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Abstract

The study investigates the determinants of total factor productivity in selected sectors of the Angolan economy for the period of 1995 and 2017. The empirical results indicate that foreign direct investment is positively and significantly associated with an increase in total factor productivity in all sectors. Moreover, openness of the economy and the exchange rate have a positive impact on total factor productivity in the manufacturing sector. However, the impact of these two variables is negative on total factor productivity in the primary and service sectors. Furthermore, the study results reveals that an increase in inflation causes a decrease in total factor productivity in the manufacturing and service sectors, whilst positively associated with an increase in total factor productivity in the primary sector. Finally, official development assistance has a negative effect on total factor productivity in the primary and service sectors, whilst having a positive effect on total factor productivity in the manufacturing sector. The results imply that to ensure sustainable total factor productivity growth, Angola should pursue policies that attract foreign direct investment. The effect of other variables such as openness of the economy, inflation, official development assistance and exchange rate depends on sectors. This suggest that it is important to come up with policies, which are sector-specific in order to improve total factor productivity growth.

Keywords: Angola; total factor productivity; ARDL

1. Introduction

Economic growth is a primary objective of policy makers and their governments. Hence, many studies that total factor productivity is a key determinant of economic growth in the long run (Ahmed, 2015). Moreover, the superiority of economic growth has led to an excess of economic models to explain the drivers of economic growth. Solow (1956) explains that the growth model is one of the models that explains the drivers of growth. The model focuses on diminishing marginal return on capital, exogenous population growth and savings rate. However, the model does not put emphasis on the depreciation and changes in the technology.

The endogenous growth theory is another important growth theory. However, it differs from the exogenous growth theories since it identify technological changes as the most important factor that influences economic growth. Lucas (1990) emphasize that economic growth is a function of human capital. However, physical capital accumulation and human capital accumulation are the main factors that influence economic growth.

Moreover, several studies have identified theoretically and empirically, factors that determine the total factor productivity in both developed and developing countries. Theoretically, some studies have further acknowledged that the degree of openness, investment in knowledge and education are the key determinants of total factor productivity in both developed and developing countries (Nelson and Phelps, 1996). Other studies concluded that research and development, infrastructure affect positively total factor productivity in all the sectors of an economy (Romer, 1990). Khalid (2012) found that macroeconomic fundamentals, such as exchange rate, inflation, fiscal deficits and government size could increase total factor productivity. Aghion (1998) suggests that human capital affects total factor productivity growth by facilitating the adoption and implementation of new technology exogenously or by facilitating the domestic production of technological innovations.

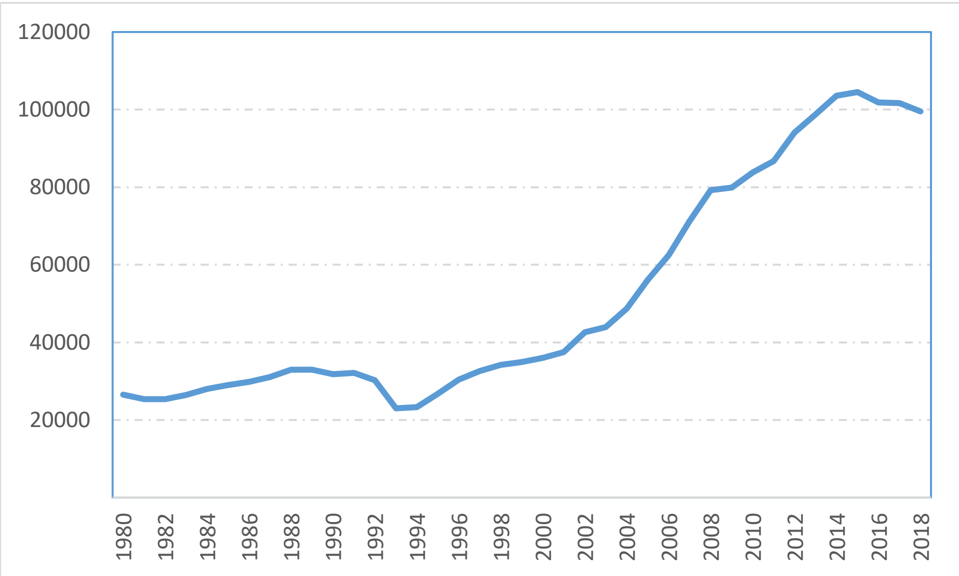
Several mechanisms or channels through which trade openness affects TFP growth have been provided. These include exploitation of comparative advantage, knowledge and technological transfer, exposure to competition and economics of scale. In the context of developing countries, Danquah (2006) focuses on the determinants of total factor productivity in Ghana. The results show that there is a negative relationship between inflation and total factor productivity due to its adverse effect on capital accumulation, demand for real money balances, labor supply and inefficiency in resource allocation. Akanbi et al., (2017) conducted a study on the relationship between institutions and total factor productivity in South Africa. This study concluded that, there is a positive relationship between institutions and total factor productivity. That is because this relationship is viewed as an expansion of investment, technological innovation progress and economic performance.

Most empirical studies investigated the determinants of total factor productivity at an aggregate level (for the entire economy). They did not investigate the determinants of total factor productivity and for different sectors of the economy. Investigation of total factor productivity at an aggregate level may not be appropriate. That implies one blanket policy to improve productivity for the sectors. It is important to note that because sectors of the economy are different and require dissimilar policy response to deal with total factor productivity. In addition, there are many empirical studies conducted in African countries on the determinants of total factor productivity, but did not include Angola. Studies on drivers of productivity in Angola are scanty or non-existent. This is despite the fact that total factor productivity is considered one of key drivers of economic growth. Hence, it is important to estimate total factor productivity in different sectors of the Angolan economy. Contrary to previous studies, this study will estimate the determinants of total factor productivity in different sectors of the Angolan economy. It employs the autoregressive distributed lag (ARDL) estimation technique for this purpose. To our best knowledge, this is the first study that investigates the determinants of total factor productivity in different sectors of the Angolan economy. The objective of this study is therefore to investigate the determinants of total factor productivity in different sectors of the Angolan economy. The remainder of the study is organized as follows. Section 2 provides economic overview and the sources of growth in Angola. Section 3 discusses the literature on the determinants of total factor productivity. Section 4 presents the methodology. Section 5 presents empirical results. Finally, section 6 conclude the study.

2. Brief economic overview and sources growth in Angola

Angola has historically faced a great deal of challenges in increasing its level of Gross Domestic Product (GDP). Although the country has been exporting massive amounts of crude oil since it is independence from Portugal in 1975, its GDP remained very low for many years. This attributed to the civil war that lasted for decades (1975 – 2002). It is not surprising to note that for almost 30 years, Angola did not significantly increase its GDP. Figure 1 presents the trend in Angola's GDP for the period 1980 to 2018. Figure shows that Angola's GDP fluctuated between US$20 and US$ 40 billion. This is mainly attributed to the civil war that affected the country. However, after the end of the civil war in 2002, Angola increased its GDP from US$ 42.3 billion in 2002 to US$ 101 billion in 2015. This implies that the GDP increased by almost three times as much during the period 2002 to 2015 (Angola National Bank, 2015). According to Angola National Bank (2015), this was also an increase of more than 30 times since the country's independence in 1975.

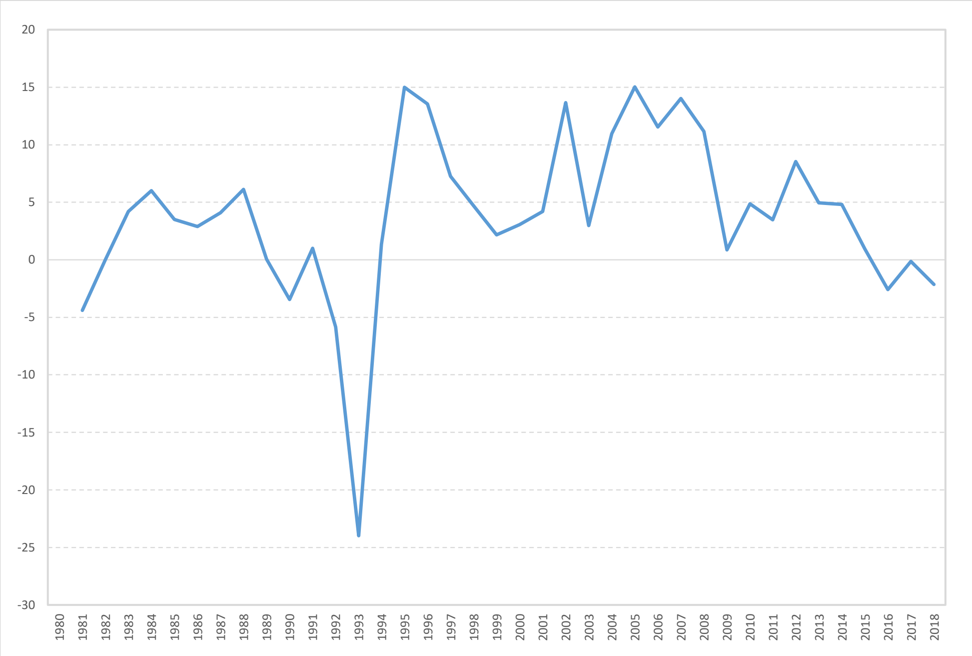
Figure 1. Angola's gross domestic product, 1983-2018



Source: Data for the figure are obtained from the World Bank (2018)

Figure 2 shows Angola's economic growth for the period 1983 - 2018. Moreover, Angola's economic growth rate has experienced many periodic negative spirals. The country has seen it all when it comes to economic growth rates. It achieved an outstanding growth rate of 15.0 percent in 1995, a devastating negative growth rate of -24 in 1993 and a remarkable growth rate of 14 percent in 2010. Over the past 54 years, Angola has had an average growth rate of 3.4 percent- a situation attributed to too many negative spirals of growth. However, the average growth rate from 2002 to 2015 increased to over 8.68 percent. This period can rightly be termed as the post-civil war period.

Figure 2. Angola's economic growth, 1983 to 2018



Source: Data for the figure are obtained from the World Bank (2018)

The growth rate of the Angolan economy for the period 1980 to 2018 is presented in Figure 2. Figure 2 indicates that Angola's real GDP growth was on a downward trend for the period 1980 to 1993. The economy declined by 23 percent in 1993. This is attributed to political uncertainly and civil war during that period. The country achieved high growth rate after the end of the civil war in 2002. Angola achieved a high growth rate of 11.2 percent in 2008, but the economy declined in 2016 and 2018as a result of a fall in prices of international crude oil. Despite this external shock, Angola's economy remains strong with growth expected to increase above 3.2% in 2020 predicted by international Monetary Fund.

Table 1 presents the sources of economic growth in Angola for two periods. These periods are 1995 – 2001 (civil war period) and 2002 – 2017 (post-civil war period). Table 1 shows that during the period 1995 to 2001, the economic growth in the primary sector in Angola was led by labor and productivity whilst the contribution of capital was low. During the period 2002 -2017, economic growth in the primary sector was driven by labor and capital. The contribution of productivity was very low. The higher contribution to growth by labor and productivity in the primary sector during periods 1995 to 2001 may partly be due to political uncertainties and the civil war that the country experienced during that time. In addition, during the civil war, farmers in Angola were receiving draft deferments as well as loans for increasing production through mechanization, land acquisition, and increased use of fertilizers. This could explain the higher contribution of productivity to growth.

During the period 1995 and 2001, economic growth in the manufacturing sector was led by growth capital. Labor and productivity contributed very low to economic growth. The possible reason for the low contribution to growth by labor and productivity is the fact that in Angola during the civil war, the agricultural sector was the principal source of employment for the population. That means most people we employed in the agricultural sector. There were also many people that were employed in the military. Furthermore, the civil war and marginal investment in the manufacturing sector attributed to low productivity during the 1995 to 2001 period. The period 2002 and 2017, was a transitional period for Angola, as this signified the end of the civil war and led to an increase in investment in the manufacturing sector. Hence, biggest contributors to growth in the manufacturing sector during that period were capital and productivity. When the civil war ended in Angola in 2002, prospecting for new minerals and oil crude exploration resumed. The long-term growth prospects of the manufacturing sector looked brighter due to increased investment in new technologies and exploration (Angola Reserve Bank, 2017). Therefore, the contribution to growth by productivity increased from 0.05% in the period 1995 - 2001 to 2.06% during the period between 2002 and 2017.

Table 1 shows that during periods of civil war (1995 – 2001) growth in the services sectors was driven three factors. The three factors (labor, capital and productivity) contributed almost equally to growth in the service sector (although productivity's was higher than that of capital and labor). The post-civil war period (2002 – 2017) economic growth in the service sector was driven by productivity and capital. The post-civil war period (2002-2017) is associated with the prospecting for new investments in the financial sector, tourism and telecommunication resumed. Therefore, the contribution to growth by productivity increased from 0.71 % during the period 1995 to 2001 to 2.04 % for the period between 2002 and 2017.

Table 1. Source of economic growth

	1995-2001	**2002-2017**
Source of growth in the Primary Sector		
Capital growth Primary sector	0.15%	0.62%
Labor growth Primary sector	0.39%	0.45%
Total input growth Primary sector	*0.54%*	*1.07%*
Total factor productivity Primary sector	0.46%	0.37%
Total output growth in the primary sector	**1%**	**1.44%**
Source of growth in the manufacturing sector		
Capital growth manufacturing sector	0.59%	2.5%

Labor growth manufacturing sector	0.10%	0.08%
Total input growth manufacturing sector	*0.69%*	*2.58%*
Total factor productivity manufacturing sector	0.05%	2.06%
Total output growth manufacturing sector	**0.74%**	**4.64%**
Source of growth service sector		
Capital growth in service sector	0.47%	1.98%
Labor growth service sector	0.51%	0.46%
Total input growth in service sector	*0.98%*	*2.44%*
Total Factor productivity in service sector	0.71 %	2.04%
Total output growth in the service Sector	**1.69%**	**4.48%**

Source: Authors' own computation

3. Literature review

There is an extensive literature on the determinants of total factor productivity. There are two strands of literature. The first strand of literature looks at cross country or panel data studies. The second strand of the literature deals with single country studies. Phillip (2012) conducts a cross-country empirical study on macroeconomic and institutional determinants of total factor productivity (TFP) in four economies for the period of 1980 -2014. The panel autoregressive distributed lag (PARDL) regression technique was used to estimate the model. The results showed that the total factor productivity growth rate declined on average by 1.4% and 1.8% in Mexico and Turkey, respectively, while Indonesia and Nigeria did not experience productivity growth on average. The results also showed that in the long run, human capital and government stability have positive and significant effects on TFP, while FDI and corruption had negative but significant effects on TFP. In the short run, there existed a significant negative relationship between TFP and inflation. However, the effects of human capital and corruption on TFP were positive and significant. The study concluded that human capital and corruption were key drivers of total factor productivity in Mexico, Indonesia, Nigeria and Turkey in both the long run and short run.

Liao and Liu (2007) conducted a cross-country empirically research on the determinants of total factor productivity growth for eight East Asian economies. The study reveals that very limited studies have been conducted on the causal links between exports and productivity growth in Asian economies. The results show that export-led growth Korean and Singapore economies. The results also found that productivity –led export growth in the economies of China, Hong Kong, Indonesia, Philippines and Malaysia. There is a bi-directional causality between export and productivity in Korea, Singapore and Taiwan. This implies that exports and productivity growth are causing each other. However, causality is unidirectional, running from productivity of exports for China, Hong Kong, Indonesia, Malaysia and Philippines.

Akinlo (2006) examined the effects of macroeconomic factors on total factor productivity in 34 Sub-Sahara African countries for the period between 1980 and 2002. The study used of pooled time series and a cross sectional data in its analysis. The study revealed that external debt, inflation rate, agriculture value-added as percentage of GDP, the lending rate and local price deviation from purchasing power parity are significantly and negatively related to total factor productivity. However, human capital, export-GDP ratio, credit to private sector as percentage of GDP, foreign direct investment as a percentage of the GDP and manufacturing value-added have a significant positive effect on total factor productivity. The study concluded that policies that reduce population growth rate and debt, facilitate greater openness, sound macroeconomic fundamentals, price stability, financial deepening and greater private participation would lead to higher total factor productivity in Sub-Saharan African region.

Giampaolo (2019) investigated the relative importance of physical capital accumulation and TFP in explaining output growth in 36 sub-Saharan African (SSA) countries over 1996-2014. The study used the stochastic frontier analysis, an empirical methodology that decomposes total output growth into input growth, technological change and technical efficiency change. The results shows that the contribution of physical capital to total growth exceeds that of TFP in 22 out of the 36 countries. The result withstands issues of TFP-induced effects on inputs.

As mentioned earlier there are also single country studies on the determinants of total factor productivity. Myasnikow (2018) investigated the determinants of total factor productivity growth in Russian regions, in particular, the role of spillovers and agglomeration effects. The study concluded that firms from regions with large capitals and high shares of credit in gross regional product (GRP) are more actively expanding into neighboring regions. Moreover, the linkages with local firms in host regions create positive correlations between total factor productivities in such host regions and their home regions. In the same line, Ludmila (2016) examined the impact of the productivity sector in Latvian on the total factor productivity growth. The study use the Cobb-Douglass and trans log production functions to control the changes in the sources of total factor productivity. The results are clear that an increase in productivity sector in Latvian adds value to total output growth, which has a positive impact on total factor productivity.

Nunung (2016) investigates the determinants of total factor productivity in oil palm production sector in Indonesia. The results show that land, pesticide, fertilizer and labor have significant impact on total production of oil palm production. Wadad (2016) conducted a study on determinants of total factor productivity growth in Lebanon. The autoregressive distributed lag (ARDL) modelling approach was employed. The results demonstrated that trade openness and credit extended to the private sector have positive impact on total factor productivity in Lebanon.

Idris (2007) undertook an empirical investigation on determinants of total factor productivity growth in Malaysia for the period 1971 – 2004. The data envelopment analysis (DEA) approach was used to estimate the changes in the production frontier. The Malinquist Production Index was used to decompose total productivity into technical change and technical efficiency change. The results of study indicate that the TFP growth of the Malaysian economy for the entire test period had not been satisfactory due to negative contribution from technical efficiency. Furthermore, the results show that the Malaysian economy was able to cause shifts in its own frontier due to innovation. The study also concluded that the economy needs an enhancement of its productivity-based catching-up capability.

Shao et al (2016) used a panel data regression fixed effect regression to investigate the determinants of total factor productivity in China in different sectors. The use of a panel data regression fixed effect regression was due to the fact that it is able to control the individual effects of the sectors. The result discloses that one of the key determinants of total factor productivity in China is the nonferrous metal sector. Hence, increase in production of nonferrous metal sector leads to increase in total factor productivity in China. Biatour and Dumont (2011) analyze the standard determinants of industry-level TFP in Belgium for the period 1988-2007 and find that research and development (R&D) significantly influences TFP dynamics. Bengoa and Perez (2011) focus on the Spanish regions and find a positive impact of R&D on total factor productivity. Harrison (1999) study revealed that there is a negative effect from FDI on total factor productivity among Venezuelan plants. They attribute this to the fact that foreign-owned firms recruit most of the workers (from outside Venezuela) and hence deprive domestic plants of their services.

Chaudhry (2015) employed Cobb-Douglass and trans log production functions to investigate the determinant of total factor productivity in agriculture and manufacture sectors of Pakistan. The study reveals that research, development, and trade openness have a positive impact on total factor productivity growth in the primary and secondary sectors.

Suphannachart (2010) estimated the determinants of total factor productivity in the rice sector of four regions (North, Northeast, Central and South) in Thailand for the period 1995-2011. The results show that an increase on the productivity in the rice sector in Thailand is associated with an increase in total factor productivity. The empirical part of the study demonstrate that the rice sector added a greater value on output growth in Thailand and the decline in total factor productivity in recent years is due to decline in the production of main crops. Panel data regression was used to estimate the model due to the fact it is helps to distinguish between fixed and random effects in the regression.

Melaku and Abegaz (2017) investigate the impact of technical efficiency on total factor productivity on the manufacturing sector in Ethiopia for the period between 1996 and 2009. The results show that due to large technical inefficiencies in the manufacturing sector in Ethiopia, the variation in output growth had a negative impact on total factor productivity growth. Moreover, the study also concluded that in the past years the growth in total factor productivity was related to the improvement in technical efficiency in the manufacturing sector of Ethiopia.

Alexander (2016) investigated total factor productivity growth of the Tunisian agricultural sector for the period 1961 - 2012 across different provinces. The results revealed that the instability in total factor productivity in Tunisia in the past decade was related to the changes in the agricultural output index, and these changes in the agricultural output index was related to climatic conditions. The results also show that some structural characteristics of the agricultural sector, such as the share of the cereal (main crop) areas in the total cropped areas, and the rural GDP growth, are significantly and negatively slowing down productivity gains of this sector. To identify the determinants of total factor productivity growth in the agricultural sector in Tunisia, panel data regression procedures were used because it is easy to control factors that vary across entities but do not vary overtime.

Ogunleye and Ayeni (2008) investigated the link between trade and productivity growth for the Nigerian economy with special focus on the export-productivity nexus in the manufacturing sector. The study used the Engle-Granger co-integration technique and the error correction model for the period 1970 - 2003. The study employed a multivariate framework by adding a set of control variables, which include import growth, rate of foreign income, relative income and capacity utilization. The study revealed that there is bi-directional causality between export and total factor productivity and this provides support for a link between export growth and productivity growth. They concluded that Nigeria should look outward in order to promote and develop the manufacturing sector towards increasing production, not only for domestic consumption but also for export since it is clear that increased productivity can increase export growth.

A review of all the strands of the empirical literature shows that most studies investigated determinants of total factor productivity at an aggregate level. They did not investigate determinants of total factor productivity at sectoral level. The sectors are different and policies based on aggregate results will only benefits some sectors. Other sectors may not benefit from policies based on the results of total factor productivity determinants at an aggregate level. Hence, it is important to investigate determinants of total factor productivity per sector. This will ensure that policies are sector specific. Previous studies did not investigate the determinants of total factor productivity in Angola. Contrary to previous studies, this study will compute total factor productivity in different sectors of the Angolan economy. The motivation behind this study is that there are large numbers of studies in Africa on determinants of total factor productivity but these studies do not focus on Angola. Therefore, Angola is the focus of this study.

4. Methodology

4. 1 Empirical model

Following the theoretical arguments brought by the neoclassical (Jorgensen, 1967), exogenous (Solow, 1956; Swan, 1956) and endogenous (Romer, 1986; Lucas, 1988) and the earlier empirical studies (Spilioti and Vamvoukas, 2015) the total factor productivity growth dynamics equation in this study can be expressed as follows:

$$\boldsymbol{TFP_{pt}}=\alpha_0+\alpha_{1pt}INF+\alpha_{2pt}\,OPEN+\alpha_{3pt}\,ER+\alpha_{4pt}\,FDI+\alpha_{5pt}\,ODA+u_{pt} \quad (1)$$

$$\boldsymbol{TFP_{mt}}=\alpha_0+\alpha_{1mt}INF+\alpha_{2mt}\,OPEN+\alpha_{3mt}\,ER+\alpha_{4mt}\,FDI+\alpha_{5mt}\,ODA+u_{mt} \quad (2)$$

$$\boldsymbol{TFP_{st}}=\alpha_0+\alpha_{1st}INF+\alpha_{2st}\,OPEN+\alpha_{3st}\,ER+\alpha_{4st}\,FDI+\alpha_{5st}\,ODA+u_{st} \quad (3)$$

Where:

The subscripts p, m and s stands for primary, manufacturing and service sectors. TFP is total factor productivity in different sectors; INF represents inflation rate; OPEN represents openness of the economy (to international trade); ER represents the exchange rate; FDI represents the net inflows of foreign direct investment; ODA represents the official development assistance received per capita. The variables are measure is US dollars.

Inflation is an indicator of macroeconomic stability. Macroeconomic stability tends to stimulate long-term productivity growth, reduce interest rates and encourage entrepreneurs to spread their projects over a longer horizon. Hence, a negative effect of inflation on total factor productivity growth is naturally expected (Espinoza, 2012).

Openness of the economy also plays an important role in the determination of total factor productivity in sectors of economies around the world. Moreover, openness of the economy can contribute to accelerating total factor productivity by promoting the competitiveness of domestic producers and accelerating the integration of countries into the global economy. Increased competition between firms encourages innovation and increases the probability of openness of the economy and overall factor productivity growth becomes positive (Espinoza, 2012).

The exchange rate is another important macroeconomic driver of growth and a measure of competitiveness (Rodrik, 2008). Depending on the level of exchange rate, an appreciation of exchange rate has been found to be negatively associated with decrease in total factor productivity growth, while a devaluation of the exchange rate regime is positively associated with an increase in total factor productivity.

Foreign direct investment is another variable included in this study that can positively influence total factor productivity due to the fact foreign direct investment promotes investment in necessary infrastructure, education of population, liberalized markets, and social stability that is needed for innovation to promote economic growth (Ahmed, 2008). Thus, the impact of foreign direct investment on total factor productivity is expected to be positive.

Official development assistance is another key variable included in this study that has a positive impact on total factor productivity. Moreover, this is because official development assistance promotes investment human capital and increases financial resources in the country. A prior expectation is that official development assistance positively impact total factor productivity.

4.2 Data

The study uses annual data and covers the period 1995 – 2017. The data for variables used in the estimation are as follows. Inflation (INF) is measured by GDP deflator. The data for this variable is a sourced from World Bank Development Indicators (WDI). Openness of the economy (OPEN) is the sum of exports and imports to GDP. The data for computation of this variable was obtained from World Bank Development Indicators (WDI). Exchange rate (ER) is Kwanza per US dollar. The data of this variable is source of World Bank Development Indicators (WDI). Foreign direct investment (FDI) is the net inflows. The data of this variable is from the World Bank Development

Indicators (WDI). Official development assistance (ODA) is the net official development assistance received per capita in US dollar currency. The data of this variable is sourced from the World Bank Development Indicators (WDI).

The data for total factor productivity in different sectors in Angola were computed using the Cobb-Douglas production function that is linking output to factor inputs (capital and labor) and productivity (along the lines of the neoclassical Solow-Swan model). Hence, the Cobb-Doulas production that was used to derive total factor productivity in the three sectors is specified as follows:

Primary sector

$$Y_{pt=}A_{pt}\ K_{pt}^{\alpha}\ \ L_{pt}^{1-\alpha} \tag{4}$$

$$A_{pt=}\ TFP = Y_{pt}\ /(K_{pt}^{\alpha}\ L_{pt}^{1-\alpha}) \tag{5}$$

Manufacturing sector

$$Y_{mt=}A_{mt}\ K_{mt}^{\alpha}\ \ L_{mt}^{1-\alpha} \tag{6}$$

$$A_{mt=}\ TFP = Y_{mt}\ /(K_{mt}^{\alpha}\ L_{mt}^{1-\alpha}) \tag{7}$$

Tertiary sector

$$Y_{st=}A_{st}\ K_{st}^{\alpha}\ \ L_{st}^{1-\alpha} \tag{8}$$

$$A_{st=}\ TFP = Y_{st}\ /(K_{st}^{\alpha}\ L_{st}^{1-\alpha}) \tag{9}$$

Where *Y* is the output in different sectors, *K* is the real capital stock and *L* is the total employment in different sectors, α is the elasticity of output with respect to capital stock and 1-α is the elasticity of output with respect to labor. The subscripts *pt, mt, st* represent primary, secondary and tertiary sectors. We enforce constant return to scale, in such a way that the sum of α and 1-α must be equal to 1.

4.3 Estimation technique

This study uses autoregressive distributive lag (ARDL) estimation technique in order to estimate the empirical models specified in equation (1) to (3). Firstly, unlike other estimation techniques such as the Engle and Granger (1978) two-two step and the Johansen and Juselius (1990), it does not require that all the series be integrated of the same order. Secondly, it can be applied regardless of whether the repressors are integration of I (0), I (1) or equally integrated, as long as they are not integrated of I(2) or more (Pesaran et al., 2001). Thirdly, it is valid even for small sample data sets and on variables with different optimal lags. Lastly, with ARDL, the Error Correction Model (ECM) can be derived from the ARDL model through a simple linear transformation, which integrates short-run adjustments with long-run equilibrium without losing long-run information (Pesaran et al., 2001). Therefore, the ARDL estimation technique for equations 10, 11 and 12 is specified as follows:

$$\Delta \boldsymbol{TFP_{pt}} = \beta_0 + \sum_i^n \beta\ 1_i \Delta lnTFP_{t-1} + \sum_i^n \beta\ 2_i \Delta lnINF_{t-1} + \sum_i^n \beta\ 3_i \Delta lnOPEN_{t-1}$$

$$+\sum_i^n \beta\ 4_i \Delta lnER_{t-1} + \sum_i^n \beta\ 5_i \Delta lnFDI_{t-1} + \sum_i^n \beta\ 6_i \Delta lnODA_{t-1}\ + \alpha_1 TFP_{t-1} + \alpha_2 lnINF_{t-1}$$

$$+\alpha_3 lnOPEN_{t-1} + \alpha_4 lnER_{t-1} + \alpha_5 lnFDI_{t-1} + \alpha_6 lnODA_{t-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \epsilon_T \quad (10)$$

$$\Delta \boldsymbol{TFP_{mt}} = \beta_0 + \sum_i^n \beta\, 1_i \Delta lnTFP_{t-1} + \sum_i^n \beta\, 2_i \Delta lnINF_{t-1} + \sum_i^n \beta\, 3_i \Delta lnOPEN_{t-1}$$
$$+ \sum_i^n \beta\, 4_i \Delta lnER_{t-1} + \sum_i^n \beta\, 5_i \Delta lnFDI_{t-1} + \sum_i^n \beta\, 6_i \Delta lnODA_{t-1} + \alpha_1 TFP_{t-1} + \alpha_2 lnINF_{t-1}$$
$$+\alpha_3 lnOPEN_{t-1} + \alpha_4 lnER_{t-1} + \alpha_5 lnFDI_{t-1} + \ldots + \alpha_6 lnODA_{t-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \epsilon_T \quad (11)$$

$$\Delta \boldsymbol{TFP_{st}} = \beta_0 + \sum_i^n \beta\, 1_i \Delta lnTFP_{t-1} + \sum_i^n \beta\, 2_i \Delta lnINF_{t-1} + \sum_i^n \beta\, 3_i \Delta lnOPEN_{t-1}$$
$$+ \sum_i^n \beta\, 4_i \Delta lnER_{t-1} + \sum_i^n \beta\, 5_i \Delta lnFDI_{t-1} + \sum_i^n \beta\, 6_i \Delta lnODA_{t} + \alpha_1 TFP_{t-1} + \alpha_2 lnINF_{t-1}$$
$$+\alpha_3 lnOPEN_{t-1} + \alpha_4 lnER_{t-1} + \alpha_5 lnFDI_{t-1} + \alpha_6 lnODA_{t-1} + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \epsilon_T \quad (12)$$

The ARDL procedure is performed in two steps. The first step is the determination of the existence of a long run relationship among variables. This is a test for cointegration and uses bound test of Pesaran and Shin (1999) and Pesaran et al. (2001) for large samples and Narayan et al. (2005) for small samples. These tests contain two types of critical values. These are lower or I(0) and upper or I(1) limits. The computed F-test is used to test for cointegration. If the computed F-test statistic is below the lower limit, I(0), the null hypothesis of no cointegration cannot be rejected. This means that there is no cointegration. If the computed F-test statistic is between the upper and lower limit, it cannot be determined whether there is cointegration. If the computed F-test statistic is above the upper limit, then the null hypothesis of no cointegration is rejected. Rejection of the null hypothesis of no cointegration implies that there is cointegration. If there is cointegration, it is appropriate to proceed to the error correction model (ECM). The ECM is written as follows:

$$\Delta \boldsymbol{TFP_{pt}} = \beta_0 + \sum_i^n \beta\, 1_i \Delta lnTFP_{t-i} + \sum_i^n \beta\, 2_i \Delta lnINF_{t-i} + \sum_i^n \beta\, 3_i \Delta lnOPEN_{t-i}$$
$$+ \sum_i^n \beta\, 4_i \Delta lnER_{t-i} + \sum_i^n \beta\, 5_i \Delta lnFDI_{t-i} + \sum_i^n \beta\, 6_i \Delta lnODA_{t-i} + \alpha_1 TFP_{t-i} + \alpha_2 lnINF_{t-i} + \alpha_3 lnOPEN_{t-i}$$
$$+\alpha_4 lnER_{t-i} + \alpha_5 lnFDI_{t-i} + \alpha_6 lnODA_{t-i+} \omega_1 EMC_{t-1} + u_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

$$\Delta \boldsymbol{TFP_{mt}} = \beta_0 + \sum_i^n \beta\, 1_i \Delta lnTFP_{t-i} + \sum_i^n \beta\, 2 \quad {}_i \Delta lnINF_{t-i} + \sum_i^n \beta\, 3_i \Delta lnOPEN_{t-i}$$
$$+ \sum_i^n \beta\, 4_i \Delta lnER_{t-i} + \sum_i^n \beta\, 5_i \Delta lnFDI_{t-i} + \sum_i^n \beta\, 6_i \Delta lnODA_{t-i} + \alpha_1 TFP_{t-i} + \alpha_2 lnINF_{t-i} \;\; \alpha_3 lnOPEN_{t-i}$$
$$+\alpha_4 lnER_{t-i} + \alpha_5 lnFDI_{t-i} + \alpha_6 lnODA_{t-i+} \omega_1 EMC_{t-1} + u_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (14)$$

$$\Delta \boldsymbol{TFP_{st}} = \beta_0 + \sum_i^n \beta\, 1_i \Delta lnTFP_{t-i} + \sum_i^n \beta\, 2_i \Delta lnINF_{t-i} + \sum_i^n \beta\, 3_i \Delta lnOPEN_{t-i}$$
$$+ \sum_i^n \beta\, 4_i \Delta lnER_{t-i} + \sum_i^n \beta\, 5_i \Delta lnFDI_{t-i} + \sum_i^n \beta\, 6_i \Delta lnODA_{t-i} + \alpha_1 TFP_{t-i} + \alpha_2 lnINF_{t-i}$$
$$+\alpha_3 lnOPEN_{t-i} + \alpha_4 lnER_{t-i} + \alpha_5 lnFDI_{t-i} + \alpha_6 lnODA_{t-i+} + \omega_1 EMC_{t-1} + u_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (15)$$

The coefficients of the lagged ECM is expected to be negative and statistically significant, indicating the existence of a long-run relationship between the variables. It also indicates that there is adjustment to equilibrium.

5. Empirical results

5.1 Unit root test

Before estimating the empirical models, it is important to test for the stationarity of the variables. The unit root test is done in order to establish the order of integration of the variables. It is important to do a unit root test in order to ensure that there is no I (2) variable. The presence of I(2) will make the ARDL estimation technique to crash. . Henceforward, in this study, unit root tests were conducted using the Augmented Dickey-Fuller (ADF) test. The results for unit root tests are presented in Table 2. The results of Table 2 shows that INF, ER, TFP_{pt} and TFP_{st} are I(0). The variables OPEN, FDI, ODA, and TFP_{mt} are I(1). Table 2 shows that there are no I(2) variables. That means it is appropriate to use ARDL estimation technique.

Table 2. Unit root test results

Variables	**Level**		**First difference**	
	No trend	With trend	No trend	With trend
INF	-12.210***	-7.489***		
OPEN	-1.538	-1.502	-2.498**	-4.380***
ER	4.717**	-7.667***		
FDI	-1.054	-2.629	-4.590***	-4.370***
ODA	-1.708	-2.195	-3.026**	-2.923*
TFP_{pt}	-3.040**	-0.656		-3.519*
TFP_{mt}	-0.518	-2.268	-4.098***	-4.167***
TFP_{st}	-3.527**	-3.22		-4.097**

Note: *, ** and *** imply stationarity at 10%, 5% and 1% significance levels, respectively

TFP_{pt} is total factor productivity in primary sector; TFP_{mt} is total factor productivity in manufacturing sector and TFP_{st} is total factor productivity in service sector.

Sources: Computed by the authors

5.2Cointegration – ARDL bounds test results

The results of the cointegration or bound test are presented in Table 3. The results in Table 3 shows that the F-test statistics is greater than the upper bound critical values for all sector. It is statistically significant at 1 percent significant level. That means the null hypothesis of no cointegration is rejected for all the models (for the sectors).

Rejection of the null hypothesis of no cointegration indicates that there is cointegration. There is a long run relationship between total factor productivity in its independent or explanatory variables.

Table 3. Cointegration or bounds test results

Model	F- statistic	lag	I(0)	I(1)	Significance level
TFP_{pt}	8.234	1	2.75	4.43	1%
TFP_{mt}	5.169	1	3.41	4.68	1%
TFP_{st}	11.380	1	3.41	4.18	1%

Where: TFP_{pt} is total factor productivity in primary sector; TFP_{mt} is total factor productivity in the manufacturing sector and TFP_{st} is total factor productivity in service sector.

Source: computed by the authors

5.3 Estimation results

The estimation results are presented in Table 4, 5 and 6**.** Table 4 shows that inflation has a positive effect on total factor productivity in the primary sector in the primary sector. The coefficient is positive and statistically significant at 5 percent, which means that a 1 percent increase in the inflation rate increases total factor productivity by 0.01 percent in the primary. The positive coefficient may not be in line with theoretical expectation. It could be attributed to the structural inflation, and underdevelopment of the primary sector, which comprises of mainly fishing and agriculture. Openness of the economy, official development assistance and an increase in exchange rate are associated with a decrease in primary sector's total factor productivity. The negative coefficients of these three variables is inconsistent with theoretical expectations. Foreign direct investment is associated with an increase in total factor productivity. A one percent increase in foreign direct investment causes total factor productivity to increase by 2.27 percent. This is in line with the theoretical expectation. The coefficient of the error tem is negative and statistically significant which indicate that there is adjustment to equilibrium.

The results of the manufacturing sector are presented in Table 5. The results in Table 5 shows that inflation is associated with a decrease in total factor productivity. A one percent increase in inflation rate causes total factor productivity to decrease by 0.02 percent. Openness, exchange rate, foreign direct investment, official development assistance are all associated with an increase in total factor productivity. An increase in openness, exchange rate, foreign direct investment and official development assistance by one percent causes total factor productivity to increase by 0.4, 0.35, 0.01 and 1.96 percent. These results of the manufacturing sectors are consistent with theoretical expectation. The coefficient of the error term is negative statistically significant. This suggest that there is adjustment to equilibrium.

Table 6 presents the results of the service sector. Inflation, openness, exchange rate and official development assistance causes total factor productivity in the service sector to decrease. An increase in inflation rate, openness, exchange rate and official development assistance by one percent will cause total factor productivity to decrease by 0.001, 1.23, 3.12 and 1.89 percent respectively. While a negative impact of inflation is expected, the inverse relationship between openness, exchange rate, and official development on one hand and total factor productivity on the other hand is not consistent with theoretical expectations. Increase in foreign direct investment causes total factor productivity to decrease. If foreign direct investment increase by one percent, total factor productivity will increase by 0.03 percent. This in line with theoretical expectation. The coefficient of the lagged error term in the short run is negative and statistically significant, suggesting that there is adjustment to equilibrium.

Table 4. Long run and short run results of the primary sector

(a) Long run results

Dependent variable: TFP_{pt}

Variables	Coefficients	T-test	Probability
INF	0.01	3.44	0.009**
OPEN	-1.39	-2.83	0.022**
ER	-1.73	-3.95	0.004**
FDI	0.02	2.27	0.053**
ODA	-0.07	-1.90	0.094*
R-squared	0.9611		
Adjusted R- Squared	0.8978		

(b)*Short run results*

Dependent variable: $\Delta\, TFP_{pt}$

Variables	Coefficients	T-test	Probability
Δ INF	-0.01	3.44	0.009**
Δ OPEN	-1.39	-2.83	0.022**
Δ ER	-1.73	-3.95	0.004**
Δ FDI	0.24	2.27	0.053**
Δ ODA	-0.75	-1.89	0.095**
ECM(-1)	-0.262	-0.76	0.046**
R- squared	0.9131		
Adjusted R-squared	0.7720		

Note: * 0%, ** 5% significance level. Δ is first difference operator.

Source: computed by the authors

Table 5. Long run and short run results of the manufacturing sector

(a) Long run results

Dependent variable: TFP_{mt}

Variables	Coefficients	T-test	Probability
INF	- 0.02	-2.02	0.072*
OPEN	0.40	2.25	0.048**
ER	0.35	2.63	0.025**
FDI	0.01	0.30	0.771*
ODA	1.96	1.25	0.240
R- squared	0.9782		
Adjusted R-squared	0.9441		

(b) Short run results

Dependent variable: ΔTFP_{mt}

Variables	Coefficients	T-test	Probability
ΔINF	-0.02	-2.01	0.072*
ΔOPEN	0.40	2.63	0.025**
ΔER	0.35	2.25	0.048**
ΔFDI	0.01	0.30	0.769
ΔODA	1.95	1.25	0.095*
ECM(-1)	-0.698	-3.63	0.005**
R- squared	0.8442		
Adjusted R-squared	0.6737		

Note: *10%, ** 5% significance level. Δ is first difference operator.

Source: computed by the authors

Table 6. Long run and short run results of the tertiary sector

(a) Long run results

Dependent variable**:** TFP_{st}

Variables	Coefficients	T-test	Probability
INF	-0.001	4.20	0.003*
OPEN	-1.23	-2.24	0.05**
ER	-3.12	-5.79	0.000***
FDI	0.03	2.05	0.075*
ODA	-1.89	-3.20	0.075*
R- squared	0.9136		
Adjusted R- squared	0.7732		

(b) Short run results

Dependent variable: ΔTFP_{st}

Variables	Coefficients	T-test	Probability
ΔINFLATION	-0.01	1.43	0.192
ΔLNOPEN	-1.04	-2.35	0.047**
ΔLNER	-0.84	-2.58	0.033**
ΔFDI	-0.31	-2.87	0.021**
ΔODA	2.04	1.04	0.329
ECM(-1)	-0.360	-1.22	0.025**
R- Squared	0.8167		
Adjusted R-Squared	0.5189		

Note: *10%, **5%, statistical significance. Δ is first difference operator

Source: computed by the authors

The diagnostic tests were performed on the estimated results of the three sectors. The diagnostic tests namely serial correlation, heteroscedasticity**,** normality and stability test, were performed on the ECM-based ARDL models of total factor productivity. The results indicated that the models passed all the three diagnostic tests. The stability test was also performed on the three estimated equations. The results show that the estimated equations are stable and there is no misspecification. This means that the estimated parameters in the models are consistent and reliable. The diagnostic statistics are not presented here but can be obtained from the authors on request.

6. Conclusion

The purpose of this study was to investigate the determinants of total factor productivity in Angola. In addition to this, the study was done through an extensive review of relevant theoretically and empirically literature. Moreover, this study differs from previous studies in the sense that it investigates the determinants of total factor productivity not on an aggregate level but in different sectors. Contrary to previous studies, this study estimated the determinants of total factor productivity for the primary, manufacturing and service sectors of the Angolan economy.

This study contributes because, according to the researcher's knowledge, there have not been any studies that investigate the determinants of total factor productivity in Angola in different sectors. Moreover, previous studies that were done in other Africa countries did not focus on the determinants of total factor productivity in different sectors but only at aggregate level. The empirical model was estimated and used to analyze the three sectors of the Angolan economy. The ARDL model was used to estimate and the results.

The results indicate shows that the effect of the determinants of total factor productivity is sensitive to the sector selected. For example, inflation rate has a positive effect on total factor productivity in the primary sectors. Other variables such as openness, exchange rate and official development assistance has a negative effect on total factor productivity. However, foreign direct investment cause the Angolan economy to improve its productivity. The results suggests that total factor productivity in the Angolan primary sector can be improved by attracting foreign direct investment. Contrary to theoretical expectations, increase in openness, exchange rate depreciation, and official development assistance cannot improve total factor productivity in the primary sector.

The results of the manufacturing sector showed that openness, exchange rate depreciation, foreign direct investment, official development assistance are associated with an improvement in total factor productivity. Inflation causes a deterioration of the total factor productivity of the manufacturing sector. The results suggest that total factor productivity in the manufacturing sector can be improved by increasing openness of the economy, attracting foreign direct investment, official development assistance and exchange rate depreciation. Achieving maintaining price stability is also important for improving total factor productivity.

The results of the service sector indicate that inflation, openness, exchange rate, and official development assistance are associated with a deterioration of total factor productivity. Only foreign direct investment direct investment causes an improvement in the service sector's total factor productivity. The results suggest that total factor productivity in the service sector can be improved by attracting foreign direct investment and price stability. Increasing openness, exchange rate depreciation, and official development assistance will not improve total productivity in the service sector.

These results of the three sectors indicate that the effect of the determinants of total factor productivity is sensitive to the sectors. Hence, it is important to come up with policies that are sector specific and not blanket policies that are targeting the entire economy. For example, policies aimed at improving total factor productivity in the service sector may not be appropriate for the manufacturing sector.

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