ECONOMIC ANNALS, Volume LXIV, No. 220 / January – March 2019
UDC: 3.33 ISSN: 0013-3264

https://doi.org/10.2298/EKA1920007C

*Themba G Chirwa**
*NM Odhiambo***

AN EMPIRICAL TEST OF EXOGENOUS GROWTH MODELS: EVIDENCE FROM THREE SOUTHERN AFRICAN COUNTRIES

ABSTRACT: *This paper aims to empirically investigate the relevance of exogenous growth models to explaining economic growth in three Southern African countries, using the ARDL bounds-testing approach. In addition, the relevance of the convergence hypothesis in these study countries is tested using an extended exogenous growth model. The study results reveal that the predictions of the Solow and augmented Solow growth models are consistent in the three study countries, and that the convergence hypothesis holds. However, when additional factors are taken into account in exogenous growth models, the response of income per capita due to changes in investment and human capital development is slow in economies with low income per capita, such as Malawi and Zambia, compared to South Africa, which is ranked as an economy with a high income per capita. This study has important policy implications in these study countries. These implications include the need for policymakers to ensure that macroeconomic stability is encouraged by reducing government consumption, inflation, and population growth; and by promoting trade in order to allow for the diffusion of technologies from abroad.*

KEY WORDS: *Exogenous Growth Models; Autoregressive Distributed Lag Model; Economic Growth; Malawi; Zambia; South Africa*

JEL CLASSIFICATION: F43, N17, O47

* Corresponding Author, Independent Research Contractor, Department of Economics, University of South Africa, E-mail: themba.chirwa@mmd.gov.mw / tchirwa@gmail.com
** Department of Economics, University of South Africa, E-mail: odhianm@unisa.ac.za / nmbaya99@yahoo.com

1. INTRODUCTION

Investigations seeking to identify the factors that promote or hinder economic growth have been some of the central pursuits amongst theoretical and empirical growth researchers – but with little consensus reached to date. Within the framework of economic growth theory, two important new approaches have spearheaded much of the discussion on economic growth: the neoclassical or exogenous growth theories and the endogenous growth theories. In both cases, the main focus has been on the importance of state factors, such as the accumulation of physical capital, human capital development, and technology (see, amongst others, Solow 1956; Romer 1986; Lucas 1988; Grossman and Helpman 1991; Aghion and Howitt 1992). However, there have been other equally important contributions to the economic growth literature, which focus either on the role of efficiency factors in economic growth (see, among others, Easterly and Wetzel 1989; World Bank 1990) or the importance of fundamental sources of economic growth such as institutional, legal, demographic, geographic, socioeconomic, and political factors (see, among others, Barro 1999, 2003; Sachs and Warner 1997; Radelet et al. 2001).

The neoclassical (Solow 1956) economic growth theory, also known as the exogenous growth model, postulates that the accumulation of physical capital is an important driver of economic growth in the short run, while technological advancement is the key determinant of economic growth in the long run. An important extension of this neoclassical growth model is the inclusion of human capital stock as one of the key factors driving economic growth, as a complement to physical capital accumulation (Mankiw et al. 1992; Islam 1995). On the other hand, the major contribution of endogenous growth theorists is based on productivity factors such as learning-by-doing (Becker 1962; Mincer 1962; Weisbrod 1962; Romer 1986; Lucas 1988) and the importance of useful technological knowledge (research and development) as important drivers of growth (Frankel 1962; Grossman and Helpman 1991; Aghion and Howitt 1992; Stokey 1995).

Much as there is consensus that state factors – such as accumulation of physical capital (investment) and human capital development – and productivity factors (technological growth) are important macroeconomic determinants of economic growth in almost any country, there are other proponents that postulate the key roles of the following: factors affecting the efficiency of savings and investment, such as financial repression (McKinnon 1973; Shaw 1973); real exchange rate misalignment (Balassa 1964; Samuelson 1964); inflation (Mundell 1963; Tobin 1965; Sidrauski 1967; Stockman 1981; Fischer 1983; Bruno and Easterly 1998); government spending (Wagner 1892; Peacock and Wiseman 1961; Barro 1990; Barro and Sala-i-Martin 1992); international trade (Dollar 1992; Knight et al. 1993; Sachs and Warner 1997); and foreign aid (Chenery and Strout 1966; Mosley 1980; Riddell 1987). All of the above mentioned are arguably equally important determinants of economic growth (Easterly and Wetzel 1989; World Bank 1990; Fischer 1992). These efficiency factors became prominent in the 1990s with three key outcomes being targeted, namely: the stability of the macro-economic environment; the effectiveness of an economy's institutional framework related to political and economic governance, incentive structures, and social infrastructure; and the establishment of the right price mechanism and the regulatory environment necessary to clear markets (World Bank 1990; Corbo et al. 1992; Snowdon and Vane 2005). However, to our knowledge, the relevance of these factors has not been empirically investigated in exogenous growth models.

Therefore, against this backdrop, the present study seeks to investigate the relevance of exogenous growth models to explaining economic growth in three Southern African countries. In particular, the importance of efficiency factors in explaining long-run economic growth is investigated using an extension to the exogenous growth model. Three models – Solow (1956), Mankiw et al. (1992), and World Bank (1990) – are estimated in this study using data from three countries, namely, Malawi, Zambia, and South Africa, in order to test the importance of these factors and how they affect parameter estimates. The selection of these countries takes into account their level of development and the fact that they all belong to the Southern African Development Community (SADC). In particular, of the eleven countries in the SADC these three have distinct economies: Malawi is a low-income and predominantly agriculture-based economy; Zambia is a low-middle-income country with natural resources at the heart of its economy; and South Africa is an upper-middle-income country whose economy thrives on natural resources, manufacturing, and services.

The rest of this paper is organised as follows. Section 2 discusses the theoretical foundations of the exogenous growth model and its challenges. Section 3 discusses the empirical model specification and the estimation techniques used in the study. Section 4 presents the empirical analysis results of the estimated models. Lastly, Section 5 concludes the study and discusses policy recommendations.

2. THEORETICAL FOUNDATIONS

To establish linkages with the theoretical foundations, the empirical dynamic model adopted in this study is assumed to follow a Cobb-Douglas aggregate production function with labour-augmenting (Harrod-neutral) technological progress. Building on the methodology of Fischer (1993), Knight et al. (1993), and Acikgoz and Mert (2014), the aggregate Cobb-Douglas production function is assumed to take the form:

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

In equation (1), *K, HC,* and *L* stand for physical capital, human capital, and labour and represent the traditional inputs used in the Solow (1956) and Mankiw et al. (1992) growth functions; α represents the partial elasticity of output with respect to physical capital; and β is the partial elasticity of output with respect to human capital. When using time series data, the literature recommends that the technological change factor (A_t) should be assumed to be labour-augmenting and should follow a Harrod-neutral technical change (Uzawa 1965; Lucas 1988; Acikgoz and Mert 2014). The model builds on Fischer's (1993, p.494) approach where he assumes the labour-augmenting technology to have two multiplicative components: the level of technological progress, which is assumed to be labour-augmenting (Harrod-neutral); and the overall economic efficiency, which is dependent on institutional factors and government economic management policy. This framework has also been supported by Barro (1999, p.445), where the empirical model of the long-run or equilibrium level of per capita output is assumed to depend on government policies, institutions, and the national population. Barro (1990) concludes that better enforcement of regulations and fewer market distortions tend to raise the long-run equilibrium level of per capita output and, hence, its growth rate.

According to the World Bank (1990) report, sustainable economic growth has three requirements, namely, a stable macroeconomic environment, an appropriate price mechanism and regulatory structure, and efficient and effective institutions that can convert national savings into productive investments (World Bank 1990, p.100). Fischer's (1993, p.487) definition of a stable macroeconomic framework implies a policy environment that is conducive to economic growth. This reflects an environment where inflation is low and predictable, real interest rates are at appropriate levels to attract savings, fiscal policy is stable (distortions are sustainable), the real exchange rate is competitive and predictable, and the balance of payments position is perceived to be viable (World Bank 1990, p.4).

Rather than assuming economic efficiency factors to be fixed regressors, these factors have been assumed to consist of policy variables that affect the stabilisation curve of the exogenous growth model (Fischer 1992, 1993). Fischer (1993) regresses the growth rate of real GDP on inflation rate, ratio of budget surplus to GDP, black market premium on foreign exchange, and terms of trade. In Bassanini et al.'s (2001, p.54) framework, using a cross-country regression, the included variables are real GDP per capita, accumulation of physical capital, human capital, growth of working age population, inflation, government consumption, government capital accumulation, tax and non-tax receipts, direct/indirect taxes, business and non-business research and development, private credit, stock market capital, and trade exposure. The rationale of taking this approach originates from three fronts, namely, the Solow residual or total factor productivity, the conditional convergence hypothesis, and macroeconomic uncertainty or the efficiency of traditional inputs of growth.

First, in the exogenous growth model, total factor productivity is defined as the portion of production and productivity that cannot be explained by the amount of traditional inputs such as the accumulation of physical capital and human capital stock. As such, the Solow residual is a source of omitted variables. Mosley et al. (1987) use export growth in addition to domestic savings, foreign aid, foreign direct investment, and literacy growth to isolate the components of total factor productivity that drive economic growth. In addition, Fischer (1993, p.494) argues that the standard procedure of adding policy-induced macroeconomic variables to a growth regression implicitly assumes that policy variables affect economic growth through the productivity residual. Thus, rather than assuming that these important determinants are lumped in with the Solow residual, isolating their influence on growth is important to guide policy decision-makers.

Second, the absolute convergence hypothesis of the neoclassical growth model (Solow 1956; Cass 1965) postulates that poorer economies grow faster and tend to catch up with richer economies. However, Barro (2003, p.235) argues that this hypothesis does not hold empirically, and in order to understand why this is the case, the relationship between growth rates and the initial position of real GDP per capita has to be examined after holding constant some variables that are unique to each country or a set of countries. Thus, the empirical growth framework should integrate state variables that consist of the accumulation of physical and human capital stock, as well as policy variables that include common characteristics driven by governments and private agents, such as the ratio of government consumption to GDP, the extent of international openness, indicators of macroeconomic stability, and political stability measures such as maintenance of the rule of law and democracy (Barro 2003, p.236).

Third, macroeconomic stability matters for economic growth through uncertainty (Fischer 1992, p.173). In the theoretical literature, two sources of uncertainty are described: macroeconomic uncertainty that affects the efficiency of the price mechanism is policy-induced (Lucas 1973; Froyen and Waud 1980), while uncertainty that affects the future potential of investment growth and causes capital flight is temporal (Pindyck 1988; Pindyck and Somalino 1993). Thus, the sources of uncertainty based on the endogenous and empirical growth theories assume the efficiency of capital (both physical and human) to be affected by a number of policy-related factors that include trade policy, inflation, financial repression, and real exchange rate instability (Easterly and Wetzel 1989; World Bank 1990; Dollar 1992; Fischer 1993).

Growth economists that study economic growth trends have postulated that the international differences in income between developing and developed countries can be explained in part by differences in the macroeconomic policy environment. Savings and investment (both physical and human capital) are traditionally the key determinants of economic growth, and many empirical studies have found these determinants to be positively and significantly associated with economic growth. However, a stable macroeconomic environment is a necessary condition for maintaining efficient savings and investment as well as for minimising capital flight (World Bank 1990, p.100; Fischer 1993, 486; Bassanini et al. 2001, p.5). Many endogenous empirical studies also single out policy distortions that affect the price mechanism and the efficient allocation of resources as key factors that result in international differences in economic performance, especially in developing countries (Easterly and Wetzel 1989, p.1; Corbo et al. 1992, p.160). The endogenous growth theories postulate that eliminating policy distortions can lead to a one-time increase in the output level in the long run (level effects) as well as affect the growth rate of output in the short run (growth effects). The standard neoclassical Solow (1956) growth model postulates that distortionary policies exhibit only growth effects and not level effects. The endogenous growth literature, on the other hand, presents models where policy distortions have significant effects on both short- and long-run economic growth (Romer 1986; Lucas 1988; Barro 1989, 1991; Barro and Sala-i-Martin 1992).

The variables that are included in this study, therefore, consist of the accumulation of physical capital (investment), human capital (average years of schooling), population growth, and policy variables (efficiency factors) that include government consumption share in GDP, real exchange rate, inflation, and international trade. The distortions in these efficiency factors are assumed to affect the rate of savings and investment at certain thresholds where the relationship can either be positive or negative. Thus, these efficiency factors, just like population growth, are assumed to grow exogenously, as follows (see Mankiw et al. 1992, Nonneman and Vanhoudt 1996, among others):

$$L_t = L(0)e^{\eta t} \tag{2}$$

$$A_t = A(0)e^{gt} \tag{3}$$

$$GC_t = GC(0)e^{\theta t} \tag{4}$$

$$RER_t = RER(0)e^{\tau t} \tag{5}$$

$$INF_t = INF(0)e^{\pi t} \tag{6}$$

$$TRD_t = TRD(0)e^{\delta t} \tag{7}$$

The growth rates are represented by the exponential coefficients such as population, η; technology, g; public consumption, θ; the real exchange rate, τ; inflation, π; diffusion of knowledge (international trade), δ; as well as their initial endowments for population, $L(0)$; technology, $A(0)$; public consumption, $GC(0)$; real exchange rate, $RER(0)$; inflation, $INF(0)$; and international trade, $TRD(0)$. The theoretical model specification adopted is based on the notion that adequate levels of savings and investments are necessary but not sufficient to guarantee higher rates of economic growth in an economy. Macroeconomic stability is also essential and affects the efficiency of the factors of production at certain thresholds (World Bank 1990; Fischer 1993). Some of the empirical studies that support the role of macroeconomic instability include threshold effects that arise from government expenditure (Anaman 2004), real exchange rate instability (Rodrik 2008; Vieira et al. 2013), inflation (Bruno and Easterly 1998), and trade volatility (Mendoza 1997).

Assuming that the fraction of income invested in physical capital and human capital is given by s_k, s_h, respectively, the evolution of the economy can be assumed to be determined by the following two extended and empirical dynamic equations, expressed in quantities per unit of effective labour (see Mankiw et al. 1992; Fischer 1993; Barro 2003, among others):

$$\Delta k_t = s_k y_t - (\eta + g + \theta + \tau + \pi + \delta) k_t \tag{8}$$

$$\Delta h_t = s_h y_t - (\eta + g + \theta + \tau + \pi + \delta) h_t \tag{9}$$

In equations 8 and 9, the small letters represent quantities per unit of effective labour, $A_t L_t$, and postulate that a unit of consumption can be transformed into either a unit of physical capital or a unit of human capital (Acikgoz and Mert 2014). For the production function to converge towards its equilibrium steady state, decreasing returns to the sources of capital, $\alpha + \beta < 1$, are assumed. Therefore, the evolution of investment and human capital towards a steady state with respect to a given set of policy variables in a given country is defined by the following two equations (see Mankiw et al. 1992; Fischer 1993; Barro 2003, among others):

$$k^* = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{(\eta + g + \theta + \tau + \pi + \delta)} \right)^{1/1-\alpha-\beta} \tag{10}$$

$$h^* = \left(\frac{s_k^{\alpha} s_h^{1-\alpha}}{(\eta + g + \theta + \tau + \pi + \delta)} \right)^{1/1-\alpha-\beta} \tag{11}$$

where (■)* = Steady state value of investment and human capital stock

Substituting equations 10 and 11 into the production function (Equation 1) and expressing the variables in logarithmic form, the steady state empirical long-run growth equation can be expressed as follows (see Mankiw et al. 1992, among others):

$$\ln y_t = \ln A(0) + gt + \frac{\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\beta}{1-\alpha-\beta}\ln(s_h) - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(\eta + g + \theta + \tau + \pi + \delta) \tag{12}$$

Equation 12, therefore, reveals the structural theoretical model that shows how the long-run level of income per capita is dependent on the accumulation of physical capital and human capital stock; a Harrod-neutral (or labour-augmenting) technological factor, represented by the linear trend variable, gt; and policy factors that improve their efficiency – population growth, government consumption, real exchange rate, inflation, and trade. An important aspect of the initial technological endowment factor, $In\ A(0)$, is that it represents exogenous and country-specific fixed regressors that may induce growth (see Mankiw et al. 1992; Fischer 1993; Barro 2003, among others).

In summary, the efficiency factors provide the essentials and a link to how policy variables influence the aggregate production function (see World Bank 1990; Fischer 1993; Barro 2003, among others). Distortions in these factors are expected to have a long-lasting influence on the accumulation of savings and investments and can either prevent or induce capital flight (World Bank 1990, p.100). At first glance, the efficiency factors are not directly controllable by policy, and each variable optimally varies in response to shocks in the economy (Fischer 1993, p.487). Furthermore, significant distortions in these efficiency factors that pass a certain threshold have significant adverse macroeconomic consequences: firstly on the level of savings and accumulation of physical capital (neoclassical theory) and secondly on growth (new growth theories).

3. EMPIRICAL MODEL SPECIFICATION AND ESTIMATION TECHNIQUES

3.1 Empirical Model Specification

In order to test this modelling approach that takes into account efficiency factors, time series data from three study countries in SADC are used. The selected countries include a low-income economy (Malawi), a lower-middle-income economy (Zambia), and an upper-middle-income economy (South Africa). The three models estimated in this study are as follows: Model 1, based on Solow (1956); Model 2, based on Mankiw et al. (1992); and Model 3, based on an extended growth model with additional factors proposed by the World Bank (1990). The models are presented as Equations 13 to 15.

Model 1 (Solow 1956):

$$Y = f(INV, POPG) \tag{13}$$

Model 2 (Mankiw et al. 1992):

$$Y = f(INV, HC, POPG) \tag{14}$$

Model 3 (World Bank 1990):

$$Y = f(INV, HC, POPG, GC, RER, INF, TRD) \tag{15}$$

The selected variables included in Equations 13–15 comprise the following traditional factors: income per capita represented by real GDP per capita, investment (INV) proxied by gross fixed capital formation as a share of real GDP, human capital (HC) proxied by total enrolment, and population growth $(POPG)$; and the following efficiency factors: general government final consumption expenditure (GC) as a share of real GDP, real exchange rate (RER), inflation (INF), and international trade (TRD) proxied by the ratio of exports and imports.

3.2 Estimation Techniques

The study uses the recently developed Autoregressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran et al. (2001). The ARDL model has numerous advantages, such as the inclusion of lags for both the dependent variable and regressors to investigate short- and long-run properties (Pesaran and Shin 1999; Collier and Goderis 2012). It can also be used to identify cointegrating relationships regardless of whether the integrated variables are of order zero or one (Odhiamb, 2013). Correction of endogeneity in the regressors (Pesaran and Shin 1999; Acikgoz and Mert 2014) and the provision of robust results even when the sample size is small (Narayan 2005) are further advantages associated with the model. The ARDL representation of Models 1–3 can be expressed as follows:

Model 1:

$$\Delta lnY_t = \beta_0 + \beta_1 T_t + \sum_{i=1}^{n} \beta_{2i} \Delta lnY_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta lnPOPG_{t-i} + \alpha_1 lnY_{t-1} + \alpha_2 lnINV_{t-1} + \alpha_3 lnPOPG_{t-1} + \varepsilon_t \quad (16)$$

Model 2:

$$\Delta lnY_t = \beta_0 + \beta_1 T_t + \sum_{i=1}^{n} \beta_{2i} \Delta lnY_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta lnINV_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta lnHC_{t-i} + \sum_{i=0}^{n} \beta_{5i} \Delta lnPOPG_{t-i} + \alpha_1 lnY_{t-1} + \alpha_2 lnINV_{t-1} + \alpha_3 lnHC_{t-1} + \alpha_4 lnPOPG_{t-1} + \varepsilon_t \quad (17)$$

Model 3:

$$\Delta lnY_t = \beta_0 + \beta_1 T_t + \sum_{i=1}^{n} \beta_{2i} \Delta lnY_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta lnINV_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta lnHC_{t-i} + \sum_{i=0}^{n} \beta_{5i} \Delta lnPOPG_{t-i} + \sum_{i=0}^{n} \beta_{6i} \Delta lnGC_{t-i} + \sum_{i=0}^{n} \beta_{7i} \Delta lnRER_{t-i} + \sum_{i=0}^{n} \beta_{8i} \Delta lnINF_{t-i} + \sum_{i=0}^{n} \beta_{9i} \Delta lnTRD_{t-i} + \alpha_1 lnY_{t-1} + \alpha_2 lnINV_{t-1} + \alpha_3 lnHC_{t-1} + \alpha_4 lnPOPG_{t-1} + \alpha_5 lnGC_{t-1} + \alpha_6 lnRER_{t-1} + \alpha_7 lnINF_{t-1} + \alpha_8 lnTRD_{t-1} + \varepsilon_t \quad (18)$$

In Equations 16–18, the parameters $\beta_2,\ldots,\beta_9$ represent the short-run elasticities, and $\alpha_1,\ldots,\alpha_8$ are the long-run elasticities, given that all variables are expressed in natural logarithm. The deterministic terms are represented by a constant β_0 and a trend term T_t. The white noise residual term denoted by ε_t is assumed to be independent and identically distributed. The error correction models associated with Equations 16–18 that measure the speed of adjustment towards the long-run equilibrium path are expressed as follows:

Model 1:

$$\Delta lnY_t = \beta_0 \Delta T_t + \sum_{i=1}^{n} \beta_{1i} \Delta lnY_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta lnINV_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta lnPOPG_{t-i} + \rho ECM_{t-1} + \varepsilon_t \quad (19)$$

Model 2:

$$\Delta lnY_t = \beta_0 \Delta T_t + \sum_{i=1}^{n} \beta_{1i} \Delta lnY_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta lnINV_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta lnHC_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta lnPOPG_{t-i} + \rho ECM_{t-1} + \varepsilon_t \quad (20)$$

Model 3:

$$\Delta lnY_t = \beta_0 \Delta T_t + \sum_{i=1}^{n} \beta_{1i} \Delta lnY_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta lnINV_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta lnHC_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta lnPOPG_{t-i} + \sum_{i=0}^{n} \beta_{5i} \Delta lnGC_{t-i} + \sum_{i=0}^{n} \beta_{6i} \Delta lnRER_{t-i} + \sum_{i=0}^{n} \beta_{7i} \Delta lnINF_{t-i} + \sum_{i=0}^{n} \beta_{8i} \Delta lnTRD_{t-i} + \rho ECM_{t-1} + \varepsilon_t \quad (21)$$

3.3 Data

The data used in this study is obtained from the World Bank Development Indicators (World Bank 2015) and the United Nations Educational, Scientific and Cultural Organisation (UNESCO) Institute of Statistics (UNESCO 2015). The study uses annual time series data covering the period 1970–2013. The ARDL model estimation is computed using Microfit 5.0, while unit root tests are reported based on Eviews 9 software. The following definitions of variables have been used in the study: Real gross domestic product (real GDP) per capita is expressed as real GDP in 2010 constant USD prices divided by population; physical capital is proxied by gross fixed capital formation as a share of real GDP expressed in 2010 constant USD prices; human capital stock is proxied by total enrolment as a sum of enrolments at primary, secondary, and tertiary levels; population growth is defined as the rate of change of total population per annum; government consumption is defined as a share of general government final consumption expenditure to real GDP expressed in 2010 constant USD prices; real exchange rate is expressed as the ratio of nominal exchange rate (Local Currency Unit (LCU) per US dollar, period average) and Power

Purchasing Parity (PPP, LCU per international $) as suggested by Rodrik (2008); inflation rate is defined as the growth rate of the consumer price index (2010=100); and trade openness is represented by the sum of exports and imports expressed in 2010 constant USD prices as a share of real GDP.

4. EMPIRICAL RESULTS

4.1 Stationarity Tests

Table 1 reports the stationarity test results for the time series data used in this study based on the Augmented Dickey-Fuller (1979), Elliott, Rothenberg and Stock (1996) Dickey Fuller Generalized Least Squares (DF-GLS), and Perron (1990) structural-break unit-root tests. Overall, all variables in the study countries were found to be either integrated of order one or zero. Therefore, the ARDL bounds testing procedure for cointegrating relationships as suggested by Pesaran et al. (2001) can be employed.

Table 1: Stationarity Tests for all Variables

	Stationarity of all Variables in Levels						*Stationarity of all Variables in 1st Differences*					
	ADF		*DF-GLS*		*Perron*		*ADF*		*DF-GLS*		*Perron*	
Variable Name	*Without Trend*	*With Trend*	*Without Trend*	*With Trend*	*Without Trend*	*With Trend*	*Without Trend*	*With Trend*	*Without Trend*	*With Trend*	*Without Trend*	*With Trend*
Malawi												
Log(GDPPC)	–	-2.02	–	-1.85	–	-3.78	–	-7.42***	–	-2.91*	–	-8.00***
Log(INV)	-3.32**	–	-3.08***	–	-4.55	–	–	–	–	–	-9.18***	–
Log(HC)	–	-1.34	–	-1.38	–	-2.39	–	-6.32***	–	-5.99***	–	-6.43***
Log(POPG)	-2.67*	–	-2.71***	–	-7.32***	–	-4.82***	–	–	–	–	–
Log(GC)	-3.57***	–	-3.60***	–	-4.36*	–	–	–	–	–	-9.75***	–
Log(RER)	–	-3.08	–	-3.17*		-4.35*	–	-6.19***	–	-6.32***	–	-6.69***
Log(INF)	-4.19***	–	-4.20***	–	-5.73***	–	–	–	–	–	–	–
Log(TRD)	-4.13***	–	-4.05***	–	-4.96***	–	–	–	–	–	–	–
Zambia												
Log(GDPPC)	–	0.98	–	-0.94	–	-4.52	–	-7.26***	–	-7.42***	–	-9.86***
Log(INV)	-1.41	–	1.31	–	-2.79	–	-11.16***	–	-9.32***	–	-13.11***	–
Log(HC)	–	-1.31	–	-1.52	–	-3.37	–	-3.91**	–	-3.95**	–	-6.45***
Log(POPG)	0.26	–	-0.82	–	-1.75	–	-1.91*	–	-1.65*	-	-4.23*	–
Log(GC)	-4.18***	–	-3.14***	–	-5.04***	–	–	–	–	-	–	–
Log(RER)	–	-0.79	–	-0.95	–	-4.69	–	-5.18***	–	-5.25***	–	-10.04***
Log(INF)	–	-1.82	–	-1.25	–	-5.41**	–	-6.15***	–	-5.99***	–	–
Log(TRD)	-1.74	–	-1.62*	–	-3.39	–	-5.38***	–	-5.31***	-	-6.50***	–
South Africa												
Log(GDPPC)	–	-1.12	–	-1.38	–	-3.57	–	-4.34***	–	-4.28***	–	-5.17***
Log(INV)	–	-1.95	–	-2.05	–	-4.34	–	-6.61***	–	-6.25***	–	-7.05***
Log(HC)	–	-0.77	–	-0.96	–	-6.77***	–	-5.61***	–	-5.65***	–	–
Log(POPG)	–	-2.19	–	-1.98	–	-6.19***	–	-4.51***	–	-4.55***	–	–
Log(GC)	–	-2.21	–	-2.13	–	-5.56**	–	-5.95***	–	-5.18***	–	–
Log(RER)	–	-2.89	–	-2.83	–	-4.16	–	-5.70***	–	-5.73***	–	-6.64***
Log(INF)	–	-3.94**	–	-3.10*	–	-4.94*	–	–	–	-8.70***	–	-12.55***
Log(TRD)	-2.76*	–	-2.10**	–	-3.45	–	-6.37***	–	–	–	-7.74***	–

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

4.2 ARDL Bounds Test for Cointegration

The Akaike Information Criteria (AIC) and Schwarz-Bayesian Criteria (SBC) were employed to determine the appropriate lag length in the three models studied in this paper. In Model 1 – the Solow (1956) model – the optimal ARDL model selected were $ARDL(1,1,2)$ for Malawi, $ARDL(3,1,2)$ for Zambia, and $ARDL(1,1,0)$ for South Africa. For Model 1, the growth equation reported an F-statistic of 8.24 in Malawi, 5.28 in Zambia, and 5.11 in South Africa. The computed F-statistics in the three study countries were statistically significant at the 1% (Malawi) and 5% (Zambia and South Africa) significance levels. In Model 2 – the Mankiw et al. (1992) model – the optimal ARDL models selected were $ARDL(1,1,0,2)$ for Malawi, $ARDL(2,1,2,0)$ for Zambia, and $ARDL(1,0,2,2)$ for South Africa. In Model 2, Malawi reported a computed statistic of 6.37, Zambia a computed statistic of 10.28, and South Africa a statistic of 6.04. All computed statistics for Model 2 were statistically significant at the 1% significance level. Lastly, for Model 3 – the World Bank (1990) model – the optimal ARDL models selected were $ARDL(1,0,0,2,1,1,2,1)$ for Malawi, based on the AIC; $ARDL(2,0,0,0,0,0,0,2,0)$ for Zambia, based on the SBC; and $ARDL(1,0,0,0,0,0,1,1)$ for South Africa, based on the SBC. In Model 3 the computed F-statistic for the Malawi growth equation was 4.14, for Zambia it was 5.85, and for South Africa it was 5.67: all computed bounds test statistics were statistically significant at the 1% significance level. In summary, for all three models the bounds test for co-integrating relationships using the Pesaran et al. (2001) approach confirmed the existence of long-run level relationships between the dependent variable, real GDP per capita, and the set of covariates.

4.3 Empirical Analysis of the ARDL-Based Error Correction Model

Tables 2–4 below present the short- and long-run multipliers for the estimated growth equations based on the Solow (1956), Mankiw et al. (1992), and World Bank (1990) models. Table 2 presents the empirical results of the Solow (1956) growth model, and the coefficients for investment and population have the predicted signs.

Table 2: Model 1 Estimated Results – Solow (1956)

Panel 1. Long-Run Coefficients [Dependent Variable: $\log(GDPPC)_t$]						
	Malawi		**Zambia**		**South Africa**	
Regressor	**Coefficient**	**Probability**	**Coefficient**	**Probability**	**Coefficient**	**Probability**
$\log(INV)_t$	0.6050**	0.044	1.2319***	0.000	0.4178***	0.001
$\log(POPG)_t$	-0.2416	0.149	-2.4391***	0.000	-0.2446*	0.098
T_t	0.0074**	0.033	–	–	0.0042	0.137
β_0	5.3318***	0.000	–	–	8.1931***	0.000
Panel 2. Estimated Short-Run Coefficients [Dependent Variable: $\Delta\log(GDPPC)_t$]						
	Malawi		**Zambia**		**South Africa**	
Regressor	**Coefficient**	**Probability**	**Coefficient**	**Probability**	**Coefficient**	**Probability**
$\Delta\log(GDPPC)_{t-1}$	–	–	-0.1631	0.318	–	–
$\Delta\log(GDPPC)_{t-2}$	–	–	0.0541	0.714	–	–
$\Delta\log(INV)_t$	0.0370	0.219	0.0570***	0.005	0.1520***	0.000
$\Delta\log(POPG)_t$	-0.0763*	0.066	-0.4580	0.370	-0.0691	0.152
$\Delta\log(POPG)_{t-1}$	0.1512***	0.001	0.8029	0.126	0.0597	0.249
ΔT_t	0.0013**	0.027	–	–	0.008	0.223
ECM_{t-1}	-0.1796**	0.030	-0.6377***	0.002	-0.1945***	0.009

	Malawi	Zambia	South Africa
R-Squared	0.4928	0.5703	0.5993
R-Bar Squared	0.3884	0.4764	0.5168
S.E. of Regression	0.0375	0.0312	0.0164
F-Stat	6.60[0.000]	8.49[0.000]	10.17[0.000]
Residual Sum of Squares	0.0479	0.0313	0.0091
DW-statistic	2.49	1.90	1.98
Akaike Info. Criterion	-74.70	-78.29	-109.35
Schwarz-Bayesian Criterion	-67.75	-71.53	-102.40

***Note:** *** 1% significance level; ** 5% significance level; * 10% significance level.*

On average, the computed R-squared and the adjusted R-squared support the fact that investment and population growth account for a large part of income per capita in South Africa and Zambia (which supports the empirical results of Mankiw et al. (1992)) but not necessarily for Malawi. The error correction terms in all three study countries are statistically significant and negative, implying that all regressions converge toward their equilibrium steady path. The long-run results presented in Panel 1 show that investment is statistically significant in all three study countries. In the long run a 1% increase in investment leads to a

0.61% increase in income per capita in Malawi, a 1.23% increase in Zambia, and a 0.42% increase in South Africa. These results support the convergence principle, where economies with low levels of income, such as Malawi and Zambia, face relatively high long-run responses to income per capita compared to economies with high levels of income like South Africa.

The short-run results in Panel 2 reveal that investment is positively and significantly associated with economic growth in Zambia and South Africa. A 1% increase in investment growth leads to a 0.06% increase in income growth per capita in Zambia and a 0.15% increase in South Africa. The results also reveal that population growth is only statistically significant in Malawi, where a 1% increase in population growth in the short run leads to a –0.08% decrease in income per capita in the current period and a 0.15% increase in the previous period.

Table 3 adds human capital to provide estimates of the Mankiw et al. (1992) augmented growth model.

Similarly, the error correction term in all three study countries is statistically significant. The addition of human capital improves the R-squared and adjusted R-squared and reduces the overall impact of investment in all study countries, implying that human capital development is an important determinant of income per capita together with the accumulation of physical capital. These results are supported by Mankiw et al. (1992), who found similar results. It is also interesting to note that the inclusion of human capital development in the growth regressions gives mixed results. In Zambia, on the one hand, human capital is positively and significantly associated with long-run income per capita. On the other hand, the results for South Africa show that human capital development is significantly and negatively associated with long-run income per capita. The response to investment is positive and statistically significant in all three study countries. In Malawi a 1% increase in investment leads to a 0.51% increase in income per capita. The results are similar for Zambia, where a 1% increase in investment leads to a 0.54% increase in income per capita. In South Africa a 1% increase in investment leads to a 0.23% increase in income per capita. Although the inclusion of human capital development in the Mankiw et al. (1992) model reduces the impact of the long-run response of investment on income per capita, the results still support the convergence hypothesis that economies with low income per capita will experience higher growth rates than rich countries. The short-run results are similar to the Solow (1956) model, where investment remains positively and significantly associated with the growth of income per capita in Zambia and South Africa. The coefficient estimates remain the same, where a 1% increase in the growth of investment leads to a 0.06% and 0.15% increase in the growth of income per capita in Zambia and South Africa, respectively. Population growth is only significant in Malawi, where the results are also mixed, with a short run response of –0.09% in the current period and 0.18% in the previous period.

Table 3: Model 2 Estimated Results – Mankiw et al. (1992)

Panel 1. Long-Run Coefficients [Dependent Variable: $\log(GDPPC)_t$]

	Malawi		Zambia		South Africa	
Regressor	**Coefficient**	**Probability**	**Coefficient**	**Probability**	**Coefficient**	**Probability**
$\log(INV)_t$	0.5124**	0.039	0.5391***	0.005	0.2348***	0.000
$\log(HC)_t$	-0.3709	0.259	0.2811**	0.015	-0.2921***	0.000
$\log(POPG)_t$	-0.3093*	0.090	0.4244	0.291	-0.0907***	0.004
T_t	0.0282	0.147	–	–	0.0119***	0.000
β_0	9.7665**	0.016	5.0186**	0.022	12.974***	0.000

Panel 2. Estimated Short-Run Coefficients (Elasticities) [Dependent Variable: $\Delta\log(GDPPC)_t$]

	Malawi		Zambia		South Africa	
Regressor	**Coefficient**	**Probability**	**Coefficient**	**Probability**	**Coefficient**	**Probability**
$\Delta\log(GDPPC)_{t-1}$	–	–	-0.2813*	0.061	–	–
$\Delta\log(INV)_t$	0.0361	0.229	0.0633***	0.001	0.1466***	0.000
$\Delta\log(HC)_t$	-0.0742	0.255	0.0415	0.763	-0.0153	0.722
$\Delta\log(HC)_{t-1}$	–	–	-0.2749*	0.071	0.1195**	0.014
$\Delta\log(POPG)_t$	-0.0953**	0.035	-0.0774	0.404	-0.0345	0.355
$\Delta\log(POPG)_{t-1}$	0.1821***	0.001	–	–	0.0653	0.104
ΔT_t	0.0056	0.143	–	–	0.0074***	0.000
ECM_{t-1}	-0.2001**	0.019	-0.1825***	0.008	-0.6242***	0.000

	Malawi	Zambia	South Africa
R-Squared	0.5126	0.6634	0.7768
R-Bar Squared	0.3945	0.5818	0.7140
S.E. of Regression	0.0373	0.0281	0.0126
F-Stat	5.78[0.000]	10.84[0.000]	15.91[0.000]
Residual Sum of Squares	0.0460	0.0261	0.0051
DW-statistic	2.48	1.82	2.16
Akaike Info. Criterion	-74.53	-86.41	-119.64
Schwarz-Bayesian Criterion	-66.72	-78.59	-110.95

Note: **** 1% significance level; ** 5% significance level; * 10% significance level.*

In Table 4, efficiency factors such as government consumption, real exchange rate, inflation, and international trade are included as regressors in the exogenous growth models. The results in Panel 2 reveal that in the short run the adjustment process measured by the error correction term (ECM) is negative and statistically significant in the three study countries. The results show that the speed of adjustment towards the long-run equilibrium path is estimated as –0.30% per annum for Malawi, –0.22% for Zambia, and –0.07% for South Africa. The speed of adjustment that monotonically converges towards the equilibrium path thus confirms the long-run equilibrium relationship between real GDP per capita and the regressors in the respective countries. The study results also reveal that the underlying ARDL models in the three study countries are a good fit, represented by an estimated R-squared of 67% for Malawi, 78% for Zambia, and 76% for South Africa. The high R-squared values also suggest that both traditional factors and efficiency factors account for a significant part of income per capita in these study countries.

The long-run results in Table 4 reveal that investment and human capital development are positively and significantly associated with economic growth in all three study countries. A 1% increase in investment leads to a 0.30% increase in income per capita in Malawi and a 0.39% increase in Zambia. In South Africa a 1% increase in investment leads to a 1.04% increase in real GDP per capita. These results are consistent with empirical growth studies that find similar results in developing countries (see, among others, Bleaney et al. 2001; Anyanwu 2014). In terms of human capital, the long-run results show that a 1% increase in human capital development leads to a 0.16% increase in real GDP per capita in Malawi, a 0.27% increase in Zambia, and a 0.36% increase in South Africa. These results are unsurprising, as empirical evidence has shown that wealthier countries are likely to benefit more from innovation than developing economies, which benefit more from imitation. Similarly, the quality of investment and human capital development is likely to be higher in wealthier economies than in poor ones, as the former are likely to support research and development activities and to improve the quality of education (see Papageorgiou 2003, among others).

Table 4: Estimated Results – World Bank (1990) Model

Panel 1. Long-Run Coefficients [Dependent Variable: $\log(GDPPC)_t$]

	Malawi		Zambia		South Africa	
Regressor	**Coefficient**	**Probability**	**Coefficient**	**Probability**	**Coefficient**	**Probability**
$\log(INV)_t$	0.2955*	0.092	0.3940***	0.012	1.0413***	0.009
$\log(HC)_t$	0.1627**	0.024	0.2697***	0.004	0.3622***	0.004
$\log(POPG)_t$	-0.2319*	0.070	0.5962	0.131	-0.4372*	0.082
$\log(GC)_t$	0.0442	0.762	-0.3275**	0.046	-0.8754**	0.042
$\log(RER)_t$	0.0474	0.832	-0.0598	0.371	0.1114	0.586
$\log(INF)_t$	-0.1611**	0.015	0.0357	0.511	-0.4216*	0.058
$\log(TRD)_t$	0.5201**	0.045	-0.1242	0.296	1.3527**	0.019
β_0	2.6194**	0.025	5.5124***	0.007	–	–

Panel 2. Estimated Short-Run Coefficients (Elasticities) [Dependent Variable: $\Delta\log(GDPPC)_t$]

	Malawi		Zambia		South Africa	
Regressor	**Coefficient**	**Probability**	**Coefficient**	**Probability**	**Coefficient**	**Probability**
$\Delta\log(GDPPC)_{t-1}$	–	–	-0.4481***	0.003	–	–
$\Delta\log(INV)_t$	0.0873**	0.022	0.0459***	0.010	0.0684**	0.030
$\Delta\log(HC)_t$	0.0481**	0.025	0.0586***	0.005	0.0238	0.122
$\Delta\log(POPG)_t$	-0.0743	0.252	0.1295	0.273	-0.0287*	0.051
$\Delta\log(POPG)_{t-1}$	0.1094	0.110	–	–	–	–
$\Delta\log(GC)_t$	-0.0716	0.232	-0.0711***	0.006	-0.0575**	0.030
$\Delta\log(RER)_t$	-0.0049	0.931	-0.0129	0.443	0.0073	0.583
$\Delta\log(INF)_t$	-0.0249**	0.011	0.0077	0.554	-0.0071	0.219
$\Delta\log(INF)_{t-1}$	0.0124	0.152	–	–	–	–
$\Delta\log(TRD)_t$	0.1329**	0.033	0.0155	0.596	-0.0371	0.297
$\Delta\log(TRD)_{t-1}$	–	–	-0.0437*	0.100	–	–
ECM_{t-1}	-0.2954**	0.034	-0.2171**	0.014	-0.0657**	0.012

	Malawi	**Zambia**	**South Africa**
R-Squared	0.6706	0.7779	0.7559
R-Bar Squared	0.4805	0.6860	0.6873
S.E. of Regression	0.0346	0.0244	0.1323
F-Stat	5.292[0.000]	10.16[0.000]	14.16[0.000]
Residual Sum of Squares	0.0311	0.0173	0.0056
DW-statistic	2.42	2.05	2.07
Akaike Info. Criterion	-75.76	-91.14	-117.77
Schwarz-Bayesian Criterion	-61.86	-79.85	-109.08

Note: **** 1% significance level; ** 5% significance level; * 10% significance level.*

The impact of efficiency factors on economic growth can also be seen in the individual countries. Population growth was found to be negatively and significantly associated with long-run economic growth in Malawi and South Africa. The long-run results showed that in Malawi and South Africa respectively, a 1% increase in population growth leads to a −0.23% and a −0.44% decrease in real GDP per capita. These results are similar to some empirical growth studies that find support for a negative relationship between population growth and economic growth (see, among others, Most and Vann de Berg 1996; Checherita-Westphal and Rother 2012; Anyanwu 2014). The relationship between government consumption and economic growth was found to be negative and significantly associated with economic growth in Zambia and South Africa. The long-run results revealed that a 1% increase in government consumption leads to a −0.33% decrease in real GDP per capita in Zambia and a −0. 88% decrease in South Africa. These results are similar to other studies that find a negative and significant relationship between government consumption and economic growth (see, among others, Barro 1999, 2003; Bhaskara-Rao and Hassan 2011).

In terms of inflation, the results revealed a negative and significant relationship between inflation and economic growth in Malawi and South Africa. A 1% increase in inflation leads to a −0.16% decrease in real GDP per capita in Malawi and to a −0.42% decrease in South Africa. These results are consistent with empirical results that also find a negative and significant association between inflation and economic growth (Fischer 1992; Barro 1999, 2003; Burnside and Dollar 2000; Chen and Feng 2000; Bhaskara-Rao and Hassan 2011; Anyanwu 2014). The relationship between international trade and economic growth was found to be positive and significant in Malawi and South Africa. The long-run results revealed that a 1% increase in international trade leads to a 0.52% increase in real GDP per capita in Malawi and a 1.35% increase in South Africa. These results are consistent with the empirical growth literature that reveals a positive association between trade and economic growth (see, among others, Fischer 1993; Barro 1999; Anyanwu 2014).

The short-run results in Panel 2 of Table 4 reveal that the growth of investment is positively and significantly associated with the growth of income per capita in all three study countries. A 1% increase in the growth of investment leads to a 0.09% increase in the growth of income per capita in Malawi, a 0.06% increase in Zambia, and a 0.07% increase in South Africa. The growth of human capital development is positively and significantly associated with economic growth only in Malawi and Zambia, where a 1% increase in the growth of school enrolment leads to a 0.05% and 0.06% increase in the growth of income per capita in the respective countries. Population growth was found to be negatively and significantly associated with economic growth only in South Africa, where a 1% increase in population growth leads to a –0.03% decrease in the growth of income per capita. Government consumption was found to be negatively and significantly associated with economic growth in Zambia and South Africa, where the results revealed a –0.07% and –0.06% decrease in the growth of income per capita in the respective countries. Inflation was found to be negatively and significantly associated with short-run economic growth only in Malawi, where a 1% increase in inflation leads to a –0.02% decrease in the growth of income per capita. Lastly, the growth of international trade was found to be negatively and significantly associated with economic growth only in Zambia, where a 1% increase in the growth of international trade leads to a –0.04% decrease in the growth of income per capita.

There are two important revelations that emerge from the results reported in Table 4. First, the convergence hypothesis no longer applies when efficiency factors are included in the exogenous growth model, as predicted by Solow (1956). Second, the study results suggest that income disparities between countries can be better explained when efficiency factors are included in the exogenous growth model. The study results show that the long-run response of investment and human capital development increases the income difference between low-income economies such as Malawi and Zambia and higher-income economies such as South Africa. These results respond to the growth puzzle observed by Mankiw et al. (1995), who noted that Solow's neoclassical growth model did not explain the high magnitude of income per capita when comparing income differences between countries. Macroeconomic instability in economies can significantly slow down economic growth in the long run, and these factors are more prominent in poor economies than in rich ones. This confirms that the exogenous growth model does indeed suffer from omitted variable bias.

Finally, Table 5 reports post-estimation diagnostic results for all study countries.

Table 5: ARDL-VECM Post-Estimation Diagnostic Tests

Test Statistic	**Country**		
Solow (1956) Model	**Malawi**	**Zambia**	**South Africa**
Breusch-Godfrey Test: No Serial Correlation	3.51 [0.070]	0.65 [0.423]	0.00 [0.960]
Breusch-Pagan-Godfrey Test: No Heteroskedasticity	2.59 [0.115]	0.05 [0.811]	0.00 [0.989]
Ramsey RESET Test: Functional Form	1.98 [0.168]	0.02 [0.866]	1.59 [0.215]
Normality: CHSQ (2)	2.56 [0.277]	0.59 [0.743]	0.36 [0.832]
ARCH Test: Heteroskedasticity	2.05 [0.144]	0.11 [0.891]	0.91 [0.412]
Mankiw et al. (1992) Model	**Malawi**	**Zambia**	**South Africa**
Breusch-Godfrey Test: No Serial Correlation	2.88 [0.099]	0.14 [0.709]	0.55 [0.462]
Breusch-Pagan-Godfrey Test: No Heteroskedasticity	2.15 [0.150]	0.00 [1.000]	0.01 [0.924]
Ramsey RESET Test: Functional Form	0.86 [0.360]	0.01 [0.889]	0.01 [0.981]
Normality: CHSQ (2)	3.65 [0.160]	3.00 [0.223]	1.50 [0.472]
ARCH Test: Heteroskedasticity	1.13 [0.335]	0.16 [0.852]	0.55 [0.580]
World Bank (1990) Model	**Malawi**	**Zambia**	**South Africa**
Breusch-Godfrey Test: No Serial Correlation	2.28 [0.143]	0.33 [0.568]	0.18 [0.672]
Breusch-Pagan-Godfrey Test: No Heteroskedasticity	1.75 [0.194]	0.71 [0.405]	0.02 [0.882]
Ramsey RESET Test: Functional Form	1.32 [0.261]	0.45 [0.509]	0.00 [0.949]
Normality: CHSQ (2)	1.06 [0.589]	4.17 [0.124]	0.90 [0.636]
ARCH Test: Heteroskedasticity	1.73 [0.199]	1.32 [0.284]	0.11 [0.743]

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

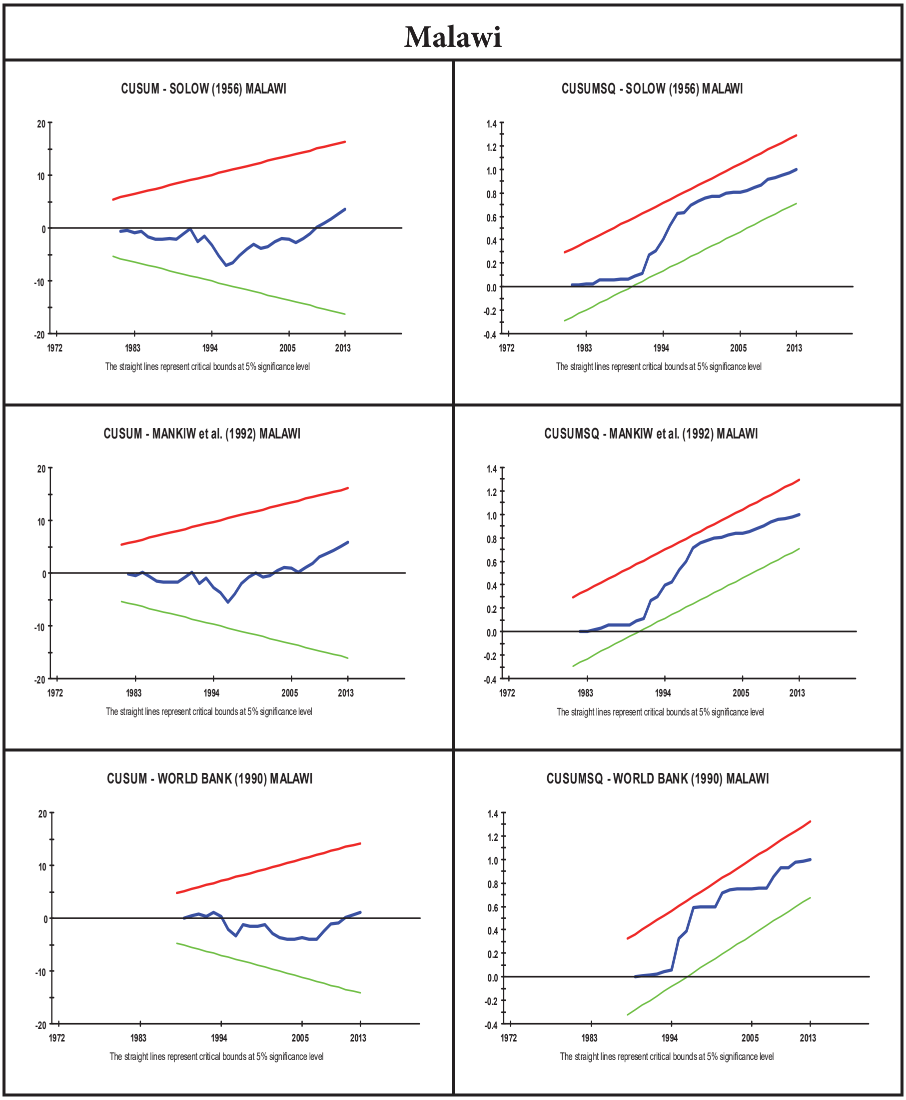
The following post-diagnostic tests are reported: Breusch-Godfrey serial correlation test, Breusch-Pagan-Godfrey test for heteroskedasticity, Ramsey RESET test, Normality test, ARCH test, cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of the recursive residuals (CUSUMSQ) tests. The results reveal that the null hypotheses cannot be rejected for all post-diagnostic tests at the 5% significance level. This implies that the final ARDL models for the estimated growth equations in the study countries are well specified, and the parameter estimates are not biased. Figure 1 shows the CUSUM and CUSUMSQ results for the estimated growth equations. All CUSUM and CUSUMSQ tests reveal parameter and variance stability, respectively.

5. CONCLUSION

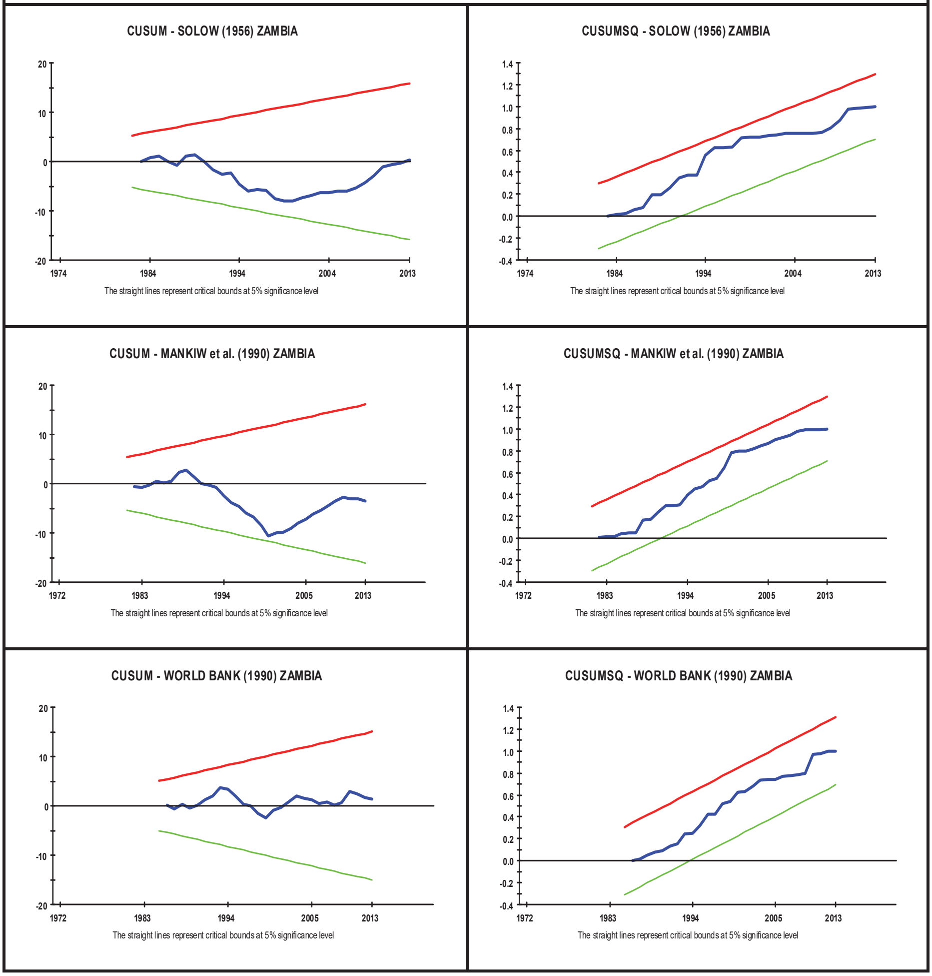
In this paper the relevance of exogenous growth models to explaining economic growth was investigated using data from three Southern African countries, Malawi, Zambia, and South Africa, during the period 1970 to 2013. The study used three exogenous growth models: the traditional Solow (1956) growth model, the augmented Solow growth model suggested by Mankiw et al. (1992), and an extended exogenous growth model that includes additional factors suggested by the World Bank (1990). Using the Autoregressive Distributed Lag (ARDL) modelling approach, the study results show that the predictions of the Solow and augmented Solow growth models, especially that of the convergence hypothesis, hold in the three Southern African countries. The response of income per capita to changes in investment in a low-income economy such as Malawi and a low-middle-income economy (Zambia) is higher than in an upper-middle-income economy such as South Africa. However, when other macroeconomic factors are included in the exogenous growth model the study results reveal that the convergence hypothesis no longer holds. Economies with low income per capita like Malawi, which are susceptible to macroeconomic instability, are likely to experience slow growth compared to wealthier economies that experience macroeconomic stability.

The study results thus support the argument that the main reason why macroeconomic stability matters is because of the certainty it creates with regard to expectations concerning the future trajectory of economic growth. Based on the study results, the South African economy is more stable than the Zambian economy, while the Zambian economy is more stable that the Malawian economy. Much as there is consensus that state factors such as savings, investment, human capital development, and technological growth are important macroeconomic determinants of economic growth in almost any country, factors that affect the efficiency of savings and investment such as financial repression, real exchange rate misalignment, inflation, excessive government spending, and trade barriers are equally important and cannot be neglected. It is therefore recommended that the economies studied in this paper should implement macroeconomic policies that favour the creation of a macroeconomic environment that is conducive to economic growth.

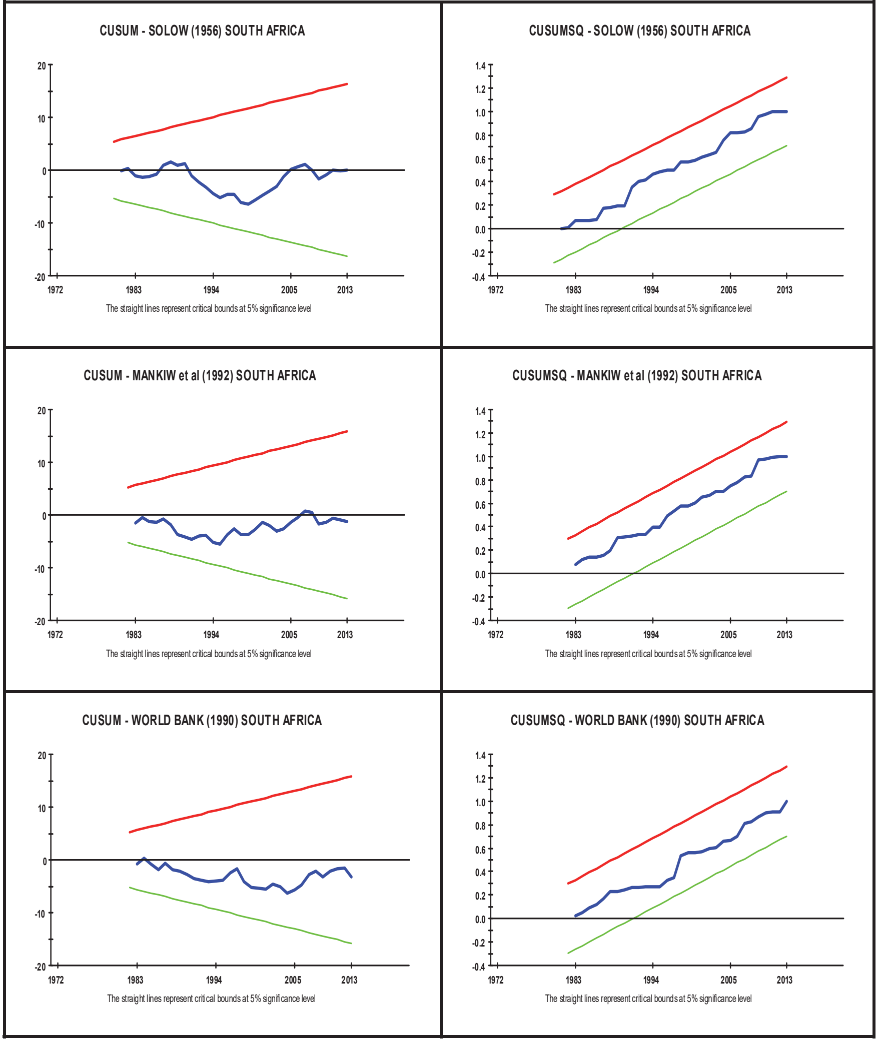
Figure 1: CUSUM and CUSUMQ Tests



Zambia


CUSUM - SOLOW (1956) ZAMBIA
20
10
0
-10
-20
1974
1984
1994
2004
2013
The straight lines represent critical bounds at 5% significance level
CUSUMSQ - SOLOW (1956) ZAMBIA
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
1974
1984
1994
2004
2013
The straight lines represent critical bounds at 5% significance level
CUSUM - MANKIW et al. (1990) ZAMBIA
20
10
0
-10
-20
1972
1983
1994
2005
2013
The straight lines represent critical bounds at 5% significance level
CUSUMSQ - MANKIW et al. (1990) ZAMBIA
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
1972
1983
1994
2005
2013
The straight lines represent critical bounds at 5% significance level
CUSUM - WORLD BANK (1990) ZAMBIA
20
10
0
-10
-20
1972
1983
1994
2005
2013
The straight lines represent critical bounds at 5% significance level
CUSUMSQ - WORLD BANK (1990) ZAMBIA
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
1972
1983
1994
2005
2013
The straight lines represent critical bounds at 5% significance level

South Africa



REFERENCES

Acikgoz, S., and M. Mert 2014. Sources of Growth Revisited: The importance of the nature of technological progress. *Journal of Applied Economics*, Vol. 17, No. 1, pp. 31–62.

Aghion, P. and P. Howitt. 1992. A Model of Growth through Creative Destruction. *Econometrica*, Vol. 60, No. 2, pp. 323–351.

Anaman, K. A. 2004. Determinants of Economic Growth in Brunei Darussalam. *Journal of Asian Economics*, Vol. 15, No. 4, pp. 777–796.

Anyanwu, J. C. 2014. Factors Affecting Economic Growth in Africa: Are there any lessons from China? *African Development Review*, Vol. 26, No. 3, pp. 468–493.

Balassa, B. 1964. The Purchasing-Power Parity Doctrine: A reappraisal. *Journal of Political Economy*, Vol. 72, No. 6, pp. 584–596.

Barro, R. J. 1989. A Cross-Country Study of Growth, Saving, and Government. *NBER Working Papers Series No. 2855*, Cambridge, Massachusetts, pp. 1–57.

Barro, R. J. 1990. Government Spending in a Simple Model of Endogenous Growth. *Journal of Political Economy*, Vol. 98, No. 5, pp. S103–S125.

Barro, R. J. 1991. Economic Growth in a Cross Section of Countries. *The Quarterly Journal of Economics*, Vol. 106, No. 2, pp. 407–443.

Barro, R. J. 1999. Determinants of Economic Growth: Implications of the Global Evidence for Chile. *Cuadernos de Economía*, Vol. 36, No. 107, pp. 443–478.

Barro, R. J. 2003. Determinants of Economic Growth in a Panel of Countries. *Annals of Economics and Finance*, Vol. 4, No. 2, pp. 231–274.

Barro, R. J., and X. Sala-i-Martin 1992. Public Finance in Models of Economic Growth. *The Review of Economic Studies*, Vol. 59, No. 4, pp. 645–661.

Bassanini, A., Scarpetta, S. and Hemmings, P. 2001. Economic Growth: The role of policies and institutions. Panel data evidence from OECD countries. *Economics Department Working Papers*, No. 283, pp. 1–70.

Becker, G. S. 1962. Investment in Human Capital: A theoretical analysis. *Journal of Political Economy*, Vol. 70, No. 5, pp. 9–49.

Bhaskara-Rao, R., and G. Hassan 2011. Determinants of the Long-Run Growth Rate of Bangladesh. *Applied Economics Letters*, Vol. 18, No. 7, pp. 655–658.

Bleaney, M., N. Gemmell and R. Kneller 2001. Testing the Endogenous Growth Model: Public expenditure, taxation, and growth over the long run. *Canadian Journal of Economics*, Vol. 34, No. 1, pp. 36–57.

Bruno, M., and W. Easterly 1998. Inflation Crises and Long-Run Growth. *Journal of Monetary Economics*, Vol. 41, No. 1, pp. 3–26.

Burnside, C., and D. Dollar 2000. Aid, Policies, and Growth. *The American Economic Review*, Vol. 90, No. 4, pp. 847–868.

Cass, D. 1965. Optimum Growth in an Aggregative Model of Capital Accumulation. *Review of Economic Studies*, Vol. 32, No. 3, pp. 233–240.

Checherita-Westphal, C., and P. Rother 2012. The Impact of High Government Debt on Economic Growth and its Channels: An empirical investigation for the Euro area. *European Economic Review*, Vol. 56, No. 7, pp. 1392–1405.

Chen, B. and Y. Feng 2000. Determinants of Economic Growth in China: Private enterprise, education, and openness. *China Economic Review*, Vol. 11, No. 1, pp. 1–15.

Chenery, H. B., and A. M. Strout. 1966. Foreign Assistance and Economic Development. *The American Economic Review*, Vol. 56, No. 4, pp. 679–733.

Collier, P., and B. Goderis 2012. Commodity Prices and Growth: An empirical investigation. *European Economic Review*, Vol. 56, No. 6, pp. 1241–1260.

Corbo, V., S. Fischer, and S. B. Webb (Eds.) 1992. *Adjustment Lending Revisited: Policies to restore growth*. A World Bank Symposium, The World Bank, Washington D. C.

Dollar, D. 1992. Outward-Oriented Developing Economies Really do Grow More Rapidly: Evidence from 95 LDCs, 1976–1985. *Economic Development and Cultural Change*, Vol. 40, No. 3, pp. 523–544.

Easterly, W. R., and D. L. Wetzel 1989. Policy Determinants of Growth: Survey of theory and evidence. *Policy, Planning and Research Working Papers Series No. 343*, Washington D. C., World Bank, pp. 1–41.

Elliott, G., T. J. Rothenberg, and J. H. Stock 1996. Efficient Tests for an Autoregressive Unit Root. *Econometrica*, Vol. 64, No. 4, pp. 813–836.

Fischer, S. 1983. Inflation and Growth. *NBER Working Paper Series No. 1235*, pp. 1–22.

Fischer, S. 1992. Macroeconomic Stability and Growth. *Cuadernos de Economía*, Vol. 29, No. 87, pp. 171–186.

Fischer, S. 1993. The Role of Macroeconomic Factors in Growth. *Journal of Monetary Economics*, Vol. 32, No. 3, pp. 485–512.

Frankel, M. 1962. The Production Function in Allocation and Growth: A synthesis. *The American Economic Review*, Vol. 52, No. 5, pp. 996–1022.

Froyen, R. T., and R. N. Waud 1980. Further International Evidence on Output–Inflation Tradeoffs. *The American Economic Review*, Vol. 70, No. 3, pp. 409–421.

Grossman G. M. and E. Helpman 1991. *Innovation and Growth in the Global Economy*. Cambridge, MA: MIT Press.

Islam, N. 1995. Growth Empirics: A Panel data Approach. *The Quarterly Journal of Economics*, Vol. 110, No. 4, pp. 1127–1170.

Knight, M., N. Loayza and D. Villanueva 1993. Testing the Neoclassical Theory of Economic Growth: A panel data approach. *Staff Papers (International Monetary Fund)*, Vol. 40, No. 3, pp. 512–541.

Lucas, R. E. Jr. 1973. Some International Evidence on Output–Inflation Tradeoffs. *The American Economic Review*, Vol. 63, No. 3, pp. 326–334.

Lucas, R. E. Jr. 1988. On the Mechanics of Economic Development. *Journal of Monetary Economics*, Vol. 22, pp. 3–42.

Mankiw, N. G., D. Romer, and D. N. Weil 1992. A Contribution to the Empirics of Economic Growth. *The Quarterly Journal of Economics,* Vol. 107, No. 2, pp. 407–437.

Mankiw, N. G., E. S. Phelps and P. M. Romer 1995. The Growth of Nations. *Brookings Papers on Economic Activity*, Vol. 1995, No. 1, pp. 275–326.

McKinnon, R. I. 1973. *Money and Capital in Economic Development*. Washington, D.C., The Brookings Institution.

Mendoza, E. G. 1997. Terms of Trade Uncertainty and Economic Growth. *Journal of Development Economics*, Vol. 54, No. 2, pp. 323–356.

Mincer, J. 1962. On-the-Job Training: Costs, returns, and some implications. *Journal of Political Economy*, Vol. 70, No. 5, pp. 50–79.

Mosley, P. 1980. Aid, Savings and Growth Revisited. *Oxford Bulletin of Economics and Statistics*, Vol. 42, No. 1, pp. 79–95.

Mosley, P., J. Hudson, and S. Horrell 1987. Aid, the Public Sector and the Market in Less Developed Countries. *The Economic Journal*, Vol. 97, No. 387, pp. 616–641.

Most S. J., and H. Vann de Berg 1996. Growth in Africa: Does the source of investment financing matter? *Applied Economics*, Vol. 28, No. 11, pp. 1427–1433.

Mundell, R. 1963. Inflation and Real Interest Rate. *Journal of Political Economy*, Vol. 71, No. 3, pp. 280–283.

Narayan, P. K. 2005. The Savings and Investment Nexus from China: Evidence from cointegration tests. *Applied Economics*, Vol. 37, No. 17, pp. 1979–1990.

Nonneman, W. and P. Vanhoudt 1996. A Further Augmentation of the Solow Model and the Empirics of Economic Growth for OECD Countries. *The Quarterly Journal of Economics*, Vol. 111, No. 3, pp. 943–953.

Odhiambo, N.M. 2013. Financial systems and economic growth in South Africa: A dynamic complementarity test. *International Review of Applied Economics*, Vol. 28, No. 1, pp. 83–101.

Papageorgiou, C. 2003. Distinguishing between the Effects of Primary and Post-Primary Education on Economic Growth. *Review of Development Economics*, Vol. 7, No. 4, pp. 622–635.

Peacock, A. T., and J. Wiseman 1961. *The Growth of Public Expenditure in the United Kingdom*. National Bureau of Economic Research Inc., London: Oxford University Press.

Perron, P. 1990. Testing for a Unit-root in a Time Series with a Changing Mean. *Journal of Business and Economic Statistics*, Vol. 8, No. 2, pp. 153–162.

Pesaran, M. and Y. Shin 1999. An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis. Chapter 11 in *Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch centennial symposium*, S. Strom (ed.). Cambridge University Press: Cambridge.

Pesaran, M. H., Y. Shin and R. J. Smith 2001. Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics,* Vol. 16, No. 3, pp. 289–326.

Pindyck, R. S. 1988. Irreversible Investment, Capacity Choice, and the Value of the Firm. *The American Economic Review*, Vol. 78, No. 5, pp. 969–985.

Pindyck, R. S., and A. Somalino 1993. Economic Stability and Aggregate Investment. *NBER Macroeconomics Annual*, Vol. 8, pp. 259–318.

Radelet, S., J. Sachs, and J. Lee 2001. The Determinants and Prospects of Economic Growth in Asia. *International Economic Journal*, Vol. 15, No. 3, pp. 1–29.

Riddell, R. 1987. *Foreign Aid Reconsidered*. Baltimore: Johns Hopkins University Press.

Rodrik, D. 2008. The Real Exchange Rate and Economic Growth. *Brookings Papers on Economic Activity*. Brookings Institute Press.

Romer, P. M. 1986. Increasing Returns and Long run Growth. *Journal of Political Economy*, Vol. 94, No. 5, pp. 1002–1037.

Sachs, J. D., and A. M. Warner 1997. Fundamental Sources of Long-Run Growth. *The American Economic Review*, Vol. 87, No. 2, pp. 184–188.

Samuelson, P. A. 1964. Theoretical Notes on Trade Problems. *The Review of Economics and Statistics*, Vol. 46, No. 2, pp. 145–154.

Sidrauski, M. 1967. Inflation and Economic Growth. *Journal of Political Economy*, Vol. 75, No. 6, pp. 796–810.

Shaw, E. S. 1973. *Financial Deepening in Economic Development*. New York, Oxford University Press.

Snowdon, B. and H. R. Vane 2005. *Modern Macroeconomics: Its origins, development and current state*. Edward Elgar, Northampton: Massachusetts.

Solow, R.M. 1956. A Contribution to the Theory of Economic Growth. *Quarterly Journal of Economics*, Vol. 70, No. 1, pp. 65–94.

Stockman, A. C. 1981. Anticipated Inflation and the Capital Stock in a Cash-in-Advance Economy. *Journal of Monetary Economics*, Vol. 8, pp. 387–393.

Stokey, N. L. 1995. R&D and Economic Growth. *The Review of Economic Studies*, Vol. 62, No. 3, pp. 469–489.

Tobin, J. 1965. Money and Economic Growth. *Econometrica*, Vol. 33, No. 4, pp. 671–684.

UNESCO Institute of Statistics, Education (full dataset), retrieved from http://data.uis.unesco.org/Index.aspx?DataSetCode=EDULIT_DS&lang=en# on May 05, 2015.

Uzawa, H. 1965. Optimum Technical Change in an Aggregative Model of Economic Growth. *International Economic Review*, Vol. 6, No. 1, pp. 18–31.

Vieira, F.V., M. Holland, C. G. da Silva, and L. C. Bottecchia 2013. Growth and Exchange Rate Volatility: A panel data analysis. *Applied Economics*, Vol. 45, No. 26, pp. 3733–3741.

Wagner, A. 1892. *Grundlegung der Politischen Okonomie*. *In* C. F. Leipzig (eds.), Winter.

Weisbrod, B. A. 1962. Education and Investment in Human Capital. *Journal of Political Economy*, Vol. 70, No. 5, pp. 106–123.

World Bank 1990. *Adjustment Lending Policies for Sustainable Growth*. Policy and Research Series, Washington D. C., World Bank.

World Bank 2015. *World Development Indicators 2015*. Retrieved from www.worldbank.org on May 5, 2015.

Received: August 9, 2018
Accepted: March 4, 2019