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Macroeconomic determinants of total factor productivity and its trend in Ethiopia

Adisu Abebaw Degu*, Dagim Taddese Bekele*

*Salale University, Department of Economics, Fiche, Ethiopia

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ABSTRACT

Total factor productivity (TFP) as a source of economic growth, has been recognized in economic theory for a long period of time. In this research we tried to examine the effect of some macroeconomic factors, which include trade openness, inflation, government expenditure, credit extended and foreign direct investment, and natural disaster drought on total factor productivity and its trend in Ethiopia by using Time series data spanning from 1991 to 2018. The TFP was computed by using the growth accounting method from Cobb–Douglas production function. ARDL was used for estimation of the short and long run econometric model. Accordingly, the trend analysis shows the growth in TFP has been fluctuating over the study period. The result from ARDL indicated that; in long run foreign direct investment, government expenditure and drought negatively and significantly affect TFP. Credit extended is found to affect TFP positively and significantly, while inflation and trade openness are insignificant. Therefore, policies such as; subsidizing domestic firms, effective government spending and making the agriculture sector drought resistant need to be stimulated.

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Introduction

Ethiopia has been achieved high economic growth for the last two decades. The country, by now, is among the ten fastest growing economy in the world by having 7.7 percent real gross domestic product growth rate (IMF, 2018). Accordingly, per capita income has continuously increased and reached USD 883 in 2017/18. Poverty has declined to 22 percent from 38.7 percent in 2004/05. Investment to GDP ratio has increased to 34.1 percent while that of domestic savings rose to 22.4 percent (NBE, 2019).

However, there is no general consensus among the concerned bodies regarding the source of this remarkable economic growth. Theoretically, based on neoclassical growth model, main sources of economic growth are factor accumulation and total factor productivity (Tadesse, 2011). But, According to Bart, (2014), productivity is the only sustainable source of long-term economic growth since it is not affected by diminishing return as of homogenous inputs. There are two most commonly used productivity measures which are single factor productivity and Total factor productivity (Aymen *et al.*, 2015). The former reflect units of output produced per unit of a given input, while the later relates to a measure of output to multiple inputs (Schreyer and Pilat, 2001). Among these two measures of productivity, the widely looked one is total factor productivity. This is because it is invariant to the intensity of use of observable factor inputs and less likely to be affected by difference in factor prices (Tsegay *et al.*, 2017).

* Corresponding author. ORCID ID: 0000-0002-5998-7394

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Total factor productivity as a source of growth in output was raised by scholars like Fabricant (1954), Abramovitz (1956) and Solow (1957). Fabricant (1954) argued that if increase in national income per capita is above the increase in total input per capita, the source of economic advance is improving efficiency. Little was known about the causes of productivity change, and Abramovitz (1956) defined the residual as “a measure of our ignorance.”

Total factor productivity or the “Solow residual” is defined as that portion of a country’s output which is not accounted for in the corresponding level of inputs employed in production (Comin, 2006). Total factor productivity can also be defined as the part of output growth that cannot be explained by input growth (Edward, 1998). TFP indicates how efficiently production factors are being used in production. TFP is a residual and includes other factors other than labor and capital. Some of these factors include technical innovation, organizational or institutional changes, changes in both factor shares and labor skills, and scale effects or variations in work intensity (Sayed and Samuel, 2017). TFP captures the effects of changes in technology, institutions, and other productivity shocks (Kohli, 2015).

Abdychew *et al.* (2015), argue that it contributes to long term economic growth by improving resource allocation, providing new and improved methods of production, as well as generating international competitiveness. Syverson (2011) also argued that the TFP growth model is also associated with the opportunity to generate sustainable incomes and improve the welfare of citizens. In addition, TFP growth has been recognized as an important source of improvement in income and wealth as well as being important in assessing countries’ past and potential economic performance (Ghosh *et al.*, 2000).

Theoretically, the role of TFP for economic growth is un-doubtedly positive. In order to look this, empirical investigations have been conducted at macro and sector specific level by using an aggregate production function for econometric estimations, and the growth accounting approach which uses discrete data and assumes an aggregate production function implicitly (Edward, 1998).

In Developing countries, Ethiopia is one among them, where there is inefficient use of resource, exploring aspect of TFP has great importance (David and Olusegun, 2017). Specifically looking, Ethiopian development policy stresses on development push from agriculture to industry based on use of all means of increasing productivity and production of the sector (Melaku, 2013). The issue of Improvement in factors productivity through efficient utilization of resources and technical change via learning-by doing, adoption of new technologies, and imitation are important for the process of industrialization. Since the country has scarce and limited resources which prevent massive capital accumulation for industrial development, improving productivity has to be must (Yared *et al.*, 2016). In addition the average farm size in Ethiopia is shrinking and the option for expanding the land frontier is also very limited. This is a real treat for the economy where agriculture sector contributes much for the total GDP, employment and export. As a result, increasing farm productivity is critical for achieving higher growth and national food security (Kifle, 2016).

In general, the effect of total factor productivity as a source of economic growth was low up to 2004 while TFP growth and its share in GDP has been the largest contributor during the decade up to 2014. Nevertheless, TFP growth and its share in GDP growth appear to diminish slightly in the last half-decade (2010–14) (Yared *et al.*, 2016). The World Bank, (2015) shows Ethiopian firms compare less well with those in peer countries when using measures of firm productivity that take capital intensity into account, such as capital productivity and total factor productivity (WB, 2015).

Even if the role of total factor productivity as a source of economic growth has been well recognized theoretically, only few studies have done on the issue of total factor productivity in Ethiopia. For example, Tsegaye *et al.* (2017) explored the determinants of productivity for medium and large firms in the textile and garment industries in Ethiopia. They used Levishom-Petrin estimator and found that human capital, agglomeration effects and incentive systems to be core drivers of productivity. In other study, Keflie, (2016) applied a stochastic input distance function to decompose and test the significance of economic efficiency improvement in boosting the productivity of small-scale farmers. The results show the opportunities for increasing productivity through improving efficiency alone is significant. In addition, Farmers that cultivate diverse crops are technically more efficient and while farmer specific factors played some roles, most of the inefficiencies are traced to externally imposed policy and institutional constraints.

Melaku (2013), in his study of technical efficiency and total factor productivity (TFP) in the Ethiopian manufacturing sector, with a firm level unbalanced panel data over the period 1996 –2009 , found wide dispersion of efficiency and TFP levels among firms. He also found TFP has shown better progress after 2001/02 and the growth is largely explained by technical change which is a shift in production frontier. A study by Mohammed (2008) analyzed TFP and competitiveness of textile and garment industries using a Stochastic Frontier Analysis (SFA) and a panel data from the Large and Medium Manufacturing Industries Survey for the period 2001–2005. He found a negative TFP growth and that these sectors are uncompetitive, even in the domestic market.

While macroeconomic factors have their own effect on total factor productivity, as we have been seen in the above researches, even the existed studies in Ethiopia on the issue of total factor productivity have been focused for specific sector and the effect of sector specific variables on it. This is mainly because of data shortcoming. Differently, in this research we tried to explore the trend of total factor productivity and the effect of macroeconomic variables on total factor productivity in Ethiopia. To the best of our knowledge, so far, there is no study which attempted to examine the impact of macroeconomic policies on TFP growth in Ethiopia. This research will help as to understand the productivity of the total economy during this period and have essential role to consider the effect of policy interventions on macro-economy on total factor productivity. It can also be used to implement appropriate policy measures to improve the productivity of the total economy as whole. Beyond these, Since Ethiopia has been achieved a high

economic growth mainly emanated from a high public expenditure spending, in this research the role of public expenditure on total factor productivity has also been addressed.

Data and Methodology of the Study

This study relied on secondary data. Secondary data was collected on GDP, Investment (which was used for computing capital), labour force (which was used for estimation of total factor productivity computation), credit extended to the private sector, trade openness, foreign direct investment, general government expenditure and inflation were collected from various sources (WB, IMF, and NBE).

Model specification

The issue of total factor productivity estimation has been the focus of many studies on factor productivity, thus providing a sound basis for further empirical investigation (David and Olusegun, 2017). We have no direct data on productivity, so it must be inferred as the part of GDP growth that cannot be explained through growth in inputs. For this study we used a growth accounting via Cobb-Douglas production function to extract total factor productivity and its determinants.

Growth Accounting

Using the aggregate production approach (Cobb-Douglas production functions) of GDP measurement, Solow (1957) showed how factor accumulation and technological progress determine the path of economic growth in market economy (Taddese, 2012). This procedure is usually referred to as growth accounting. Therefore Growth accounting is the process of estimating all of these growth factors and calculating a “Solow residual”, which is “unexplained increase in TFP.” Hence total factor productivity growth is what remains in output growth after subtracting out growth in the factors of production (capital and labor). Solow specified the following aggregate production function with Hicks-neutral technology ¹(Sayed and Samuel, 2017).

$$Y = AK^\alpha L^\beta$$

Where; Y, K, L and A respectively represents, aggregate production, the stock of physical capital used in production, the amount of labour inputs and the cumulative change in TFP that occurred over time. While α and β are factor shares for capital and labour with a definite return to scale² assumption.

By taking the natural logarithm, the above equation (1) can be written as follows;

$$\ln Y = \ln A + \alpha \ln K + \beta \ln L$$

By differentiation of the above equations,

$$\frac{d}{dt} \ln Y = \frac{d}{dt} \ln A + \alpha \frac{d}{dt} \ln K + \beta \frac{d}{dt} \ln L =$$

As explained above the growth accounting model can be used for the decomposition of output growth rate into the growth rates of capital and labor and TFP growth rate.

$$g_Y = g_A + \alpha g_K + \beta g_L$$

In the above equation (4) the growth rate of GDP depends on: the rate of growth of technological progress (A), the growth rate of capital and the growth rate of labor input parameter α —showing how capital and labor combine to produce output.

From equation (4), the total factor productivity (TFP) growth rate can be expressed as a residual as follows:

$$g_A = g_Y - (\alpha g_K + \beta g_L)$$

Residual computed in equation (5) represents contribution to output growth of technological progress. In order to calculate g_A , it requires to estimate the elasticities of capital and labor (α and β). There are two approaches of estimating elasticities of capital and labor. These are: Fixed factor share approach and Econometric approach (Taddese, 2012). According to fixed factor share approach α and β are estimated as income share of capital and labor in output respectively. This method assumes; profit maximization under perfectly competitive output and input markets, constant returns to scale ($\alpha + \beta = 1$) and the Hicksian neutrality of technical progress—the measurement of technical progress over “T” periods as the summation of the rates of technical progress over the individual intervening periods. The Econometric approach on the other hand estimates the elasticities directly using of regression. For this study, we produce TFP growth share following Fischer (1993) and (Jungsuk, 2017) and assigned a common labor share of 0.6 to

¹ Hicks-neutral technological change has the effect of increasing the efficiency of both capital and labour to the same extent. On the other hand, Harrod-neutral technological change is labour-augmenting and Solow-neutral technological change capital-augmenting.

² When the sum of α and β is greater than, equal to or less than one, shows respectively increasing, constant and decreasing returns to scale.

calculate TFP growth. This choice is premised on the fact that many developing countries like Ethiopia are more labour abundant and thus tend to adopt a labour-intensive method of production.

However there is no readymade capital data in order to compute the TFP. Therefore we estimate the capital stock at each period by using perpetual inventory approach. Following (Anthony and Oluwabunmi, 2016), the initial capital stock is then estimated from the Solow model steady state relationship. Consider the following equation;

$$K_0 = \frac{I_0}{\delta + g}$$

From equation (6) K_0 is the invitational capita stock, I_0 is the initial investment δ is annual average depreciation rate (assumed to be 5% per annum) and g the average geometric growth rate of real investment over the study period (1991- 2018). After estimating of the initial capital stock (K_0), we can compute the level of capital stock at each period using the following equation.

$$K_t = I_t + (1 - \delta) K_{t-1}$$

Determinants of TFP growth

Growth of total factor productivity (TFP) provides society with an opportunity to increase the welfare of people. It is, therefore, worthwhile to ask, what determinants should policy focus on to enhance the performance of TFP? In reality total factor productivity can be determined by several factors. According to Anders (2007), human capital (education and health), infrastructure, imports, institutions, openness, competition, financial development, geography, capital intensity and innovation are the determinants of TFP among others. On the other hand Anthony and Oluwabunmi (2016) human capital, trade openness and inflation are the determinants of TFP. Sayed and Samuel (2017) in their study showed economic diversification, human capital, Openness and inflation affects TFP growth in Botswana. For this study we specify; inflation rate, the natural log of FDI, openness with respect to the rest of the world, the natural log of government expenditure, the natural log of credit extended and dummy for the existence of drought as the determinants of total factor productivity growth in Ethiopian economy.

$$\ln TFP = \alpha + \beta_1 INF + \beta_2 \ln FDI + \beta_3 \ln TO + \beta_4 \ln GOV + \beta_5 \ln CRD + \beta_6 DRT$$

Where $\ln TFP$ is the natural logarithm of Total Factor Productivity which is derived from a Cobb –Douglas production function as a residual. The explanatory variables are; inflation rate, the natural log of FDI, openness with respect to the rest of the world, the natural log of government expenditure, the natural log of credit extended and dummy for the existence of drought.

Estimation procedure

Unit root test

The first step in time series data analysis is to assess the undergoing stationary process of the data. In time series analysis with econometrics results, before running any test it is important to distinguish between correlation that arises from a share trend and one associated with an underlying causal relationship; we first explore the stationary properties of analyzed time series using the augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests.

Autoregressive Distributed Lag Model (ARDL) Approach to Co-integration Testing

In order to examine the determinants of TFP in Ethiopian economy the study used ARDL co-integration test. Unlike the Johansen and Juselius (1990) co-integration procedure, Autoregressive Distributed Lag (ARDL) approach to co-integration helps in identifying the co-integrating vector(s). That is, each of the underlying variables stands as a single long run relationship equation. If one co-integrating vector (i.e the underlying equation) is identified, the ARDL model of the co-integrating vector is re-parameterized to give short -run dynamics and long run relationship of the variables of a single model (Nkoro and Kelvin, 2016). This co-integration testing procedure specifically helps us to know whether the underlying variables in the model are co-integrated or not, given the endogenous variable. Therefore the major advantage of this procedure lies in its identification of the co-integrating vectors where there are multiple co-integrating vectors. Equation (8) is re-arranged into ARDL form to estimate both short-run and long- run relations and error correction term (ECT), is derived from long run relation. The the resulting new equations (9) became as follows.

$$\begin{aligned} D(\ln(TFP)) = & \beta_0 + \beta_1 \ln(TFP_t - i) + \beta_2 (INF_t - i) + \beta_3 \ln(FDI_t - i) + \beta_4 (TO_t - i) + \beta_5 \ln(GEt - i) \\ & + \beta_6 \ln(CRD_t - i) + \beta_7 (DRT_t - i) \\ & + \sum_{i=1}^p \alpha_1 D(\ln(TFP_t - i)) + \sum_{i=1}^p \alpha_2 D(INF_t - 1) + \sum_{i=1}^p \alpha_3 D(FDI_t - i) + \sum_{i=1}^p \alpha_4 D(TO_t - i)) \\ & + \sum_{i=1}^p \alpha_5 D(\ln(GEt - i)) + \sum_{i=1}^p \alpha_6 D(\ln(CRD_t - i)) + \epsilon_t \end{aligned}$$

In the above equation all variables are as defined previously, k is the ARDL model maximum lag order and chosen by the user. All the variables are previously defined, $\ln$ denotes logarithmic operator, D is difference of a variable and ϵ_t are error terms. The F -

statistic is carried out on the joint null hypothesis that the coefficients of the lagged variable are zero ($\delta_1 - \delta_7$) correspond to the long-run relationship, while ($\alpha_1 - \alpha_6$) represent the short-run dynamics of the model. The hypothesis that the coefficients of the lag level variables are zero is to be tested.

The null of non- existence of the long -run relationship is defined by;

$$H_0: \delta_1 = \delta_2 = 0 \text{ (null, i.e. the long run relationship does not exist)}$$

$$H_1: \delta_1 \neq \delta_2 \neq 0 \text{ (alternative, i.e. the long run relationship exists)}$$

The ARDL bound test has three possible decision rules. If the F-statistics lied above the upper bound of the critical value for a given significance level, the study will fail to accept the null hypotheses of no co-integration. If the F -statistic is below the lower bound critical value, then the H_0 cannot be rejected (there is no co-integration among the variables). However if the F-statistics lied in between the lower and the upper bound of the critical value for a given significance level, conclusive inference can be made (Nkoro and Kelvin, 2016). The issue of finding the appropriate lag length for each of the underlying variables in the ARDL model is very important because we want to have Gaussian error terms (i.e. standard normal error terms that do not suffer from non- normality, autocorrelation, heteroskedasticity *etc.*). The optimal lag length (k) for equation is selected by using the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC) or Hannan -Quinn Criterion (HQC) model order selection criterion.

Once the existence of co-integration is confirmed, the Error Correction Model (ECM) can be derived from ARDL model through a simple linear transformation, which integrates short run adjustments with long run equilibrium without losing long run information. If error correction term (ECT) is negative and significant it will signify the long run causality Granger (1988).

$$D(\ln(TFP))_t = \beta_0 + \sum_{i=1}^p \beta_1 D(\ln(TFP)_t - i) + \sum_{i=1}^p \beta_2 D(X_t - i) + \gamma ECT_{t-1} + \delta DRT + \mu_t$$

Where β 's are the coefficients associated with short-run dynamics of the model coverage to equilibrium, X represents independent variables that determines TFP growth, ECT_{-1} is the error correction term and μ_t is stochastic error term.

Result and Discussion

Descriptive Analysis

Total Factor Productivity, defined as growth in economic output that is not due to increases in labour and capital, leads to increasing and sustainable returns, has been the main source of growth for developed nations (Sayed, 2017). Thus, TFP may include all those factors which contribute to the generation of output other than labour and capital. This can happen because of several reasons such as, change in the quality of inputs, output, introduction of new techniques, inputs and outputs, better organization and so on. For this study we extracted the total factor productivity data for Ethiopian economy by using growth accounting practice. The result of growth in TFP is illustrated under figure 1 below.

Source: Authors' construction

Figure 1: Total factor productivity growth

Accordingly, it is observed that TFP growth of Ethiopia has been fluctuating over the study period. The growth in TFP was fluctuating from the study period 1991 to 2004, and starting 2004 it has been declining slowly with positive values. Particularly the growth of TFP in the period of 1991, 1998 and 2002-2003 was negative. The possible justification of this negative growth rate of TFP would probably be the occurrence of drought, and Ethio-Eritrean border conflict—particularly in the period of 1997-98.

Regression Analysis

The dependent variable is the natural logarithm of TFP as described previously. The independent variables are; inflation rate, the natural log of FDI, openness with respect to the rest of the world, the log of government expenditure and the natural log of credit extended and dummy for the existence of drought. The first step in regression with time series data is to test for stationarity of variables in order to avoid spurious regression. The result of stationarity test is reported under table 1 and 2 below. Accordingly both ADF and PP tests revealed that all variables under the study are a mixture of I (0) and I (1)—making it suitable for using ARDL model.

Unit root test

Table 1: Unit root test results of ADF and PP test at level I(0)

Variables	ADF test at level I(0)		PP test at level I(0)	
	t-Statistic	P value	t- stat	P value
<i>ln</i> TFP	-2.599353	0.2833	-3.50677	0.0580***
Inflation rate	-3.886429	0.0264**	-3.92591	0.0242**
<i>ln</i> FDI	-2.305944	0.4174	-2.20030	0.4711
TOPP	-1.516981	0.7992	-1.66496	0.7399
<i>ln</i> GOV	-2.053121	0.5482	-2.16727	0.4883
<i>ln</i> CRDT	0.057677	0.9951	0.157398	0.9963

*, ** and *** represents significance level at 1%, 5% and 10% critical values, respectively

Source: Eviews 9 result

Table 2: Unit root test results of ADF and PP test at level I(1)

Variables	ADF test at I(1)		PP test at level I(1)	
	t-Stat	P value	t- stat	P value
<i>ln</i> TFP	-5.00428	0.0023*	-4.21078	0.0133**
Inflation rate	-7.13317	0.0000*	-10.6122	0.0000*
<i>ln</i> FDI	-5.49382	0.0007*	-5.53615	0.0006*
TOPP	-6.45294	0.0001*	-6.45294	0.0001*
<i>ln</i> GOV	-4.69267	0.0045*	-4.66388	0.0048*
<i>ln</i> CRDT	-3.87810	0.0274**	-3.84427	0.0294**

*, ** and *** represents significance level at 1%, 5% and 10% critical values, respectively

Source: Eviews 9 result

However, the ARDL model is very sensitive for a given lag length. Hence this study applied different lag length selection criterion such as; Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC) and Hannan -Quinn Criterion (HQC). All criterions suggest three lag for each variables and the result is reported under table 3 below.

Table 3: VAR Lag Order Selection Criteria

Endogenous variables: LNTFP INF LNCRD LNFDI TO LNGOV						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-221.013	NA	1.545841	17.4626	17.7529	17.54621
1	-89.0587	192.85*	0.001045	10.0814	12.1137	10.66667
2	-54.8689	34.1897	0.001999	10.2207	13.9949	11.30755
3	36.35506	49.1206	0.00017*	5.9727*	11.489*	7.56117*

* indicates lag order selected by the criterion

Source: EViews 9

After the identification of the order integration and lag length, the next step is test for the existence of long run co-integration. To do so we employed ARDL model through bounds test to identify the presence of the long run relationship among all variables. The result of the bounds tests is reported in table 4. The order of the variables is total factor productivity, inflation rate, credit extended, trade openness and government expenditure. As indicated by table 4 below, the value of F-Statistics which is 5.239357 is much greater than the upper bound value of 1%, 5% and 10% significance level. Therefore we can conclude that there is a long-run relationship between dependent and explanatory variables, when total factor productivity is modeled as dependent variable.

Table 4: ARDL Co-integration result

ARDL Bounds Test		
Test Statistic	Value	k
F-statistic	5.239357	5
Critical Value Bounds		
Significance level	I(0) Lower Bound	I(1) Upper Bound
10%	2.08	3
5%	2.39	3.38
1%	3.06	4.15

Source: E-Views 9 result

Long Run Equation

The long-run result as indicated by table 5 below shows foreign direct investment, government expenditure, domestic credit extended and the occurrence of drought significantly affect total factor productivity. Specifically looking, foreign direct investment affects TFP negatively at 5 percent significance level. Accordingly, holding other factors constant, when FDI flow increase by one percent TFP declines by about 0.066 percent. Theoretically, the finding shows a ‘market-stealing’ hypothesis of Aitken and Harrison (1999), which states FDI may promote technology transfer, foreign investors ‘steal’ market share at the expense of domestic firms and this forces domestic firms to produce smaller output at higher average costs and FDI negatively affect total factor productivity, is working in Ethiopia. This negative effect can possibly be happened because of crowding out effect of FDI on domestic private and public investment. It is also in line with empirical findings of Azman-Saini *et al.* (2010), Ang (2009), Alfaro *et al.* (2004), Aitken and Harrison (1999), and Haddad and Harrison (1993).

The effect of government expenditure on TFP is also negative and significant at 1 percent level. *Citrus paribus* a one percent rise in government expenditure causes TFP to decline by approximately 0.18 percent on average. In least developed countries like Ethiopia where both market and government failures are common; government expenditure is considered to be inefficient. Commonly, public investments are vulnerable for corruption and rent seeking activities and it results misallocation of limited productive resources. So, our finding can be looked as a robust. Beyond this, our finding is also similar with Elhadj and Zakaria (2017). On the other hand, Credit extended for domestic private sector is found to be having a positive effect on TFP with 1 one percent significant level.

Table 5: Long run ARDL Estimation result

Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF	-0.004495	0.002876	-1.563129	0.1788
LNFDI	-0.066286	0.023406	-2.832037	0.0366**
TO	-0.002940	0.002739	-1.073515	0.3321
LNGOV	-0.179757	0.041240	-4.358853	0.0073*
LNCRD	0.172581	0.036515	4.726327	0.0052*
DRT	-0.034030	0.014981	-2.271581	0.0723***
C	5.038060	0.235169	21.423109	0.0000*

Note: The sign *, ** and *** indicate that the variables are significant at the level of 1%, 5% and 10% respectively.

Source: EViews 9

Other things remain unaffected when domestic credit extended increase by one percent, TFP declines by about 0.17 percent. Theoretically this can be true since the financial system, peroxide by credit extended to the private sector, reallocate scarce resource from firms with low productivity to those with promising growth prospects. The primarily channel that finance help economic growth is through improvements in resource allocation and productivity. This is true in Ethiopia too where credit extended show some improvement and it is the main source of private investment financing. This finding is in line with the finding of Nyamongo *et al.* (2012), Oluitan (2012), Ikhida (2015), Taiva and Nene (2016), Mlachila *et al.* (2016), Inoue and Hamori (2016), and Elhadj and Zakaria (2017).

The effect of drought is as we expected priori and found to be negative and significant at 10 percent level. That means the period when drought occurred shows lower total factor productivity than the good periods. In one way or other drought affect nearly all sectors of the economy in general even if its effect on agriculture sector is huge. This result is robust in countries like Ethiopia where agriculture contributes the highest share of the total economy and Drought is a very common phenomenon. Since drought results deterioration in agricultural productivities at best and creates starvation and death at worst through which it affects the productivity of labor in particular and the sectors productivity in general.

Short Run Equation

The estimated coefficient of error correction term found to be -0.913249 and statistically significant at 5% level of significance which has the correct sign, and indicates a relatively high speed of adjustment to equilibrium after the occurrence of shock. Approximately 91 percent of the disequilibrium from the previous year's shock converges back to the long-run equilibrium in the current year. This significant error correction term is further confirms the existence of a stable long-run relationship among the variables.

Table 6: Short run coefficients

Dependent Variable: LNTP				
Selected Model: ARDL (3, 1, 3, 2, 2, 3)				
Co-integrating Form				
Variable	Coeff.	Std. Error	t-Statistic	Prob.
D(LNTP(-1))	0.471354	0.194156	2.427704	0.0595***
D(LNTP(-2))	0.424236	0.211496	2.005888	0.1012
D(INF)	-0.002871	0.001175	-2.443558	0.0584***
D(LNFDI)	-0.060458	0.013479	-4.485275	0.0065*
D(LNFDI(-1))	-0.005071	0.008501	-0.596588	0.5768
D(LNFDI(-2))	-0.021682	0.007915	-2.739291	0.0408**
D(TO)	-0.000637	0.001125	-0.566240	0.5957
D(TO(-1))	0.001257	0.000863	1.456853	0.2049
D(LNGOV)	-0.009674	0.032790	-0.295018	0.7798
D(LNGOV(-1))	0.094022	0.032960	2.852620	0.0357**
D(LNCRD)	0.063448	0.105007	0.604226	0.5721
D(LNCRD(-1))	0.153077	0.119850	1.277236	0.2576
D(LNCRD(-2))	-0.214162	0.104369	-2.051976	0.0954***
D(DRT)	-0.031078	0.014352	-2.165418	0.0826***
ECT-1	-0.913249	0.242789	-3.761494	0.0131**
Cointeq = LNTP - (-0.0045*INF -0.0663*LNFDI -0.0029*TO -0.1798				
*LNGOV + 0.1726*LNCRD -0.0340*DRT + 5.0381)				

Note: The sign *, ** and *** indicate that the variables are significant at the level of 1%, 5% and 10% respectively.

Source: EViews 9

The short run results also indicated that FDI have negative and significant effect in the short run. However, trade openness has no effect on TFP both in the long run and in the short run. While drought has negative effect both in the long run and in the short run. Generally, Foreign Direct Investment, Government expenditure and credit extended for private sectors are the major long-run determinants of Total factor productivity growth in Ethiopian economy.

Model Diagnostic Test

In order to analyze validity of the short-run and long-run estimation in the ARDL model, the diagnostic tests such as Serial correlation test (Brush & Godfray LM test), Heteroscedasticity test (Breusch and Godfray LM test), Normality (Jarque-Bera test) and Functional form (Ramseys RESET) test were performed. The tests and their respective statistics are summarized by table 7 below. In order to test for normality of the residual the study used the popular Jarque-Bera normality test. As confirmed in the table 7, the P-value of the equation is greater than 5%. Therefore, the study failed to reject the null hypothesis and conclude that error terms of the specified model are normally distributed.

Table 7: Long run ARDL Diagnostic Tests

Tests	LM-version		F-version	
	Statistic	P-value	Statistics	P- value
Normality: Jarque-Bera test	$\chi^2(2)=0.741178$	0.690328	Not applicable	
Serial Correlation: Breusch-Godfrey serial correlation LM test	$\chi^2(3)= 5.441944$	0.1422	$F(3,2)=0.9042$	0.176474
Heteroskedasticity:Breusch-Godfrey test	$\chi^2(20)= 15.96206$	0.7190	$F(20,5)= 0.9363$	0.397543
Ramsey RESET test	$\chi^2(4)= 0.449018$	0.6767	$F(1,4)=0.201617$	0.6767

Source: Author's calculation from E view 9 results, 2019

To test heteroscedasticity this study used Breusch-pagan-Godfrey test because these test is used in most studies using ARDL model. Accordingly the p-values of the equations is above the critical value (5%), implying that the residuals of the equations have no problem of heteroscedasticity. Under Breusch-Godfrey serial correlation test result shown in the table above, for the model specified

their p-value is greater than 5% which assures that there is no serial correlation problem and the study accepts the null hypothesis, therefore there is no serial correlation between residuals under this study.

Conclusions

Total factor productivity as a source of economic growth has been recognized in economic theory for a long period of time. Researchers have been also tried to look macroeconomic factors which determine it and its effect on these variables. But this type of research is scanty in Ethiopia. So in this research we tried to examine the effect of some macroeconomic factors such as; trade openness, inflation, government expenditure and foreign direct investment, and natural disaster drought on total factor productivity (TFP) and its trend in Ethiopia by using Time series data spanning from 1991 to 2018. The TFP was generated by using the growth accounting method from Cobb–Douglas production function. Autoregressive Distributed Lag (ARDL) model was used for estimation of the short and long run econometric model. Accordingly, the trend analysis shows the growth in TFP has been fluctuating in the study period where the growth of TFP was negative with higher value in the 1991, 1998 and 2002-2003. The long run ARDL result showed that foreign direct investment, government expenditure and drought are negatively and significantly affect TFP. Credit extended is the only variable which affects TFP growth positively and significantly, while inflation and trade openness are found to be insignificant. Accordingly, any policy to promote foreign direct investment has to consider its crowd out effect on domestic investment and private firms have to be subsidized. In addition, government has to promote the privatization process and spend in more productive sectors, and government has to implement policies which support improvement in TFP. Lastly, the works to make the agriculture sector in particular and the economy in general to be natural disaster resistant have to be encouraged.

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