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Source of Economic Growth in Ethiopia: An Application of Vector Error Correction Model

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Abstract

The primary objective of this research is to examine the recent impressive economic growth of Ethiopia and to evaluate the major determinates of gross domestic product (GDP) growth. While emphasizing on the role of investment (grow fixed capital formation), human capital (employment and labor productivity growth), and trade openness (export and import) using time series data that covered from 1981 to 2014. The data analysis was performed through econometric testing with augmented Dickey-Fuller test to check the stability of time series data. Johansen co-integration test is employed to check whether GDP has empirically meaningful relationships with other variables or not? Our empirical findings reject the null hypothesis of no co-integration and accept the co-integration relationship in our model. The vector error correction model and Granger causality test identify long-run equilibrium and short-run causality in GDP growth. The result of this research shows that GDP growth has a long-run relationship with independent variables and short-run causality from export, import, and employment but grow fixed capital formation and labor productivity growth have no impact on GDP growth in short run.

Keywords: Economic Growth; Human Capital; Gross Domestic Product; Unit Root Test; Vector Error Correction Model; Causality

1. Introduction

Economic growth is a measurable change that expands the output of the country in a given period. It is a process that increases the welfare of the nation (Osipian, 2009). The World Bank stated that gross domestic product (GDP) is one of the macroeconomic indicators that measure the economic growth as an increase of national wealth that conventionally quantifiable in the percentage increase in GDP or gross national product. Economic development is a process of change that brings economic and social transformation (Thirlwall, 2006). Furthermore, economic development requires many processes that integrate physical capital, human capital, and technological innovations (Walter, 1972). This paper reviews the source of economic growth that contributed to a current high economic growth of Ethiopia. Since 1991, the political and economic policies of Ethiopia had started to change radically and introduced liberal economic policies to encourage private enterprise and to attract foreign direct investment. Accordingly, Ethiopia registered impressive double-digit economic growth for a decade and become one of the fastest growing economies in Africa (IMF, 2014; MoFED, 2014).

This research is an attempt to answer what are the determinant factors of economic growth? It also evaluates other associated factors of economic growth. We use empirical data analysis and extended theories, and a quantitative approach on the data of economic growth. The first section of this paper reviews an overview of the GDP growth of Ethiopia. The second section focuses on the empirical analysis of time series data through econometrics models to evaluate the determinate of

GDP growth. The data analysis uses augmented Dickey-Fuller (ADF) test to check the existence of unit roots and Johansen co-integration test to get the co-integration between variables. The third part conducts Granger causality test to evaluate the determinate of GDP growth. The last part summarizes the empirical findings of the study and conclusion.

2. An Over View of Ethiopia's GDP Growth

The economic growth of Ethiopia has been registering sustainable and vigorous growth for decades. The growth moment was driven by strong domestic demand, investment on infrastructural and economic liberalization. Moreover, the stable macroeconomic policies contributed for structural transformation from agricultural sectors to service sectors, the share of GDP shifted from low productive agriculture sectors to value-added service sectors (IMF, 2011; McMillan and Harttgen, 2014). Moreover, the government expenditure on infrastructure and human capital have been increasing dramatically and also introduced the economic policies to encourage private sectors expansion. These have attracted world attention as investment destinations. Accordingly, Ethiopia registered impressive economic growth and become one of the fastest growing economies in the world.

Ethiopia introduced market-oriented economic policies to encourage private investment and also attracted foreign investment. This liberal economic policies promoted trade openness and provided tax incentive for export sectors and foreign direct investment. In addition, import substitution police introduced to transfer agricultural-based economy to industrial-based economy. These policies had contributed for macroeconomic, structural transformations (Geda and Berhanu, 2000; Rashid et al., 2009; Berhanu and White, 2000). The classical economic theories supported that international trade has a significant role in economic growth and create competitiveness through specialization (Jung and Marshall, 1985; Siddiqui et al., 2008). Thus, Ethiopia implemented export-led growth strategy to increase competitiveness and boost export that catalyzed GDP growth. The share of trade has increased sharply from 20% of GDP in 1990 to 45% of GDP in 2012 (MoFED, 2014; WDI, 2014).

Investment is the main factor that derives economic growth (Jangili, 2011). Harrod-Domar growth model explained the rate of economic growth proportional to the rate of investment (Zhang, 2005). Saving accelerates investment that contributes to economic growth (Jappelli and Pagano, 1994). Furthermore, Solow's growth model emphasized the importance of physical capital for economic growth (Jangili, 2011). After introducing liberal economic policies, domestic saving has been growing from 9.7% of GDP in 1991 to 22.4% of GDP in 2014. At the same, gross fixed capital formation (GFCF) also has been growing proportional to saving from 14.5% of GDP in 1991 to 40.3% of GDP in 2014 (MoFED, 2014; World Bank, 2014; IMF, 2014).

Several theoretical and empirical evidence shows economic growth and human capital have a positive relationship (Hafner, and Mayer-Foulkes, 2013; Hanushek, 2013). To understand the causal relationship between human capital and economic growth, it needs to develop a two-way approach of study (Hafner, and Mayer-Foulkes, 2013; Musai, and Mehrara, 2013; Suri et al., 2011); therefore, the study employed Granger causality test. Economic growth recognized as the accumulation of human and physical capital, and increased productivity, arising from technological innovation (Lucas, 1998). The endogenous growth theory had given complementary theoretical support, which described human capital as the engine of growth through innovation (Barro, 2002). Human capital is a driving force of economic growth, which is the engine of growth (Benhabib and Spiegel, 1994). According to Meraj study (2013. p. 41), "Adjustment in labor and capital is required to maintain long-run growth with the help of technological advancement in order to increase productivity." Solow growth theory also stresses the importance of physical capital that clearly defined the factors behind economic growth such as accumulation of capital, labor force, and technology (Lucas, 1998). Economic growth was recognized as the accumulation of human and physical capital. Based on above argument, this paper evaluates the relationship between economic growth and the determinant factors such as investment (grow fixed capital formation), trade openness (export and import), and human capital (employment and labor productivity growth).

3. Methodology

The primary objective of the study is to empirically analyze the factors that affect economic growth using time series data that covered from 1981 to 2014. The data analysis was employed with different econometric models. First, ADF unit root test to measure the stability of the data. Followed by Johansen co-integration test is to evaluate the series for integration of data, and then, error correction model (ECM) is to identify the direction of causality in long-run equilibrium and short-run equilibrium of vector ECM (VECM). Finally, Granger causality technique has employed to check the casual relationship among vectors. Before applying co-integration test models, VAR lag order selection criteria is employed using sequential modified LR test statistic (each test at 5% level), final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SIC), and Hannan-Quinn information criterion (HIQ). Lag order selection criteria have employed to determine the optimal number of lag length. In addition, we perform Granger causality test using Wald statistic as well as we check GDP model whether it has any statistical problem using the value of R^2 and F-statistics (P value). Then, we perform residual diagnostics test using Breusch-Godfrey serial correlation LM test, Heteroscedasticity test of Breusch-Pagan-Godfrey, and Histogram Normality test of Jarque-Bera.

This paper examines the dynamic relations between macroeconomic indicators of economic growth. The conceptual framework of GDP and the model that proposed to evaluate the determinant of economic growth of Ethiopia are stated as:

$$GDP=\propto+\beta_1 GFCF+\beta_2 EXPT+\beta_3 IMPT+\beta_4 EMPT+\beta_6 LPB+\mu$$

Where, gross domestic product (*GDP*), gross fixed capital formation (*GFCF*), export (*EXPT*), import (*IMP*), employment (*EMPT*), and labor productivity growth (*LBP*), $\propto$: intercept, μ: error term, and β_i: coefficient.

3.1. Data source

The yearly time series data of GDP, GFCF, export, import, employment, and labor productivity growth collected from various sources, it covers from 1981 to 2014. The macroeconomic development data obtained from the World Bank Development Indicators Data base, The Ethiopian Ministry of Finance and Economic Development, International Labour Organization, United Nations Educational, Scientific and Cultural Organization, and Central Statistical Agency of Ethiopia.

3.2. ADF unit root test

Before constructing an econometric model, ADF test is essential to perform to check unit root test before running co-integration test to track autocorrelation problem. Because macroeconomic time series data have a major problem for empirical econometrics that might cause spurious regressions, which create difficulty to measure regression results. The unit root tests are mainly a descriptive tool performed to classify the stability of time series data. Using ADF test exams whether the variable has unit root or not. Thus, ADF test determines the order of integration of variables. The findings indicate all variables at level have unit root and became stationery at difference with trend and intercept. The null hypothesis assumed that a time series data appear to be non-stationary, which has a unit root. The alternative hypothesis assumed that the date is stationer and reject null hypothesis (Dickey and Fuller, 1979). The following equation estimates the ADF model.

$$\Delta x_t = \alpha + \beta t + \pi x_{t-1} + \sum_{i=1}^{k} \gamma_t \Delta x_{t-i} + \varepsilon_t$$

According to Fuller (1976), the null hypothesis is that $x_t=x_{t-1}+\varepsilon_t$ where ε_t~NID $(0,\sigma^2)$. The notation NID $(0,\sigma^2)$ symbolizes normally and independently distributed with mean zero and variance σ^2 or ε_t the white noise error. The null hypothesis is H_0: $\pi=0$ [$x_t \sim I(1)$] against alternative hypothesis H_a: $\pi<0$ [$x_t \sim I(0)$]. The following ADF test selects an appropriate number of lag length using automatic lag section criteria of SIC.

Tables 1 and 2 of ADF test result indicate all variables that examined are non-stationary at level, and accept the null hypothesis, which indicates all variables have unit root at 1%, 5%, and 10% level.

However, all variables became stationery at the difference in Tables 3 and 4 (trend and intercept) and the result reject null hypothesis at 1% and 5% level and accept the alternative hypothesis. Thus, all variables become stationery at difference.

Table 1 shows ADF unit root test is for intercept only at 1% and 5% critical value, MacKinnon (1996) one-sided P values.

The result of Table 2 shows ADF unit root test is for intercept only at 1% and 5% critical value, MacKinnon (1996) one-sided P values.

Table 3 indicates ADF unit root test results use intercept and trend at 1% and 5% critical value, MacKinnon (1996) one-sided P values.

Table 4 indicates ADF unit root test results use intercept and trend at 1% and 5% critical value, MacKinnon (1996) one-sided P values.

3.3. Lag length selection criteria

Before performing Johansen co-integration test and vector correction error model test, it requires to identify the number of optimal lag length using VAR lag order selection criteria of sequential modified LR test statistic (each test at 5% level), FPE, AIC, SIC, and HIQ. It is necessary to determine the right lag length because endogenous variables are highly sensitive to a number of lag length. Thus, the lag selection criteria can select automatically an appropriate number of lag length. The finding indicates that all testing criteria are in favor of using two lag except SIC recommended to use one lag. Therefore, we use lag two as optimal lag length for Johansen co-integration test and VECM test.

Table 1: Augmented Dickey-Fuller unit root test result for intercept only at level

Variables	Augmented Dickey-Fuller test statistic at only intercept				
	At level				
	1% level	5% level	10% level	t-statistic	P value
GDP	−3.6463	−2.9540	−2.6158	4.0853	1.0000
GFCF	−3.6617	−2.9604	−2.6192	4.8681	1.0000
EXPT	−3.6463	−2.9540	−2.6158	4.1475	1.0000
IMPT	−3.6999	−2.9763	−2.6274	4.6303	1.0000
EMPT	−3.6463	−2.9540	−2.6158	10.6042	1.0000
LBP	−3.6617	−2.9604	−2.6192	1.4942	0.9989

GDP: Gross domestic product, GFCF: Gross fixed capital formation, EXPT: Export, IMPT: Import, EMPT: Employment, LBP: Labor productivity growth

Table 2: Augmented Dickey-Fuller unit root test result for intercept only at difference

Variables	Augmented Dickey-Fuller test statistic at only intercept				
	At difference				
	1% level	5% level	10% level	t-statistic	P value
GDP	−3.6537	−2.9571	−2.6174	−2.9067	0.0557
GFCF	−3.6793	−2.9678	−2.6230	1.8892	0.9997
EXPT	−3.6537	−2.9571	−2.6174	−2.7779	0.0727
IMPT	−3.7379	−2.9919	−2.6355	3.5246	1.0000
EMPT	−3.6537	−2.9571	−2.6174	−0.6296	0.8501
LBP	−3.6702	−2.9640	−2.6210	−1.4591	0.5401

GDP: Gross domestic product, GFCF: Gross fixed capital formation, EXPT: Export, IMPT: Import, EMPT: Employment, LBP: Labor productivity growth

3.4. Johansen co-integration test

This paper employs testing for co-integration to evaluate long-run (equilibrium) relationships and short-run adjustment between variables. Johansen's method checks if the GDP modeling has empirically meaningful relationships between vectors. There are several tests of co-integration. Among these methods, Engle and Granger (1987) formulated one of the first test of co-integration (or common stochastic trends), since then, the Engle-Granger (EG) has become a widely applied method of co-integration. In addition to EG long-run relationship approach, Johansen (1988; 1991) and Johansen and Juselius (1990) introduced a systems-based approach to evaluate the existence of co-integration among variables. Despite Johansen co-integration test has weakness of the test on small sample size and sensitive to specification errors, it has theoretical advantage and methodological superiority (Sjö, 2008; Utkulu, 1997). Therefore, this paper employed Johansen maximum likelihood (ML) method to determine whether a stable long-run relationship (equilibrium) exists between the variables or not? The testing approach assumes that "the system is integrated of order one. If there are signs of I (2) variables, we will transform them to I (1) before setting up the VAR. Using the difference operator $\Delta = 1-L$, or $L = 1-\Delta$, the VAR in levels can be transformed to a VECM" (Sjö, 2008. p.14).

Johansen ML approach identifies the number of cointegrating relationships between GDP and other variables (Table 5). The ML testing model constructs based on trace test and maximum eigenvalue test. Where the null hypothesis is that the number of cointegrating vectors is *r*, against an alternative of (*r*+1) vector. The empirical model for this test is based on the following trace statistics and maximum eigenvalue equations; as follow:

Table 3: Augmented Dickey-Fuller unit root test results for intercept and trend at level

Variables	Augmented Dickey-Fuller test statistic at trend and intercept				
	At level				
	1% level	5% level	10% level	t-statistic	P value
GDP	−4.2627	−3.5530	−3.2096	1.9272	1.0000
GFCF	−4.2967	−3.5684	−3.2184	3.6375	1.0000
EXPT	−4.2627	−3.5530	−3.2096	0.9809	0.9998
IMPT	−4.3393	−3.5875	−3.2292	4.2330	1.0000
EMPT	−4.2627	−3.5530	−3.2096	4.3403	1.0000
LBP	−4.3098	−3.5742	−3.2217	1.7013	1.0000

GDP: Gross domestic product, GFCF: Gross fixed capital formation, EXPT: Export, IMPT: Import, EMPT: Employment, LBP: Labor productivity growth

Table 4: Augmented Dickey-Fuller unit root test results for intercept and trend at difference

Variables	Augmented Dickey-Fuller test statistic at trend and intercept				
	At difference				
	1% level	5% level	10% level	t-statistic	P value
GDP	−4.2733	−3.5578	−3.2124	−4.0826	0.0157
GFCF	−4.2733	−3.5578	−3.2124	−5.6178	0.0003
EXPT	−4.2846	−3.5629	−3.2153	−3.8924	0.0246
IMPT	−4.3943	−3.6122	−3.2431	1.2041	0.0028
EMPT	−4.2846	−3.5629	−3.2153	−7.4726	0.0000
LBP	−4.3098	−3.5742	−3.2217	−4.1444	0.0146

GDP: Gross domestic product, GFCF: Gross fixed capital formation, EXPT: Export, IMPT: Import, EMPT: Employment, LBP: Labor productivity growth

$$\lambda_{max}(r,r+)=-Tln(1\text{-}\lambda_{r+1})$$

$$\lambda_{Trace}(\mathrm{r}) = -T\sum_{i=r+1}^{g} ln(1-\lambda_i)$$

In additions, maximum eigenvalue test result in Table 6 also confirmed the same result as trace statistic, which concluded that there are four co-integration vectors in the model. Therefore, the null hypothesis of no co-integration has been rejected, and the study accepted the alternative hypothesis of the existence of co-integration among time series data. The finding determined that there is long-run equilibrium (relationship) between the variables.

3.5. VECM

After evaluating the stability of vector for stationary and unit roots by performing ADF test. The vector should be in levels and first differences. VECM will be employed once the variables integrated in the same order and cointegrated. Then, we proceed to check whether a long-run equilibrium exists between variables. Furthermore, Wald statistics performed to identify the direction of short-run Granger causality. The empirical model of VECM is represented by the following equation:

$$\Delta GDP_t = \propto + \lambda Z_{t-n} + \sum \beta_1 \Delta GDP_{t-n} + \sum \beta_2 \Delta GFCF_{t-n} + \sum \beta_3 \Delta \mathrm{EXPT} + \sum \beta_4 \Delta \mathrm{IMPT}$$
$$+ \sum \beta_5 \Delta \mathrm{EMPT} + \sum \beta_5 \Delta \mathrm{LBP} + \mu_t$$

Where, λ is the coefficient of error correction, and Z_{t-n} is error correction term (ECT), which is the lagged residual series of the cointegrating vector. Δ denotes first differences and *n* is the optimal lag length determined by AIC and SC criteria and μ_t is the white noise term. The coefficient of cointegrated equation indicates the speed of adjustment toward long-run equilibrium; the coefficient must be negative

Table 5: Johansen co-integration test (trace statistic)

Hypothesized number of CE(s)	Eigenvalue	Trace statistic	Critical value 5%	P**
None*	0.855058	174.3795	95.75366	0.0000
At most 1*	0.824081	116.4369	69.81889	0.0000
At most 2*	0.638744	64.30502	47.85613	0.0007
At most 3*	0.522899	33.76001	29.79707	0.0166
At most 4	0.317416	11.55917	15.49471	0.1793
At most 5	0.003430	0.103069	3.841466	0.7482

Trace test indicates that there are four cointegrating equation(s) at the 0.05 level. *Denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) P values

Table 6. Johansen co-integration test (maximum eigenvalue statistic)

Hypothesized number of CE(s)	Eigenvalue	Maximum-Eigen statistic	Critical value 5%	P**
None*	0.855058	57.94262	40.07757	0.0002
At most 1*	0.824081	52.13189	33.87687	0.0001
At most 2*	0.638744	30.54501	27.58434	0.0202
At most 3*	0.522899	22.20083	21.13162	0.0353
At most 4	0.317416	11.45611	14.26460	0.1328
At most 5	0.003430	0.103069	3.841466	0.7482

Maximum-Eigen value test indicates 4 cointegrating equation(s) at the 0.05 level. *Denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) P values and significant. β denotes the coefficient of short-run equilibrium that measures Granger causality for ECM of the dependent variable. Coefficient parameters of ECT are the speed of adjustment for the short-run imbalances. All the variables of VECM are endogenously determined within GDP model, and the empirical result indicates the coefficient is negative and significant with P value of 3.9%. Therefore, there is long-run causality from independent variable to GDP. Thus, GFCF, EXPT, IMPT, EMPT, and LBP have a positive impact in GDP growth in long run.

Likewise, the Wald statistic result shows trade openness (export and import) cause GDP growth in short run, which is in favor of liberalization theory. Moreover, employment has a positive impact on short-run growth. Nevertheless, GFCF and labor productivity growth have no short-run causality with GDP, which is against endogenous growth theory. The Granger causality test shows that GDP has bidirectional causality with export and import. However, the Granger causality findings surprisingly indicate that GFCF, employment, and labor production cause GDP, but the reverse is statically insignificant. In addition, export has bidirectional causality with import and GFCF. Trade openness (import and export) cause labor productivity, due to the impact of knowledge spillover and positive externalities effect (learning by doing), but labor productivity does not Granger cause import and export.

Furthermore, this paper performed residual diagnostics test using Breusch-Godfrey serial correlation LM test, heteroscedasticity test of Breusch-Pagan-Godfrey, and histogram normality test of Jarque-Bera. The study assesses thoroughly the validity of time series regression data modeling assumptions. The finding indicates that there is no serial correlation and also there is no heteroscedasticity. We, therefore, decide to accept the null hypothesis, which is desirable and expected. Hence, the residual of GDP model has no autocorrelations, and the regression model is homoskedastic. However, the Jarque-Bera test of normal distribution rejects the null hypothesis. Therefore, there is no normal distribution in the model. Finally, we evaluate whether the GDP model has a statistical problem or not by checking the value of R^2 and F-statistics (P value). The finding concluded that there is strong R^2 value (0.752862) and statically significant P value (0.000809).

4. Conclusion

This study has measured the determinate factors of GDP growth of Ethiopia using Co-integration and VECM. The primary objective of the study is to determine the relationship between GDP growth and GFCF, export, import, employment, and labor productivity growth. The empirical findings show that the time series data has unit root at the level and become stationery at difference. Moreover, the co-integration test indicates that the series data is cointegrated in long run. VECM approach found evidence on the causality relationship between GDP and independent variable in the long run.

Likewise, the empirical result reveals that trade openness (export and import), human capital (employment and labor productivity growth), and physical investment (GFCF) will cause GDP growth in long run in Ethiopia. The Wald test causality findings surprisingly indicate that GFCF does not cause GDP growth in the short run, which is theoretically unexpected. In addition, trade openness (import and export) cause labor productivity, this due to the impact of knowledge spillover and positive externalities effect (learning by doing), but the reverse is statically insignificant.

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