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Determinants of Total Factor Productivity in Kenya

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Declaration

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the Research Project contains no material previously published or written by another person except where due reference is made in the Research Project itself.

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This Research Project has been submitted for examination with my approval as the Supervisor.

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Abstract

Neoclassical growth accounting literature has shown that total factor productivity has a positive relationship with output. Based on OLS estimation techniques on data for Kenya between the years 2002 and 2013, this study finds that agglomeration economies, macroeconomic stability and political stability are good contributors of total factor productivity growth, which in turn leads to aggregate output growth. The findings of this study point to a shift from the notion that growth in National Income has to be stimulated by expansionary monetary spending. Other factors such as Population Density and attempts to stabilize the Macro economy can indirectly foster growth of National Income. Accordingly, the findings provide a basis for Policy makers' focus on Monetary Policy that keeps Inflation stable and the preservation of political stability and the absence of violence because this will lead to an increase in Total Factor Productivity and eventually National Output.

Key words: National Income, Total Factor Productivity, Growth Accounting, Labor, Capital, Macro economy

JEL Classification: E010

1 INTRODUCTION

1.1 Background

Is it possible to spur economic growth without necessarily increasing capital or labor? If so, can we control such growth?

Solow and Swan (1956) through their famous Solow-Swan model show that it is indeed possible to increase output without increasing capital or labor. The authors contend that an increase in total factor productivity increases the output contribution of both the existing quantities of capital and labor. This means that holding constant amounts of capital and labor can lead to varied increments in output depending on Total Factor Productivity (TFP).

This study builds on the findings of Solow and Swan (1956) that output responds positively to increments in total factor productivity and focuses solely on the effects of Total Factor Determinants on Total Factor Productivity. This is in tandem with the writings of Prescott (1998) where he says that standard economic growth theory first needs to analyze the TFP determinants to become also a theory of international income differences. Researchers examine a myriad of variables such as agglomeration of economies, social capital, human capital, average education of workforce, Research and Development Expenditure, Female labor Participation, Foreign Direct Investment, Macroeconomic Factors and many more variables. Economists such as Romer (1986, 1990), Grossman and Helpman (1991), Aghion and Howitt (1992), have studied select Determinants, and were able to show that there existed a relationship between the population of employees in the Research and Development Sector and growth in Total Factor Productivity. The establishemnent of such relationships has been met by contradictory findings for instance, Jones (1995) who upon examining time series plots of Total Factor Productivity Growth against growth rates of number of Scientists and Engineers across four countries (France, Germany. Japan and United States of America) invalidated the Research and Development based models that suggest their positive impact on Total Factor Productivity.

(Audretsch, 2015) in his paper reports that an analysis of European countries' level of R&D investment between 2000 and 2009 revealed a positive correlation with their total factor productivity.

The results were summarized in the graph shown below:

Figure 1

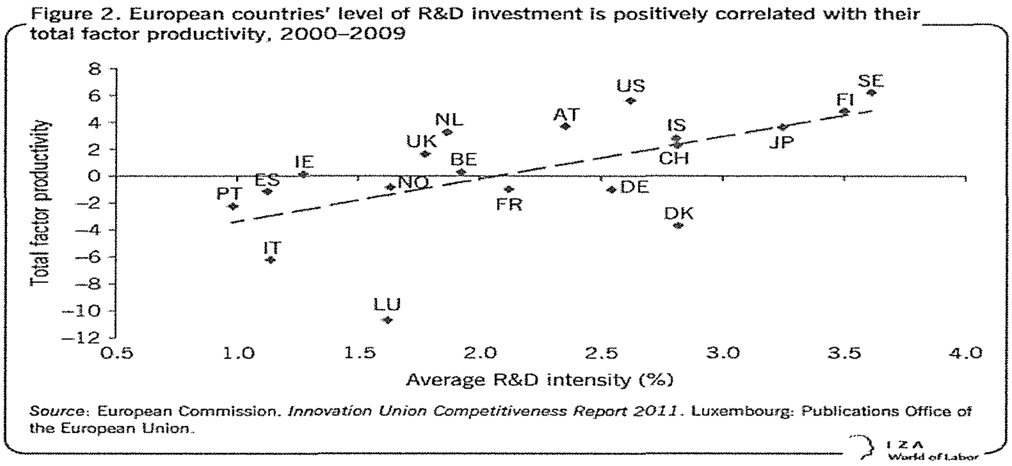

Figure 2. European countries' level of R&D investment is positively correlated with their total factor productivity, 2000–2009

Source: European Commission. *Innovation Union Competitiveness Report 2011*. Luxembourg: Publications Office of the European Union.

This graph shows the scatter plot between Total Factor Productivity and Average R&D Intensity for different European countries effectively implying a positive relationship

Another Economist Lucas (1998) was able to conclude that growth models are heavily based on accumulations of human capital.

Glaeser (2007) on the other hand writes about Agglomeration economies and how it contributes to growth in total factor productivity

Dinda (2007) shows that social capital generates human capital and in an indirect form fosters growth in total factor productivity

Factors such as levels of competition, improved business environment, improved trade, and trade openness have theoretical impacts on Total Factor Productivity but pose significant measurement problems.

The contributions of the aforementioned among other economists who have through their research established how select Determinants of Total Factor Productivity affect Total Factor Productivity have led to the creation of an inquisitive spark to ascertain the nature of such a relation in the Kenyan context if at all it exists. This study confines itself to analyzing the impact of Female Labor Participation, agglomeration of economies, Inflation, Government Size, Research and Development Expenditure, Average education of workforce, Sectorial Composition of Output and Foreign Direct Investment on total factor productivity. This is because they are easy to measure and theoretical literature supports a significant relationship between them and total factor productivity. Basically, this study hopes to illustrate how we can optimally utilize existing resources to achieve optimal output growth results by scaling up the total factor productivity.

1.2 Statement of the problem

The Solow-Swan model proposes total factor productivity as a factor that leads to growth of output independent of labor and capital. The question however is to what extent output grows relative to a change in total factor productivity in Kenya. Even in the determination of this elasticity of output to total factor productivity changes, a further question ensues as to what causes changes in total factor productivity and to what extent does total factor productivity change given a change in these factors.

Having launched Vision 2030 on 10 June 2008, the economy's average Gross Domestic Product needs to grow at 10% per annum if Kenya is to achieve this vision. It is possible to achieve this target without necessarily increasing county government revenue allocation, but by smart and efficient allocation of County Resources. Following thorough review of Literature on the topic, researchers in various geographical jurisdictions have established how the aforementioned factors affect Total Factor Productivity. However, there exists a research gap in Kenya vis-à-vis this particular topic. Literature on such studies in Kenya is scarce particularly due to difficulties in data collection.

This study attempts to establish the sensitivity of total factor productivity to changes in its determinants.

1.3 Research Objectives

The main objective of this research is to determine the determinants of total factor productivity in Kenya

1.4 Research questions

The research question under investigation in this study is what are the determinants of total factor productivity in Kenya?

1.5 Significance of study

The establishment of the response of Total Factor Productivity to changes in its determinants provides a basis for the allocation of government resources in its bid to achieve a desired rate of output growth. Policy makers can as well find grounding for their policy makers through reference to this kind of a study. Lots of research has been done on the determinants of total factor productivity; however, this research aims to determine the extent of movement of Total Factor Productivity to changes in its determinants in Kenya specifically.

1.6 Scope of study

This a localized study of Kenya's Total Factor Productivity Determinants. It analyzes data from the period 2002-2013.This is to observe the effects of the total factor productivity related efforts by government within the period to boost the economy. Data will be drawn from several sources such as the World Bank, Nation master, Economic Research Department of the Federal Reserve Bank of St. Louis, Nation Master, Kenya national Bureau of statistics and the Kenyan economic survey. In the use of data, the source will be aforementioned.

2 Literature review

2.1 Introduction

Many scholars have contributed to growth accounting theory. Since the development of economic growth measurements such as Gross Domestic Product, Gross National Product and so on, it has been economists' concern to explain what exactly brings about economic growth. Production theory is one way of explaining economic growth. It explains that the outputs of a firm, economy or a nation are a function of the inputs it possesses. In other words, a firm, economy or nation converts its existing inputs into finished products called the outputs of production.

By analyzing the yearly values of output in the economy, formerly measured by the Gross Domestic Product, we are able to tell whether the economy has grown, stagnated or is shrinking. Since it is desirable that the economy continually grow to enhance social welfare, it is important to understand what causes economic growth, that is, the Determinants of economic Growth.

Economists, over the decades have successfully put up theories that explain how Total Factor Productivity is a major Determinant of Economic Growth. However, it is worth noting that Total Factor Productivity cannot exist in the absence of the input of production. Inputs have to exist to increase their productivity. This makes it important to make a brief identification of such factors. Several models create linkage between inputs and outputs of the production process.

The Classical Growth Model is one such model. Developed and contributed to by many economists such as Adam Smith, David Ricardo and Thomas Malthus, it describes the life of economic growth in relation to population growth. Classical economists are of the opinion that economic performance has an impact on population and population itself has an impact on economic growth. The Model theorizes that economic growth stimulates an increase in population, which places pressure on resources. The resources become limited thus causing a decline in the economy's GDP. Over time, criticisms of the model have invalidated it especially because it makes a deadly explanation for economic growth in total disregard of the impact of technology. However, this model acknowledged the fact that growth in output is dependent on the availability of resources. In their separate works, they identified such resources as capital and labor and land among others.

The Harrod-Domar Model developed by Sir Roy Harrod (1939) and Evsey Domar (1946) is another such model. The model attempted to summarize economic growth as dependent on the savings ratio in the economy and the Capital Output ratio. The Model assumes that capital is formed through investments, which are facilitated by saved funds. High levels of saving provide funds that can be borrowed and invested by firms, which in turn increase the country's capital stock and thus bring about economic growth. That been said, the economy would grow if the citizens saved more and if the capital created is productively utilized. The capital Output ratio is a statement of the quality/productivity of capital. The model however, falls short when it makes the rather unrealistic assumption that production takes place in fixed proportions and that there exists no possibility of substituting labor for capital. Since this is a crucial assumption, then its reduction to the absurd also has a similar impact on the model itself. Nonetheless, what is important and still stands is that an increase in inputs is expected to increase aggregate output.

Robert Solow, the 1987 Nobel Laureate and Trevor Swan, whose growth accounting model (Solow, February 1956), developed an Improvement of the Harrod Domar Model, The Solow-Swan Growth Model, which identified capital, labor and new ideas/technological advancements alias the Solow Residual as the causers of growth in output. Their Model, simplified the economy to being a producer of a single commodity, output. Instead of assuming that production in the economy takes place in fixed proportions, the Solow-Swan Growth Model attempts to identify the time paths of both the capital and the labor force. Once these have been determined, it becomes easy to determine the time path of the real output. The Solow model is a good model in explaining development patterns across developing and developed nations. It explains why there exist high levels of economic growth developing relative to those in developed nations. The model introduces the concept of Diminishing Marginal Returns to capital and explains why this is the cause of discrepancies in the rate of economic growth due to identical increments of capital across nations of different wealth. The model even goes further to imply that due to varied sensitivities of economic growth to capital increments, developing countries, whose economic growth is much more sensitive to capital increments will at some point actualize similar living standards as those of developed countries due to their lower sensitivity.

The Solow Growth model also hints that there indeed exists an optimal level of capital necessary to attain a desirable level of economic growth. His model implies that capital accumulation comes with a cost. An increase in capital stock will increase the amount of money required to maintain and service existing capital. This makes therefore the decision on how to allocate a nation's resources in order to actualize its economic goals rather interesting (This is where this study picks up from). Allocation of resources towards capital has to be on a cost-benefit basis. The model reveals that due to capital depreciation and growth in population, capital economies eventually reach a point of economic stagnation if no more technological progress is actualized. They reach what is referred to as a "Steady state". By and by, what ensues from the Solow-Swan model is that beyond the optimal level of capital, economic growth is achievable by enhancing total factor productivity.

(Aquilars M. Kalio, 2012) However concludes that in the Kenyan scenario, the accumulation of classical inputs, capital and labor, are more important than total factor productivity growth with contributions of 71.4%, 25% and 3.6%

Prescott (1998) writes that standard economic growth theory first needs to analyze the Total Factor Productivity determinants to become also a theory of international income differences. Though his was in the context of studying international income differences, the principle also applies in the time series analysis of output values.

2.2 Determinants of Total Factor Productivity

Literature on the Determinants of Total Factor Productivity is widespread with several contributions from various economists streaming in by the day. This study highlights a number of these determinants as pointed out by various scholars. It restricts itself to those that are going to form part of the investigation for which this study will be done.

Endogeneous Growth Models developed by Romer (1986, 1990), Grossman and Helpman (1991) and Aghion and Howitt (1992), were able to show that there existed a relationship between the population of employees in the Research and Development Sector and growth in Total Factor Productivity. Their models tended to show that technological innovations were the byproduct of investments in Research and Deveelopment. However, empirical tests by Jones (1995) whereby time series plots of Total Factor Productivity Growth against growth rates of number of Scientists and Engineers across four countries (France, Germany. Japan and United States of America) invalidated the Research and Development based models. Later on though, vast Macroeconomic works confirmed an empirircal linkage between Research and Development expenditures and Total Factor Productivity Growth for instance Cameron (2003) and Griffith et al. (2000,2003). To capture the effects of Reseach and Development on Total Factor Productivity, a measure of private enterprise spending on Research abd Development, number of researchers on total workforce among those used by Jones(1995)

Lucas (1998) makes a very important point by asserting that growth models are heavily based on accumulations of human capital. In order to exploit new technology or higher levels of technology, knowledge as to how to utilise that technology is important. This however, poses a great challenge as human ccapital is linked/can be referred to as an input in the production process as argued by Guido Ascari and Valeria Di Cosmo (2005) in their paper, *Determinants of Total Factor Productivity in the Italian Regions.* They however, go about this problem by constructing two different measures of Total Factor productivity. In one, they consider human capital as a production input while in another they do not. They measure human capital by considering average education attained by the workforce. In this study average number of years of education received by people ages 25 and older, converted from education attainment levels using official durations of each level is used as proxy for the measurement of human capital.

According to Glaeser (2007) Agglomeration economies, which are the benefits derived by virtue of firms and people locating near each other in cities and industrial clusters, promotes trade oppenness and cost reduction e.g transport costs, which contributes to growth in total factor productivity. This makes perfect sense because if you think about it, cost reduction of the production process eases demand of financial capital to generate output opening it up for further production of extra output. Theoretical and empirical literature on economic geography and regional economics proposes that there exists as well the benefit economies of scale as a spillover effect of agglomeration of firms. In their bid to explain differences in productivity levels across Italian regions, Aiello and Scoppa (2000), used population density as a proxy for agglomeration economies.

Dinda (2007) shows that social capital generates human capital and in an indirect form fosters growth in total factor productivity. Dinda is just but among several scholars whose works have heightened the consideration of social capital as a total factor productivity grower. Guido and Cosmo (2005) state that unity and trust in the social community creates the right environment for economic activity development. However, there exist several challenges in the determination of the variable 'Social Capital' as concluded by Temple(2001). Degli Antoni(2004) constructed a measure of social capital through the consideration of the number of voluntary homicides experienced in an area.

Public capital has also been proven to be positively related to total factor productivity. Destefanis and Sena (2005) provide quite convincing evidence through reference to the Italian region that public capital has a significant impact on the evolution of total factor productivity. Barro (1990) found that public capital is a possible source of growth.

Jean-Claude Nachega and Thomson Fontaine (2006) explain that political instability is counteractive to economic growth. It negatively impacts the growth in TFP by disrupting the normal functioning of the business and economic environment. It also decreases certainty and subsequently incentive to invest.

Boileau Loko and Mame Astou Diouf (2009) in their works introduced other determinants of Total Factor Productivity as Government size, the sectoral composition of output, and the share of women in the labor force. They referred to these variables as the non-traditional determinants of Total Factor Productivity.

(Aquilars M. Kalio, 2012) succesfully show how total factor productivity is influenced by determinants such as oppennes of the economy, instituitions and terms of trede. In their paper, it was established that the aforementioned had elasticities of 0.3136, -0.3822 and -0.3352.

2.3 Empirical evidence

The whole empirical investigation of the effect of total factor productivity growth on economic growth is not a new concept. Jean-Claude Nachega and Thomson Fontaine (2006) in their working paper, "Economic Growth and Total Factor Productivity in Niger," established that there was erosion in output per capita over the sample period of their investigation that was as a result of negative growth of both total factor productivity and physical capital per capita.

On the Determinants of Total Factor Productivity, the following are analyses of whether or not theory holds:

Theory categorises, factors affecting total Factor Productivity into various ypes. One such broad Category is Macroeconomic factors. Macroecconomic factors comprise of indicators such as Inflation and Government size.

Based on works from several writer, it has been a common argument that macroeconomic stability, inflation to be more precise has a negative effect on economic performance. For this reason, inflation is widely taken to be an indicator of Macroeconomic stability.

Governemnt size, measured as the portion of a country's GDP spent on public expenditures, has also been shown to have a positive effect on total factor productivity owing to positive externalities associable e.g development of legal and administrative instituitions, development of economic infrastruture as well as interventions to save the market from failures according to Ghali(1998). However, (Barro,1991;Atul A. Dar, Khalkhali, 2002) have held contrary opinions in this regard based on their findings. They hold that large government spending can in fact inhibit TFP growth especially because of government ineffeciencies, the tax burden and distortions provoked by interventions to free markets. Most empirical findings support this contradiction.

Female labor participation also has proven to be key to total factor productivity growth. Studies have shown that educated women allocate high portions of household income to education and healthcare which in turn boost total factor productivity. According to McGuckin and Van Ark (2005), high female participation in labor may lead to productivity losses when new entrants are older women integrating into the work force on a part-time basis and after a period of inactivity, a contradiction to other scholars findings. DeJong and Tsiachristas (2008) provide empirical evidence of growth in TFP as a result of high female participation.

The promotion of women's education and the integration of women into the labor force may increase productivity and growth. In development economics, it is now fully acknowledged that educated women allocate a higher share of households' resources to education and healthcare—two factors that are expected to boost productivity and growth in the long-run. A few studies have attempted to examine the im

Theoretical literature proposes that Foreign Direct Investments improve technology and productivity and thus economic growth (Borensztein et al., 1998). Foreign Direct Investment has positive externality effects on the host country such as introduction of new processes and managerial skills, know-how diffusion to the domestic market and introduction of new technologies. By considering the ratio of agriv Direct Investments to GDP, this study seeks to establish the exact effect on Total Factor Productivity since there exists contention as to the exact effect on TFP as proposed by Alaro et al (2009)

A good number of empirical studies have concluded that a change of focus of economic activity from agriculture to nonagricultural sectors lead to total factor productivity growth because it shifts energies from low-yield activities to high yield activities (Poirson, 2000; Jaumotte and Spatafora, 2007). Further studies propose that nations with a higher share of high productivity growth sectors have high total factor productivity growth. The effect of sectoral composition on output is measurable by considering the share of agricultural value added to overall GDP.

(Aquilars M. Kalio, 2012) succesfully show how total factor productivity in Kenya is influenced by determinants such as oppennes of the economy, instituitions and terms of trade. In their paper, it was established that the aforementioned had elasticities of 0.3136, -0.3822 and -0.3352. (Miller, 2000) made a similar conclusion. That higher openness positively influences total factor productivity. He goes on to say that in poor countries, human capital interacts with openness to yield a positive effect.

(Aquilars M. Kalio, 2012)'s work provided some information as to the interaction between Total factor productivity and its determinants in Kenya. In their work factors such as openness of the economy, institutions and terms of trade are considered. It is the objective of this study to examine how other such factors that have an impact on Total Factor Productivity actually affect it.

3 METHODOLOGY

3.1 Research design

This study involved empirical analysis of total factor productivity determinants' effects on total factor productivity in Kenya. Considering Time series data of the determinants of total factor productivity a regression function was fashioned to serve as an explanation of total factor productivity movements. Once data on the independent variables happened, tests for stationarity using the Augmented Dickey Fuller Test followed and adjustments made to make it stationary. Thereafter, pre-estimation tests such as tests for Heteroskedasticity, Normality of the residuals and Johansen Test of Cointegration were done. The adjusted data variables were then incorporated in a linear regression model and the relationship established between total factor productivity and its determinants.

3.2 Data and measurement of variables

The study used data from 2002 to 2013. This is because, the government has put in place some conscious investments in total factor productivity for instance, free primary education, increased the size of government, investment in social capital by deploying police to fight against terror and militia and so on. In addition, as a nation, Kenya has faced political instability periods within the 11 years post 2002. The study is of the Kenyan output growth response to changes in the determinants of Total Factor Productivity. Data sources are the World Bank, Economic Research Department of the Federal Reserve Bank of St. Louis, the International Monetary Fund (IMF), Economic Research Department of the Federal Reserve Bank of St. Louis, Nation Master, Kenya national Bureau of statistics and the Kenyan economic survey.

3.3 Definition of the production function

It would be appropriate to construct a Cobb-Douglas Function that explains the economy's output in terms of the factor inputs namely capital and labor as expressed in the Solow-Swan model. The aggregate production function would appear as follows:

$$Yt = A_0 e^{bt} K_t{}^{\alpha} Lt^{1-\alpha} \qquad (1)$$

Where

-t is a time index,

-Y is real GDP,

-K is real capital stock,

-L is total employment,

-α is the sensitivity of output to capital,

- (1-α) is the sensitivity of output to labor,

-$A_0 e^{bt}$is an expression of Total Factor Productivity (TFP)

Total Factor Productivity (TFP) measures the shift in the production function at given levels of capital and labor. The fixed component of TFP (A_0) is assumed to grow at a rate b.

For the purpose of an easier regression analysis, it would help to divide both sides of equation (1) by L and take the natural logarithms of both sides as well to eliminate the power values (indices) in the equation.

What you end up with is:

$$y_t = a + bt + \alpha k_t \quad (2)$$

This is much simpler to manipulate in an econometric context. The lower case variables, k and y represent the natural logs of physical capital and output per capita respectively. In the course of our analysis, since we cannot exactly observe the natural logarithm of A_0, we would have to estimate it as the residuals of the second equation. This makes sense as it implies a movement in per capita output that does not result from movements in per capita capital, the definition of total factor productivity and thus the name Solow residual.

The production function (2) is a good approximation of production possibilities because it exhibits the following properties: Perfect competition, Constant Factor Income shares and Constant Returns to scale; Properties that complement the application of the Solow Growth Model.

3.4 Growth attribution and the endorsement of TFP growth

Jean-Claude Nachega and Thomson Fontaine (2006) propose a means for deriving total factor productivity. After the estimation of parameter α in equation (2), it is easy to breakdown the growth in output based on the factor contributions, i.e. stimulus of labor, stimulus of capital and stimulus of TFP to the output growth. If we assume that the production function exhibits Constant Returns to Scale and that the markets for goods and factors are competitive, the output growth rate ($\Delta Y/Y$) can be re-written as:

$$\Delta Y/Y = \alpha \Delta K/K + (1-\alpha)\,\Delta L/L + \Delta A/A \qquad (3)$$

Since the growth rate of Total Factor Productivity ($\Delta A/A$) cannot be measured directly, we make it the subject of the equation to express it in terms of other measurable variables. We get:

$$\Delta A/A = \Delta Y/Y - (\alpha \Delta K/K + (1-\alpha)\,\Delta L/L) \qquad (4)$$

This implies that the growth in TFP is the portion of economic growth not explained by growth in the labor force and physical capital stock.

We know that the Solow Growth model defines a scenario whereby economic growth is possible beyond the steady state through growth in the Total Factor Productivity. Therefore, if we assume that in the model, the key parameter (α) remains stable across time labor productivity(Y/L) would have to increase to sustain increases in real wages (W/P) and eventually better life standard.

Since at the steady state, the growth rate of capital per unit of labor is zero, we can have the growth attribution formula (3) written in terms of the labor productivity growth rate as below:

$$\Delta(Y/L)/\,(Y/L) = \Delta A/A \qquad (5)$$

Equation (5) holds in the steady state.

3.5 Definition of the Total Factor Productivity Regression Function

Having described the determinants of total factor productivity, the following will be the regression function used to examine their relationship with total factor productivity

$$lnTFP_{it} = \beta_1 R\&D_{it} + \beta_2 FDI_{it} + \beta_3 EDU_{it} + \beta_4 INFL_{it} + \beta_5 AGRIC_{it} + \beta_6 DENSITY_{it} + \beta_7 GVT_{it} + \beta_8 FEMLAB_{it} + \beta_9 POLIT_{it} + V_{it}$$

Where:

lnTFP	-the natural logarithm of Total Factor Productivity
DENSITY	-agglomeration of economies as measured by population density
FEMLAB	-Female labor Participation as measured by number of percentage of women in employment
R&D	-Expenditure Research and Development
INFL	-Inflation as measured by CPI
AGRIC	-share of agricultural value added to overall GDP
GVT	-ratio of Government Spending relative to GDP
EDU	-average number of years of education received by people ages 25 and older
FDI	-Foreign Direct Investment
POLIT	-World Bank Governance Indicator on Political Stability and the absence of Violence
Vit	- Regression error

This regression function is instrumental in determining whether there exists a meaningful or significant relationship between the determinants of total factor productivity and total factor productivity. This is important, as it will aid in policy making when generating policies aimed at increasing output through investment in total factor productivity.

3.6 Data and Data Collection

3.6.1 Data Collection

Having defined the aggregate demand function and manipulated it into equation (2), what we need to do is to collect historical data on real capital stock labor force. Data on real capital stock is derivable from the Economic Research Department of the Federal Reserve Bank of St. Louis that possesses data on Capital Stock at Constant National Prices for Kenya among many other nations. Data on the labor force in Kenya is derivable from the Central Data Source, Nation

Master. The analysis of data will be an analysis over an 11 year period from 2002-13 and data collected will be on a quarterly basis

Data for the determinants will as well have to be collected for the regression of total factor productivity against its determinants. Data on Female labor participation, average age of workforce, Political stability and Research and Development expenditure can be found on the World Bank statistics database. Data on Foreign Direct Investment, Inflation, Agricultural value added share of GDP and Public Expenditure to GDP ratio can be found from the Kenya national Bureau of statistics and the Kenyan economic survey. Data on population density can be derived from census reports.

3.7 Data Analysis

3.7.1 Regression Analysis

Once the collected, data regression of the total factor productivity against its determinants follows. This occurs in three steps:

3.7.1.1 Generation of the Total factor productivity Variable

As is illustrated from equation (2):

$$\boldsymbol{yt = a + b_t + \alpha k_t}$$

The sensitivity of output to changes in capital (**α**) will be generated using the formula below:

$$\boldsymbol{\alpha = \Delta y_t / \Delta k_t}$$

This is on the deductional basis that both $\mathbf{y_t}$ and $\mathbf{k_t}$ are natural logarithms and that the formula for calculating elasticity of output to capital is:

$$\alpha = \frac{\partial \ln x}{\partial \ln k} = \frac{\%\Delta x}{\%\Delta k}$$

Iff:

$$x = f(k, l) = \alpha k^{\alpha} l^{1-\alpha}$$

It is known that, the total factor productivity growth rate $\mathbf{b}_t$, is calculated using equation (5) whereby:

$$\Delta(Y/L)/\,(Y/L) \;=\; \Delta A/A$$

With this in mind, it seems reasonable to start by finding the growth rate of Total Factor Productivity so as to enable its insertion in the equation that will give us data on Total Factor Productivity, which is a manipulation of equation (5), i.e.

$$a \;=\; y_t \;-\; b_{\,t} - \alpha k_t$$

3.7.1.2 Pre-Estimation analysis and Adjusting

Before the use of collected data, the series will be tested for stationarity using the Dickey-Fuller unit root test and adjustments made to the series if necessary. Thereafter, a regression will be done to determine the elasticity of output to total factor productivity and another to determine the relationship between total factor productivity and its determinants.

Tests of significance of the regression itself will follow as well as of the estimates to provide validation for the regression results.

3.7.1.3 Regression of Total Factor Productivity against its Determinants

Once this is done, data on total factor productivity will have been arrived at and it thereafter becomes easy to regress it against its determinants.

4 Research findings

Before the Running of the Regression, it was important to test for stationarity to guard against generation of spurious results. Augmented Dickey Fuller Tests were done on all the Variables. The table below summarizes the results. The intention was to guarantee that all data used was stationary at a 99% confidence level. The data that was nonstationary was going to have to be differenced until it was stationary at the prescribed confidence level. The ADF test statistic was going to be compared to the 1% critical values.

Table 1: ADF Test Statistics Results

Variable	**Stationary at Level**	**Stationary at 1st Difference**	**Stationary at 2nd Difference**
LN(TFP)	×	×	√
POLIT	×	×	√
FEMLAB	×	√	×
GVT	×	×	√
AGRIC	×	×	√
EDUC	×	×	√
R&D	×	×	√
DENSITY	×	√	×
INFL	×	×	√
FDI	×	×	√

This table summarizes the results achieved after subjecting the regression variables to Augmented Dickey Fuller Tests. Ticks (√) imply that at a difference n, the time series variable is stationary. Crosses(×) imply that at the difference n, the time series variable is nonstationary.

4.1 Pre-Estimations Results

Alongside the Unit root test, the following tests were done:

Johansen test of cointegration: To establish Long run association between Total Factor Productivity and its Determinants, it was important for this test to be done. Data was evaluated after differencing. Considering the Trace Statistics, it was observed that the p values were less than 5% for null hypotheses that there existed up to 9 numbers of cointegrated equations. Effectively, such hypotheses were to be rejected. However, for the hypothesis that there exist at most nine cointegrated equations, p values as high as 41.09% were actualized hence the only possible option is to fail to reject the null hypothesis. This means that all that variables have an association

Breusch Pagan Godfrey Test: This test was done to test for Heteroskedasticity. This is done to gain some level of trust in the standard errors and t statistics; and that the OLS estimation be efficient. Having formulated the Null hypothesis that there is homoscedasticity, the Breusch-Pagan-Godfrey test was applied and the following results obtained:

As can be seen (table 2 in the appendix), both the Prob. Chi-square p values and the Prob (F-statistic) are greater than 5%. This means we can reject the null that there is homoscedasticity without incurring a type II error.

Residual Normality Test: To trust the regression results, we need the residuals to be normally distributed. To test this, a histogram was plotted of the residuals. This was to be able to gain insight as to whether there is normality of the residuals.With a p value of 55.5016% we have to fail to reject the null hypothesis that the residuals are normally distributed. Based even on the graph (graph 1 in the appendix), it can be effectively concluded that the residuals are normally distributed.

4.2 Estimation and analysis of the Regression Function Results

After all such preliminary tests had been done, the Regression line function was estimated and the following results arrived at

Table 2: OLS Estimation Results

Differenced Variable	Coefficient	t-statistic	P values
Agricultural share of GDP	-1.3032 (2.6191)	-0.4976	0.6221
Agglomeration of economies	30.5567 (4.2165)	7.2470	0.0000
Average education of workforce	-166.0590 (54.7847)	-3.0311	0.0047
Female Labor Participation	10.8474 (8.4122)	1.2895	0.2062
Foreign Direct	-4.3700 (3.8618)	-1.1316	0.2660
Government Size	1.5631 (4.2760)	0.3655	0.7170
Inflation	-4.3651 (0.6898)	-6.3284	0.0000
Political stability and the absence of Violence	-69.6809 (29.6183)	-2.3526	0.0248
Research and Development Expenditure	24.4012 (22.8987)	1.0656	0.2943
C	-1275.276	-2.0480	0.0486
	(622.6965)		
R-Squared	0.7774		
Adjusted R-Squared	0.7167		
F- Statistic	12.8054		0.0000

This table shows the OLS estimation results. In the parentheses is the standard deviation values of the variables regressed against the regressand. It summarizes the co-efficients, t-statistics and p-values as well as the R-Squared and F-Statistic values.

4.3 Discussion of Results

As is seen from the results:

There is a high R-squared: This is clear indication of how significant the regression is at explaining the relationship between the regressand and regressors. An R-Square value of 0.7774 is much closer to 1 than it is to zero. The Regression line has explained largely the variance of the actual line from the mean is explained by this regression.

The results are however quite revealing: Based on the p values where the focus is only on those variables with p values less than 5% (that is, only those co-efficient that are statistically significant are considered). In that regard, it is data on: agglomeration of economies, average number of years of education received by people ages 25 and older, Inflation and World Bank Governance Indicator on Political Stability and the absence of Violence that can be credibly analyzed. The rest that is, Female labor Participation, Expenditure Research and Development, share of agricultural value added to overall GDP, ratio of Government Spending relative to GDP, Foreign Direct Investment suggest a linear relationship with the natural Logarithm of Total Factor Productivity (TFP) but this relationship is statistically insignificant. This means we cannot credibly conclude that there is a relationship between the aforementioned variables and Total Factor Productivity as much as we cannot also credibly conclude that there is no relationship. Since it is more difficult to prove the negative connotation, we do not use such results.

The results show that a unit change in agglomeration of economies as measured by Density will increase natural Logarithm of Total Factor Productivity (TFP) by 30.56 all other factors held constant. This is a positive acclamation of Glaeser (2007) suggestion that Agglomeration economies contributes to growth in total factor productivity. It means that the more the population grows, the moe beneficial it is to total factor productivity and effectively national output.

The average number of years of education received by people ages 25 and older, is suggested to have an inverse relationship with total factor productivity; so much so that Ceteris Paribus, a unit increase in the average educational competence of the workforce would reduce total factor productivity by 166.05. This goes against all the findings metioned above in the Literature Review. However, these resuts ought be taken with a huge level of skepticism, especially because the access of such data was quite difficlt and that this data has just recently started being collected.

Inflation, predictably has a negative relationship with total factor productivity. As a proxy for Macroeconomic stability, it can be seen that Macroeconomic Instability hinders growth of total factor productivity. Inflation as a Macroconomic stability counter-proxy reduces total factor productivity by 4.365 times per unit increase in inflation levels.

Political stability and the absence of violence as well was in tandem with the findings of Jean-Claude Nachega and Thomson Fontaine (2006) who explain that political instability is counteractive to economic growth. From the Regression, a unit increase in the Indicator on Political instability reduces Total Factor Productivity by 69.68 per every unit increase.

5 Conclusion and recommendations

Bearing the findings in mind, the following are recommended way forwards:

Shift from the notion that growth in National Income has to be stimulated by expansionary monetary spending. It has been seen that when you invest in the determinants of total factor productivity such as agglomeration economies, macroeconomic stability and maintenance of political stability. This in itself can lead to economic growth.

The fact that agglomeration economies have a positive relationship with total factor productivity provides steady footing for policies that promote growth of population. This is because the greater the surface are of persons who are able and willing to transact with businesses, the cheaper it is to deliver products(distributional costs) and services and also the more efficient it becomes to produce the output due to economies of scale. This gives production agents better efficiency in converting its inputs into outputs. This is total factor productivity growth at its best.

Based on the discovery on how Macroeconomic stability as measured by inflation is a precondition for the growth of Total Factor Productivity, policy makers ought to focus on measures that would keep Macroeconomic variables Inflation included within stable ranges. This is because the results show that there is an inverse relationship between inflation and Total Factor Productivity. This implies that a steep movement upwards by inflation, a characteristic of instability in the Macroeconomy, is likely to inhibit economic growth through growth of Total Factor Productivity.

In order to nurture Total Factor Productivity growth, leader ought to do their best to foster a healthy socio-political climate. Political instability or any such unpredictability is an absolute turn off to potential capital spending persons. Political instability causes a diversion of Foreign Investment, flight of local capital held by both local and foreign holders due to lost confidence in the protection of their business interests and property rights. This was even evidenced in the Kenyan economy where slowed and diminished growth rates were witnessed in various sectors of the economy and the Macro-economy following the 2007-2008 post election violence.

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Appendices

Appendix 1: Johansen test of Cointegration

Date: 12/02/15 Time: 13:35
Sample (adjusted): 2003Q4 2013Q4
Included observations: 41 after adjustments
Trend assumption: Linear deterministic trend
Series: AGRICDIFF2 DENSITYDIFF1 EDUCDIFF2 FEMLABDIFF1 FDI2 GVTDIFF2 INFLDIFF2 LN_TFP_DIFF2 POLITDIF
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.792800	315.0901	239.2354	0.0000
At most 1 *	0.709126	250.5533	197.3709	0.0000
At most 2 *	0.685247	199.9238	159.5297	0.0000
At most 3 *	0.581611	152.5292	125.6154	0.0004
At most 4 *	0.533365	116.8041	95.75366	0.0008
At most 5 *	0.459500	85.55352	69.81889	0.0017
At most 6 *	0.444723	60.32781	47.85613	0.0022
At most 7 *	0.374325	36.20803	29.79707	0.0080
At most 8 *	0.328141	16.98212	15.49471	0.0297
At most 9	0.016356	0.676123	3.841466	0.4109

Trace test indicates 9 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Appendix 2: Breusch Godfrey Pagan Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.334585	Prob. F(9,33)	0.2574
Obs*R-squared	11.47456	Prob. Chi-Square(9)	0.2446
Scaled explained SS	7.492387	Prob. Chi-Square(9)	0.5860

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 12/02/15 Time: 11:58
Sample: 2003Q2 2013Q4
Included observations: 43

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2353.311	3652.812	0.644246	0.5239
AGRICDIFF2	13.19192	15.36399	0.858626	0.3967
DENSITYDIFF1	13.89989	24.73429	0.561969	0.5779
EDUCDIFF2	-397.6048	321.3734	-1.237205	0.2247
FDI2	5.483305	22.65380	0.242048	0.8102
FEMLABDIFF1	-38.43378	49.34712	-0.778845	0.4416
GVTDIFF2	-20.55667	25.08329	-0.819537	0.4184
INFLDIFF2	-1.357036	4.046269	-0.335379	0.7395
POLITDIFF2	-201.2247	173.7442	-1.158167	0.2551
R_DDIFF2	72.66194	134.3264	0.540935	0.5922

R-squared	0.266850	Mean dependent var	21.16830
Adjusted R-squared	0.066900	S.D. dependent var	31.89386
S.E. of regression	30.80854	Akaike info criterion	9.893885
Sum squared resid	31322.48	Schwarz criterion	10.30347
Log likelihood	-202.7185	Hannan-Quinn criter.	10.04493
F-statistic	1.334585	Durbin-Watson stat	2.046061
Prob(F-statistic)	0.257370		

Appendix 3: Residual Histogram Plot