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**Chapter**

# Determinants of Economic Growth: An Empirical Evaluation of the Ugandan Economy

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## Abstract

This paper investigated the determinants of economic growth in Uganda for the period 1982–2015 using the autoregressive distributed lag (ARDL) mode. The paper was motivated by the impressive economic performance of Uganda since 1986 that made her graduate from a "failed state" to a "mature reformer" in a short time. The paper established that while the initial level of GDP growth, government consumption and investment positively affected Uganda's economic growth in the short run, inflation, foreign aid and a policy dummy variable representing structural adjustment programmes negatively impacted GDP growth. The results revealed that in the long run, trade openness, population growth, government consumption and investment positively influenced GDP growth in Uganda. The results failed to show a significant relationship between trade openness, population growth and human capital accumulation and economic growth in the short run. The study also failed to show a significant relationship between inflation, human capital and foreign aid and economic growth in the long run. The paper recommends policies that enhances sound macroeconomic fundamentals such as price stability, investment promotion, trade openness, increased government consumption, increased population growth and effective foreign aid.

**Keywords:** Uganda, Economic growth, Auto Regressive Distribute Lag Model

## 1. Introduction

"Once one starts to think about the human welfare consequences of economic growth, it is hard to think about anything else" [1]. Economic growth is the basis for increased prosperity, and its importance cannot be overstated. Barro and Sala-i-Martin [2] argue that continuous and sustained economic growth is important for improving the welfare of individuals and that aggregate growth is probably the single most important factor affecting individual levels of income. Due to the importance of economic growth, attainment of high economic growth rates is a major national objective of any country. It is, however, puzzling and at the same time worrisome that the riches of the world are so unequally shared among countries [3].

Over the years, growth performance has varied notably across regions and countries. In some economies, it has experienced major shifts over time. A few developing countries have experienced rapid growth yet some other countries have grown at only a stagnant rate. This discrepancy in economic growth among numerous countries and the dynamics of growth have become provocative research targets. The

main questions are why some countries are rich while others are poor, and what determines the rate of growth? Rosa notes that it seems certain that there is no all-encompassing theory of economic growth, but different sources of economic growth can be observed to be relevant for different stages of economic development.

Several reasons have been provided that explain the differences, key among them being the fact that initial conditions differ greatly. Isaksson [4] asserts that some, if not many, of the differences in income per capita are human-created. He asserts that how a society and its production are organized can significantly explain the observed income divergence since the industrial revolution.

In the case of Uganda, the last five decades have been difficult in terms of overall economic growth and stability, let alone the first eight years after independence and the last three decades, when episodes of high yet unstable economic growth occurred, especially from the late 1980s to the late 2000s. Economic growth was impressive for the first eight years after independence, but by 1986, the economy had descended into a deep recession owing to poor governance from the early 1970s to that time. Since 1986, the country has undergone a major transformation from a "failed state" to one of the fastest-growing economies in the world. As early as 1993, Uganda started implementing structural adjustment programmes (SAPS) and other economic policies and programmes such as; economic recovery programme (ERP), medium-term expenditure framework, Plan for Modernization of Agriculture (PMA), and Poverty Eradication Action Plan (PEAP), among others all aimed at poverty reduction and attaining higher levels of economic growth in Uganda. The reforms ushered in relatively high economic growth rates based on incentives for private production. Between 1990 and 2010, GDP growth averaged 7.3 percent per annum, placing Uganda among the fastest-growing economies in the world and creating momentum for take-off. This growth was higher than the Sub-Saharan African growth rate, which averaged approximately 2.1 and was close to that of the East Asian and Pacific region of 7.9 and 6.6 percent, respectively.

To consolidate and accelerate this growth process, the Ugandan government approved the Comprehensive National Development Planning Framework Policy in 2007 which provided the developmental agenda for a 30-year vision to be implemented through three 10-year plans and six 5-year national development plans (NDPs), among other operational plans. However, data shows that Uganda's growth has been mostly unstable; it has been described as unsustainable because it has been sustained partly by significant aid inflows and only a few tradable commodities, such as coffee, flowers and fish. The government of Uganda, like many other governments elsewhere continues to target improving GDP growth. The key to achieving this improvement has been the careful development and implementation of policies and programmes to improve capital stock, labour stock, price stability and productivity and competitiveness as major drivers of economic growth [5].

Uganda has set its Vision 2040 as a guiding framework for transforming the country from "a peasant to a modern and prosperous country with a per capita income of USD 9,500 from the base figure of USD 506 in the year 2010 by the year 2040". For the country to achieve this transformation, Uganda Vision 2040 projects that Uganda's real GDP will have to grow at an average of 8.2 percent, while the IMF forecasts approximately 9 percent growth rate as necessary for the remaining period. However, the achievement of Vision 2040 has been threatened not only by lower-than-targeted rates of annual GDP growth since the inception of the vision but also by a recent slump from the average GDP growth rate of approximately 6.8 percent that was posted in the last half of the 2000s to an average of 4.6 percent between 2010 and 2015.

To achieve the Vision, understanding the determinants of past growth, removing the constraints on present growth and maximizing the prospects for future growth are key. It is important to note that inferring the determinants of growth

faces considerable uncertainty due to the existence of multiple overlapping theories that emphasize different channels of growth over time. Therefore, this paper aims at providing more robust and targeted policy interventions to generate higher and more sustainable economic growth by examining the determinants of economic growth in Uganda using the ARDL frameworks.

## 2. A review of empirical literature

A wide range of studies have investigated the factors underlying economic growth in different countries. Using differing conceptual and methodological viewpoints, studies have identified different factors that explain economic growth world over [6]. However, existing literature has not yet reached a consensus about a typical set of variables that may affect economic growth.

The accumulation of physical capital (investment) is one of the most fundamental determinants of economic growth identified in the literature per the neo-classical and endogenous growth models and much empirical work has been performed on the subject [7–9]. It has been found to be robust to most specifications and sample size changes [10]. The impact of several types of investment has been studied over time and varying levels of significance have been attached to varying types of investment. Gross capital formation affects economic growth by either directly increasing the physical capital stock in the domestic economy [11] or indirectly promoting technology [12]. Other researchers have investigated the impact of private and public investment on economic growth and have found significant variations. Khan and Kumar [13] found private investment to be more productive than public investment. In this paper, investment is represented by physical capital accumulation and it is expected to have a positive and statistically significant relationship with economic growth.

Exports are another factor identified by both the neoclassical and endogenous growth models in explaining economic growth variations. Awokuse [14] notes that linking exports to economic growth is pied when he found that there is a flow of Granger cause from real exports to real GDP. There is also a strand of studies that find no conclusive evidence of the causal relationship between exports and GDP growth. Ruiz-Nápoles [15] argues that even in cases where increasing exports has a positive effect on production expansion, such an effect may be limited and offset by increasing manufacturing imports displacing domestic production. Fouad Abou-Stait [16] found that time series studies find fewer conclusive associations between exports and growth, whereas cross-sectional studies appear to support the positive relationship.

Closely related to exports is trade openness with mixed results. A large part of the literature find that economies that are more open grow more rapidly [17–20]. Baliamoune [21] finds that trade openness is closely associated with positive effects in higher-income and negative effects in lower-income African countries. Arezki and Gylfason [22] find that trade openness has a positive and statistically significant impact on non-resource GDP growth. Several scholars have however criticized the robustness of these findings, especially on methodological and measurement grounds (see, [23, 24]). Vamvakidis [24] and Wong [25] find a negative relationship between openness to international trade and economic growth. Fowe finds no significant effect of openness to trade on economic growth in SSA.

Several endogenous growth models and extensions of the neoclassical growth model find human capital and/or knowledge to be a major source of growth [26]. A large number of studies find evidence suggesting that an educated population is a key determinant of economic growth (see [8, 27, 28]). However, other scholars find mixed results while others question studies that have found a positive relationships

[29, 30]. Some empirical findings have shown that human capital accumulation plays only a small role in economic growth [31]. Studies by Bils and Klenow [32], Pritchett [29], Easterly and Levine [33] found that the evidence was weak, absent or even pointed to a negative impact.

Population growth rate is another important variable in economic growth literature. The relationship between population and economic growth is mixed and varies between countries [34]. Some empirical studies have found a negative relationship between population and economic growth [35, 36]; and in others there was a positive association with economic growth [37, 38]. Another factor influencing economic growth is population growth rate [36, 39, 40]. High population growth, for example, could have a negative impact on economic growth, influencing the dependency ratio, investment and saving behavior and quality of human capital countries [41]. However, the findings are again inconclusive since there some studies have reported no (strong) correlation between economic growth and demographic trends (e.g., [29, 42]).

Foreign Aid has received renewed political interest in economic growth discourse resulting into numerous studies. There is however little evidence of a significant positive effect of aid on the long-term growth of poor countries [43, 44]. Andersson and Karlsson, C. [45] finds support for the basic idea that an increase in aid flows strengthens economic growth in poor countries when the policy environment is conducive. Collier and Dehn [46] find that well-timed aid alleviates effects of negative export shocks while Collier and Hoeffler [47] find that aid works particularly well in good policy environments a few years after a conflict has ended. Other scholars argue that aid spurs economic growth unconditionally (see, [37, 48]), or in certain macroeconomic environments that it is growth-neutral [49]. In contrast, some studies have argued that aid has historically been ineffective in promoting growth [50, 51]. Rajan and Subramanian [43] provide evidence that total aid is ineffective at promoting growth.

The relationship between government consumption expenditure and economic growth has attracted a great deal of interest among policymakers and economists. Empirical work on this subject has also provided mixed results. On one side, there are Keynesian economists who consider consumption expenditure as a dependable function of income and on the other side there are substantial numbers of economists who believe that higher consumption can stimulate economic growth [52, 53]. Other studies have found that small to moderate government sizes are positively associated with economic growth while large government sizes impede economic growth [54, 55].

It is argued that inflation is a good macroeconomic indicator of how the government manages the economy [55–57]. Although the empirical evidence has strongly supported a negative relationship between inflation and growth, especially through the impact of inflation on capital intensity [58], other studies have found that inflation exhibits threshold effects on economic growth [59, 60]. Khan and Senhadji, [60] explore this issue and reach several conclusions. In particular, medium and high inflation hamper economic growth due to the adverse impact on the efficient distribution of resources by changing relative prices [57].

## 3. Analytical framework and data

### 3.1 Theoretical framework

Based on the foregoing literature, we assume a Cobb–Douglas production function with labour-augmenting (Harrod-Neutral) technological progress following Mankiw, et al. [27] and Acikgoz and Mert [61].

$$Y = K^\alpha (A\,L)^\beta; \; <\alpha, \beta < 1 \text{ Such that } \alpha + \beta = 1 \qquad (1)$$

where $Y$, $K$ and $L$ indicate the levels of output, capital stock and, labour respectively, and $A$ indicates the level of technology. But Economists have long stressed the importance of human capital to the process of economic growth. Following Mankiw, et al. [27], the augmented classic Solow model takes the following form:

$$Y_t = K_t^\alpha HC_t^\beta (A_t L_t)^{1-\alpha-\beta} \qquad (2)$$

where HC is human capital, and all other variables are defined as before. Following Mankiw, et al. [27], Acikgoz and Mert [61], and Chirwa and Odhiambo [17], the aggregate Cobb–Douglas production function is assumed to take the following form:

$$Y_t = K_t^\alpha HC_t^\beta (A_t \{GC_t, AID_t, INF_t, TRD_t\} L_t)^{1-\alpha-\beta} \qquad (3)$$

where α and β represent the partial elasticity of output with respect to physical capital and human capital respectively. Per the literature, technological progress $(A_t)$ is assumed to be labour augmenting and the function therefore denotes a skill-adjusted measure of the labour input.

Several efficiency variables have been identified in the literature to provide a link to how policy variables influence the aggregate production function [55, 57]. The variables selected for this study consist of the accumulation of physical capital (investment); human capital (total school enrolment); population; and policy variables (efficiency factors) that include government consumption share in GDP, inflation, foreign aid as a share of GDP and international trade. The efficiency factors, similar to population growth, are assumed to grow exogenously (see [27, 62]).

### 3.2 Estimation techniques

Auto Regressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran and Shin [63], Pesaran, Shin and Smith [64] was employed. The modeling approach allows us to capture the short and long run dynamics as well as the speed of adjustment between the independent variables and the dependent variable. The embedded Error Correlation Model (ECM) is a restricted representation that has cointegration restrictions built into the specification so that it is designed for use with non-stationary series that are known to be cointegrated. The ECM specification restricts the long run behavior of the endogenous variables to converge to their cointegrating relationships while allowing a wide range of short run dynamics. Choice of the ARDL model was taken based on the following reasons: (1) the variables were found to be integrated of different orders i.e. (I(0) and I(1) and ARDL can be applied even when variables are not integrated of the same order; (2) ARDL performs better than other co-integration tests in small and finite data samples [65]. The two stage ARDL approach effectively corrects for any possible endogeneity in the regressors [61, 66]; (3) According to [67, 68] the ARDL model also allows for different optimal lags among the different variables to capture the data-generating process as a general-to-specific modeling framework [68, 69], (4) ARDL is known to have information about the structural break in time series data and lastly Pesaran and Shin [63] contented that appropriate modification of the orders of the ARDL model is sufficient to simultaneously correct for residual serial correlation and the problem of endogenous variables. The only drawback being that ARDI approach collapses when variables are integrated of order two (i.e I(2)).

The ARDL representation of the empirical model for this study is expressed as follows:

$$\Delta LGDP_t = \alpha_0 + \sum_{i=1}^{P} \alpha_{1i}\Delta LGDP_{t-1} + \sum_{i=0}^{P} \alpha_{2i}\Delta LTRO_{t-1} + \sum_{i=0}^{P} \alpha_{3i}\Delta LTSE_{t-1}$$
$$+ \sum_{i=0}^{P} \alpha_{4i}\Delta LPOPN_{t-1} + \sum_{i=0}^{P} \alpha_{5i}\Delta LGGC_{t-1} + \sum_{i=0}^{P} \alpha_{6i}\Delta LGFCF_{t-1}$$
$$+ \sum_{i=0}^{P} \alpha_{7i}\Delta LCPI_{t-1} + \sum_{i=0}^{P} \alpha_{8i}\Delta LAID_{t-1} + \beta_1 LGDP_{t-1} + \beta_2 LTRO_{t-1}$$
$$+ \beta_3 LTSE_{t-1} + \beta_4 LPOPN_{t-1} + \beta_5 LGGC_{t-1} + \beta_6 LGFCF_{t-1} + \beta_7 LCPI_{t-1}$$
$$+ \varepsilon_{it}$$

$$(4)$$

where $\Delta$ is the difference operator, $\alpha_0$ is the drift component, p is the lag length, $\alpha_{1i}$ is the short-run coefficient and $\beta_{1i}$ is the corresponding long-run multiplier and $\varepsilon_{it}$ is the white-noise error term of the underlying ARDL model.

Two steps are involved in estimating an ARDL model. First, the long-run equilibrium relationship between the variables is tested using the upper and lower bounds; then, the short-run and long-run causalities are estimated. The ARDL bounds test is based mainly on the joint F-statistic in which its asymptotic distribution is non-standard under the null hypothesis of no co-integration [70].

In Eq. 4 above, the null hypothesis of no co-integration relationship, defined as $H_0 : \emptyset_1 = \emptyset_2 = \emptyset_3 = \emptyset_4 = \emptyset_5 = \emptyset_6 = \emptyset_7 = \emptyset_8 = 0$, is tested against the alternative of the existence of a co-integration relationship as $H_1: \emptyset_1 \neq \emptyset_2 \neq \emptyset_3 \neq \emptyset_4 \neq \emptyset_5 \neq \emptyset_6 \neq \emptyset_7 \neq \emptyset_8 \neq 0$ for i = 1, 2, 3, 4, 5, 6, 7, 8. The hypothesis is tested using the mean of the computed F-statistic. According to Pesaran et al. [64], given that the model takes the form of ARDL (p, q), two sets of critical values for a given significance level are then determined because p and q need not be integrated of the same order.

Using the Wald test, the computed F-statistic is then compared with the lower and upper asymptotic critical bounds values, as reported in Pesaran et al. [64]. The lower-bound critical value assumes that all the regressors are l(0), while the upper-bound critical value assumes that they are I(l). We reject the null hypothesis of no co-integration if the computed test statistic exceeds the upper-bound critical value, and we do not reject the null hypothesis if the F-statistic is lower than the lower-bound critical value. The test is, however, inconclusive if the computed F-statistic lies between the lower-bound and upper-bound critical values. In this context, unit root tests should be conducted to ascertain the order of integration of the variables. If all the variables are found to be I(1), then the decision is made on the basis of the upper-bound critical value. On the other hand, if all the variables are I(0), then the decision is based on the lower-bound critical value. To test for the long-run relationship between the variables, we exclude the lagged-level variables from Eq. (4). Once the presence of co-integration is confirmed, we estimate the long-run coefficients of the growth model and the associated ARDL of the ECM for the short-run coefficients.

The ARDL method estimates $(p + 1)^k$ number of regressions to obtain the optimal lags for each variable, where p is the maximum number of lags to be used and k is the number of variables in the equation [71]. The model is selected based on the Schwartz-Bayesian criterion (SBC) or the Akaike information criterion (AIC).

*3.2.1 Estimation of the error correction-based ARDL model*

ARDL estimation provides both the short run (model) and long run estimation results. The ECM is specified as follows:

$$\Delta LGDP_t = \alpha_0 + \sum_{i=1}^{P} \alpha_{1i}\Delta LGDP_{t-1} + \sum_{i=0}^{P} \alpha_{2i}\Delta LTRO_{t-1} + \sum_{i=0}^{P} \alpha_{3i}\Delta LTSE_{t-1}$$

$$+ + \sum_{i=0}^{P} \alpha_{4i}\Delta LPOPN_{t-1} + \sum_{i=0}^{P} \alpha_{5i}\Delta LGGC_{t-1} + \sum_{i=0}^{P} \alpha_{6i}\Delta LGFCF_{t-1}$$

$$+ \sum_{i=0}^{P} \alpha_{7i}\Delta LCPI_{t-1} + \sum_{i=0}^{P} \alpha_{8i}\Delta LAID_{t-1}\ \beta_{9i}ECT_{t-1} + \varepsilon_t \qquad (5)$$

where $\beta_{9i}$ is the coefficient of the one-lag error correction model, which measures the short-run speed of adjustment to restore equilibrium in the dynamic model following a disturbance [72]. This implies that the coefficient of the error correction should be negative and statistically significant and that the magnitude of this coefficient should be less than one.

### 3.3 Data type and sources

Annual time series data for the period 1982–2015, that was obtained from World Bank Development Indicators [73, 74] was used in this study. The following variables were used: Real GDP (expressed in 2010 U.S. dollars.) at purchaser's prices; Investment (proxied by gross fixed capital formation as a share of GDP); Inflation (measured by the consumer price index); General government expenditure as a share in GDP (General government expenditure as a share in GDP); Human Capital (representing knowledge spill over effects) was proxied by Human capital index[3], based on years of schooling and returns to education); Demography (proxied by total population); Trade openness (measured by the sum of exports and imports as a proportion of GDP); and Foreign Aid as a proportion to GDP (measured by net official development assistance and official aid received as a share of real GDP). Eviews 9.5 software was used to conduct the empirical analysis.

### 3.4 Analysis and discussion of results

#### 3.4.1 Unit root tests

Unit roots/stationarity tests were conducted because this is a prime requirement for any co-integration and causality tests. The augmented Dickey-Fuller test (ADF: [75]) was used to establish the order of integration. The ADF test results were augmented with the Phillips-Perron (PP: [76]) test. **Table 1** presents the results of the unit root tests.

The ADF test results with trend and intercept at level in part A indicate that GDP, GGC, and GFCF were stationary at the 5 percent level of significance, whereas CPI was stationary at the 1 percent level of significance. The researcher thus carried out stationarity tests for all series in first difference with constant and trend, as indicated in part B (ADF test), and the variables, except CPI, became stationary.

The variables were also tested for stationarity using the Phillips-Perron test. The PP test results at level with constant and trend were found to be non-stationary except for GDP and GGC, which were found to be stationary at 10 percent and 5 percent levels of significance, respectively. The variables were tested for stationarity in first difference, and they all became stationary except CPI.

#### 3.4.2 ARDL bounds tests for co-integration results

We tested for co-integration among the variables to establish whether they had a long-run relationship. From a statistical point of view, a long-run relationship

| Variables | Augmented Dickey Fuller | Phillips-Perron test |
|---|---|---|
| | Constant + trend | Constant + trend |
| **Part A: Level** | | |
| Log Real Gross Domestic Product | −3.48* | −3.48* |
| Log Trade Openness | −2.81 | −2.62 |
| Log Human Capital | −2.84 | −2.26 |
| Log Population Growth | −0.06 | −1.72 |
| Log Gross Government Final Consumption (% GDP) | −1.77 | −1.71 |
| Log Gross Fixed Capital Formation | −3.95** | −2.89 |
| Log Inflation Rate | −5.28*** | −2.22 |
| Log Aid | −2.24 | −2.18 |
| Log Total School Enrolment, Primary | −1.85 | −1.74 |
| Log Imports | 3.41* | −2.43 |
| Log Exports | −2.86 | −3.21 |
| **Part B: First difference** | | |
| Log Real Gross Domestic Product | −3.38* | −3.38* |
| Log Trade Openness | −4.51*** | −4.37*** |
| Log Human Capital | −3.80 | −3.85* |
| Log Population Growth | −3.80** | −2.35 |
| Log Gross Government Final Consumption (percent) GDP) | −4.92*** | −6.02*** |
| Log Gross Fixed Capital Formation | −4.33*** | −5.24*** |
| Log Inflation Rate | −2.05 | −2.30 |
| Log Aid | −6.41*** | −7.56*** |
| Log Total School Enrolment, Primary | −6.91*** | 7.08*** |
| Log Imports | −3.77** | −3.40* |
| Log Exports | −6.49*** | −6.49*** |

*\*\*\*, \*\*, and \* denote rejection of the null hypothesis of unit root at the 1 percent, 5 percent and 10 percent significance levels, respectively.*

**Table 1.**
*Unit root test at level and in first difference.*

implies that variables move together over time and that short-term disturbances arising from the long-term trend are corrected. Co-integration is necessary because a valid ARDL requires the presence of a co-integrating set of variables. The ARDL method allows us to test both short- and long-run relationships between the dependent and independent variables in a multivariate framework. The critical value bounds are computed by stochastic simulations using 20,000 replications [66].

The variables are jointly tested if they are equal to zero. That is:

H0: They are jointly equal to zero.
H1: They are not jointly equal to zero.

Once the test statistic is computed, it is compared to two asymptotic critical values corresponding to polar cases of all variables being purely I(0) or purely I(1). When the test statistic is below the lower-bound critical value, the null hypothesis is not rejected, and co-integration is not possible. In contrast, when the test statistic is above the upper-bound critical value, the null hypothesis is rejected, and co-integration is indeed possible. Alternatively, should the test statistic fall between the lower-bound and upper-bound critical values, the test results are inconclusive, and knowledge of the co-integration rank is required to proceed further.

The Akaike information criterion was employed to determine the appropriate lag length for the estimated ARDL equation. This method was chosen because it tends to over-fit the model of interest, given that the optimal lag length for the growth model is up to 2 lags. The optimal lag length is chosen based on the number of dynamic regressors included in the model and the sample size. The optimal lag-length selection criteria are based on the lowest AIC obtained. For this growth equation, (regression I), the optimal ARDL model selected was the ARDL (2, 1, 0, 1, 0, 1, 0, 0, 2) model with restricted intercept and trend, while for regression II, the optimal ARDL model selected was the ARDL (2, 0, 2, 0, 1, 0, 0, 1, 0, 2) model with restricted intercept and trend. **Table 2** reports the Pesaran et al. [64] bounds test for level relationships for the selected equation.

As illustrated in **Table 2**, regression I, the computed ?-statistic is 5.47, and it is statistically significant at the 1 percent upper-bound critical value, meaning that the null hypothesis of no co-integration is rejected at the 1 percent significance level. In regression II, the computed ?-statistic is 3.909, and it is statistically significant at the 5 percent upper-bound critical value, meaning that the null hypothesis of no co-integration is rejected at the 5 percent significance level. In summary, the bounds test of co-integration relationships using the Pesaran et al. [64] approach confirms the existence of long-run level relationships between the dependent variable and the set of covariates in both regressions. The study results also reveal that the underlying ARDL model is a good fit, represented by an estimated $R-$squared value of 0.84 and an adjusted $R-$squared value of 0.67.

| ARDL bounds test | Regression I | | Regression II | |
|---|---|---|---|---|
| **Included observations: 32 after adjustments** | | | | |
| **Null hypothesis: no long-run relationships exist** | | | | |
| **Test statistic** | **Value** | **k** | **Value** | **K** |
| F-statistic | 5.47*** | 8 | 3.909** | 9 |
| Critical Value Bounds | | | | |
| Significance | I0 Bound | I1 Bound | I0 Bound | I1 Bound |
| 10 percent | 1.95 | 3.06 | 1.88 | 2.99 |
| 5 percent | 2.22 | 3.39 | 2.14 | 3.3 |
| 2.5 percent | 2.48 | 3.7 | 2.37 | 3.6 |
| 1 percent | 2.79 | 4.1 | 2.65 | 3.97 |
| R-squared | 0.845152 | | 0.852168 | |
| Adjusted R-squared | 0.699981 | | 0.672657 | |

*\*\*\*, \*\*, and \* denote 1 percent, 5 percent and 10 percent significance levels, respectively.*

**Table 2.**
*Results of ARDL bounds test for co-integration.*

### 3.4.3 Relative superiority of the selected models

Using the ARDL model, the researcher selected the overall best model from the 20 best selected ARDL models. As shown in **Figure 1**, the selected model in regression I is ARDL (2, 1, 0, 1, 0, 0, 1, 0, 0, 2), and the selected model in the second regression is ARDL (2, 0, 2, 0, 1, 0, 0, 1, 0, 2). These two models were significantly superior to the second-best models in each case [66].

### 3.4.4 Empirical results of the ARDL models

The short and long run elasticities for the ARDL model were estimated. **Table 3**, part A presents the short-run ARDL results (including the ECM representation), while part B pre-sets the long-run results of the ARDL models.

Part A of **Table 3** reports the estimated short-run coefficients, while Part B reports the estimated long-run coefficients. Two different regressions were estimated. Regression I was the "benchmark" regression, while regression II was used for sensitivity/options analysis. Among other variables, regression II used a different proxy for trade openness, which is a fundamental variable for GDP growth, according to the literature. Specifically, instead of using trade openness, we used exports and imports to examine the effect of trade on GDP growth.

As shown in part A, the short-run dynamics and the adjustment towards the long-run equilibrium path are measured by the error correction term (ECT) [77]. In the short run, deviations from the long-run equilibrium can occur due to shocks in any of the variables in the model; thus, all the short-run coefficients show the dynamic adjustments of all variables to their long-run equilibrium [70]. If the coefficient is significant, it implies that past equilibrium errors play a role in determining the outcomes of the current period. The ECT measures the speed of adjustment to restore equilibrium in the dynamic model after a disturbance. For the coefficient to be significant, it is required that the error correction term (ECT) must be negative and significant. A highly significant ECT is further proof of a stable long-run relationship [78].

From **Table 3**, part A, regression I, the ECT estimation results show that the estimated coefficient of the error correction term has the expected sign (negative) and is statistically significant. This reinforces the finding of a long-run relationship in the co-integration equation. The results show that a 1 percent deviation from the equilibrium path is corrected in the next period at a rate of 59.5 percent and is statistically significant at the 1 percent significance level. This confirms the
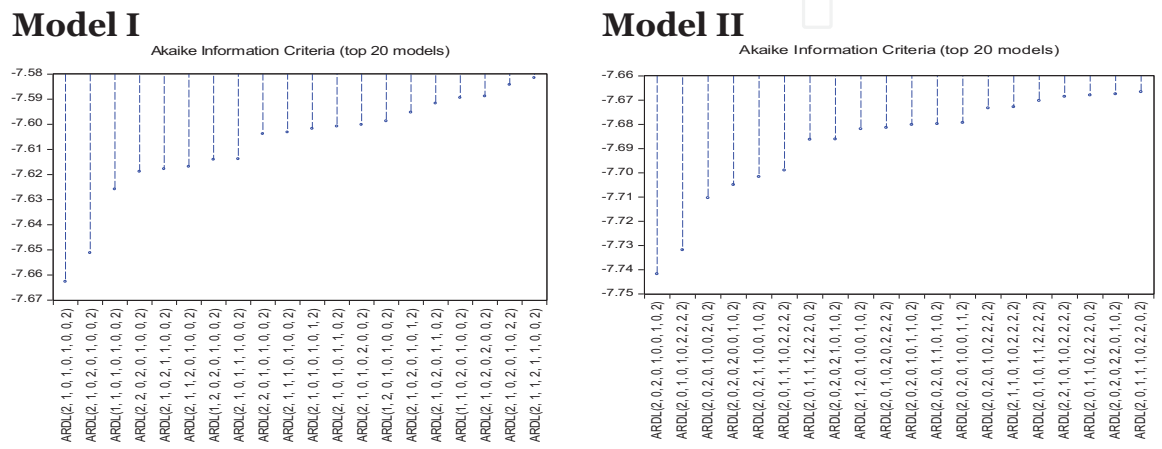


**Figure 1.**
*Relative superiority of the selected models.*

| ARDL co-integration and long-run form | | |
|---|---|---|
| **Dependent variable: LRGDP** | | |
| **Part A** | | |
| **Co-integration form** | | |
| Selected Model: Included observations: 32 | ARDL (2,1,0,1,0,1,0,0,2) | ARDL (2,0,2,0,1,0,0,1,0,2) |
| Co-integration Form | Regression I | Regression II |
| Variable | Coefficient(Prob.) | Coefficient (Prob.) |
| D(Log Real Gross Domestic Product (−1)) | 0.179(0.049)** | 0.279(0.003)*** |
| D(Log Trade Openness) | 0.036(0.190) | |
| D(Log Population Growth) | 0.481(0.784) | 0.126(0.941) |
| D(Log Inflation Rate) | −0.085(0.000)** | −0.086(0.000)* |
| D(Log Human Capital) | 0.240(0.507) | 0.619(0.109) |
| D(Log Gross Government Consumption) | 0.061(0.001)*** | 0.066(0.000)*** |
| D(Log Gross Fixed Capital Formation) | 0.192(0.000)*** | 0.145(0.000)*** |
| D(Log Aid) | −0.033(0.022)** | −0.021(0.111) |
| D(Log Exports) | | 0.027(0.047)** |
| D(Log Imports) | | 0.056(0.178) |
| D(Dummy for Structural Adjustment) | −0.008(0.092)* | −0.018(0.007)*** |
| C | 0.185(0.001)*** | 2.786(0.000)*** |
| Coint Eq (−1) | −0.595(0.00)*** | −0.646 (0.000)*** |
| **PART B** | | |
| **Long-Run Coefficients** | | |
| **Variable** | **Coefficient** | |
| Log Trade Openness | 0.295(0.002)*** | |
| Log Population Growth | 1.008(0.090)* | 0.334(0.605) |
| Log Inflation Rate | −0.009(0.624) | −0.018(0.361) |
| Log Human Capital | 0.293(0.639) | 0.848(0.244) |
| Log Gross Government Consumption (percent, GDP) | 0.198(0.001)*** | 0.159(0.007)*** |
| Log Gross Fixed Capital Formation | 0.316(0.003)*** | 0.220(0.029)** |
| Log Aid | −0.053(0.227) | −0.032(0.399) |
| Log Exports | | 0.121(0.007)*** |
| Log Imports | | 0.090(0.244) |
| D(Dummy for Structural Adjustment) | −0.007(0.003)*** | −0.071(0.003)*** |

*\*\*\*, \*\*, and \* denote 1 percent, 5 percent and 10 percent significance levels, respectively.*

**Table 3.**
*Short-run and long-run ARDL results.*

presence of a long-run level equilibrium path between real GDP and the selected regressors (trade openness, human capital, population, government consumption, investment, inflation, foreign aid and a policy dummy (structural adjustment programme). The regression results for the ARDL model reveal a good fit

represented by an estimated *R*-squared value of 0.85 and an adjusted *R*-squared value of 0.70, as shown in **Table 3**.

Part B, regression I of **Table 3** presents the long-run coefficient estimates. The results reveal that the key macroeconomic determinants that are significantly associated with long-run economic growth in Uganda include trade openness, population growth, government consumption, investment, and the policy dummy variable for the structural adjustment programmes (SAPs).

In the long run, the relationship between trade openness and real GDP is positive and statistically significant at the 1 percent significance level. The results reveal that a 1 percent increase in trade openness in the long run leads to a 0.295 percent increase in the level of real GDP. These findings are supported by previous studies that have found a positive and significant relationship between trade openness and economic growth (e.g. [17, 19, 20]).

The study reveals that population growth is positively and significantly associated with the growth of real GDP in Uganda at the 10 percent level of significance. It shows that a 1 percent increase in population leads to a 1.01 percent increase in real GDP. These results are supported by similar studies conducted in developing countries that have found a positive relationship between investment and economic growth in the long run (e.g., [41, 79]).

The study reveals a positive relationship between government consumption and the growth of real GDP at the 1 percent significance level in the long run. A 1 percent increase in government consumption results in a 0.20 percent increase in the level of real GDP. These results are supported by similar studies conducted in developing countries that have found a positive relationship between government consumption and economic growth in the long run (e.g., [17]).

The results confirm the widely established empirical estimation finding that investment and growth in GDP have a positive relationship. A 1 percent increase in the level of investment results in a 0.32 percent increase in the level of real GDP. These results are supported by similar studies conducted in developing countries that have found a positive relationship between investment and economic growth in the long run (e.g., [10, 54, 80–82]).

The study results did not reveal a significant association between inflation, human capital and foreign aid and the long-run level of GDP growth.

The short-run results presented in Part A of **Table 3** reveal that the key macroeconomic determinants that are significantly associated with the growth of real GDP in the short run are initial GDP, inflation, government consumption (percent of GDP), investment, foreign aid, and the policy dummy. The results show that a 1 percent increase in initial real GDP leads to a 0.18 percent increase in real GDP. Meaning that the level of and sign of initial GDP has a positive relationship with current GDP.

The results reveal a negative association between inflation and economic growth. A 1 percent increase in inflation leads to a 0.90 reduction in GDP. These results are supported by a number of empirical growth studies that have also found a negative association between inflation and economic growth in developing countries (e.g., [56, 57, 83–86]).

The results show that government consumption is positively and significantly associated with the growth of real GDP at the 1 percent significance level. A 1 percent change in government consumption leads to a 0.06 percent increase in the growth of GDP. The positive relationship found between government consumption and economic growth is supported by similar studies in the empirical growth literature that have found a positive relationship between trade openness and economic growth (e.g., [17, 87]).

There is a positive and significant relationship between investment and economic growth at the 1 percent level of significance. A 1 percent increase in

investment leads to a 0.19 percent increase in GDP. The results are consistent with existing empirical growth studies that have found a positive relationship between investment and economic growth (e.g., [10, 17, 88]).

The results show that foreign aid is negatively and significantly associated with the growth of real GDP, and the results are statistically significant at the 5 percent significance level. A 1 percent change in foreign aid leads to a 0.03 percent reduction in the growth of GDP. The negative relationship found between foreign aid and economic growth is supported by similar studies in the empirical growth literature (e.g., [10]).

The study results did not reveal a significant association between trade openness, population growth, human capital, and real GDP growth in the short run.

Sensitivity analysis was carried out to examine the significance of other variables or proxies for the variables used in regression II. This analysis was carried out bearing in mind theory, certain empirical studies and the nature of the Ugandan economy. Key variables/proxies were imports and exports as proxies for trade openness. Exports were found to be positively and significantly associated with GDP at the 1 percent level of significance, while imports were found to be non-significant.

From **Table 3**, Part A, regression II above, the ECT estimation results show that the estimated coefficient of the error correction term has the expected sign (negative) and is statistically significant. The ECT shows that a 1 percent deviation from the equilibrium path is corrected in the next period at a rate of $-0.65$ percent and is statistically significant at the 1 percent significance level. This confirms the presence of a long-run level equilibrium path between real GDP and the selected regressors (total school enrolment, primary; real exchange rate; population; government consumption; investment; inflation; foreign aid; imports; and exports). The regression results for the ARDL model reveal a good fit represented by an estimated $R$-squared value of 0.85 and an adjusted $R$-squared value of 0.67, as shown in **Table 3**.

Part B, regression II of **Table 3** presents the long-run coefficient estimates. The results reveal that the key macroeconomic determinants that are significantly associated with long-run GDP growth in Uganda are government consumption, investment, exports and the policy dummy.

The study reveals a positive relationship between government consumption and real GDP growth at the 1 percent significance level in the long run. A 1 percent increase in government consumption results in a 0.20 percent increase in the level of real GDP. These results are supported by Doppelhofer and Weeks [89] who find a positive relationship between government consumption and economic growth in the long run in developing countries.

The study reveals a positive relationship between investment and real GDP growth at the 1 percent significance level in the long run. A 1 percent increase in the level of investment results in a 0.22 percent increase in the level of real GDP. These results are supported by similar studies conducted in developing countries that have found a positive relationship between investment and economic growth in the long run (e.g., [10, 17, 54, 81, 82]).

There is a positive and significant relationship between GDP and exports in the long run at the 1 percent level of significance. A 1 percent increase in exports leads to a 0.12 percent increase in GDP growth (see [14, 16]).

There is also a negative and significant relationship between GDP and the policy dummy for SAPs in Uganda, as a 1 percent increase in implementation of the SAPs leads to a 0.07 percent reduction in real GDP growth.

The study results did not reveal a significant association between population growth, inflation human capital and foreign aid, imports and GDP growth in the long run.

The short-run results for the sensitivity/option analysis are shown in Part A, regression II of **Table 3** above. The key macroeconomic determinants that are significantly associated with the growth of real GDP in the short run are initial GDP, inflation, government consumption (percent, GDP), investment, exports, and the policy dummy in both the current and the previous period.

The results show that a 1 percent increase in initial real GDP leads to a 0.28 percent increase in real GDP.

The results reveal a negative association between inflation and economic growth. A 1 percent increase in inflation leads to a 0.90 percent reduction in GDP. These results are supported by a number of empirical growth studies that have also found a negative association between inflation and economic growth in developing countries (e.g., [55–57, 83–86]).

The results show that government consumption is positively and significantly associated with the growth of real GDP at the 1 percent significance level. A 1 percent change in government consumption leads to a 0.07 percent increase in the growth of GDP. The positive relationship found between government consumption and economic growth is supported by similar studies in the empirical growth literature that have found a positive relationship between trade openness and economic growth (e.g., [17]).

There is a positive and significant relationship between investment and economic growth at the 1 percent level of significance. A 1 percent increase in investment leads to a 0.15 percent increase in GDP. The results are consistent with the existing empirical growth studies that have found a positive relationship between investment and economic growth (e.g., [10, 17, 88]).

The results show that exports are positively and significantly associated with the growth of real GDP at the 5 percent significance level. A 1 percent change in exports leads to a 0.03 percent increase in GDP growth. The positive relationship found between exports and GDP growth is supported by similar studies in the empirical growth literature (e.g., [14, 90]).

There was a negative and significant relationship between the implementation of the structural adjustment programmes and GDP growth in the current period. A 1 percent increase in the implementation of the SAPs led to a 0.1 reduction in GDP.

The results indicate that in the short run, policy variables contributed to economic growth more than factor accumulation, while in the long run, a mixture of factor accumulation and policy variables was the major driver of economic growth.

### 3.5 Post-estimation diagnostic tests

The regressions were tested to ascertain their applicability and robustness. Robustness was confirmed by the Breusch-Godfrey serial correlation LM test, Jarque-Bera normality test, recursive stability tests, and Breusch-Pagan-Godfrey heteroscedasticity test. This means that the model has the desired econometric properties of time series data.

Recursive Tests were done using a visual examination of the graphs of the recursive parameter estimates. Additionally, a formal statistical test to test the null hypothesis of model stability was undertaken using the CUSUM test [91]. **Figure 2** regression I and regression II illustrate the CUSUM and CUSUMSQ at the 5 percent significance level.

As illustrated in **Figure 2**, the CUSUM test reveals parameter stability, while the results of the CUSUMQ test reveal variance stability given that the residuals for both tests are within the 5 percent critical lines. According to these tests, our ARDL model is stable and has no serial correlation.
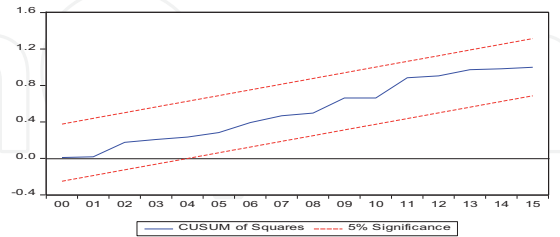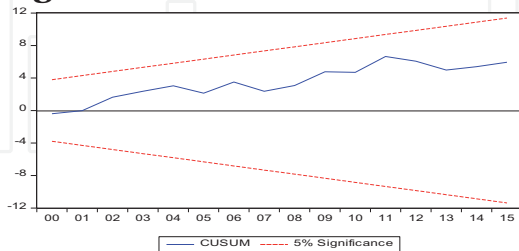
## Regression I
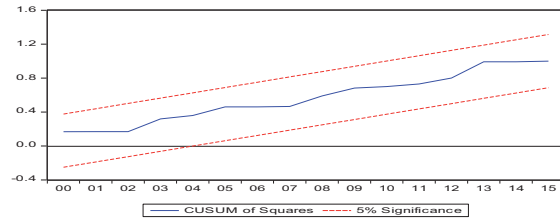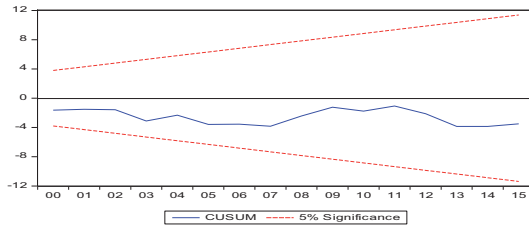


## Regression II



**Figure 2.**
*CUSUM and CUSUMSQ results for the estimated growth equation.*

### 3.5.1 Serial correlation tests of residuals

Serial correlation was undertaken to test whether the residual is correlated with its own lagged values using the Breusch-Godfrey LM test for serial correlation, and the results are presented in **Table 4** below.

The Breusch-Godfrey serial correlation test statistic for the null hypothesis of no serial correlation (**Table 4**) for regression I has a probability value of 0.2739, which is greater than 5 percent. Thus, we fail to reject the null hypothesis, which indicates that there is no serial correlation in the residuals.

### 3.5.2 Heteroscedasticity test

The Breusch-Pagan-Godfrey tests for heteroscedasticity statistic for the null hypothesis of no heteroscedasticity in regressions I and II have probability values of 0.6996 and 0.0612, respectively, which are greater than 5 percent. Thus, we fail to reject the null hypothesis, which indicates that there is no heteroscedasticity in the residuals (**Table 5**).

| Breusch-Godfrey serial correlation LM test | | | Regression I | Regression II |
|---|---|---|---|---|
| F-statistic | 1.332638 | Prob. F(3,13) | 0.2739 | 0.0223 |
| Obs*R-squared | 7.526409 | Prob. Chi-Square(3) | 0.1921 | 0.0004 |

**Table 4.**
*The Breusch-Godfrey test for serial correlation in the residuals of the regression.*

| Heteroscedasticity test: Breusch-Pagan-Godfrey | | | Model I (probability) | Model II |
|---|---|---|---|---|
| F-statistic | 0.760385 | Prob. F(15,16) | 0.6996 | 0.0612 |
| Obs*R-squared | 13.31781 | Prob.Chi-Square(15) | 0.5778 | 0.1320 |
| Scaled Explained SS | 2.325347 | Prob.Chi-Square(15) | 0.9999 | 0.9945 |

**Table 5.**
*Breusch-Pagan-Godfrey test for heteroscedasticity results.*

*3.5.3 Normality test*

The ARDL model assumes that the residuals are normally distributed. The Jarque-Bera statistic is assumed to have a *chi-square* ($\chi 2$) distribution with two degrees of freedom, and the null hypothesis assumes that the errors are normally distributed [92–94].

As indicated in **Figure 3**, in regression I, the probability value for the Jarque-Bera statistic is 0.49 with a probability value of 0.782, which is more than 5 percent; hence, the residuals are normally distributed. In regression II, the probability value for the Jarque-Bera statistic is 0.647 with a probability value of 0.724, which is more than 5 percent; hence, the residuals are normally distributed. This means that statistical tests for inference on regression coefficients are reliable, since these tests require that the dependent variable (and hence the residuals) follows a normal distribution.

*3.5.4 Ramsey rest test for the functional form*

Specification errors can be errors in the specification of the functional form that the equation should take in describing the relationship between the variable. If the F test statistic is greater than the F critical value, we reject the null hypothesis that the true specification is greater than the F critical value, hence reject the null hypothesis that the true specification is linear (which implies that the true specification is non-linear). If we are unable to reject the null, then the results suggest that the true specification is linear and the equation passes the Ramsey Reset test (**Table 6**).

The probability values from the Ramsey rest test for the T and F statistics are greater than 0.05 level of significance, meaning that the estimated model is free from specification errors.
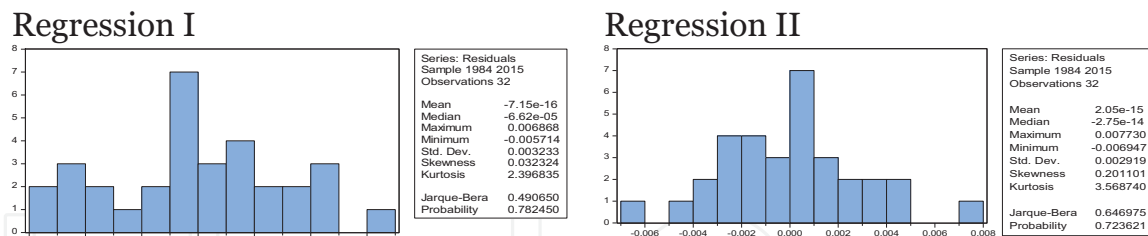
## Regression I

## Regression II



**Figure 3.**
*Histogram normality test model I.*

| Ramsey RESET Test | | | |
|---|---|---|---|
| **Equation: UNTITLED** | | | |
| **Specification: LRGDP LRGDP(−1) LTRO LTRO(−1) LPOPN LINF LINF(−1) LHC LHC(−1) LHC(−2) LGGC LGGC(−1) LGFCF LAID C** | | | |
| Omitted variables: squares of fitted values | | | |
| | **Value** | **df** | **Probability** |
| t-statistic | 0.326505 | 17 | 0.7481 |
| F-statistic | 0.106606 | (1, 17) | 0.7480 |

**Table 6.**
*Ramsey rest test for the functional form test results.*

## 3.6 Conclusion

Attaining high and sustainable economic growth is a major policy objective for any country especially among developing countries. In this paper, we examined the macroeconomic determinants of economic growth in Uganda using the factor accumulation framework for the period 1982–2015.

The autoregressive distributed lag (ARDL) approach to co-integration was used to estimate both the short- and long-run elasticities of the selected macroeconomic determinants. The ARDL bounds testing approach to co-integration in the benchmark regression indicated that the key determinants that are positively associated with growth in GDP in the short run are the initial level of real GDP growth, government consumption and investment, while foreign aid, inflation and a dummy for SAPs were negatively and significantly associated with real GDP growth. The results failed to show that trade openness, population growth and human capital accumulation were significantly associated with real GDP growth in the short run [95–98].

The study revealed that in the long run, trade openness, population growth and government consumption and investment were positively and significantly associated with GDP growth, while the policy dummy on SAPs was negatively and significantly associated with GDP. In the long run, the study failed to show that inflation, human capital and foreign aid were significantly associated with GDP growth. It can be concluded that in the short run, policy variables contributed to economic growth more than factor accumulation (physical and human capital), while in the long run, a mixture of both factor accumulation and policy variables was the major driver of economic growth.

The study results have significant policy implications for Uganda. They show that investment and population have are significantly associated with economic growth both in the short and long run. Thus, it is recommended that the economic strategies to be adopted should include those that create incentives to attract investment—with an emphasis on the adoption of labour–intensive technologies, on quality–based human capital development. In the short run trade openness, government consumption, foreign aid and inflation are positively and significantly associated with economic growth meaning that the country should pursue policies that enhance trade, government effectiveness, aid effectiveness and economic management.

The study found that the key determinants that were positively associated with growth in GDP in the short run were the initial level of GDP growth, government consumption, investment and a dummy for SAPs, while foreign aid and inflation were negatively associated with GDP growth. The results failed to show that trade openness, population growth and human capital accumulation were significantly associated with GDP growth in the short run. In the long run, the study revealed that trade openness, population growth, government consumption and investment were positively associated with GDP, while the policy dummy on SAPs was negatively associated with GDP growth. In the long run, the study failed to show that inflation, human capital and foreign aid were significantly associated with growth in GDP.

These results have significant policy implications for Uganda, both in the short and long run. In the short run it is recommended that economic strategies that would spur accumulation of physical capital/Investment, increase government consumption, improve price stability be pursued while in the long run, strategies that improve trade openness, population growth, government consumption and investment should be pursued.

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