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The Nexus Between Key Macroeconomic Determinants and Economic Growth in Zambia: A Dynamic Multivariate Granger-Causality Linkage

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Abstract

This study investigates the nexus between key macroeconomic determinants and economic growth in Zambia by employing the Autoregressive Distributed Lag model to test for Granger-causality covering the period 1970–2015. The empirical results reveal that there are three distinct Granger-causality hypotheses that exist in Zambia related to economic growth. The dominant hypothesis is the feedback hypothesis between investment, population growth, foreign aid and economic growth in both the short and long run; between real exchange rate, trade openness and economic growth in the short run; and between government consumption, inflation and economic growth in the long run. The second is the supply-leading hypothesis that runs from government consumption and inflation to economic growth in the short run; and from real exchange rate and trade openness to economic growth in the long run. Lastly, the neutrality hypothesis holds between human capital and economic growth in the short run. These results have significant policy implications for the Zambian economy. They imply that the authorities should focus on promoting economic incentives that encourage the growth of real GDP per capita and investment, improve the quality of human capital, trade reforms, population control, macroeconomic stability, and the effectiveness of foreign aid.

Keywords: Zambia; Autoregressive Distributed Lag Models; Cointegration; Granger-causality; Economic Growth

JEL Classification Code: C22, O47, O55

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1. Introduction

Economic growth has always been an important phenomenon to any economy in the world. If policymakers knew what strategies to adopt quickly to turn around an economy in recession then the world would be a better place. Understanding the factors that cause economic growth is an extremely important area of economic research, given the need for countries to expand their revenue base without having to increase taxes: at the same time ensuring that Pareto optimality is observed as it relates to poverty reduction. The economic growth literature is underpinned by a volume of both theoretical and empirical linkages that describe many economic variables as important macroeconomic determinants of economic growth. These determinants are discussed in the economic growth literature by using different econometric estimation methods and techniques (Ciccone and Jarocinski 2010).

These studies have found a wide array of economic policy determinants that are significantly associated with long-run economic growth. Much as these relationships have been investigated, there is still no consensus on the appropriate theoretical and empirical framework to guide policymakers (see Chirwa and Odhiambo 2016a, among others). So far, many of the country-specific macroeconomic determinants that are considered as important to sustainable economic growth today include the accumulation of physical capital, human capital development, foreign aid, foreign direct investment, fiscal policy, trade, demographics, monetary policy, natural resources, reforms and geographic, regional, political and financial factors (Barro 2003; Chirwa and Odhiambo 2016a).

Most studies that investigate the key macroeconomic determinants that impact economic growth focus more on correlation and not on causality tests. Despite a growing literature that investigates the correlation between specific economic determinants and economic growth the question still remains whether a conjoined set of key macroeconomic determinants promote economic growth. In this study, we extend the analysis to investigate the nexus between key macroeconomic determinants and economic growth by conducting multivariate Granger- causality tests that include up to eight variables of interest related to economic growth in Zambia during the period 1970–2015 (Chirwa and Odhiambo 2017). The foremost objective of this study is to examine the causal relationships between key traditional factors such as the accumulation of physical capital, human capital development, and

population growth conditioned on policy factors that include government consumption, real exchange rate depreciation, inflation, trade openness, and foreign aid. The principal hypothesis, therefore, is to investigate the nature of short- and long-run causal relationships on the selected key macroeconomic determinants and whether they contain useful information that helps predict economic growth or whether their development is a result of economic expansion in Zambia. To our knowledge, this study is the first of its kind as most Granger causality studies have used at most four variables in a multivariate Granger-causality framework.

According to Engle and Granger (1987), a variable that is found to Granger-cause another variable entails that the former contains useful information that helps to predict the dependent variable apart from information contained within its own lags. Furthermore, the concept of analysing a cointegration relationship helps in establishing whether a long-run relationship exists between a set of regressors and the dependent variable in order not to estimate a spurious relationship. Once found, the evidence reveals that at least a one-way Granger-causality exists where the set of regressors selected are found to provide some useful information that helps in predicting the dependent variable in both the short and the long run. The results from the Granger-causality linkage between these determinants and economic growth investigated are thus important for Zambia and are expected to assist policymakers design appropriate economic policies and strategies that create incentives and/or opportunities to promote or control these important factors of economic growth.

The principal aim of this paper is therefore to investigate the direction of causality between selected key macroeconomic determinants and economic growth in Zambia using a multivariate Granger-causality framework based on the Autoregressive Distributed Lag (ARDL) introduced by Pesaran *et al*. (2001). The ARDL-based error correction model approach used to test causality has five main advantages. First, the ARDL modelling approach provides a platform where both short- and long-run level relationships between the covariates and the dependent variable are investigated (Ahmed 2012; Odhiambo 2013). Second, the ARDL model takes up a sufficient number of lags that capture the data-generating process in a general to specific modelling framework (Hirnissa *et al*. 2009). Third and related to the previous advantage, the ARDL model can easily correct for endogeneity in the regressors by including or excluding lags (Pesaran and Shin 1999). Fourth, the ARDL approach provides robust results in studies affected by finite or small sample sizes (Narayan 2005). Lastly, the

bounds test based on the unrestricted error correction model proposed by Pesaran *et al*. (2001) can be applied irrespective of whether the study variables are integrated of either order zero or one (Odhiambo 2013). Although the results derived from the ARDL model are efficient and reliable, the test is based on a single cointegration equation between the variables. Nevertheless, the ARDL cointegration methodology can indeed be applied to both directions (see De Vita and Trachanas 2016, among others).

The rest of the paper is structured as follows: Section 2 summarises Zambia's economic performance and identifies some of the key macroeconomic drivers of economic growth during the study period. Section 3 reviews empirical literature on causality linkages between the selected key macroeconomic determinants and economic growth. Section 4 discusses the multivariate Granger-causality framework in an ARDL setting as well as estimation techniques. Section 5 presents an empirical analysis of the regression results. Lastly, section 6 provides conclusions and policy implications derived from the study.

2. Factors affecting Economic Performance in Zambia

The Zambian economy, since attaining independence in 1964, has undergone a number of growth episodes, mainly driven by mineral recessions and booms. The structure of the economy could be regarded as having gone through two economic structures: a command economy driven by administrative and economic controls that ran from 1964 to 1991, and a market-oriented economy with fewer economic restrictions that existed from 1991 onwards (Chirwa and Odhiambo 2016c). Throughout this period, the Zambian economy has been driven by the industrial sector mainly through copper mining, which was highly affected by mineral booms and recessions. The first mineral boom was during the period 1964–1973, where the Zambian economy grew at an average rate of 7.6% p.a. as a result of high international copper prices that averaged US$5,697 per metric ton p.a. Furthermore, this period was characterised by low crude oil prices that averaged US$6.76 per barrel p.a. At the same time, the economy also experienced a real GDP per capita that averaged approximately US$1,600 in 2010 constant USD prices and an investment share level that averaged 29.3% of real GDP (World Bank 2017a, 2017b).

The situation in the 1970s was different as the Zambian economy was hit by two international commodity price shocks. First, copper prices fell by half in just two years during the period 1974–1975: this increased cumulatively just over three-quarters between 1974 and 1986. Second, the Zambian economy faced two huge crude oil price increases, in 1973 by 221% and in 1979 by 115%. These combined commodity price shocks hit the Zambian economy severely between 1974 and 1991: this resulted in the economy growing at an average rate of 0.6% p.a. and real GDP per capita almost halved from US$1,722 per capita in 1965 – middle-income economy – to US$975 per capita by 1992 – low-income economy (World Bank 2017a, 2017b).

The effects of the copper and oil price shocks could be summarised as follows: Zambia's trade deficit increased to an average of -8.5% of real GDP p.a. between 1966 and 1974. Eventually exchange rate misalignments ensued as the exchange rate went through a number of devaluations introduced in 1976 and in the process creating parallel markets for foreign exchange trading (Aron and Elbadawi 1992). As a result of falling copper prices, government revenues fell significantly from 71% in 1965 to 13% in 1975: this increased government borrowing and in the process increased the public debt. With increased public debt, the fiscal deficit was inflationary as inflation doubled from an average of 8% p.a. in 1975 to an average of 16% p.a. during the period 1976–1980 (Andersson *et al*. 2000). The economic challenges that the Zambian government faced in the 1970s led to a number of economic reforms in the 1980s with financial support from development partners. Within the same period, the key traditional drivers of economic growth that were pursued included the accumulation of physical capital and of human capital development to support diversification. However, as one key source of investment, gross domestic savings declined from an average of 40.1% of GDP p.a. during the period 1960–1970 to an average of 13.8% of GDP p.a. during the period 1981–1990 (World Bank 2015b). The dwindling government revenues also affected the implementation of human capital development strategies which were central to all National Development Plans that emphasised its development by improving the education system at all levels during the period 1964–1991 (Republic of Zambia 2011).

From 1991 onwards, the Zambian economy went through a number of economic and structural reforms to address the macroeconomic imbalances that emanated during the command economy. These reforms included significant reduction in government expenditures targeting a reduction in government subsidies and real wage growth, and financial liberalisation in the monetary sector that

focused on reducing money supply growth and elimination of real exchange rate controls (Adam *et al*. 1993a, 1993b; Mungule 2004). Further reforms that the Zambian authorities implemented were privatisation or commercialisation of some state-owned firms, particularly in the mining, electricity and banking sectors (Bull *et al*. 2006).

The success from implementing these reforms was seen in improvements in the macroeconomic environment where both inflation and the exchange rate stabilized during the period 2001–2015, growing at an average rate of 12.9% and 8.8% p.a., respectively (World Bank 2017b). In nominal terms, the exchange rate depreciation declined significantly from 166.4% in 1992 to 4.8% by 2013: this performance also extended to inflation where it declined significantly from 183.3% in 1993 to an average of 10.1% in 2015 (World Bank 2017b). The benefits of such improvements could be seen in high growth rates that the Zambian economy attained, averaging 6.5% p.a. during the 2001– 2015 period and reaching a maximum of 10.3% in 2010 (World Bank 2017b). Throughout the study period, the key drivers of economic growth in Zambia thus included, among others, investment, human capital development, population growth, government consumption, real exchange rate depreciation, inflation, international trade, and foreign aid.

3. Literature Review

The investigation into the causality between key macroeconomic variables and economic growth using a multivariate framework has recently become an important research area. The use of different estimation techniques for investigating the causal relationship between variables of interest and economic growth has significantly evolved from bivariate, trivariate and now to multivariate causal linkages. Eventually, there has been a lack of consensus on what really causes economic growth to guide policymakers. One critical observation has been the change in direction of causality once critical determinants are added to the causality function (Wolde- Rufael 2009).

Granger-causality tests that focus on a bivariate relationship are considered in the econometric literature to be biased as relevant variables of interest are excluded in the bivariate analysis (Lean and Smyth 2010). Others that have used a trivariate Granger-causality framework are often limited and exclude other equally important traditional variables in their analysis. A variant to this caveat has been to use a multivariate Granger-causality framework that is estimated by including equally

important determinants of economic growth to establish a long-run cointegrating relationship as well as making the causal inference drawn more robust. However, most of the multivariate linkages, though including regressors – mostly up to four – as determinants, have not considered other equally important key determinants of economic growth investigated in this study with a specific focus on using the production function as an appropriate multivariate growth framework to investigate the direction of causality. Overall, most Granger-causality studies have also provided inconclusive results due to the problem of omitted variables, even in simple multivariate cases. In this study, eight key macroeconomic determinants are considered which have been extensively studied in the economic literature. These include the accumulation of physical capital, human capital, population growth, government consumption, real exchange rate depreciation, inflation, trade openness, and foreign aid.

One of the key traditional drivers of economic growth supported by both the exogenous and endogenous growth theories is investment or the accumulation of physical capital (Solow 1956; Grossman and Helpman 1991; Aghion and Howitt 1992). Much as the relationship between investment and economic growth is largely positive, a number of studies that have investigated the causal relationship between these two variables have found different results. Studies that support the supply-led growth hypothesis argue that investment inflows stimulate growth through increases in the capital stock (Borensztein *et al*. 1998; Tang *et al*. 2008). On the other hand, studies that support the demand-following growth hypothesis argue that countries that face high GDP growth rates create new investment opportunities that attract increased inflows of capital (Blomstrom *et al*. 1996; Qin *et al*. 2006; Mah 2010). Empirical studies that support the feedback hypothesis have found bidirectional causality between investment and GDP growth (Shan 2002; Liu *et al*. 2002). Furthermore, there are other studies that support the neutrality hypothesis who have found no causal linkage between investment and GDP growth (Herzer *et al*. 2008; Yalta 2013).

Human capital development has been studied extensively as well both theoretically and empirically as one of the key macroeconomic determinants of economic growth since the 18th century. On the theoretical front, human capital affects economic growth mainly through two avenues. The first is directly through the production of a skilled and educated workforce who are involved in increasing output production and productivity (Lucas 1988). Second, through learning by doing, human capital is able to adapt and absorb new technologies and knowledge as a source of new innovations and

inventions (Grossman and Helpman 1991; Aghion and Howitt 1992). The causal relationship between human capital development and economic growth continues to be contradictory. The controversy is further enhanced when human capital is measured through various proxies such as cost-based (Jorgenson and Fraumeni 1989), output-based (Barro and Lee 1994) and income-based approaches (Mulligan and Sala-i Martin 1997). The empirical literature has provided ambiguous causality between human capital and economic growth where some studies find the relationship to be supply-leading (Al Yousif 2008; Alfaz *et al*. 2011); demand-following (Jaoul 2004; Tsen 2006); bi-directional (Islam *et al*. 2007; Al-Yousif 2008); and no causality (Al-Yousif 2008; Hartwig 2010).

The third important traditional driver of economic growth is population growth that has also benefited from the causality debate. The Malthus 1798 classical seminal paper postulated that a lower rate of population growth has a positive bearing on per capita income growth, while a higher rate of population growth has a negative impact on per capita income growth (Malthus 1798). Though the relationship between population growth and economic growth has been mixed, the causality debate has also suffered from the same. Some empirical studies support the supply-leading hypothesis (Darrat and Al-Yousif 1999); while others postulate that the relationship is demand-following (Tsen and Furuoka 2005; Hasan 2010). Other studies have found a bi- directional causal linkage (Kapuria Foreman 1995; Hasan 2002) while others have also supported the no-causality hypothesis (Dawson and Tiffin 1998; Mushtaq 2006).

The causal relationship between government consumption and economic growth is also investigated in this study. The use of government expenditure as a policy instrument to influence economic growth was advocated by Keynes (1936). Keynes supported a deliberate use of government budget and expenditures to stimulate demand and employment during economic recessions. According to the Keynesian theory, government spending can be used to stimulate the economy through investing in infrastructure (fiscal policy) and human skills development. However, supply-side theories have postulated that government expenditure reduces the efficiency of investment through distortionary taxation and direct distortion on the allocation of resources (World Bank 1990; Bassanini *et al*. 2001). The causal linkages between government expenditure and economic growth have been studied in the literature using a bivariate or trivariate analysis and in some cases the relationship was found to be supply-leading (Abu Bader and Abu-Qarn 2003; Afonso and Jalles 2014), demand-following

(Srinivasan 2013), bi-directional (Abu-Bader and Abu-Qarn 2003; Ayo *et al*. 2011) or no causality (Chandra 2004; Puente-Ajovin and Sauso-Navarro 2015).

There is a wide array of empirical literature on the linkages between inflation and economic growth. Bassanini *et al*. (2001) argued that inflation acts as a tax on the economy. Other studies have also shown that an economy that experiences stable inflation rates has an environment that is conducive for businesses to make sound investment decisions (Hou and Cheng 2010). Studies that support the inflation-led growth hypothesis have found a unidirectional linkage running from inflation to economic growth (Pradhan *et al*. 2015). Studies that support the growth-led inflation hypothesis have found a unidirectional causality running from economic growth to inflation (Odhiambo 2009; Nguyen and Wang 2010). Studies that support the feedback hypothesis have found a bi-directional causality between inflation and economic growth (Nguyen and Wang 2010).

The causal relationship between international trade and economic growth has also been extensively studied focusing on either export-led or import-led growth hypotheses. The export-led growth hypothesis postulates that causality originates from a situation where a country's level of economic growth follows from its ability and capacity to export as well as sustain those exports on the international market. Studies on trade policies have also shown that economies that adopt an export-orientation strategy are more likely to industrialise and transform their economies towards an emerging market or developed economy (World Bank 1993; Mahadevan and Suardi 2008; Yalta 2013). At the same time, economies that are overly dependent on commodity exports have been affected by international shocks and global recessions. Overall, the results have been mixed. There are some studies that support the supply-led growth hypothesis (Dhawan and Biswal 1999; Bojanic 2012); while others have supported the growth-led hypothesis (Konya 2006; Hye *et al*. 2013). There are also some studies that support the feedback hypothesis where a bi-directional causality flow exists (Hatemi 2002; Awokuse 2008). Lastly, other studies have found that the neutrality hypothesis holds in some countries where exports have no impact on economic growth (Hutchison and Singh 1992; Konya 2006).

Within the same causality literature, the import-led growth hypothesis has also been extensively studied by a number of growth economists with mixed results as well. Those in support of the import-

led growth hypothesis argue that imports play an important role in a country's economic growth process. It is also postulated that imports are influential in complementing the export-led growth hypothesis, and if they are excluded, the results may be misleading by either deflating or inflating the association between exports and economic growth (Reizman *et al*. 1996; Awokuse 2007). Therefore, the existence of a long-run relationship between imports and economic growth is equally important for policy makers as it informs the need to develop effective import promotion strategies that would support and facilitate the importing of high-technology goods and services (Sato and Fukushige 2011).

Another area that has not benefitted from the causality debate is the relationship between the real exchange rate and economic growth. This relationship has always been an important subject in the economic growth literature and whose correlation has been extensively studied. The relationship between economic growth and changes in the real exchange rate is referred to as the Balassa-Samuelson hypothesis (Balassa, 1964; Samuelson, 1964) where economies that experience high rates of economic growth as well as low inflation rates relative to their trading partners often experience current account surpluses and currency appreciations. Conversely, economies with low rates of economic growth and high inflation rates relative to their trading partners often experience current account deficits and currency depreciations (Ito *et al*. 1999). Other observations from empirical studies have shown that most exchange rates in underdeveloped and emerging economies experience real exchange rate undervaluation or overvaluation. The empirical evidence also shows that currencies that are usually undervalued have a positive impact on economic growth (Rodrik 2008); while overvalued (more appreciated) exchange rates have a negative impact on economic growth (Elbadawi *et al*. 2012). However, the impact of the real exchange rate on economic growth is country-specific and may impact differently on the country's level of economic growth (Gluzmann *et al*. 2012).

Lastly, in most developing countries like Zambia, foreign aid has played a major role to supplement economies that are faced with low savings and foreign exchange constraints (Chenery and Strout 1966; Mosley 1980). Several studies have used neoclassical growth models to show how foreign aid can lead to economic growth by making available the needed capital for production (Chenery and Strout 1966). Thus understanding the causal relationship between foreign aid and economic growth

is equally important in order to devise effective policies that would support aid development effectiveness. The causal relationship between foreign aid and economic growth is a fairly recent new area and a number of studies support different growth hypotheses. Studies that support the supply-leading hypothesis have argued that foreign aid causes economic growth (Giles 1994). In some cases, some studies have found no causal relationship between foreign aid and economic growth (Dawson and Tiffin 1999; Tekin 2012).

4. Methodology and Estimation Techniques

4.1 Multivariate Granger-*C*ausality Framework

The multivariate model adopted in this study is based on a Cobb-Douglas production function that assumes a labour-augmenting technological factor with two multiplicative mechanisms: technological progress and overall economic efficiency (Fischer 1993; Acikgoz and Mert 2014; Chirwa and Odhiambo 2017). The policy-augmented multivariate growth equation is an extension to the augmented exogenous growth model that has been empirically investigated by Mankiw *et al*. (1992) and later replicated by Bernanke and Gurkaynak (2001), represented as follows:

$$Y_t = K_t^{\alpha} HC_t^{\beta} (A_t\{GC_t, RER_t, INF_t, TRD_t, AID_t\}L_t)^{1-\alpha-\beta} \qquad (1)$$

In a typical Cobb-Douglass production function, the variables K, HC and L represent the traditional inputs – accumulation of physical capital, human capital, and labour, respectively. The additional policy variables – GC, RER, INFL, TRD, and AID – represent government consumption, real exchange rate, inflation, trade, and foreign aid, respectively. All variables are expressed in logarithm terms: this means the coefficients of the parameters of interests are elasticities: α represents the partial elasticity of output with respect to physical capital, β is the partial elasticity of output with respect to human capital, and $1-\alpha-\beta$ represents the Solow residual. There are three arguments that structurally support the proposed policy-augmented exogenous growth framework. Firstly, for an economy to experience sustainable economic growth it is postulated that it needs a stable macroeconomic environment, an efficient price mechanism and regulatory structure that is capable of stabilising the economy, and efficient and effective public institutions that are capable of converting gross national savings into productive investments (World Bank 1990; Fischer 1993).

Secondly, the empirical literature discredits the convergence hypothesis where evidence continues to show significant income disparities between rich and poor nations thereby depicting the need to consider other equally important macroeconomic factors in the growth process (Mankiw *et al*. 1995; Temple 1999; Barro 2003). Thirdly, the fact that the Solow residual represents total factor productivity that is not explained by the traditional inputs exemplifies the omitted bias problem in theoretical growth models (Mosley *et al*. 1987; Fischer 1993).

Based on the proposed structural economic framework, the empirical specification of the ARDL specification model adopted for testing cointegration using equation (1) is generally presented as follows in matrix form:

$$\Delta log\mathbf{y}_t = \beta_0 + \sum_{i=1}^{n} \phi_i \Delta log\mathbf{y}_{t-i} + \sum_{i=0}^{n} \boldsymbol{\rho}'_{ji}\, \Delta log\mathbf{x}_{j,t-i} + \delta_i' log\mathbf{z}_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

In equation (2), $\mathbf{y}_t$ is a $(kx1)$ column vector of the dependent variable that includes real GDP and all regressors; ϕ_i represent the coefficients of the lagged dependent variable and is a scalar matrix; $\boldsymbol{\rho}'_{ji}$ represent a $(kx1)$ row vector of coefficients of explanatory variables which are short-run multipliers (elasticities); $\mathbf{x}$ represents a column vector of explanatory variables; δ_i' is a $(kx1)$ row vector of coefficients of $\mathbf{z}_{t-1}$ representing long-run multipliers (elasticities); while $\mathbf{z}_{t-1}$ represents all variables in $\mathbf{y}_t$ lagged one period. The deterministic regressor is represented by the parameter β_0 and is included based on the data generating process of the underlying data used. For each multivariate equation, the joint null hypothesis is that the respective regressor and its lagged variables do not Granger-cause the dependent variable conditioned on other variables of interest. The alternative joint null hypothesis is that the regressor and its lagged variables Granger-cause the dependent variable conditioned on other variables of interest. Once the variables are found to be cointegrated, the error correction model (ECM) based Granger-causality test within an ARDL framework is specified as follows in matrix form:

$$\Delta log\mathbf{y}_t = \beta_0 + \sum_{i=1}^{n} \phi_i \Delta log\mathbf{y}_{t-i} + \sum_{i=0}^{n} \boldsymbol{\rho}'_{ji}\, \Delta log\mathbf{x}_{j,t-i} + \delta ECM_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Based on the error correction model in equation (3), there are two sources of Granger-causality that are investigated in this study. The first is short-run Granger-causality which is determined by the joint Wald $F-$test for coefficient restrictions. The second is long-run Granger-Causality which is determined by the significance of the $t-$test for the ECM for each multivariate function once a long-run relationship is confirmed. If the computed $p-$value is less than the 5% significance level, then there is a strong multivariate Granger-causality between the dependent variable and the regressor, conditioned on other variables. If the computed $p-$value is between 5 10% then there is evidence of a weak multivariate Granger-causality between the dependent variable and the regressor. If the computed $p-$value is more than the 10% significance level, then we do not reject the null hypothesis that the regressor does not Granger-cause the dependent variable.

Finally, the data for all variables used in this study is obtained from the World Bank Development Indicators (World Bank 2017b), education statistics obtained from the UNESCO full dataset (UNESCO 2017), and inflation data for the period 1970–1979 obtained from Andersson *et al*. (2000). The full dataset comprise of annual time-series data covering the period from 1970 to 2015[2]. The variables included are defined as follows: real GDP per capita (RGDP, represent income per capita expressed in 2010 constant USD prices); investment (INV, proxied by gross capital formation as a share of real GDP in 2010 constant prices); human capital stock (HC, proxied by total enrolment as the sum of primary, secondary and tertiary enrolments); population growth (POPG, is the annual growth rate of population); government consumption (GC, which is the share of general government final consumption expenditure in real GDP); the real exchange rate depreciation (RER, is the ratio of the nominal exchange rate and PPP conversion factor for GDP); inflation rate (INF, is the growth of consumer price index); foreign aid (AID, represents net official development assistance and official aid received as a share in real GDP expressed in 2010 constant USD prices); and international trade (TRD, proxied by the sum of exports and imports as a share of real GDP expressed in 2010 constant USD prices).

[2] The study employs Eviews 9.5 for unit root tests and Microfit 5.01 to conduct multivariate Granger causality tests.

4.2 Stationarity Tests

Since the ARDL approach cannot be applied when some variables are integrated of a higher order of more than two, it is important to perform unit root tests on all regressors (Odhiambo 2013). Table 1 reports the order of integration of the variables of interest using three unit root tests: Augmented Dickey Fuller (1979), the Dickey Fuller Generalised Least Squares (DF-GLS) by Elliott *et al*. (1996), and the Perron (1990) structural break unit root tests. A two-staged approach was adopted: firstly, using a graphical analysis to determine whether to include an intercept only or an intercept and a trend in the unit root test equation; and second, conducting the unit root test using the proposed unit root tests. As illustrated in Table 1, the results reveal that the variables that are integrated of order one include real GDP per capita, human capital, population growth, real exchange rate, and foreign aid. On the other hand, government consumption is found to be integrated of order zero irrespective of the unit root test used. Investment, inflation, and trade are found to be integrated of order one with ADF and DF-GLS tests, and integrated of order zero with the Perron (1990) unit root test. Overall, all variables in Zambia are either integrated of order zero or one and thus the ARDL bounds test for cointegrating relationships suggested by Pesaran et al. (2001) can be used in this study.

Table 1: Stationarity Test for all Variables – Zambia

	Stationarity of all Variables in Levels						***Stationarity of all Variables in 1st Difference***					
	ADF		***DFGLS***		***Perron***		***ADF***		***DFGLS***		***Perron***	
Variable	***Without Trend***	***With Trend***	***Without Trend***	***With Trend***	***Without Trend***	***With Trend***	***Without Trend***	***With Trend***	***Without Trend***	***With Trend***	***Without Trend***	***With Trend***
Log(RGDPC)	-	0.27	-	1.21	-	4.88	-	7.03***	-	7.12***	-	8.69***
Log(INV)	-	1.43	-	1.36	-	6.19***	-	11.68***	-	10.82***	-	-
Log(HC)	1.10	-	0.54	-	4.11	-	3.15**	-	3.17***	-	4.65*	-
Log(POPG)	-	2.40	-	1.44	-	4.22	-	4.95***	-	4.10***	-	10.58***
Log(GC)	4.10***	-	3.03***	-	4.79**	-	-	-	-		-	-
Log(RER)	-	1.86	-	1.90	-	4.89*	-	4.75***	-	4.80***	-	8.49***
Log(INF)	-	2.58	-	1.95	-	6.16***	-	10.18***	-	5.25***	-	-
Log(TRD)	-	2.20	-	1.97	-	27.75***	-	6.60***	-	6.76***	-	-
Log(AID)	-	2.33	-	2.17	-	4.82	-	9.69***	-	9.53***	-	10.75***

*Note: for all p values: *** 1% significance level; ** 5% significance level; * 10% significance level.*

4.3 ARDL Bounds Cointegration Tests

Table 2 below report results of the Pesaran *et al*. (2001) bounds test of level relationships based on the variables of interest in this study.

Table 2: ARDL Bounds Test Results

Variable	Selection Criteria	Lag Length	Value (F statistic)	Co integration Status
Log(RGDP)	AIC	ARDL (2,0,0,1,0,2,2,0,0)	4.76***	Cointegrated
Log(INV)	AIC	ARDL (2,1,2,0,1,1,0,1,0)	3.22*	Cointegrated
Log(HC)	AIC	ARDL (1,0,0,2,0,0,2,0,0)	5.71***	Cointegrated
Log(POPG)	AIC	ARDL (2,0,0,2,2,2,2,1,2)	8.54***	Cointegrated
Log(GC)	Selected	ARDL (1,0,2,1,1,0,2,1,2)	6.84***	Cointegrated
Log(RER)	Selected	ARDL (2,0,1,1,1,0,2,1,2)	2.32	Not Cointegrated
Log(INF)	Selected	ARDL (2,0,2,2,2,0,1,2,0)	3.95**	Cointegrated
Log(TRD)	AIC	ARDL (2,2,0,2,2,2,2,2,0)	2.81	Not Cointegrated
Log(AID)	Selected	ARDL (1,0,0,2,0,2,0,0,2)	5.98***	Cointegrated

Asymptotic Critical Values						
Pesaran *et al*., 2001; Case III, p. 300 (Unrestricted intercept and no trend)	**10%**		**5%**		**1%**	
	***I*(0)**	***I*(1)**	***I*(0)**	***I*(1)**	***I*(0)**	***I*(1)**
	1.95	3.06	2.22	3.39	2.79	4.10

*Note: for all - values: *** 1% significance level; ** 5% significance level; * 10% significance level.*

The Akaike Information Criteria (AIC) and Schwarz-Bayesian Criteria (SBC) are used to determine the ARDL specifications of the Unrestricted Error Correction Models (UECM). The deterministic regressor that was used for all equations was the unrestricted intercept. As illustrated in Table 2, the evidence shows that the null hypothesis of no long-run relationships is rejected for all multivariate functions at the 1%, 5% and 10% significance levels, except for the real exchange rate depreciation

and trade openness functions that review no level relationships. The empirical results on cointegration thus proves a long-run relationship and at least a one-way Granger-Causality present between real GDP per capita, the accumulation of physical capital, human capital, population growth, government consumption, the real exchange rate, inflation, trade openness and foreign aid.

5. Empirical Analysis of ARDL-Based Granger-Causality Test

Table 3 below reports Granger-Causality test results: The first column of Table 3 represents the dependent variable of the multivariate function while the first row represents the respective regressors in each multivariate function. The results reported are the Wald $F-$test results for all coefficient restrictions except for the error correction term that reports the $t-$statistic of the error correction model estimated using ordinary least squares. Table 4, on the other hand, summarises the Granger-causality hypotheses of the real GDP per capita multivariate function derived from Table 3. As illustrated in Table 3, the $t-$statistics for all the error correction terms reported for the real GDP, investment, human capital, population growth, government consumption, inflation and foreign aid multivariate functions are statistically significant at the 1% significance level and have the correct negative sign. Furthermore, Wald $F-$test results of coefficient restrictions are not reported for the real exchange rate and trade openness multivariate functions as we could not reject the joint null hypothesis of no cointegration (see Table 2).

Table 3 illustrates some interesting results. With real GDP per capita as the dependent variable, the results reveal that the feedback hypothesis is dominant in both the short and the long run. Specifically, the results show that there is a distinct bidirectional causal relationship between real GDP per capita and investment, population growth, and foreign aid in both the short and the long run; between real GDP per capita and the real exchange rate, and trade openness in the short run; and between real GDP per capita and human capital, government consumption, and inflation in the long run. Conversely, a supply-leading causal relationship is found that runs from government consumption and inflation to economic growth in the short run; and from real exchange rate and trade openness to economic growth in the long run. No causal relationship was found to prevail between human capital and economic growth in the short run.

Table 3: Multivariate Granger Causality Test using Wald $F-$ Test for Coefficient Restrictions

Variable (F Statistic)	$\Delta log\ (RGDP)_t$	$\Delta log\ (INV)_t$	$\Delta log\ (HC)_t$	$\Delta log\ (POPG)_t$	$\Delta log\ (GC)_t$	$\Delta log\ (RER)_t$	$\Delta log\ (INF)_t$	$\Delta log\ (TRD)_t$	$\Delta log\ (AID)_t$	ECM_{t-1} **(t stat)**
$\Delta \log(RGDP)_t$	-	10.52*** [0.003]	0.46 [0.498]	32.81*** [0.000]	4.04* [0.053]	5.88*** [0.007]	7.37*** [0.002]	14.75*** [0.001]	12.24*** [0.001]	7.17*** [0.000]
$\Delta \log(INV)_t$	22.26*** [0.000]	-	9.63*** [0.001]	1.61 [0.213]	2.14 [0.153]	24.73*** [0.000]	0.51 [0.477]	3.80* [0.059]	2.12 [0.154]	6.23*** [0.000]
$\Delta \log(HC)_t$	0.20 [0.650]	0.25 [0.615]	-	10.41*** [0.000]	0.82 [0.369]	0.08 [0.772]	21.47*** [0.000]	2.98* [0.094]	1.26 [0.268]	10.35*** [0.000]
$\Delta \log(POPG)_t$	30.50*** [0.000]	6.97** [0.013]	21.82*** [0.000]	-	10.84*** [0.000]	11.78*** [0.000]	17.14*** [0.000]	24.24*** [0.000]	11.19*** [0.000]	12.49*** [0.000]
$\Delta \log(GC)_t$	1.50 [0.229]	18.10*** [0.000]	5.04** [0.032]	19.38*** [0.000]	-	0.48 [0.491]	5.75*** [0.007]	6.58** [0.015]	9.97*** [0.000]	7.91*** [0.000]
$\Delta \log(RER)_t$	13.14*** [0.001]	18.36*** [0.000]	5.32** [0.028]	21.67*** [0.000]	23.02*** [0.000]	-	9.77*** [0.000]	0.57 [0.455]	12.60*** [0.000]	-
$\Delta \log(INFL)_t$	0.29 [0.592]	5.04** [0.013]	19.87*** [0.000]	45.11*** [0.000]	8.52*** [0.007]	5.12** [0.031]	-	9.86*** [0.001]	1.66 [0.207]	6.97*** [0.000]
$\Delta \log(TRD)_t$	12.19*** [0.000]	3.40* [0.075]	0.57 [0.456]	16.77*** [0.000]	4.64** [0.018]	3.78** [0.035]	17.80*** [0.000]	-	1.95 [0.173]	-
$\Delta \log(AID)_t$	18.55*** [0.000]	12.00*** [0.002]	6.16*** [0.005]	0.00 [0.990]	5.73*** [0.007]	7.41*** [0.010]	1.42 [0.241]	6.29*** [0.005]	-	7.51*** [0.000]

*Note: for all p values: *** 1% significance level; ** 5% significance level; * 10% significance level.*

Table 4: Multivariate Granger Causality Test Summary Results for Real GDP per Capita

Growth Hypothesis	Supply Led Hypothesis		Demand Led Hypothesis		Feedback Hypothesis		Neutrality Hypothesis	
Variable	**Short Run**	**Long Run**	**Short Run**	**Long Run**	**Short Run**	**Long Run**	**Short Run**	**Long Run**
Investment					↔RGDP	↔RGDP		
Human Capital						↔RGDP	No Causality	
Population Growth					↔RGDP	↔RGDP		
Government Consumption	→RGDP					↔RGDP		
Real Exchange Rate		→RGDP			↔RGDP			
Inflation	→RGDP					↔RGDP		
Trade		→RGDP			↔RGDP			
Foreign Aid					↔RGDP	↔RGDP		

Note: ↔ denotes feedback hypothesis; ← denotes growth-led hypothesis; and → denotes supply-leading hypothesis.

In the investment function, the short-run results reveal a distinct bidirectional causal relationship between investment and its regressors, namely, real GDP per capita, real exchange rate, and trade openness; a distinct unidirectional causal relationship that is supply-leading from human capital to investment; and a distinct unidirectional causal relationship that is demand-following from investment to population growth, government consumption, inflation and foreign aid. In the long run, the dominant causal relationship revealed is a feedback hypothesis where there exists a distinct bi-directional causality between investment and real GDP per capita, human capital, population growth, government consumption, inflation, and foreign aid; and a distinct unidirectional causal relationship that is supply-leading from real exchange rate and trade openness to investment.

In the human capital function, the study results reveal that only trade openness is supply-leading in the short run. In addition, the study found that there is a distinct bidirectional causal relationship between human capital and population growth, as well as inflation, while a demand-following causal relationship is found to exist from human capital to investment, government consumption, real exchange rate, and foreign aid. No causal relationship was found between human capital and real GDP per capita in the short run. On the other hand, the results show that a feedback hypothesis is dominant in the long run between human capital and real GDP per capita, population growth, government consumption, and inflation, while a supply-leading relationship exists that runs from the real exchange rate, trade openness and foreign aid to human capital.

In the population growth function, the results reveal that all macroeconomic variables studied contain useful information in predicting population growth and that the dominant hypothesis in both the short and the long run is in support of the feedback hypothesis. The short-run results reveal that there exists a distinct bi-directional causal relationship between population growth and real GDP per capita, human capital, government consumption, real exchange rate, inflation, and trade openness; and a distinct unidirectional causal flow that is supply-leading from investment and foreign aid to population growth. In the long run, the feedback hypothesis is also found to be dominant as there exists a distinct bidirectional causal relationship between population growth and real GDP per capita, human capital, government consumption, inflation, and foreign aid, while a supply-leading relationship is found to exist from the real exchange rate and trade openness to population growth.

In the government consumption function, the short-run results show a distinct bi-directional causal relationship between government consumption and population growth, inflation, trade openness, and foreign aid; a distinct unidirectional causal relationship that is supply-leading and runs from investment and human capital to government consumption, and a distinct unidirectional causal relationship that is demand-following from government consumption to real GDP per capita, and real exchange rate. On the other hand, the dominant feedback hypothesis is found to exist in the long run between government consumption and real GDP per capita, investment, human capital, population growth, inflation, and foreign aid, while a supply-leading relationship that runs from the real exchange rate and trade openness to government consumption is found to predominate.

In the real exchange rate function, the short-run results reveal that the feedback hypothesis is dominant as the results show a distinct bi-directional causal relationship between the real exchange rate and real GDP per capita, investment, population growth, inflation, and foreign aid. In addition, a short-run supply-leading relationship is found to prevail from human capital and government consumption to the real exchange rate, while a demand-following relationship is found that runs from the real exchange rate to trade openness. Conversely, the long-run results reveal that the demand-following hypothesis is dominant where the results reveal a unidirectional causal relationship that runs from the real exchange rate to real GDP per capita, investment, human capital, population growth, government consumption, inflation and foreign aid. No causality was found to prevail between the real exchange rate and trade openness in the long run.

In the inflation function, the short-run results revealed that the feedback hypothesis holds between inflation and human capital, population growth, government consumption, the real exchange rate, and trade openness. Furthermore, a distinct unidirectional causal relationship that was demand-following was found where inflation causes real GDP per capita in the short run, while a supply-leading relationship from investment to inflation was found in the short run. No causality was found between foreign aid and inflation in the short run. In the long run, the results revealed that the feedback hypothesis was dominant as the results revealed a distinct bidirectional causal relationship between inflation and real GDP per capita, investment, human capital, population growth, government consumption, and foreign aid, and a distinct unidirectional causal relationship that is supply-leading was found to prevail from real exchange rate and trade openness to inflation.

In the trade openness function, the long-run results revealed that the demand-following hypothesis was dominant where the results showed a distinct unidirectional causal flow that runs from trade openness to real GDP per capita, investment, human capital, population growth, government consumption, inflation, and foreign aid; and no causality between trade openness and the real exchange rate was found to prevail. In the short run, the results revealed a distinct bi-directional causal relationship between trade openness and real GDP per capita, investment, population growth, government consumption, and inflation; a distinct unidirectional causal relationship that is supply-leading was found to prevails from the real exchange rate to trade openness; and a distinct unidirectional causal relationship that is demand-following was found to prevail from trade openness to human capital development and foreign aid.

Lastly, the foreign aid growth function reveals that four hypotheses hold in the short run: a distinct bidirectional causal relationship exists between foreign aid and real GDP per capita, government consumption, and the real exchange rate; a supply-leading hypothesis holds that runs from investment, human capital, and trade openness to foreign aid; a demand-following hypothesis where foreign aid Granger-causes population growth, and a neutrality hypothesis where there exists no causal relationship between inflation and foreign aid. Conversely, in the long run, the dominant hypothesis is found to be a feedback hypothesis where there exists a distinct bi-directional causal relationship between foreign aid and real GDP per capita, investment, human capital, population

growth, government consumption, and inflation, and a distinct supply-leading causal relationship from the real exchange rate and trade openness to foreign aid.

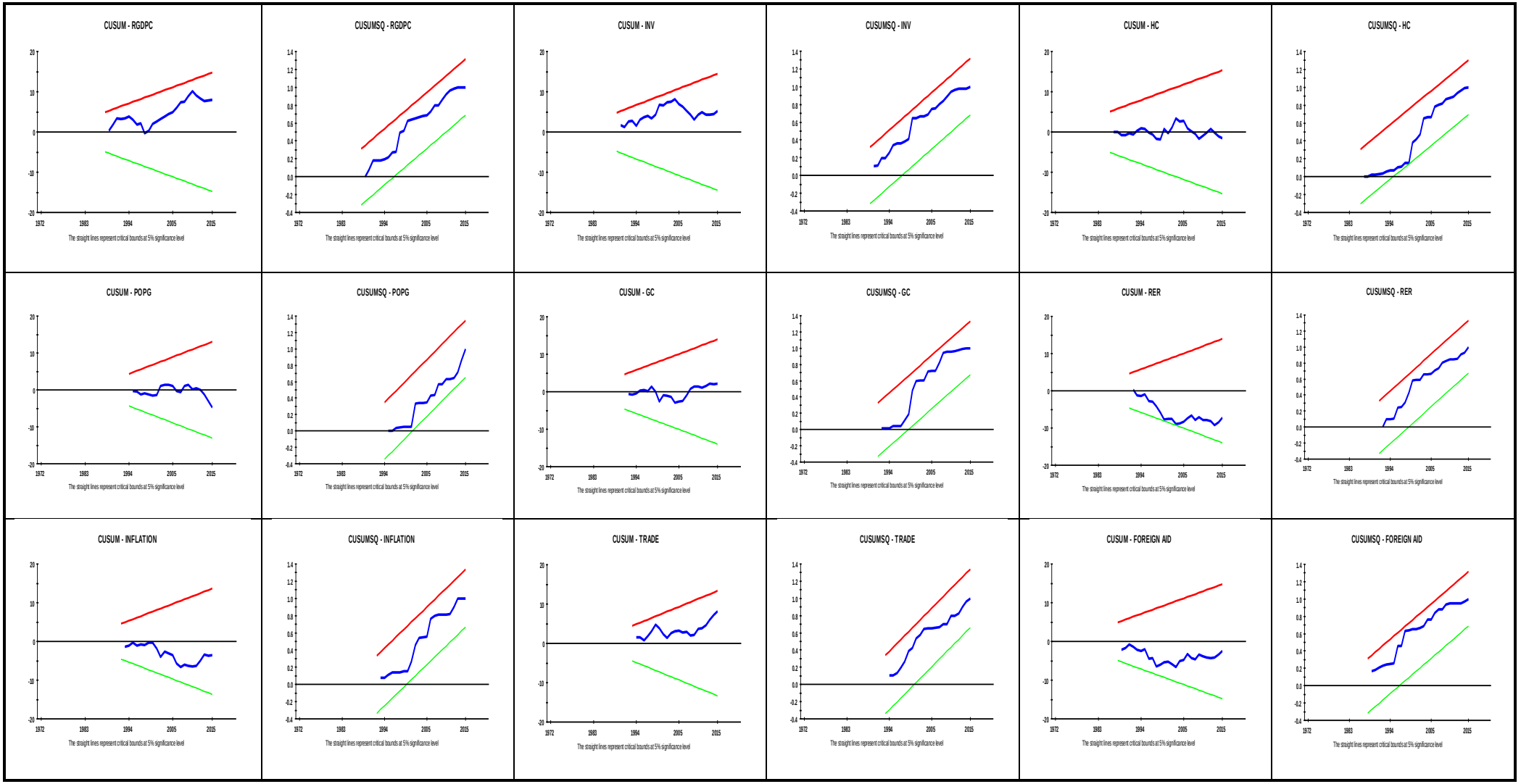
Table 5 reports post-diagnostic tests based on the Breusch-Godfrey serial correlation test; the Breusch-Pagan-Godfrey test for heteroskedasticity; the Ramsey RESET test; normality; and the ARCH test. On the other hand, Figure 1 illustrates the CUSUM and CUSUMSQ test results for the estimated growth equations based on ARDL. As illustrated in Table 5, the results reveal that the null hypotheses for all post-diagnostic tests at the 5% significance level cannot be rejected. This implies that the selected Granger-causality functions for Zambia are correctly specified and the estimated parameters in the estimated equations are not biased. Similarly, as illustrated in Figure 1, the cumulative sum of recursive residuals as well as the squares of the recursive residuals for all multivariate functions are within the 5% critical lines. The results are suggestive of both coefficient and variance stability in the estimated growth equations.

Table 5: Post-Estimation Diagnostic Tests

Post-Diagnostic Test	Breusch-Godfrey Test: No Serial Correlation	Breusch-Pagan-Godfrey Test: No Heteroskedasticity	Ramsey RESET Test: Functional Form	Normality: Skewness and Kurtosis	ARCH Test: Heteroskedasticity (no ARCH terms)
(***RGDPC*** **|** INV, HC, POPG, GC, RER, INF, TRD, AID)	0.11 [0.744]	0.01 [0.916]	0.33 [0.567]	0.17 [0.915]	0.31 [0.734]
(***INV*** **|** RGDPC, HC, POPG, GC, RER, INF, TRD, AID)	2.34 [0.138]	0.04 [0.829]	0.17 [0.676]	0.22 [0.893]	0.15 [0.853]
(***HC*** **|** RGDPC, INV, POPG, GC, RER, INF, TRD, AID)	1.28 [0.266]	0.69 [0.410]	1.12 [0.297]	5.46 [0.065]	1.17 [0.323]
(***POPG*** **|** RGDPC, INV, HC, GC, RER, INF, TRD, AID)	0.04 [0.833]	1.10 [0.298]	0.27 [0.604]	0.13 [0.936]	0.08 [0.915]
(***GC*** **|** RGDPC, INV, HC, POPG, RER, INF, TRD, AID)	1.49 [0.233]	0.54 [0.463]	2.14 [0.156]	0.62 [0.731]	0.68 [0.516]
(***RER*** **|** RGDPC, INV, HC, POPG, GC, INF, TRD, AID)	1.07 [0.311]	0.70 [0.406]	0.18 [0.672]	4.14 [0.126]	0.14 [0.862]
(***INFL*** **|** RGDPC, INV, HC, POPG, GC, RER, TRD, AID)	1.16 [0.291]	0.87 [0.355]	0.41 [0.527]	0.38 [0.824]	0.44 [0.646]
(***TRD*** **|** RGDPC, INV, HC, POPG, GC, RER, INFL, AID)	0.25 [0.621]	0.48 [0.489]	1.60 [0.219]	0.49 [0.781]	0.54 [0.589]
(***AID*** **|** RGDPC, INV, HC, POPG, GC, RER, INFL, TRD)	0.04 [0.841]	0.33 [0.565]	0.27 [0.603]	0.07 [0.963]	0.43 [0.650]

*Source: Authors' Calculations. Note: for all p values: *** 1% significance level; ** 5% significance level.*

Figure 1: CUSUM and CUSUMQ Tests



6. Conclusion

A multivariate Granger-causality technique using the ARDL bounds test was employed in this study to investigate the nexus between real GDP per capita and investment, human capital, population growth, government consumption, real exchange rate depreciation, inflation, trade openness, and foreign aid in Zambia. The main conclusions of the study are that the Zambian economy is supported by all distinct growth hypotheses: the feedback growth hypothesis, the supply-leading growth hypothesis; the demand-leading growth hypothesis; and the neutrality hypothesis. The results also revealed the existence of a long-run relationship in the real GDP per capita, investment, human capital, population growth, government consumption, inflation, and foreign aid multivariate functions; and no long-run relationship existed in the real exchange rate and trade openness functions.

In the real GDP per capita function, the study results support three causality hypotheses, the first being the feedback hypothesis where the results reveal a distinct bi-directional causal relationship between real GDP per capita and investment, population growth, and foreign aid in both the short and the long run; between real GDP per capita and the real exchange rate, and trade openness only in the short run; and between real GDP per capita and government consumption, and trade openness in the long run. These results are similar to other studies that support the feedback hypothesis between economic growth and investment (Shan 2002; Liu *et al*. 2002), economic growth and population growth (Hasan 2002), economic growth and foreign aid (Pradhan and Arvin 2015), and economic growth and government consumption (Ayo *et al*. 2011). The second hypothesis revealed is the supply-leading hypothesis where a distinct unidirectional causal relationship was found that flows from government consumption and inflation to real GDP per capita in the short run, and from real exchange rate depreciation, and trade openness to real GDP per capita in the long run. These results are consistent with other studies that have found that trade openness Granger cause economic growth (Awokuse 2007; Bojanic 2012). However, we have not come across empirical studies that have conducted causality tests on the real exchange rate–economic growth nexus to support or refute our results. The third hypothesis revealed is the neutrality hypothesis between human capital development and real GDP per capita in the short run and the results are consistent with other studies that found no causality (Hartwig 2010; Sato and Fukushige 2011).

In other results, the study reveals that a long-run relationship exists between investment and the set of macroeconomic variables investigated in this study. Specifically, the results show that the relationship between investment and the real exchange rate, and trade openness is bi-directional (feedback hypothesis) in the short run and supply-leading in the long run that runs from the real exchange rate and trade openness to investment. Conversely, the relationship is supply-leading from human capital to investment in the short run and bidirectional in the long run, thus supporting the feedback hypothesis. This evidence thus supports the role of efficiency factors on the accumulation of physical capital (World Bank 1990; Knight *et al*. 1993).

In the human capital function, the results reveal that population growth, inflation and trade openness contain useful information in predicting the behaviour of human capital: in fact, the results support the feedback hypothesis between human capital and population growth, and inflation in both the short and the long run; while the relationship supports the supply-leading hypothesis from trade openness to human capital in both the short and the long run. The trade openness–human capital nexus thus supports the importance of technological diffusion in driving human capital development (see Knight *et al*. 1993).

In the population growth function, the results support the feedback hypothesis between population growth and human capital, government consumption, and inflation in both the short and the long run. The relationship between population growth and the real exchange rate, and trade openness supports the feedback hypothesis only in the short run; while in the long run the relationship is supply-leading, and runs from the real exchange rate and trade openness to population growth. On the other hand, the causal relationship in the short run is supply-leading that runs from investment and foreign aid to population growth, and bi-directional between population growth and investment, as well as foreign aid in the long run. An important revelation of the study results depict that any expansion of all the other study variables either in the short and the long run are important in determining population growth one way or the other.

In the government consumption function, the study results reveal that the causal relationship is supply-leading in the short run, and runs from investment and human capital to government consumption, while in the long run the feedback hypothesis holds between government consumption

and investment, as well as human capital. Furthermore, the results support the feedback hypothesis between government consumption and population growth, inflation, and foreign aid in both the short and the long run. The feedback hypothesis was found between government consumption and trade openness in the short run, while the supply-leading relationship was found to prevail from trade openness to government consumption in the long run. The demand-following relationship is found to prevail from government consumption to the real exchange rate in the short run, while the supply-leading relationship is found to prevail from the real exchange rate to government consumption in the long run. The results support the notion that inflation is a government phenomenon (see Fischer 1993, among others) as well as the relationship that foreign aid and government consumption cause each other (Chenery and Strout 1966; Mosley *et al*. 1987).

In the real exchange rate function, the dominant hypothesis revealed is the feedback hypothesis between the real exchange rate and investment, population growth, inflation, and foreign aid in both the short and the long run, and between the real exchange rate and human capital, and government consumption in the short run. The supply-leading hypothesis was also found to prevail from human capital and government consumption to the real exchange rate in the short run, and a demand-following hypothesis was found to prevail from the real exchange rate to trade openness in the short run. No causality was found between the real exchange rate and trade openness in the long run. Overall, the results reveal that expansions or contractions in other variables studied also result in causing expansions or contractions in the real exchange rate variable.

In the inflation function, the dominant hypothesis found was the feedback hypothesis between inflation and human capital, population growth, and government consumption in both the short and in the long run; between inflation and the real exchange rate, and trade openness in the short run, and between inflation and real GDP per capita in the long run. The supply-leading hypothesis was also found from investment to inflation in the short run, and from the real exchange rate, and trade openness to inflation in the long run. The neutrality hypothesis also holds between inflation and foreign aid as no causality was found in the short run.

In the trade openness function, the dominant hypothesis revealed is the demand-following hypothesis where the results show a distinct unidirectional causal relationship from trade openness to human

capital, and foreign aid in both the short and the long run, and from trade openness to real GDP per capita, investment, population growth, government consumption, and inflation in the long run. On the other hand, the short-run results are dominated by the feedback hypothesis where the results show a distinct bi-directional causal relationship between trade openness and real GDP per capita, investment, population growth, government consumption, and inflation. Furthermore, the relationship was found to be supply-leading from the real exchange rate to trade openness in the short run while no causality exists in the long run.

Lastly, the foreign aid function supports all growth hypotheses: the results reveal that the feedback hypothesis is dominant as the results show a distinct bidirectional causal flow between foreign aid and real GDP per capita, and government consumption in both the short and the long run; between foreign aid and real exchange rate in the short run; and between foreign aid and investment, human capital, population growth, and inflation in the long run. The supply leading hypothesis was also found that runs from trade openness to foreign aid both in the short and long run; investment, and human capital to foreign aid in the short run; and from real exchange rate to foreign aid in the long run. The results also revealed that the demand-following hypothesis exists that flows from foreign aid to population growth in the short run. No causality was found between inflation and foreign aid in the short run.

These results have significant policy implications for the Zambian economy. First, efficiency factors such as government consumption, real exchange rate depreciation, inflation, trade openness, and foreign aid are important to economic growth as they contribute towards the stability of the macro-economic environment. This is supported through the effectiveness of the institutional framework of an economy related to political and economic governance, incentive structures and social infrastructure. Most importantly, taking into account these efficiency factors would lead to a long-run equilibrium path supported by the right price mechanism and a regulatory environment that is necessary to clear markets (World Bank 1990; Corbo *et al*. 1992). It is also worth noting some of the important feedback hypotheses that are revealed between foreign aid and real GDP per capita, foreign aid and government consumption, foreign aid and real exchange rate; government consumption and foreign aid, and real exchange rate and inflation, both in the short and long run. The evidence provided shows that these macroeconomic variables complement each other. Furthermore, trade openness is

important in promoting human capital development and foreign aid in both the short and the long run. Thus, based on these important principles and given that the study reveals that all growth hypotheses apply to the Zambian economy, it is recommended that government authorities should focus on developing economic policies that create incentives to improve the efficiency of investment, the quality of human capital, effective public institutions that are capable of translating expenditures into efficient investment, real exchange rate stability, inflation stability, trade reforms, and the effectiveness of foreign aid, in both the short and the long run: furthermore, it is important for the Zambian authorities to focus on promoting economic strategies that control population growth.

Lastly, although the study results are methodically defendable, there are two limitations that have been envisaged. First, insufficient data points for some of the variables used led to the small sample size case. Much as the study has used more variables to take into account the omitted variable bias; it has been found that more data points affect the magnitude and sign of regression results (see Bernanke and Gurkaynak 2001). Second, use of annual time series data leads to some loss of parameter precision compared to quarterly and monthly data. For many macroeconomic variables it is rare to find quarterly or monthly data, especially for developing countries like Zambia. Therefore, replicating this study whenever new data points are found would be interesting for comparative purposes.

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