,0,0,0,0,2) for equation 18, ARDL (1,0,0,0,0,1) for equation 19, and ARDL (1,0, 1,0,0,0) for equation 20 were selected for this study. Figures 2-8 (in Appendix I) which provide graphs of the AIC of the top twenty models (for models 14-20 respectively) depict the relative superiority of the selected models against alternatives. After this, having estimated the selected ARDL models (14-20), tests of possible cointegrating relationship among the series were conducted. The results obtained are shown in table 7 (in Appendix II). All the tests were conducted at 5 percent level of significance. As evident from the table, in each case, the computed (*F*-statistics) is greater than upper bond values at 5 percent level of significance. Thus, the null hypotheses of no cointegrating relationship among the variables of interest were rejected.

Sequel to the establishment of the existence of cointegration relationship among the series, the long- and short-run elasticities coefficients associated with the ARDL models (14-20) were estimated. However, while the results of the estimated long-run parameters of the selected models are presented in table 8 (in Appendix II), the study did not find any consistent estimated short-run dynamics associated with the long-run parameters obtained from the models. As such, they are not presented here in order to conserve space. It is worth noting that, for the purpose of comprehension, columns (I) and (II) of table 8 depict the long-run estimates of the impact of income inequality on economic growth (i.e. models 14 and 15), while columns (III-VII) of the table present the long-run elasticities coefficients of the five distinct transmission channels (i.e. models 16-20), through which inequality impacts growth.

4.2 Long-Run Estimates of the Impacts of Income Inequality on Economic Growth

Regarding the impacts of income inequality on economic growth, as can be seen from column (I) of table 8, the parameter estimate of Gini index has expected sign and is statistically significant. Precisely, in the long run, holding other things constant, a one percentage point increase in inequality in the distribution income will bring about 2.7023664 decrease in economic growth. In specification 2 (model 15), as previously stated, in an attempt to conduct the estimation of econometric model (14), it is likely that income inequality specified in the model captures the impact of poverty on growth. Thus, the study controlled for poverty incidence in a separate regression. Hence, in model (15), a measure for poverty incidence proxied by headcount ratio is incorporated as an additional term in order to capture the true growth impacts of income inequality. From the estimated model 15 (specification 2), an insight from the estimated long-run parameters obtained suggests that as the level of poverty incidence persists unabated, undoubtedly, the impact of inequality in the distribution income on long-run growth worsens in Nigeria. As can be observed from column (II) of table 8, the elasticities coefficients of both poverty incidence proxied by headcount ratio and Gini index are negative and highly statistically significant. Intrinsically, ceteris paribus, a one percentage point increase in both poverty incidence and Gini coefficient respectively will bring about 5.047328 and 6.93779 decrease in the long-run economic growth. Similar findings were also observed in Shin (2012), Herzer and Vollmer (2012), Wahiba and El Weriemmi (2013), Fawaz, Rahnama, and Valcarcel (2014), Cingano (2014), Ostry, Berg, and Tsangarides (2014), Darma and Ali (2014), Bagchi and Svejnar (2015), Njindan Iyke and Ho (2017), and Lahouij (2017).

With regards to the control variables, as evident in both columns (I) and (II) of table 8, the growth rate of labour force and human capital accumulation significantly enhanced the growth rate of income per capita as anticipated. Their estimated parameters have expected signs and are highly statistically significant, suggesting that labour force equipped with proper education and training, balanced health facilities and assisted by necessary tools and implements, is a vital determinant of long-run growth in Nigeria. This result is consistent with economic theory and validates the empirical findings of Raleva (2014) for the case of Bulgaria, and Hundie (2014) for the case of Ethiopia. More so, as depicted in both columns (I) and (II) of table 8, the elasticity coefficient of the growth rate of population is positive but statistically insignificant, signifying that a carefully planned population growth strategy combined with institutional and policy changes will be advantageous to long-run growth in Nigeria. In the same way, vis-à-vis the impact of financial deepening on growth, an insight from the results obtained suggest that while the financial system has grown enormously in size and structure in Nigeria, however, this has not been translated to the provision of credits and loans, in particular, to the real sector of the economy. As can be seen from columns (I) and (II) of table 8, the elasticities coefficient of financial deepening is positive but statistically insignificant. Similar findings were also observed in Igwe, Edeh, and Ukpere (2013).

In addition, on the impact of trade openness (proxy as trade share in GDP) on growth, as can be seen from the results depicted in columns (I) and (II) of table 8, the elasticity coefficients have a significant and negative impact on long-run growth in Nigeria. As shown in the table, premised on the estimated parameters, keeping all else constant, for a one-percentage point increase in trade openness, as evident in models 14 and 15 respectively, 7.023664 and 8.070993 decline are induced in the long-run economic growth. This evidence of negative impact of trade openness on growth indubitably depicts the Nigerian economy where the volume of import is skewed towards semi processed goods deviously packed as raw materials and export is dominated by crude oil, the price and quantity of which is determined on the global market and has little or no connection to economic reality. Similar results were obtained in Olufemi (2004). As well, in line with the theoretical explanations of convergence hypothesis, the coefficient of income per worker is positive and statistically significant as anticipated. As can be observed, the parameter estimates of income per worker has expected sign and is statistically significant. This result lends credence to the empirical findings of Chletsos and Fatouros (2016).

4.3 Long-Run Estimates of the Transmission Channels of Income Inequality to Economic Growth

With respect to the channels through which inequality impacts growth, in order to provide an intuitive insight to the classical economists and modern expositions predictions of some of the distinct transmission channels, the long-run parameters associated with the models (16-20) were estimated. The results obtained are shown in table 8. As can be seen from the table, columns (III-VII) respectively depicts the investment, fertility rate, human capital accumulation, relative redistribution and property rights protection channels. In all the five specifications, as depicted in the table, the elasticity coefficients of Gini index have the expected signs and are highly statistically significant. As evident from the table, all other things being equal, in the long run, a one percentage point increase in income inequality will bring about 0.654663 and 0.714514 increases in fertility rate and relative redistribution respectively. By contrast, as evident in models 16, 18 and 20, for a one percentage point increase in income inequality, 0.015552, 0.652238 and 0.181760 declines are induced in investment rate, human capital accumulation, and property rights protection respectively. In essence, premised on the estimated parameters, an upsurge in income inequality increases fertility rate and relative redistribution, but lessens investment rate, human capital accumulation, and property rights protection, which may in turn impede long-run growth in Nigeria. Hence, these findings not only corroborate the theoretical predictions of modern perspective exposition, which underscored the potential adverse impacts of income inequality on economic growth, but also invalidate the classical and neoclassical economists' predictions.

4.4 Stability and Diagnostic Tests

Following the long- and short-run estimations of the elasticities coefficients associated with the ARDL models (14-20), in order to check the robustness of the estimated regression results, the study carried out different post-estimation diagnostic tests. The results of the respective diagnostic test, in each case, are depicted in table 9 (in Appendix II). As can be observed, the residuals of the models are serially uncorrelated, normally distributed and homoscedastic. Indeed, the estimated results are devoid of econometric problems of auto-correlation, mis-specification and heteroskedasticity. In addition, since the ARDL models (14-20) were estimated by simple least squares, all of the views and procedures available to equation objects estimated by least squares are also available for the ARDL models. As such, the R^2, Adjusted R^2, F-statistic and Durbin-Watson statistic in each case for the selected ARDL models are depicted in the lower segment of the table 8. All the tests revealed that the models have the desirable BLUE properties. As can be seen from the lower segment of the table 8, the F-statistic which measures the overall significance of the estimated models were statistically significant, suggesting that models are fit and suitable for the empirical estimations. Also, as can be observed the explanatory power (the R^2) of the models are high.

Moreover, the Adjusted R^2 which measures the share of variation jointly explained by the explanatory variables after the effects of insignificant regressors have been removed are also high. As well, the Durbin-Watson statistic which is used to test for autocorrelation of residuals in the models, particularly, the first order autocorrelation displayed the absence of serial autocorrelation. Finally, as suggested by Brown, Durbin and Evans (1975), the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of recursive residual squares (CUSUMSQ) were also plotted to determine if the models were stable. A graphical presentation of this test for the selected ARDL models is depicted in figures 9-22 (in Appendix I). As can be seen from the graphs, the results evidently indicate the absence of instability of the estimated coefficients because the plot of the *CUSUM and CUSUMSQ* statistic(s) is within the confines of the 5 percent critical bounds.

5. Conclusion

The debate on whether income inequality promotes, restricts, or is independent of economic growth has been widely studied and discussed in development economics discourse. However, a careful reading of this extensive extant and burgeoning literature suggests that, other than the ambivalent nature and the fact that the bulk of these studies relied heavily on cross-section/-country/panel econometric analysis, empirical studies examining the nexus in the context of less developed economies, particularly, African countries, has received less attention, as most of the extant studies predominantly focused on developed economies. This current study, thus, attempts to examine the impact of inequality on growth in Nigeria spanning between the period 1970 and 2018. It also examined the theoretical predictions of the classical economists and modern expositions predictions of some of the distinct transmission channels through which inequality impacts growth. Time series econometrics were applied. The results obtained consistently revealed that inequality hurts long-run growth in Nigeria. Also, the results obtained revealed that inequality in income increases relative redistribution and fertility, but lessens investment, gross enrollment ratio, and property rights protection in Nigeria, which may in turn impede growth. Hence, these findings not only corroborate the theoretical predictions of modern perspective exposition, which underscored the potential adverse impacts of income inequality on economic growth, but also invalidate the classical and neoclassical economists' predictions.

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Appendix I

Channels through Which Inequality Can Affect Growth Classical Approach

Keynes (1920), Kaldor (1956), Bourguignon (1981)
↓
High initial income inequality
↓
Higher aggregate saving (marginal propensity to save
↓
High capital accumulation
↓
High economic growth

Modern Approaches

Persson and Tabellini (1991); Alesina and Perotti (1993);
Alesina and Rodrigo (1994); Keefer and Knack (2000)
High initial income inequality

↓	↓	↓	↓
High rent seeking activities	Social tension and political instability	Poor median voter Imperfect	Co-existing credit market

Figure 1. The classical and modern expositions views of the impact of inequality on growth

Source: Adapted from Tabassum and Majeed (2008)

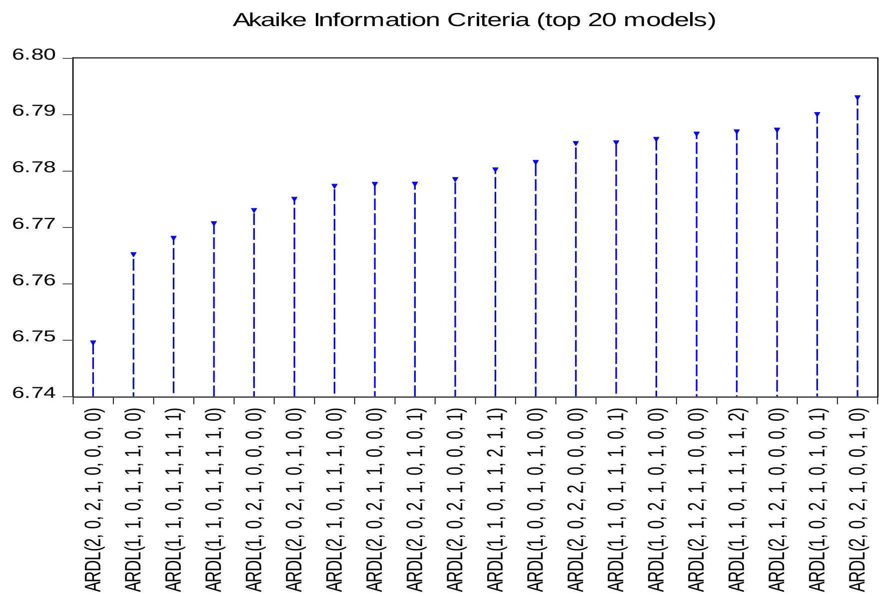

Figure 2. Model Selection Graph (Summary of the top 20 models selection) for Model 14

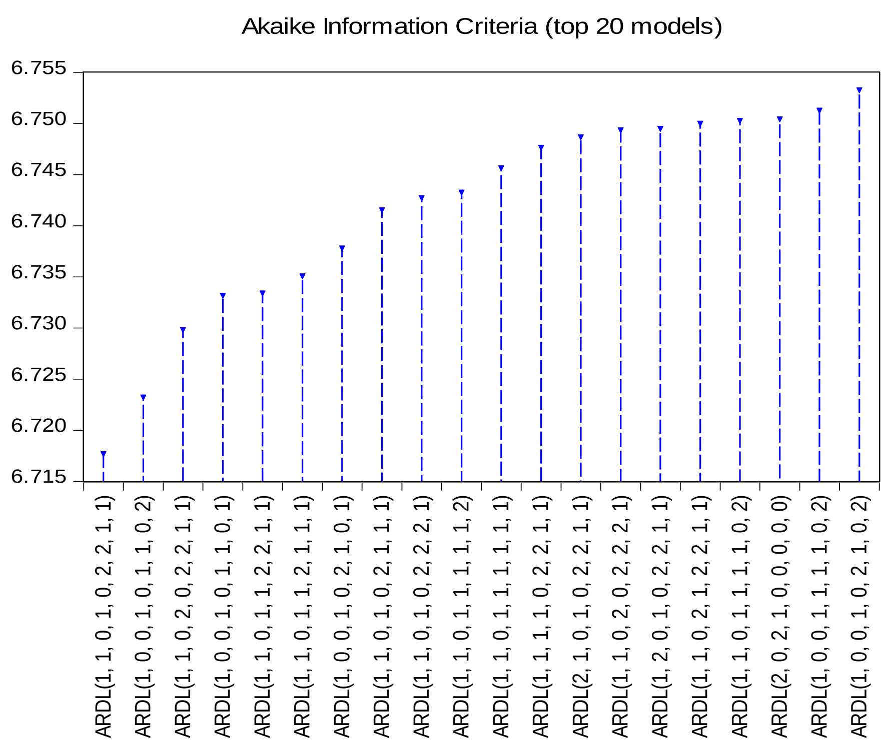

Figure 3. Model Selection Graph (Summary of the top 20 models selection) for Model 15

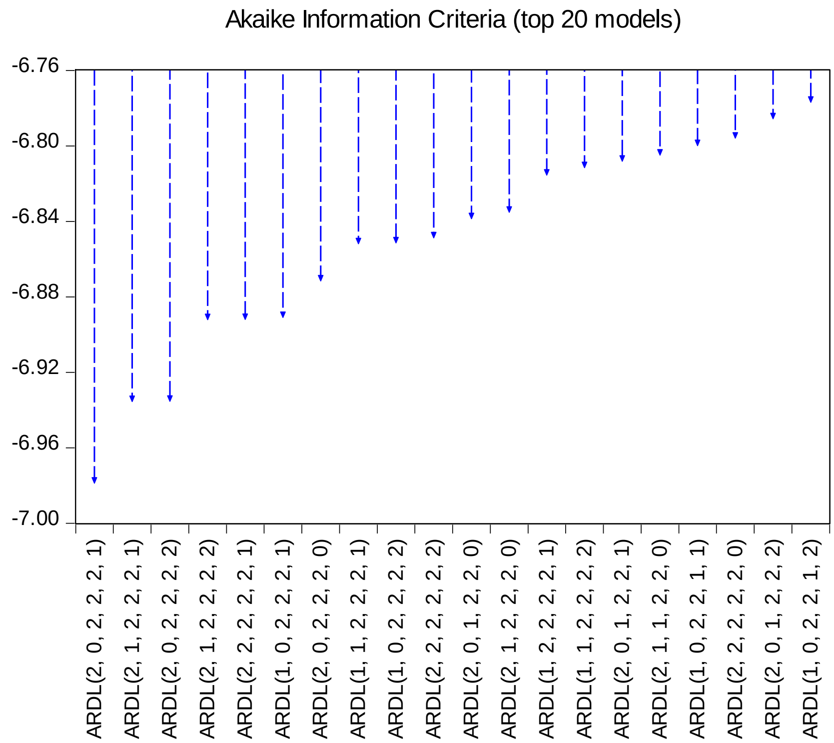

Figure 4. Model Selection Graph (Summary of the top 20 models selection) for Model 16

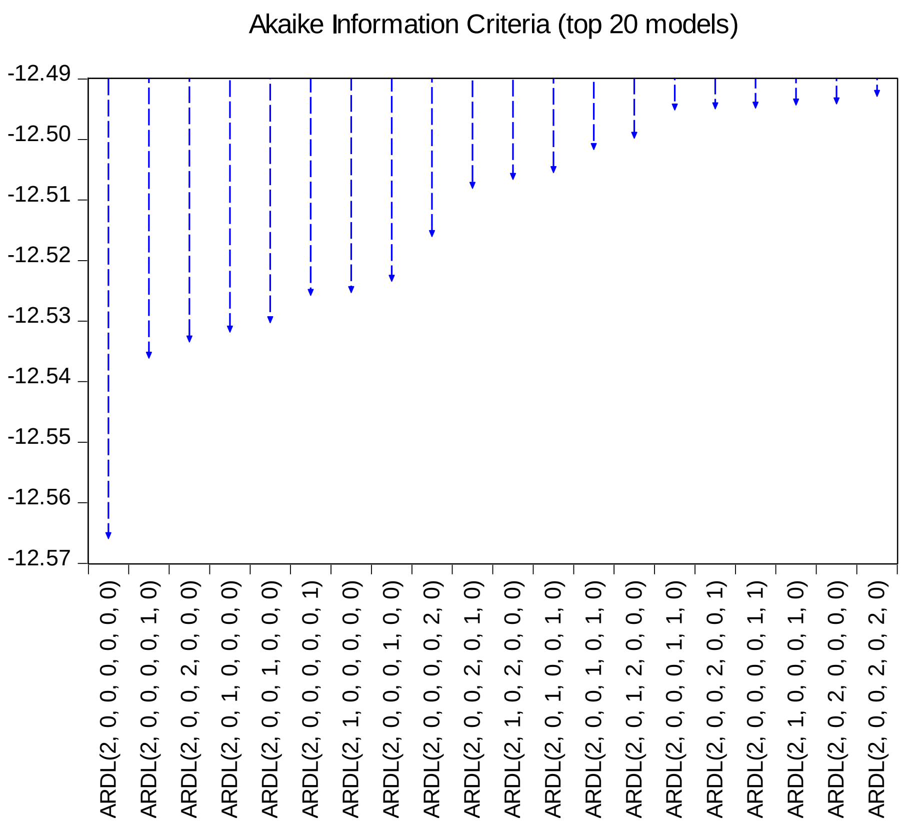

Figure 5. Model Selection Graph (Summary of the top 20 models selection) for Model 17

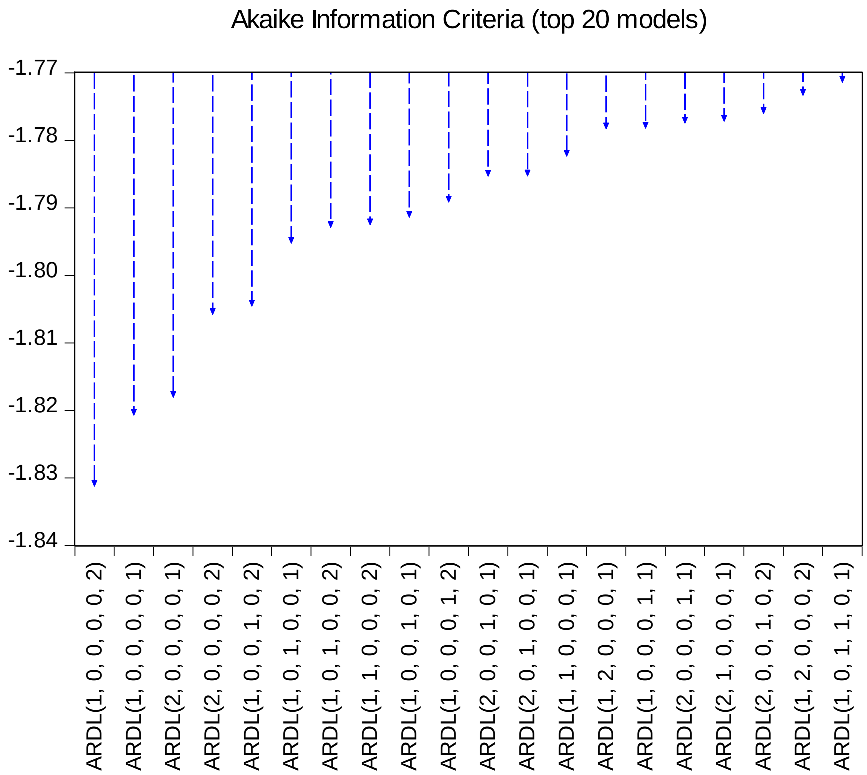

Figure 6. Model Selection Graph (Summary of the top 20 models selection) for Model 18

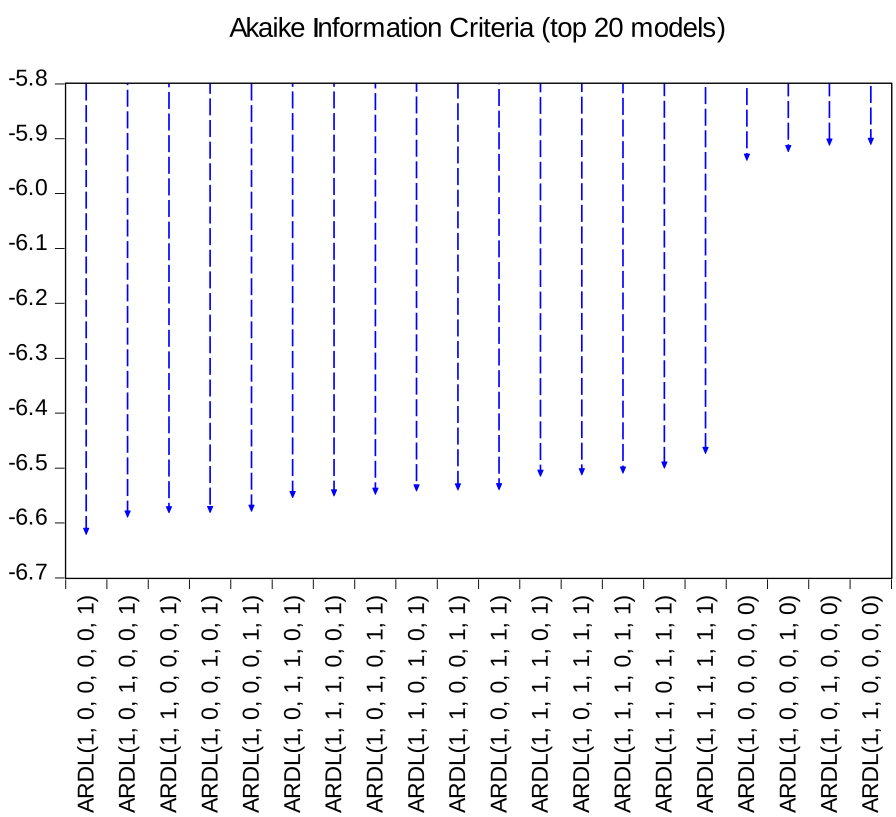

Figure 7. Model Selection Graph (Summary of the top 20 models selection) for Model 19

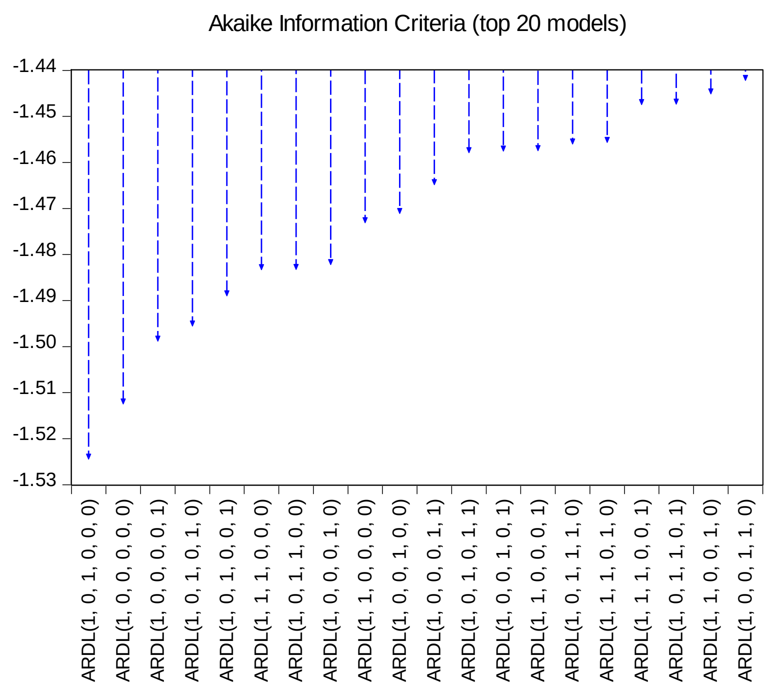

Figure 8. Model Selection Graph (Summary of the top 20 models selection) for Model 20

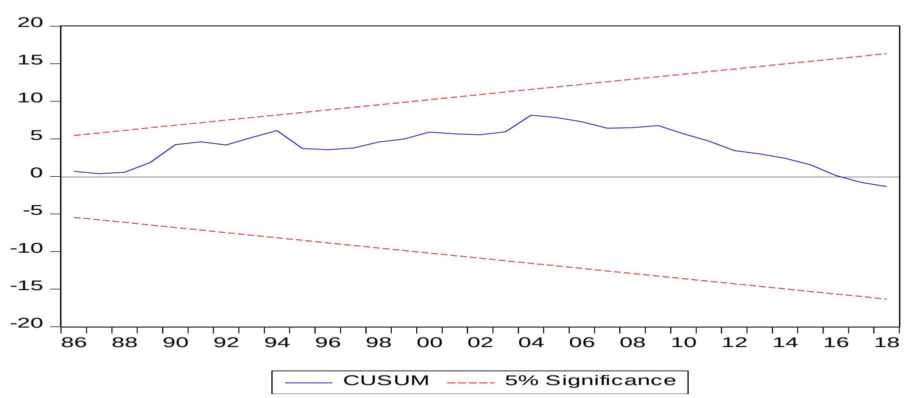

Figure 9. Plot of Cumulative Sum of Recursive Residuals CUSUM (Stability Test) for Model 14

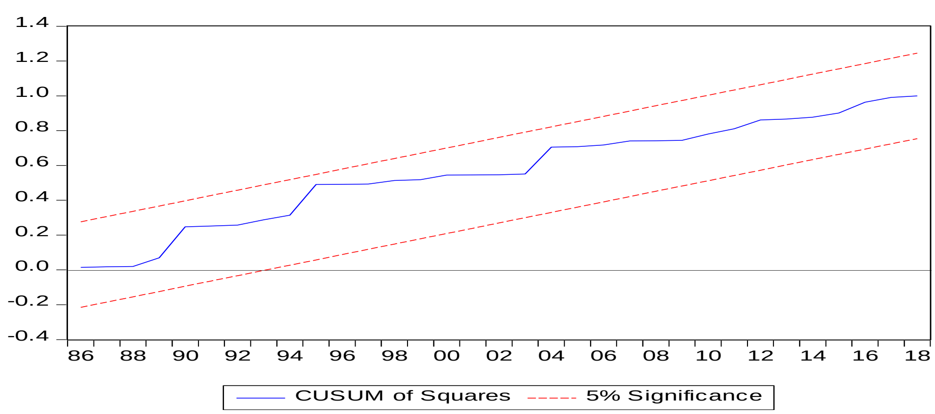

Figure 10. Plot of Cumulative Sum of Squares of Recursive Residuals CUSUMQ (Stability Test) for Model 14

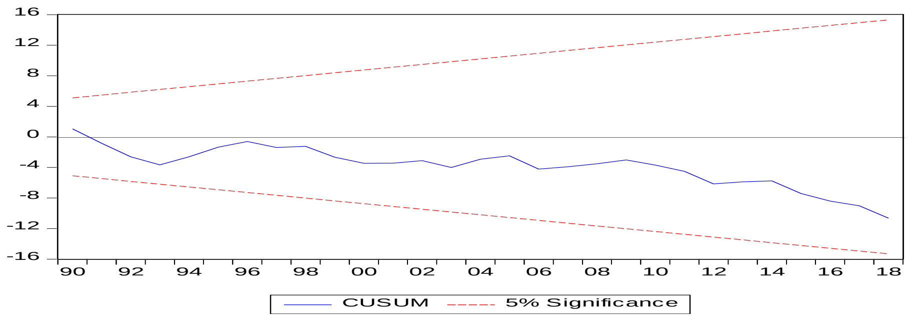

Figure 11. Plot of Cumulative Sum of Recursive Residuals CUSUM (Stability Test) for Model 15

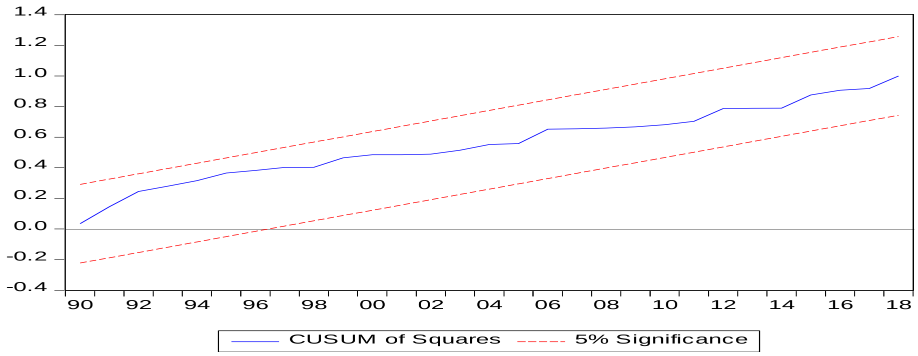

Figure 12. Plot of Cumulative Sum of Squares of Recursive Residuals CUSUMQ (Stability Test) for Model 15

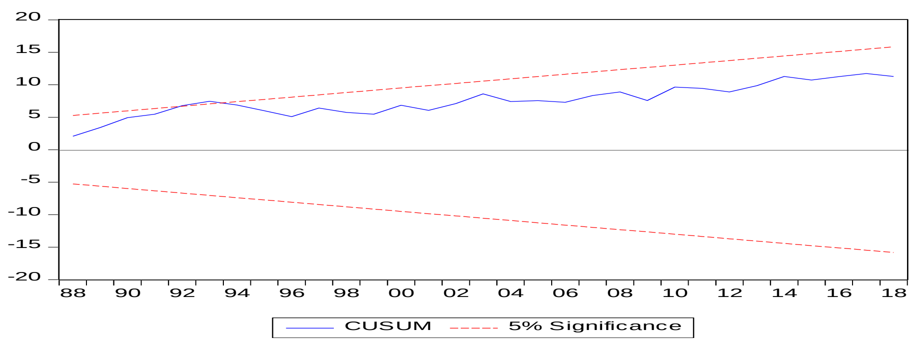

Figure 13. Plot of Cumulative Sum of Recursive Residuals CUSUM (Stability Test) for Model 16

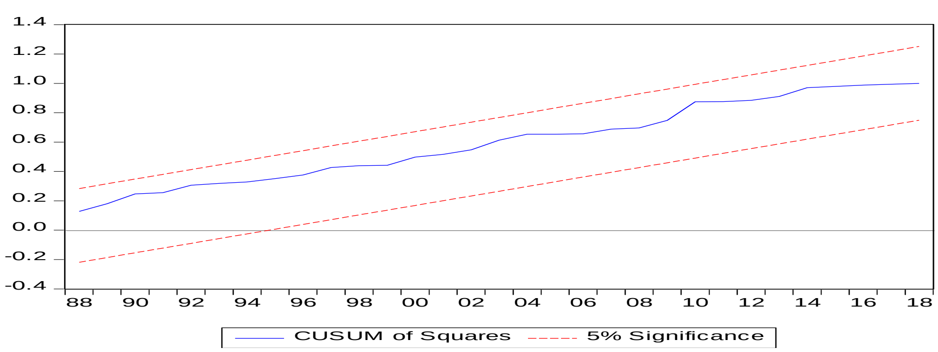

Figure 14. Plot of Cumulative Sum of Squares of Recursive Residuals CUSUMQ (Stability Test) for Model 16

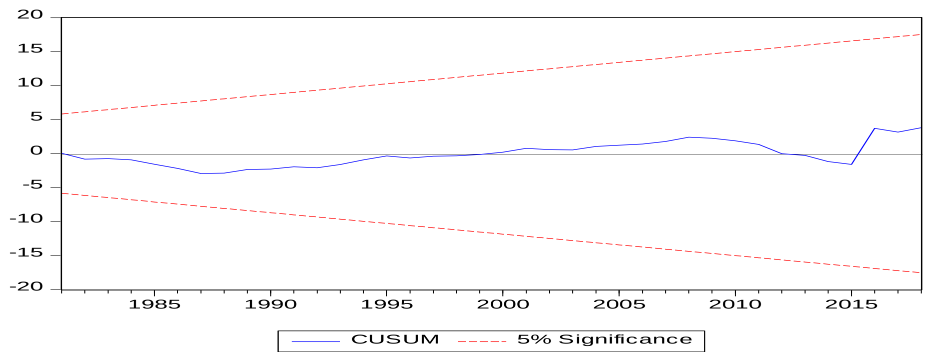

Figure 15. Plot of Cumulative Sum of Recursive Residuals CUSUM (Stability Test) for Model 17

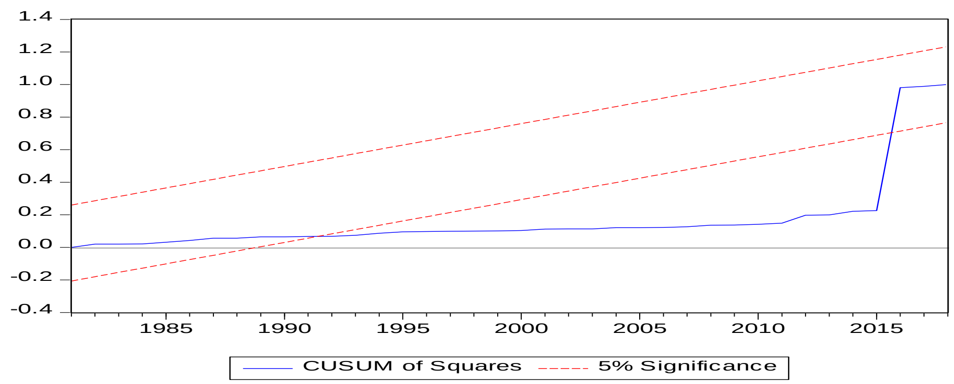

Figure 16. Plot of Cumulative Sum of Squares of Recursive Residuals CUSUMQ (Stability Test) for Model 17

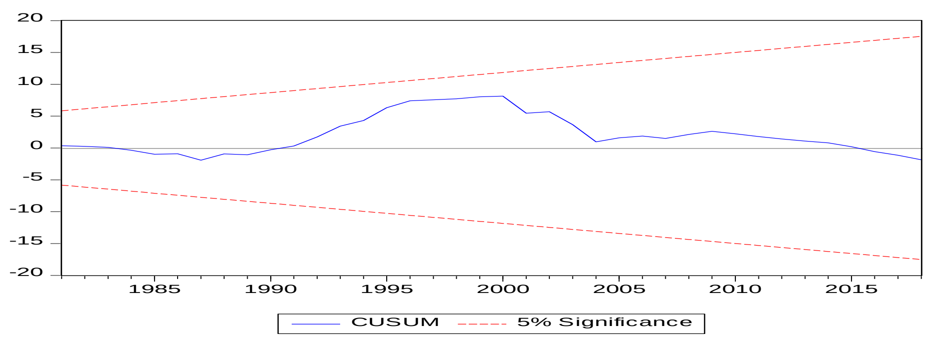

Figure 17. Plot of Cumulative Sum of Recursive Residuals CUSUM (Stability Test) for Model 18

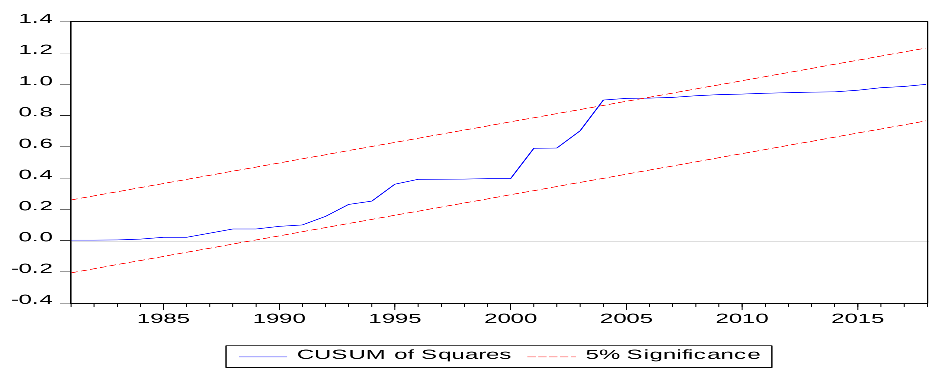

Figure 18. Plot of Cumulative Sum of Squares of Recursive Residuals CUSUMQ (Stability Test) for Model 18

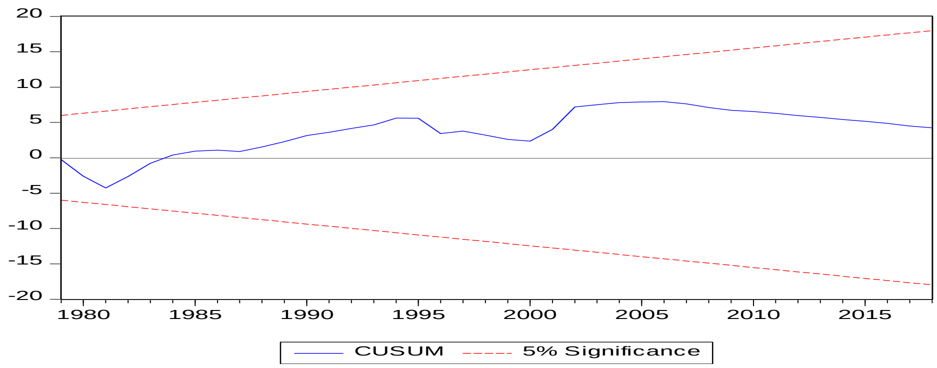

Figure 19. Plot of Cumulative Sum of Recursive Residuals CUSUM (Stability Test) for Model 19

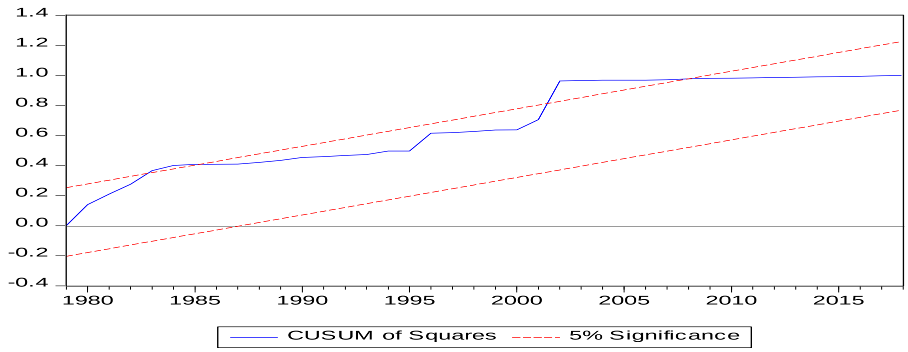

Figure 20. Plot of Cumulative Sum of Squares of Recursive Residuals CUSUMQ (Stability Test) for Model 19

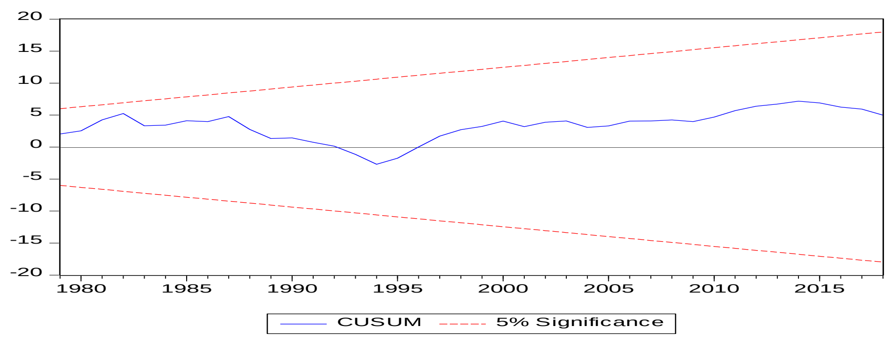

Figure 21. Plot of Cumulative Sum of Recursive Residuals CUSUM (Stability Test) for Model 20

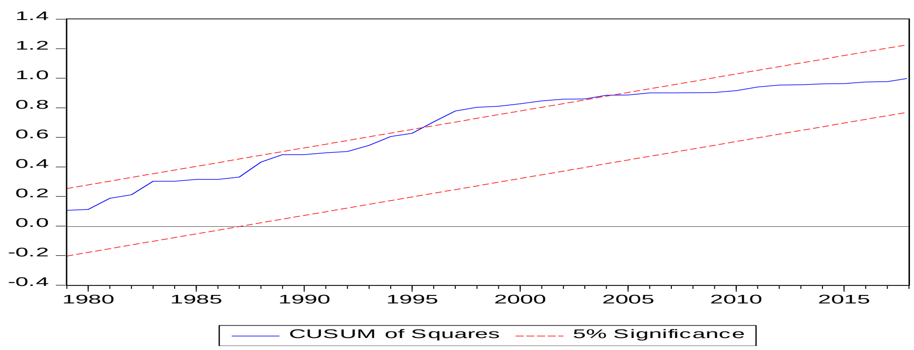

Figure 22. Plot of Cumulative Sum of Squares of Recursive Residuals CUSUMQ (Stability Test) for Model 20

Appendix II

Table 1. An overview and synopsis of the existing literature on the impact of income inequality on economic growth

Author	Samples	Data Structure	Distribution	Inequality measure	Income Inequality	Estimation	Empirical findings
Alesina and Rodrik (1994)	46/70 countries 1960-1985	Cross- section	Income, Land	Gini Coefficient	Jain Fields	OLS, 2SLS	Income: Negative for the whole sample; Negative in democracies and non-democracies; Insignificant when income and land inequality are considered simultaneously; Land: Negative for the whole sample
Persson and Tabellini (1994	56 countries 1960-1985	Cross-section	Income	Share of the fourth quintile	Paukert	OLS, 2SLS	Negative for the whole sample; Negative in democracies and insignificant in non-democracies
Clarke (1995)	74/81 countries 1970-1978	Cross-section	Income	Gini., Coef. of var., Theil, 4th quintile sh.	UN Social indicators	OLS, WLS, 2SLS	Negative for the whole sample; Negative in democracies and non-democracies
Perotti (1996)	67 countries 1960-1985	Cross-section	Income	Share of the 3th and 4th quintiles	Jain Lecaillon	OLS, WLS	Negative for the whole sample; Insignificant when regional dummies are added; negative in democracies and nondemocracies; negative in rich and insignificant in poor countries
Birdsall and Londono (1997)	43 countries 1960-1992	Cross-section	Income, land and Human capital	Gini coefficient	Deininger and Squire	OLS	Income: Negative for the whole sample; Insignificant when income, land and human capital inequality are considered simultaneously; Land and human capital: Negative for the whole sample, even when income, land and human capital inequality are considered simultaneously
Deininger and Squire (1998)	66/87 countries 1960-1992	Cross-section	Income, Land	Gini coefficient	Deininger and Squire	OLS	Income: Negative for the whole sample; Insignificant when regional dummies are added; Land: Negative for the whole sample; Insignificant in democracies and negative in non-democracies; Insignificant in rich and negative in poor countries
Li and Zou (1998)	46 countries 1960-1990	Panel	Income	Gini coefficient	Deininger and Squire	FE, RE	Positive for the whole sample

Author	Samples	Data Structure	Distribution	Inequality measure	Income Inequality Data Set	Estimation method	Empirical findings
Deininger and Olinto (1999)	60 countries, 1966-1990	Panel	Income	Gini coefficient	Deininger and Squire	System GMM	Negative impact of land inequality and positive impact of income inequality on economic growth
Deininger and Olinto (2000)	31/60 countries 1966-1990	Panel	Income, Land	Gini coefficient	Deininger and Squire	System GMM	Income: Positive when income and land inequality are considered simultaneously; Land: Negative for the whole sample
Forbes (2000)	45 (mid-high inc) countries 1966-1995	Panel	Income	Gini coefficient	Deininger and Squire	First-diff GMM	Positive in high and mid-income countries
Mo (2000)	20 countries, 1970-1985	Panel	Income	Gini coefficient	Deininger and Squire	2SLS	Negative relationship
Barro (2000)	84 countries 1965-1995	Panel	Income	Gini coefficient	Deininger and Squire	3SLS	Insignificant for the whole sample; Positive in rich and negative in poor countries
Castellò and Domenéch (2002)	67/83 countries 1960-1990	Cross-section	Income, Human capital	Gini coefficient	Deininger and Squire, Barro and Lee	OLS	Income: Negative for the whole sample; Insignificant when regional dummies are added; Positive when income and human capital inequality are considered simultaneously; Human Capital: Negative for the whole sample, even when income and human capital inequality are considered simultaneously
Balisacan and Fuwa (2003)	Philippines, provincial data, 1988-1997	Cross-section	Land	Gini coefficient	Census of Agriculture National Statistics Office	OLS, IV	Positive relationship
Gylfason and Zoega (2003)	87 countries, 1965-98	Cross-section	Income	Gini coefficient	Deininger and Squire	SUR	Negative relationship
De La Croix and Doepke (2003)	68 countries, 1960-1992	Panel	Income	Gini coefficient	Deininger and Squire	Difference GMM	Negative relationship, which becomes nonsignificant if fertility rate is taken into account
Chen (2003)	54 countries 1970-1992	Panel	Income	Gini coefficient	Deininger and Squire, Barro and Lee	OLS	Inverted-U relationship

Author	Samples	Data Structure	Distribution	Inequality measure	Income Inequality Data Set	Estimation method	Empirical findings
Banerjee and Duflo (2003)	45 countries 1965-1995	Panel	Income	Gini coefficient	Deininger and Squire	Fixed,Random,Panel ; First Difference; Arellano and Bond	Negative effect on growth resulting from changes in inequality in any direction
Pagano (2004)	40 countries, 1950-1990	Panel	Income	Gini coefficient	Dollar and Kraay, UNU-WIDER	Difference and system GMM	Positive relationship in rich countries, negative relationship in poor ones
Iradian (2005)	82 countries, 1965–2003	Panel	Income	Gini coefficient	PRSPs, WDI, IMF, OECD	FE and difference GMM	Positive relationship in the short-medium term, which becomes negative in the long term
Knowles (2005)	40 countries 1960-1990	Cross-section	Income	Gini coefficient	Deininger and Squire	OLS	Negative for the whole sample; Insignificant for high/midincome countries and negative for low-income countries; Insignificant for gross-income and negative for expenditures
Voitchovsky (2005)	21 (developed) countries 1975-2000	Panel	Income	Gini coefficient; 90/75 and 50/10 ratios	Luxembourg Income Study	System GMM	Insignificant considering aggregate inequality; Positive at the top of inequality distribution; Negative at the bottom of inequality distribution
Wan, Lu and Chen (2006)	China, 29 regions, 1987-1998	Cross-section	Income	Urban-rural per capita income ratio	UNUWIDER World Income Inequality Database.	Polynomial Inverse Lag Model, 3SLS	Negative nonlinear relationship
Easterly (2007)	100 countries, 1960-1998	Panel	Income	Gini coefficient, share of top income quintile	UNUWIDER World Income Inequality Database.	OLS, IV	Negative relationship
Sukiassyan (2007)	26 transition economies, 1988-2002	Panel	Income	Gini coefficient	TransMONEE 2004 Database, World Bank Poverty Monitoring Indicators 2004 Database (PMI), and WIID	OLS and difference GMM with Gini squared among the covariates	Negative relationship

Author	Samples	Data Structure	Distribution	Inequality measure	Income Inequality Data Set	Estimation method	Empirical findings
Noh and Yoo (2008)	60 countries, 1995-2002	Panel	Income	Gini coefficient	UNU-WIDER	FE	Positive relationship
Barro (2008)	47-70 countries, 1965-2003/4	Panel	Income	Gini coefficient	WIID	OLS	Positive relationship in rich countries, negative relationship in the poor ones.
Lin and Yeh (2009)	83 countries, 1965-2003	Panel	Income	Gini coefficient	PRSPs, WDI, IMF, OECD	SEM, difference GMM	Negative relationship
Chambers and Krause (2010)	54 countries, 1960-2000	Panel	Income	Gini coefficient	UNUWIDER World Income Inequality Database.	Local Linear Least Squares, Gaussian kernel	Negative relationship
Castellò (2010)	102/56 countries 1960-2000	Panel	Income, Human capital	Gini coefficient, Distribution of education by quintiles	UNUWIDER Luxembourg Income Study	System GMM	Income: Negative for the whole sample; Negative for poor and positive for rich countries; Human Capital: Negative for the whole sample; Negative for poor and inconclusive for rich countries
Grijalva (2011)	100 countries, 1950-2007	Panel	Income	Gini coefficient	UNUWIDER World Income Inequality Database.	FE, RE, difference and system GMM	Inverted "U" relationship the short and medium term (5-10 years). In the long term the results confirm Barro (2008
Herzer and Vollmer (2012)	46 countries, 1970-1995	Panel	Income	Gini coefficient	Deininger and Squire	Panel cointegration	Negative relationship
Ravallion (2012)	90 countries, 1980-2005	Panel	Income	Gini coefficient	Deininger and Squire	Difference GMM	Inequality does not have a statistically significant impact on growth once we control for initial poverty
Assa (2012)	141 countries, 1998-2008	Panel	Income	Gini coefficient	WDI	OLS, 2SLS	Negative relationship in the developing countries, less evident in the advanced economies

Author	Samples	Data Structure	Distribution	Inequality measure	Income Inequality Data Set	Estimation method	Empirical findings
Ostry, Berg and Tsangarides (2014)	90 countries 1960-2010	Panel	(Market and disposable) Income	Gini coefficient	SWIID	System GMM	Look at both net inequality and redistribution (the difference between market and disposable income inequality). Inequality is estimated to have a negative effect on growth, redistribution is not significant.
Halter, Oechslin and Zweimuller (2014)	90 countries 1966-2005	Panel	Income	Gini coefficient	Deininger and Squire, UNUWIDER	System GMM, First-diff GMM	First-diff GMM: positive link in whole and in sub-samples by income. System GMM: positive in rich and negative in poor countries
Bagchi and Svejnar (2015)	41 countries, 2015 1987-2002	Panel	Income, Wealth	Gini coefficient	A wealth inequality index derived by Forbes magazine's list of billionaires, UNUWIDER	RE, FE, IV	Negative relationship
Chletsos and Fatouros, N. (2016)	126 countries (1968-2007)	Panel	Income	Theil Index	Estimated Household Income Inequality Data Set (EHII)	FE, GMM, 2SLS	Positive relationship
Islam (2017)	Single Country (1960-2015)	Time Series	Income	The market Gini coefficients and the top 1 percent income shares	The Standardized World Income Inequality Database, SWIID,of Solt （2016）	ARDL, DOLS, FMOLS and Canonical Cointegrating Regression CCR）	Negative relationship
Naguib (2017)	146 countries, 2010-2014	Panel	Income, Wealth	Gini coefficient	SWIID, Credit Suisse Research Institute	Arellano- Bond GMM	Positive relationship though not robust to different model specifications
Joshi (2018)	24, Indian States	Cross-country	Income	Gini coefficient	Pal and Pal (2012)	OLS	Posittive relationship

Source: Adapted and Updated from Cingano (2014)

Table 2. Data Sources, Description and Justification of Variables

Variable	**Proxy**	**Sources**	**Justifications**
Economic Growth	RGDP per capita growth (annual %)	World Development Indicators (2019)	Devarajan, Swaroop and Zou (1996), Loayza and Ranciere (2004), El-Wassal (2012), Andreano, Laureti, and Postiglione (2013), Naguib (2017).
Income (Output) per worker	GDP per person employed (constant 2011 PPP $)	World Development Indicators (2019)	Mody and Aiyar (2011);Van der Ven, and Smits (2011); Chletsos and Fatouros (2016); Kazbekova (2018)
Labour Force	Growth rate of the labour force (%)	Penn World Table 9.0	Denton and Spencer (1997), Raleva (2014), Njindan Iyke and Ho (2017), Mbarek, Saidi, and Rahman (2018)
Population	Growth rate of the population (%)	World Development Indicators (2019)	Ram (1984); Cincotta and Engelman (1997); Klasen and Lawson (2007); Rehman, Khan and Ahmed (2008); Odusola, Mugisha, Workie, and Reeves (2017)
Financial Deepening	The ratio of broad money to GDP	Central Bank of Nigeria Statistical Bulletin (2019)	Patrick (1966),Shaw (1973), McKinnon (1973, 2010), Luintel and Khan (1999), Kirkpatrick, Sirageldin, and Aftab (2000), Ghildiyal, Pokhriyal, and Mohan (2015).
Human Capital Accumulation	Gross Enrollment Ratio	World Development Indicators (2019)	Romer (1989, 1990), Mankiw, Romer, and Weil (1992), Islam (1995), Adawo (2011), Sieng and Yussof (2014), Amir, Khan, and Bilal (2015)
Trade Openness	The ratio of sum of exports and imports to GDP	Central Bank of Nigeria Statistical Bulletin (2019)	Majeed (2010); Lim and McNelis (2014); Lai, Tan, Ong, and Lee (2015); Oloufade (2012); Lahouij (2017).
Income Inequality	Gini Coefficient	United Nations University World Income Inequality Database WIID 3.4	Alesina and Rodrik (1994), Deininger and Squire (1998), Forbes (2000), Barro (2000, 2008),Ostry et al, (2014).
Poverty Incidence	The headcount ratio (per capita final consumption expenditure)	Central Bank of Nigeria Statistical Bulletin (2019)	Ravallion (1997, 2017); Quartney (2005); Odhiambo (2009); Ho, and Odhiambo, (2011); Kar, Agir, and Peker (2011); Nindi and Odhiambo (2015).
Investment Rate	The ratio of fixed investment to GDP	United Nations Statistics Division National Accounts Main Aggregates Database (2019)	Barro (2000); Banerjee (2004); Ehrhart (2009); Er, Tugcu, and Coban (2014); Dabús and Caraballo (2014); Lahouij (2017)
Total Fertilty Rate	Fertility Rate (The average number of children that would be born to a woman over her lifetime)	World Development Indicators (2019)	Galor and Zang (1997); De La Croix and Doepke (2003); Li and Zhang (2007); Schultz (2008); Macan and Deluna (2013); Charles-Coll, Granados, and De la Garza Ramos (2015).
Mortality Rate	Infant Mortality Rate (The number of deaths of children under one year of age per 1000 live births)	World Development Indicators (2019)	Deaton (2003); Deaton and Paxson (2004); Rebeira, Grootendorst, Coyte and Aguirregabiria (2017); Lahouij (2017); Ray and Linden (2018).
Relative Redistribution	The ratio of the difference between market Gini and net Gini to the market Gini	Standardized World Income Inequality Database (SWIID, 2019)	Shin (2012); Dahlby and Ferede (2013); Delbianco, Dabús and Caraballo (2014); Luebker (2014); Gründler and Scheuermeyer (2015); Islam (2017).
Property rights protection	Fraser Institute's Legal structure and security of property rights index (Economic Freedom of the World Index, EFW)	Fraser Institute, Vancouver - James Gwartney, Robert Lawson, Michael Walker, Walter Block, Stephen T. Easton	Sonin (1999, 2003); Gradstein (2007); Besley and Ghatak (2010); Locke (2013); Amendola, Easaw, and Savoia (2013); Islam (2017).

Source: Author's computation (2019)

Table 3. Descriptive Statistics of Data Series

	$\partial \ln \hat{q}$	$\ln q$	$\partial \ln L$	$\partial \ln N$	$\ln F$	$\ln H$	$\ln T$	$\ln G$	$\ln P$	$\partial \ln FR$	$\partial \ln MR$	$\ln PR$	$\partial \ln IN$	$\ln RD$
Mean	1.263601	9.71338	0.02119	-0.0272	3.0589	16.7755	-4.2236	3.81246	9.40962	6.26962	4.70458	1.514	-0.1055	-0.0860
Median	1.524086	9.63391	0.02568	-0.0270	3.04552	16.8452	-5.1326	3.79549	9.32606	6.303	4.82028	1.60744	-0.0688	-0.0631
Maximum	30.35658	13.3249	0.07044	-0.0244	3.76737	17.4117	-1.2472	4.1239	13.2427	6.783	5.13226	2.03732	0.34858	0.17633
Minimum	-15.4548	5.72031	-0.0383	-0.0319	2.30678	15.1732	-7.7206	3.56953	5.33644	5.4271	4.13724	0.78846	-0.9728	-0.4610
Std. Dev.	7.729431	2.54169	0.01948	0.00155	0.32143	0.6324	1.9381	0.14414	2.60773	0.41141	0.25927	0.38393	0.30806	0.16487
Skewness	1.046798	0.00212	-0.5790	-1.3897	-0.3629	-1.08654	0.20096	0.42712	0.01711	-0.3642	-0.6681	-0.4975	-1.0682	-0.4735
Kurtosis	6.605925	1.51652	4.4348	4.9611	3.11589	3.28984	1.65225	2.3385	1.51241	1.9132	2.5114	2.0307	3.89491	2.4267
Jarque-Bera	35.49609	4.49316	6.79964	22.6602	1.1029	9.81274	4.03835	2.38323	4.52047	3.49491	4.13241	3.93978	10.5068	2.50191
Probability	0.700000	0.10576	0.30338	0.12000	0.57611	0.0074	0.13277	0.30373	0.10433	0.17422	0.12667	0.13947	0.00523	0.28623
Sum	61.91647	475.956	1.01730	-1.2773	149.886	821.999	-206.95	186.811	461.071	307.211	230.524	74.1858	-4.9586	-4.2163
Sum Sq. Dev.	2867.717	310.088	0.01784	0.00011	4.95912	19.1965	180.299	0.99724	326.412	8.12426	3.22665	7.07531	4.36551	1.30468
Observations	49	49	49	49	49	49	49	49	49	49	49	49	49	49

Source: Author's computation using E-view 10 (2019)

Table 4. Stationarity Tests of Variables: Augmented Dickey-Fuller (ADF) Test

Augmented Dickey-Fuller (ADF) Test with Intercept only												
Variable	Level						1st Diff					
	Test Statistic	Critical Values			P-Values	Remarks	Test Statistic	Critical Values			P-Values	Remarks
		1%	5%	10%				1%	5%	10%		
$\partial \ln \hat{q}$	-5.760200	-3.57445	-2.92378	-2.599925	0.0000	I(0)	***	***	***	***	***	I(0)
$\ln q$	-0.794907	-3.57445	-2.92378	-2.599925	0.8115	NS	-5.326543	-3.57772	-2.92517	-2.60066	0.0001	I(1)
$\partial \ln L$	-4.940908	-3.57772	-2.92517	-2.600658	0.0002	I(0)	***	***	***	***	***	I(0)
$\partial \ln N$	-0.606631	-3.58851	-2.92973	-2.603064	0.8587	NS	-4.472315	-3.58851	-2.92973	-2.60306	0.0008	I(1)
$\ln F$	-3.603376	-3.57772	-2.92517	-2.600658	0.0093	NS	-5.648685	-3.57772	-2.92517	-2.60066	0.0000	I(1)
$\ln H$	-3.254561	-3.57445	-2.92378	-2.599925	0.0228	NS	-6.309137	-3.57772	-2.92517	-2.60066	0.0000	I(1)
$\ln T$	0.3434650	-3.57445	-2.92378	-2.599925	0.9783	NS	-5.730976	-3.57772	-2.92517	-2.60066	0.0000	I(1)
$\ln G$	-2.652525	-3.57772	-2.92517	-2.600658	0.0900	NS	-7.352779	-3.57772	-2.92517	-2.60066	0.0000	I(1)
$\ln P$	-0.638814	-3.57772	-2.92517	-2.600658	0.8517	NS	-4.817563	-3.57772	-2.92517	-2.60066	0.0003	I(1)
$\partial \ln IN$	-4.185366	-3.58115	-2.92662	-2.601424	0.0019	I(0)	***	***	***	***	***	I(0)
$\partial \ln FR$	0.906438	-3.58115	-2.92662	-2.601424	0.9948	NS	-3.001555	-3.58115	-2.92662	-2.60142	0.0422	I(1)
$\partial \ln MR$	1.040611	-3.58474	-2.92814	-2.602225	0.9964	NS	-4.472929	-3.58474	-2.92814	-2.60223	0.0008	I(1)
$\ln RD$	-2.718337	-3.57772	-2.92517	-2.600658	0.0785	NS	-6.68695	-3.57772	-2.92517	-2.60066	0.0000	I(1)
$\ln PR$	-1.025111	-3.57445	-2.92378	-2.599925	0.737	NS	-8.323328	-3.57772	-2.92517	-2.60066	0.0000	I(1)
Augmented Dickey-Fuller (ADF) Test with Trend and Intercept												
Variable	Level						1st Diff					
	Test Statistic	Critical Values			P-Values	Remarks	Test Statistic	Critical Values			P-Values	Remarks
		1%	5%	10%				1%	5%	10%		
$\partial \ln \hat{q}$	-5.736619	-4.16114	-3.50637	-3.183002	0.0000	I(0)	***	***	***	***	***	I(0)
$\ln q$	-0.903475	-4.16114	-3.50637	-3.183002	0.9472	NS	-5.32714	-4.16576	-3.50851	-3.18423	0.0004	I(1)
$\partial \ln L$	-4.958471	-4.16576	-3.50851	-3.18423	0.0011	I(0)	***	***	***	***	***	I(0)
$\partial \ln N$	-1.587578	-4.18648	-3.51809	-3.189732	0.7815	NS	-7.817766	-4.18091	-3.51552	-3.18826	0.0028	I(1)
$\ln F$	-5.736403	-4.16576	-3.50851	-3.18423	0.0001	NS	-5.736403	-4.16576	-3.50851	-3.18423	0.0001	I(1)
$\ln H$	-2.295736	-4.16114	-3.50637	-3.183002	0.4281	NS	-6.992582	-4.16576	-3.50851	-3.18423	0.0000	I(1)
$\ln T$	-2.134247	-4.16114	-3.50637	-3.183002	0.5141	NS	-5.809629	-4.16576	-3.50851	-3.18423	0.0001	I(1)
$\ln G$	-2.611097	-4.16576	-3.50851	-3.18423	0.2775	NS	-7.549804	-4.16576	-3.50851	-3.18423	0.0000	I(1)
$\ln P$	-1.753503	-4.16576	-3.50851	-3.18423	0.7111	NS	-4.784277	-4.16576	-3.50851	-3.18423	0.0018	I(1)
$\partial \ln IN$	-4.156954	-4.17058	-3.51074	-3.185512	0.0104	I(0)	***	***	***	***	***	I(0)
$\partial \ln FR$	-2.931917	-4.17058	-3.51074	-3.185512	0.1624	I(0)	-5.311658	-4.17058	-3.51074	-3.18551	0.0004	I(1)
$\partial \ln MR$	-2.179248	-4.17058	-3.51074	-3.185512	0.4894	NS	-6.396121	-4.16576	-3.50851	-3.18423	0.0000	I(1)
$\ln RD$	-2.799713	-4.16576	-3.50851	-3.18423	0.2046	NS	-6.96165	-4.16576	-3.50851	-3.18423	0.0000	I(1)
$\ln PR$	-3.743726	-4.17564	-3.51308	-3.186854	0.0294	NS	-4.784277	-4.19234	-3.52079	-3.19128	0.0020	I(1)

Source: Author's computation using E-view 10 (2019)

Table 5. Stationarity Tests of Variables: Philips-Peron (PP) Test

Philips-Peron (PP) Test with Intercept only												
Variable	Level						1st Diff					
	Test Statistic	Critical Values			P-Values	Remarks	Test Statistic	Critical Values			P-Values	Remarks
		1%	5%	10%				1%	5%	10%		
$\partial \ln \hat{q}$	-5.77465	-3.57445	-2.92378	-2.599925	0.0000	I(0)	***	***	***	***	***	I(0)
$\ln q$	-0.734538	-3.57445	-2.92378	-2.599925	0.8280	NS	-5.328573	-3.57772	-2.92517	-2.60066	0.0001	I(1)
$\partial \ln L$	-4.732658	-3.57772	-2.92517	-2.600658	0.0003	I(0)	***	***	***	***	***	I(0)
$\partial \ln N$	-2.697297	-3.58115	-2.92662	-2.601424	0.0822	NS	-7.4069	-3.58115	-2.92662	-2.60142	0.0000	I(1)
$\ln F$	-2.577506	-3.57445	-2.92378	-2.599925	0.1046	NS	-5.557017	-3.57772	-2.92517	-2.60066	0.0000	I(1)
$\ln H$	-3.33839	-3.57445	-2.92378	-2.599925	0.0185	NS	-4.732568	-3.57772	-2.92517	-2.60066	0.0000	I(1)
$\ln T$	0.271728	-3.57445	-2.92378	-2.599925	0.9743	NS	-5.729917	-3.57772	-2.92517	-2.60066	0.0000	I(1)
$\ln G$	-2.508237	-3.57445	-2.92378	-2.599925	0.1199	NS	-7.339048	-3.57772	-2.92517	-2.60066	0.0000	I(1)
$\ln P$	-0.538824	-3.57445	-2.92378	-2.599925	0.8742	NS	-4.838167	-3.57772	-2.92517	-2.60066	0.0002	I(1)
$\partial \ln IN$	-4.090286	-3.58115	-2.92662	-2.601424	0.0024	I(0)	***	***	***	***	***	I(0)
$\partial \ln FR$	-2.317202	-3.57772	-2.92517	-2.600658	0.1710	NS	-3.28012	-3.58115	-2.92662	-2.60142	0.0217	I(1)
$\partial \ln MR$	-1.706544	-3.57772	-2.92517	-2.600658	0.4215	NS	-6.200201	-3.58115	-2.92662	-2.60142	0.0000	I(1)
$\ln RD$	-2.359208	-3.57445	-2.92378	-2.599925	0.1585	NS	-6.687327	-3.57772	-2.92517	-2.60066	0.0000	I(1)
$\ln PR$	-0.951713	-3.57445	-2.92378	-2.599925	0.7629	NS	-8.21580	-3.57772	-2.92517	-2.60066	0.0000	I(1)
Philips-Peron (PP) Test with Trend and Intercept												
Variable	Level						1st Diff					
	Test Statistic	Critical Values			P-Values	Remarks	Test Statistic	Critical Values			P-Values	Remarks
		1%	5%	10%				1%	5%	10%		
$\partial \ln \hat{q}$	-5.73088	-4.16114	-3.50637	-3.183002	0.0001	I(0)	***	***	***	***	***	I(0)
$\ln q$	-1.340954	-4.16114	-3.50637	-3.183002	0.8653	NS	-5.323786	-4.16576	-3.50851	-3.18423	0.0004	I(1)
$\partial \ln L$	-4.721805	-4.16576	-3.50851	-3.18423	0.0022	I(0)	***	***	***	***	***	I(0)
$\partial \ln N$	-0.130795	-3.57772	-2.92517	-2.600658	0.9398	NS	-3.055802	-3.58115	-2.92662	-2.60142	0.0372	I(1)
$\ln F$	-2.233035	-4.16114	-3.50637	-3.183002	0.4611	NS	-5.84069	-4.16576	-3.50851	-3.18423	0.0001	I(1)
$\ln H$	-2.285425	-4.16114	-3.50637	-3.183002	0.4334	NS	-6.998379	-4.16576	-3.50851	-3.18423	0.0000	I(1)
$\ln T$	-2.29916	-4.16114	-3.50637	-3.183002	0.4263	NS	-5.810635	-4.16576	-3.50851	-3.18423	0.0001	I(1)
$\ln G$	-2.351213	-4.16114	-3.50637	-3.183002	0.3995	NS	-7.549114	-4.16576	-3.50851	-3.18423	0.0000	I(1)
$\ln P$	-1.711259	-4.16114	-3.50637	-3.183002	0.7309	NS	-4.800327	-4.16576	-3.50851	-3.18423	0.0017	I(1)
$\partial \ln IN$	-4.061966	-4.17058	-3.51074	-3.185512	0.0133	I(0)	***	***	***	***	***	I(0)
$\partial \ln FR$	-0.866955	-4.16114	-3.50637	-3.183002	0.9514	NS	-4.414001	-4.16114	-3.50637	-3.183002	0.0050	I(1)
$\partial \ln MR$	-1.576762	-4.16576	-3.50851	-3.18423	0.7872	NS	-6.312812	-4.17058	-3.51074	-3.18551	0.0000	I(1)
$\ln RD$	-2.359208	-3.57445	-2.92378	-2.599925	0.1585	NS	-6.687327	-3.57772	-2.92517	-2.60066	0.0000	I(1)
$\ln PR$	-3.115232	-4.16114	-3.50637	-3.183002	0.1145	NS	-8.16247	-4.16576	-3.50851	-3.18423	0.0000	I(1)

Source: Author's computation using E-view 10 (2019)

Table 6. Optimal Lag Length Selection Criteria Results

Lag	LR	FPE	AIC	SC	HQ
Lag Length Selection Criteria Results for Model 14					
0	NA	1.15E-16	-13.99455	-13.67652	-13.87541
1	513.2222	1.84E-21	-25.08281	-22.22059*	-24.0106
2	134.9300*	3.65e-22*	-26.95296*	-21.54654	-24.92768*
Lag Length Selection Criteria Results for Model 15					
Lag	LR	FPE	AIC	SC	HQ
0	NA	1.35E-18	-15.60451	-15.24673	-15.47049
1	527.0924	2.13E-23	-26.72423	-23.14645*	-25.38397
2	142.3651*	5.57e-24*	-28.47527*	-21.6775	-25.92878*
Lag Length Selection Criteria Results for Model 16					
Lag	LR	FPE	AIC	SC	HQ
0	NA	3.90E-07	2.269201	2.507719	2.358551
1	313.3143	6.13E-10	-4.199283	-2.529654*	-3.573830*
2	62.64788*	4.76e-10*	-4.532486*	-1.431746	-3.37093
Lag Length Selection Criteria Results for Model 17					
Lag	LR	FPE	AIC	SC	HQ
0	NA	5.01E-09	0.752287	1.027841	0.85598
1	753.1796	1.69E-16	-16.4749	-14.27047	-15.64536
2	216.3903*	1.81e-18*	-21.15199*	-17.01868*	-19.59660*
Lag Length Selection Criteria Results for Model 18					
Lag	LR	FPE	AIC	SC	HQ
0	NA	2.85E-06	4.26052	4.496709	4.3494
1	510.1995	3.87E-11	-6.962552	-5.309229	-6.340395
2	142.2021*	2.94e-12*	-9.613052*	-6.542594*	-8.457618*
Lag Length Selection Criteria Results for Model 19					
Lag	LR	FPE	AIC	SC	HQ
0	NA	6.95E-07	2.847798	3.083987	2.936678
1	357.8877*	4.24e-10*	-4.567480*	-2.914157*	-3.945323*
2	46.90032	5.32E-10	-4.414986	-1.344528	-3.259552
Lag Length Selection Criteria Results for Model 20					
Lag	LR	FPE	AIC	SC	HQ
0	NA	6.81E-05	7.432939	7.669128	7.521819
1	330.6577*	8.21e-08*	0.698413*	2.351736*	1.320569*
2	39.25301	1.29E-07	1.075827	4.146285	2.231261

Source: Author's computation using E-view 10 (2019)

* 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 7. Results of Bound Test Approach to Cointegration

Results of Bound Test Approach to Cointegration for Model 14

Significance	Critical Value Bonds		Computed F-Statistic
	Lower Bound I(0)	Upper Bond I(1)	
10%	1.92	2.89	***3.661152***
5%	2.17	3.21	
2.5%	2.43	3.51	
1%	2.73	3.9	

Results of Bound Test Approach to Cointegration for Model 15

Significance	Critical Value Bonds		Computed F-Statistic
	Lower Bound I(0)	Upper Bond I(1)	
10%	1.85	2.85	***3.738379***
5%	2.11	3.15	
2.5%	2.33	3.42	
1%	2.62	3.77	

Results of Bound Test Approach to Cointegration for Model 16

Significance	Critical Value Bonds		Computed F-Statistic
	Lower Bound I(0)	Upper Bond I(1)	
10%	2.08	3	***10.44276***
5%	2.39	3.38	
2.5%	2.7	3.73	
1%	3.06	4.15	

Results of Bound Test Approach to Cointegration for Model 17

Significance	Critical Value Bonds		Computed F-Statistic
	Lower Bound I(0)	Upper Bond I(1)	
10%	1.99	2.94	***13.80097***
5%	2.27	3.28	
2.5%	2.55	3.61	
1%	2.88	3.99	

Results of Bound Test Approach to Cointegration for Model 18

Significance	Critical Value Bonds		Computed F-Statistic
	Lower Bound I(0)	Upper Bond I(1)	
10%	2.08	3	***3.462913***
5%	2.39	3.38	
2.5%	2.7	3.73	
1%	3.06	4.15	

Results of Bound Test Approach to Cointegration for Model 19

Significance	Critical Value Bonds		Computed F-Statistic
	Lower Bound I(0)	Upper Bond I(1)	
10%	2.26	3.35	***4.032603***
5%	2.62	3.79	
2.5%	2.96	4.18	
1%	3.41	4.68	

Results of Bound Test Approach to Cointegration for Model 20

Significance	Critical Value Bonds		Computed F-Statistic
	Lower Bound I(0)	Upper Bond I(1)	
10%	2.08	3	***3.479758***
5%	2.39	3.38	
2.5%	2.7	3.73	
1%	3.06	4.15	

Source: Author's computation using E-view 10 (2019)

Table 8: Estimated Long Run Coefficients for the Selected ARDL Models

	Column I	Column II	Column III	Column IV	Column V	Column VI	Column VII
Regressand	$\partial \ln \hat{q}$	$\partial \ln \hat{q}$	$\partial \ln IN$	$\ln F$	$\ln H$	$\ln RD$	$\ln PR$
Explanatory Variables	**Model 14 ARDL (2,0,2,1,0,0,0,0)**	**Model 15 ARDL (1,1,0,1,0,2,2,1,1)**	**Model 16 ARDL (2,0,2,2,2,1)**	**Model 17 ARDL (2,0,0,0,0,0,0)**	**Model 18 ARDL (1,0,0,0,0,2)**	**Model 19 ARDL (1,0,0,0,0,1)**	**Model 20 ARDL (1,0, 1,0,0,0)**
$\partial \ln \hat{q}$			0.000912*	0.002334	-0.004196*	0.073969*	-0.001885*
			{0.006654}	{0.001295}	{0.001958}	{0.115762}	{0.004037}
			[0.137106]	[1.802316]	[-2.143463]	[0.638974]	[-0.466887]
			{{0.8917}}	{{0.0046}}	{{0.0382}}	{{0.5265}}	{{0.6431}}
$\ln q$	13.45315*	12.70664*					
	{6.956318}	{3.41937}					
	[1.933947]	[3.716076]					
	{{0.0426}}	{{0.0039}}					
$\partial \ln L$	4.303837*	5.214951*					
	{2.05824}	{2.32331}					
	[2.091027]	[0.416085]					
	{{0.0189}}	{{0.0483}}					
$\partial \ln N$	0.308421*	0.286681*					
	{3.550469}	{3.435252}					
	[0.086868]	[0.083452]					
	{{0.9538}}	{{0.9997}}					
$\ln F$	0.315610*	0.021740*	0.071364*	0.453844*	-0.105839*	0.004369*	-0.129231*
	{5.405735}	{5.111789}	{0.202675}	{0.073652}	{0.069829}	{0.006027}	{0.144428}
	[0.058384]	[0.004253]	[0.35211]	[6.161992]	[-1.515675]	[0.724989]	[0.894776]
	{{0.9538}}	{{0.9966}}	{{0.7267}}	{{0.0005}}	{{0.1375}}	{{0.4727}}	{{0.3763}}
$\ln H$	5.047328*	7.339274*	0.050241*	0.341820*		-0.001670*	-0.101549*
	{2.449401}	{2.013432}	{0.219698}	{0.068612}		{0.006582}	{0.135646}
	[2.060638]	[3.645156]	[0.228681]	[4.981896]		[-0.25381]	[-0.748632]
	{{0.0000}}	{{0.0005}}	{{0.8203}}	{{0.0016}}		{{0.8009}}	{{0.4585}}
$\ln T$	-7.023664*	-8.070993*	0.34182*	0.073969*	-0.017968*	0.002378*	-0.209057*
	{4.613507}	{2.247637}	{1.391093}	{0.013992}	{0.029209}	{0.002082}	{0.041041}
	[-1.522413]	[-3.590879]	[0.245720]	[5.286661]	[-0.61515]	[1.142134]	[-5.093865]
	{{0.0000}}	{{0.0000}}	{{0.8072}}	{{0.0011}}	{{0.5419}}	{{0.2602}}	{{0.0004}}
$\ln G$	-2.7023664*	-6.93779*	-0.015552*	0.654663*	-0.652238*	0.714514*	-0.181760*
	{1.1395427}	{3.64887}	{0.006107}	{0.139107}	{0.190872}	{0.109658}	{0.039880}
	[-2.371448]	[-1.901353]	[-2.54657]	[4.706170]	[-3.417141]	[6.515838]	[-4.557673]
	{{0.0237}}	{{0.0001}}	{{0.0151}}	{{0.0022}}	{{0.0015}}	{{0.0000}}	{{0.0316}}
$\ln P$		-5.047328*					
		{1.137732}					
		[-4.436307]					
		{{0.0003}}					
$\partial \ln MR$				0.016638*			
				{0.004925}			
				[3.378130]			
				{{0.0118}}			
$\partial \ln FR$					-0.893829*		
					{0.066632}		
					[-13.41438]		
					{{0.0000}}		
C	-2.7023664*	-7.023664*	-0.264006*	-6.253265*	3.221401*	1.18217*	2.674494*
	{1.266351}	{3.062062}	{0.12959}	{1.424686}	{1.531355}	{0.408741}	{0.882743}
	[2.1339789]	[-2.293769]	[-2.037238]	[-4.389223]	[2.103628]	[2.892224]	[3.029753]
	{{0.0023}}	{{0.0369}}	{{0.0502}}	{{0.0032}}	{{0.0417}}	{{0.0062}}	{{0.0038}}
Goodness-of-fit Measures							
R^2	0.979887	0.998111	0.95837	0.999993	0.980811	0.997736	0.935816
Adjusted R^2	0.931055	0.977772	0.907962	0.999983	0.977452	0.997340	0.924584
F-statistic	2.206373	2.077699	7.168346	152276.10	219.1298	2518.139	83.31548
Prob (F-statistic)	0.0008730	0.0000290	0.0000030	0.0000000	0.0000000	0.0000000	0.0000000
Durbin-Watson Stat	2.048868	2.183073	1.945700	2.208187	1.797875	1.709269	2.014552

Notes:

1. { }, [ ] and {{ }} denote Std. Error, t-Statistic, Probability respectively
2. ***, ** and * depict Obs R-squared, Jacque-Bera Statistic and Coefficient respectively

Source: Author's computation using E-view 10 (2019)

Table 9: Diagnostic Statistical Checks for the Selected ARDL Models

	Column I	Column II	Column III	Column IV	Column V	Column VI	Column VII
Regressand	$\partial \ln \hat{q}$	$\partial \ln \hat{q}$	$\partial \ln IN$	$\ln F$	$\ln H$	$\ln RD$	$\ln PR$
Explanatory Variables	**Model 14 ARDL (2,0,2,1,0,0,0,0)**	**Model 15 ARDL (1,1,0,1,0,2,2,1,1)**	**Model 16 ARDL (2,0,2,2,2,1)**	**Model 17 ARDL (2,0,0,0,0,0,0)**	**Model 18 ARDL (1,0,0,0,0,2)**	**Model 19 ARDL (1,0,0,0,0,1)**	**Model 20 ARDL (1,0, 1,0,0,0)**
Breusch- Godfrey serial correlation LM test	2.861839*** {{0.2391}}	7.471799*** {{0.0239}}	10.20348*** {{0.0601}}	4.906454*** {{0.0860}}	0.835675*** {{0.6585}}	3.564478*** {{0.1683}}	0.508131*** {{0.77560}}
Breusch-Pagan-Godfrey test for heteroskedasticity	19.48483*** {{0.0775}}	25.74900*** {{0.0577}}	8.815054*** {{0.2662}}	13.34562*** {{0.2713}}	4.494854*** {{0.7213}}	8.467642*** {{0.2932}}	20.52652*** {{0.0545}}
ARCH test for heteroskedasticity	0.138700*** {{0.7096}}	2.542190*** {{0.1108}}	0.060224*** {{0.8061}}	0.530834*** {{0.4663}}	2.455564*** {{0.1171}}	0.07783*** {{0.7803}}	2.757391*** {{0.0968}}
Jacque-Bera normality test	0.812942** {{0.665998}}	2.075440** {{0.354261}}	1.675152*** {{0.432758}}	1.687117** {{0.430177}}	0.849894** {{0.653805}}	13.44370** {{0.120400}}	4.649564** {{0.097805}}
Ramsey RESET specification test	[1.717295] {{0.0956}}	[1.588929] {{0.1233}}	[1.2364] {{0.2241}}	[3.13772] {{0.1010}}	[2.16643] {{0.3065}}	[2.29386] {{0.6105}}	[0.527831] {{0.2165}}

Notes:

1. { }, [ ] and {{ }} denote Std. Error, t-Statistic, Probability respectively

2. ***, and ** depict Obs R-squared and Jacque-Bera Statistic respectively

Source: Author’s computation using E-view 10 (2019)