STUDIA UNIVERSITATIS BABEȘ-BOLYAI OECONOMICA
VOLUME 66, ISSUE 1, 2021, pp. 75-96
DOI: 10.2478/subboec-2021-0005

MODELLING TOTAL FACTOR PRODUCTIVITY IN A DEVELOPING ECONOMY

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Abstract. Total factor productivity is an important driver of economic growth. It is therefore important to understand its determinants. This will help to enhance it and accelerate economic growth. The objective of this paper is therefore to investigate drivers of total factor productivity in Angola. The investigation covers the period 1995 – 2018. It is conducted for selected sectors of the economy. The results show that foreign direct investment has a positive effect on total factor productivity in all sectors. Increase in openness of the economy and depreciation the exchange rate have a positive effect on total factor productivity in the manufacturing sector. However, an increase in these two variables is associated with a decrease in total factor productivity of the primary and service sectors. The results indicate that a rise in inflation is associated with a decrease in total factor productivity in the manufacturing and service sectors. However, an increase in inflation is positively associated with an increase in total factor productivity in the primary sector. Increase in official development assistance impact negatively on total factor productivity in the primary and service sectors. This variable has a positive effect on total factor productivity of the manufacturing sector. The implication of these results is that Angola should pursue policies that attract foreign direct investment in order to ensure sustainable total factor productivity growth. The impact of other drivers such as openness of the economy, inflation, official development assistance and exchange rate depends on sectors. This implies that it is important for Angola to implement policies, which are specific to sectors. This will help to enhance the growth of total factor productivity.

JEL classification: O40; O47; O49; O55.

Keywords: Angola; total factor productivity; ARDL, cointegration, growth accounting.

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1. Introduction

The primary objective of government and policy makers in any economy is the acceleration of economic growth. It is not surprising that many studies such Ahmed (2008) and Saleem et al (2019) identified total factor productivity as one of the main drivers of economic growth. Kim and Park (2018) states that an improvement in total factor productivity helped countries to move from middle income to high income group. The importance of economic growth led to many studies that developed models, which can be used to investigate its determinants (of economic growth). One of the early studies that developed models for drivers of economic growth is Solow (1956). The model in Solow (1956) put emphasis on the diminishing marginal return on capital, and assumes that population and savings rate are exogenous. This model does not take into account the depreciation and changes in the technology. It assumes that technology is exogenous, and this has been identified as a shortcoming of this model.

The Solow (1956) model is followed by the endogenous growth. The endogenous growth theory differs from the Solow model in the sense that it identifies technological changes as the most important variable that drives economic growth. According to Lucas (1990), economic growth depends on human capital. Lucas (1990) acknowledges that physical capital accumulation and human capital accumulation are the key variables, which determine economic growth.

There are several theoretical and empirical studies on the determinants total factor productivity in both developed and developing countries. Some of them acknowledge that the degree of openness, investment in knowledge and education are the main drivers of total factor productivity in both developed and developing countries (Nelson and Phelps, 1996). Other studies such as Romer (1990) postulated that research and development, infrastructure have a positive impact on total factor productivity. According to Khalid (2012), macroeconomic variables such as exchange rate, inflation, fiscal deficits and government size are important determinants of total factor productivity. Total factor productivity is influenced by human capital through the facilitation, adoption and implementation of new technologies. Human capital can also influence total factor productivity through the facilitation of domestic production and technological innovations.

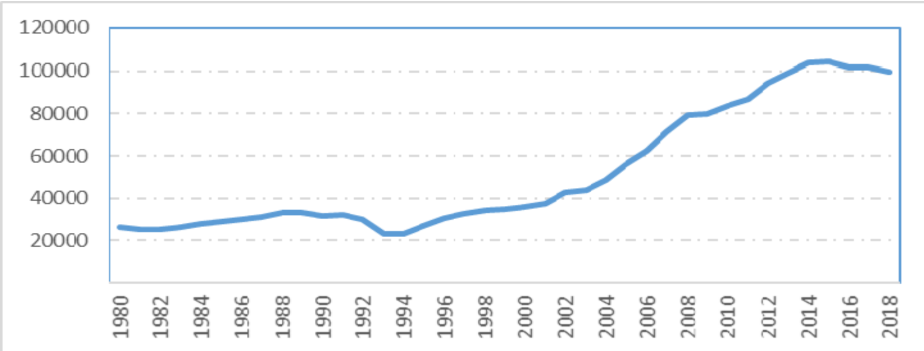
There are various channels through which variables such as trade openness affects total factor productivity. These channels include (among others) utilisation of comparative advantage, knowledge and technological transfer, exposure to competition and economics of scale. Studies such as Danquah (2006) investigate the drivers of total factor productivity in Ghana. The results indicate the effect of inflation on total factor productivity is negative. This can be attributed to the fact that inflation has an adverse effect on capital accumulation and demand for real money. Inflation also has a negative effect on supply of labour and cause inefficiency in the allocation of resources. The quality of institutions is one the important determinants of total factor productivity. This is confirmed by Fadiran and Akanbi (2017) on South Africa. The results of this study indicated that the relationship between institutions and total factor productivity is positive. According to Fadiran and Akanbi (2017), the reason for the positive relationship between the two variables is because it is regarded as an expansion of investment, technological innovation and ultimately economic growth.

Most studies estimated total factor productivity at an aggregate level. They did not examine the determinants of total factor productivity at sectoral level. Investigating the total factor productivity at an aggregate level not be appropriate and can result in blanket policy for the sectors. Blanket policy for all sectors is not appropriate. That is because sectors are not similar and if that is case, different policies will be required for different sectors. Furthermore, it is important to note that there are studies conducted on the determinants of total factor productivity in developing countries including those in Africa. These studies do not include Angola. That means studies on the determinants of total factor productivity in Angola are scanty of non-existent, despite the fact that it has been identified as one key drivers of economic growth. This suggest that it is important to investigate the determinants of total factor productivity in Angola. This study from previous research in the sense that it estimates total factor productivity at sectoral level. The determinants of total factor productivity will be estimated and investigated for selected sectors of the Angolan economy. According to our best knowledge, this is the first study that investigate the determinants of total factor productivity at sectoral level (instead of aggregate level), and specifically on Angola. The rest of the study is structured as follows. Section 2 briefly discuss economic overview and the sources of growth in Angola. Section 3 reviews the literature on the determinants of total factor productivity. Section 4 presents the methodology. The results are presented in section 5. The conclusion is provided in section 6.

2. Economic overview and sources of growth

Angola is a country that has faced economic challenges since it independence from Portugal in 1975. It has been exporting a significant amount of crude oil, but its GDP remained relative low for several years. The relative low GDP despite the fact that Angola has been the second largest oil producer in Sub-Saharan Africa is attributed to the civil war that lasted for the period 1975 – 2002. This made it difficult for Angola's GDP to grow during that 30 year period. The trends in Angola's GDP for the period 1980 to 2018 is presented in Figure 1. Figure 1 shows that the country's GDP fluctuated between US$20 and US$ 40 billion. The civil war that affected Angola resulted in fluctuating economic activities. The civil war ended in 2002, and this resulted in Angola's GDP to increase from US$ 42.3 billion in 2002 to US$101 billion in 2015. This is a huge increase and according to Angola National Bank (2015), it indicates that the GDP increased by almost three times as much during the period 2002 to 2015. Angola National Bank (2015) indicated further that this is an increase of more than 30 times since the country's independence in 1975.

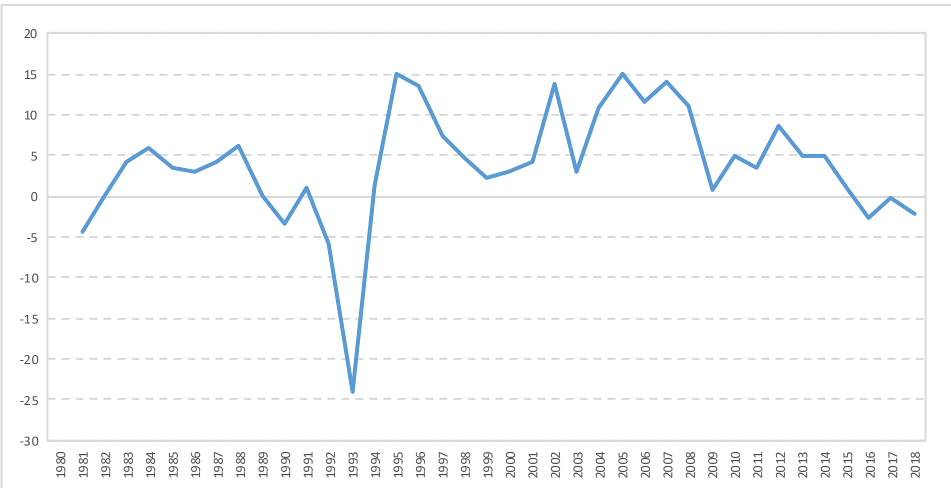
Fig. 1: Trends in Angola's GDP for the period 1983-2018 (measured in US dollars)



Source. Data for the figure are obtained from the World Bank (2018). An earlier version of this figure appeared in Eita and Pedro (2020)

The economic growth of Angola for the period 1983 to 2018 is presented in Figure 2. Angola recorded a negative economic growth rate 24 percent in 1993. This decline in economic growth rate can be attributed to the fact that there was an election in 1992 which was won by the ruling party, People's Movement for the Liberation of Angola (MPLA). The election results were rejected by the opposition party or rebel movement, the National Union for the Total Independence of Angola (UNITA). This resulted in the continuation of the civil war and the economic growth was negatively affected. Growth picked up in 1995 due to prospects of peace in Angola. After the end of the civil war in 2002, Angola's growth picked up, reaching 14% in 2010. The growth rate for the period 2015 to 2017 was on average 8.6%.

Fig. 2: Angola's economic growth, 1983 to 2018



Source: Data for the figure are obtained from the World Bank (2018). An earlier version of Figure 2 was presented in Eita and Pedro (2020)

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 2018 as 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.

The sources of Angola's economic growth are presented in Table 1. The first covers the period 1995 – 2001 and this is associated with the civil war that affected Angola. The second is the post-civil war period of 2002 – 2018.

The sources of growth (in Table 1) were computed using a growth accounting technique proposed by Solow (1956). The results of Table 1 shows that during the period 1995 to 2001, the economic growth in the primary sector in Angola was driven by labour and productivity. The contribution of capital to economic growth was low during this period. The period 2002 -2017 is associated with economic growth in the primary sector that was driven by labour and capital. The contribution of productivity was low during this period. The higher contribution to growth by labour 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 period. 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.

The period 1995 and 2001 is associated with economic growth in the manufacturing sector that was led by growth capital. The contribution of labour and productivity to economic growth was low during this period. The low contribution of labour and productivity to economic growth can be attributed to the fact that during Angola's civil war, the agricultural sector was the principal source of employment for the majority of the country's population. There were also many people that were employed in the military. During the civil war, most resources were dedicated to the military and investment in the manufacturing sector was low. This resulted in low productivity contribution to economic growth during this period. The years 2002 – 2018 represent the post-civil war period which led to an increase in investment in the manufacturing sector. It is not surprising that the leading contributors to economic growth in the manufacturing sector were capital and productivity. The post-civil war period of 2002 - 2018 is associated with the resumption of prospecting for new minerals and oil crude exploration. Investment in new technology and oil exploration increased and this made the prospect of the manufacturing sector to be optimistic. Hence, the contribution by productivity to economic growth increased from 0.05% in the period 1995 - 2001 to 2.06% during the period 2002 - 2018.

Finally, Table 1 shows that economic growth in the services sectors was driven by all three factors during the period 1995 - 2001. The three factors contributed almost equally to growth in the service sector (although productivity's contribution was higher than that of capital and labour). Economic growth in the service sector was driven by productivity and capital during the period 2002 - 2018. The post-civil war period (2002-2018) is associated with the prospecting for new investments in the financial sector, tourism and telecommunication. The contribution to economic growth by productivity increased from 0.71 % during the period 1995 - 2001 to 2.04 % for the period 2002 - 2018.

Table 1: Source of Angola's economic growth

	1995-2001	2002-2018
Primary Sector		
Capital contribution	0.15	0.62
Labour contribution	0.39	0.45
Total input contribution	*0.54*	*1.07*
Total factor productivity contribution	0.46	0.37
Total output growth in primary sector	*1*	*1.44*
Manufacturing sector		
Capital contribution	0.59	2.5
Labour contribution	0.10	0.08
Total input contribution	*0.69*	*2.58*
Total factor productivity contribution	0.05	2.06
Total output growth in manufacturing sector	*0.74*	*4.64*
Service sector		
Capital contribution	0.47	1.98
Labour contribution	0.51	0.46
Total input contribution to growth in service sector	*0.98*	*2.44*
Total factor productivity contribution	0.71	2.04
Total output growth in the service sector	*1.69*	*4.48*

Source: Authors' own computation. The earlier version of this table was presented in Eita and Pedro (2020)

3. Literature review

There are many studies conducted on the drivers of total factor productivity. These studies can be can be classified into two groups. The first group consists of studies that look at cross country or panel data studies. The second group has research that deal with single country studies. We start with the first group of studies. Phillip (2012) used panel autoregressive distributed lad (PARDL) to investigate the determinants of total factor productivity for four economies (Nigeria, Mexico, Turkey and Indonesia).The results indicate that human capital and government stability have positive and significant effects on TFP. Other variables such as foreign direct investment (FDI) and corruption have negative effect on TFP. The negative effect of foreign direct investment on total factor productivity is also found by Abdullah and Chowdhury (2020). This study is on several developing countries in both Africa and other regions such as Latin America. The results indicate that foreign direct investment does not promote trade. This can be attributed to the fact that there is a lack of absorptive capacity which prevent a direct association between foreign direct investment and total factor productivity. The negative effect of foreign direct investment on total factor productivity is also supported by Olomola and Osinubi (2018) for the economies of Mexico, Indonesia, Nigeria and Turkey. However, studies such Adnan et al (2019) conducted on four South East Asian economies revealed that foreign direct investment is associated with an increase in total factor productivity.

The determinants of total factor productivity for eight East Asian economies were investigated by Liao and Liu (2009). The results show that there is evidence of export-led growth Korean and Singapore economies. The results, further reveal that productivity– led export growth in the economies of China, Hong Kong, Indonesia, Philippines and Malaysia. The causality between exports and productivity I South Korea, Singapore and Taiwan bi-directional. However, causal relationship between export and productivity is unidirectional in China, Hong Kong, Indonesia, Malaysia and Philippines. If runs from productivity of exports.

Akinlo (2006) uses pooled time series and cross-sectional data to investigate macroeconomic variables that determine total factor productivity in 34 Sub-Saharan African countries for the period 1980 -2002. The results of the study reveals that macroeconomic variables such as 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. Other variables such as 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 impact on total factor productivity.

Garzarelli and Limam (2019) uses stochastic frontier analysis to investigate the role of physical capital accumulation and TFP in explaining output growth in 36 sub-Saharan African (SSA) countries for the period 1996-2014. The stochastic frontier analysis is a 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.

Malikane and Chitambara (2018) investigated the impact of foreign direct investment on total factor productivity for 45 African countries. The investigation covers the period 1980 – 2012. The generalised method of moment is used for this purpose. The study reveals that foreign direct investment has a positive effect on economic growth.

It is important to mention that there are also studies that focus on single country. These studies belong to the second group as explained earlier in this section. Myasnikov (2018) investigates the drivers of total factor productivity growth in several regions of Russia. Specific emphasis was put on the importance of spillovers and agglomeration effects. The results indicate that firms from regions with large capitals and high shares of credit in gross regional product (GRP) are more actively expanding into neighbouring regions. The links with local firms in host regions create positive correlations between total factor productivities in such host regions and their home regions. Ludmila (2016) investigates the impact of the productivity sector in Latvian on economic growth. It applies the Cobb-Douglass and trans log production functions to control the changes in the sources of total factor productivity. The results show that an increase in productivity sector in Latvian adds value to total output growth, which in turn has a positive effect on total factor productivity.

The drivers of total factor productivity are investigated by Nunung (2016) for Indonesia's palm oil production sector. The results of the investigation show that total factor productivity in Indonesia's palm oil production sector is determined by land, pesticide, fertilizer and labour. The autoregressive distributed lag (ARDL) was applied by Wadad (2016) to investigate the drivers of total factor productivity growth in Lebanon. The investigation reveals that total factor productivity in Lebanon is driven by trade openness and credit extended to the private sector. The positive effect of openness on total factor is confirmed by Haider et al (2019) for India. The results of this study revealed that openness has a positive effect on total factor productivity. The causality runs from openness to total factor productivity. According to Misra (2020), an increase in variables such as irrigation, health, electricity infrastructure, road infrastructure, financial development and education are associated with an increase in total factor productivity for India.

The data envelopment analysis (DEA) approach was used by Idris (2007) to analyse the drivers of total factor productivity growth in Malaysia for the period 1971 – 2004. The Malinquist Production Index was used to decompose total productivity into technical change and technical efficiency change. The analysis show 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 fixed effect regression to investigate the determinants of total factor productivity in several sectors of China. The results indicate that the nonferrous metal sector is one of the main determinants of total factor productivity in China. The results indicate that an increase in production of nonferrous metal sector causes China's total factor productivity to rise. Although this study uses panel data, its focus is solely on China. Research and development is also one of the important determinants of total factor productivity. Increase in research and development causes a rise in total factor productivity. This is confirmed by Biatour and Dumont (2011) for Belgium, and Castiglionesi and and Ornaghi (2011) for several Spanish manufacturing firms. Cobb-Douglass and trans log production functions were applied by Chaudhry (2009) to investigate the determinant of total factor productivity in agriculture and manufacture sectors of Pakistan. The results also reveals that research, development, and trade openness impact positively on total factor productivity growth in both primary and secondary sectors.

The effect of foreign direct investment on total factor productivity was found to be negative. This was revealed by Aitken and Harrison (1999) for various plants in Venezuela. The negative effect of foreign direct investment on total factor productivity can be explained by the fact that foreign-owned firms recruit most employees from outside Venezuela, and this deprive domestic plants of their services. Azeroual (2016) also found a negative effect of foreign direct investment from France to the manufacturing sector of Morocco. Adnan et al (2020) shows that foreign direct investment is associated with a decrease total factor productivity for Pakistan.

The relationship between total factor productivity and technical efficiency in the manufacturing sector of Ethiopia was investigated by Abegaz (2013) for the period 1996 – 2009. The results indicate that due to large technical inefficiencies in the manufacturing sector in Ethiopia, the variation in output growth had a negative effect on total factor productivity. This study concludes that improvement in technical efficiency in Ethiopia's manufacturing sector is associated with an increase total factor productivity.

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 for the period 1970 - 2003. 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. The results suggest 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.

A review of two groups 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 may 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 at sectoral level. This will ensure that policies are sector-specific. Previous studies did not investigate the determinants of total factor productivity in Angola. Contrary to those 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 an extensive review of the theoretical arguments by the neoclassical (Jorgensen, 1967), exogenous (Solow, 1956; Swan, 1956) and endogenous (Romer, 1986; Lucas, 1988) and the earlier empirical studies (such as Spilioti and Vamvoukas, 2015), the total factor productivity growth dynamics equation in this study can be expressed as follows:

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

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

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

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.

A rise in inflation indicates macroeconomic instability. An increase in inflation can discourage economic growth and result in higher interest rates. This discourage entrepreneurs from financing their projects. This suggest that inflation is expected to cause a decline in total factor productivity (Espinoza, 2012). This is also supported by Olomola and Osinubi (2018).

An increase in openness of the economy cause the country to be integrated in the global economy. This increase competition and innovation of the domestic firms and results in a rise of total factor productivity (Espinoza, 2012). The positive effect of openness on total factor productivity is also supported by studies such as Haider et al (2019).

According to Rodrik (2008) an appreciation of the exchange is not favourable for total factor productivity. However, if the domestic currency depreciates, total factor productivity will increase.

The effect of foreign direct investment on total factor productivity is an empirical question. If foreign direct investment is used to finance infrastructure development and education, total factor productivity will increase (Ahmed, 2008). However, there are some few studies that concluded that the effect of foreign direct investment on total factor productivity can be negative. That means, it should not be surprising if the coefficient of foreign direct investment on total factor productivity is negative. Abdullah and Chowdhury (2020) also support the view that the effect of foreign direct investment on total factor productivity can also be negative.

Official development assistance can benefit the economy if it is used to finance activities such as education and infrastructure. Official development assistance also make resources available for the financing of economic activities that enhance innovation. This suggest that the coefficient of official development assistance is expected to be positive.

4.2 Data

Annual data are used in this study and the estimation covers the period 1995 – 2018. Although, the observations are observations can be regarded as few, the equation will be estimated using a technique that is appropriate for limited observations. The variables used for estimation of the empirical model are explained as follows. GDP deflator is used as a proxy for inflation (INF) and data for this variable are obtained from World Bank's World Development Indicators (WDI). Openness of the economy (OPEN) is computed as the ratio of the sum of exports and imports to GDP. Angolan Kwanza/US dollar is used to represent the exchange rate (ER). Foreign direct investment (FDI) is proxied by net foreign inflows. The net official development assistance per capita is used as a proxy for official development assistance (ODA). The data for these four variables (OPEN, ER, FDI and ODA) are also sourced the World Bank's WDI.

The Cobb-Douglass production function is used to compute data for total factor productivity for the different sectors. Cobb-Douglas production function links output to factor inputs (capital and labour) and productivity (along the lines of the neoclassical Solow-Swan model). The Cobb-Doulas production that is used to derive total factor productivity in the three sectors is specified as follows:

Primary sector

$$Y_{pt=}A_{pt}\ K_{pt}^{\alpha}\ \ L_{pt}^{1-\alpha} \quad (4)$$

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

Manufacturing sector

$$Y_{mt=}A_{mt}\ K_{mt}^{\alpha}\ \ L_{mt}^{1-\alpha} \quad (6)$$

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

Tertiary sector

$$Y_{st=}A_{st}\ K_{st}^{\alpha}\ \ L_{st}^{1-\alpha} \quad (8)$$

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

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 labour. The subscripts *pt, mt, st* represent primary, secondary and tertiary sectors. Constant return to scale is enforced 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 distributed 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:

$$\Delta \boldsymbol{TFP_{pt}} = \beta_0 + \sum_i^n \beta\, 1_i \Delta lnTFP_{pt-1} + \sum_i^n \beta\, 2_i \Delta lnINF_{t-1} + \sum_i^n \beta\, 3_i \Delta lnOPEN_{t-1}$$
$$+ \sum_i^n \beta\, 4_i \Delta lnER_{t-1} + \sum_i^n \beta\, 5_i \Delta lnFDI_{t-1} + \sum_i^n \beta\, 6_i \Delta lnODA_{t-1} + \alpha_1 TFP_{pt-1} + \alpha_2 lnINF_{t-1}$$
$$+ \alpha_3 lnOPEN_{t-1} \quad + \alpha_4 lnER_{t-1} + \alpha_5 lnFDI_{t-1} + \alpha_6 lnODA_{t-1} \dots\dots\dots\dots\dots\dots\dots\dots \epsilon_T \qquad (10)$$

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

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

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 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

It is important to test for the stationarity of the variables before estimating the empirical models. This process involves unit root test. The unit root test is done in order to establish the univariate characteristics 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) is not appropriate for estimating the empirical models using ARDL. The Augmented Dickey-Fuller (ADF) test is used to test for stationarity of the variables and the results are presented in Table 2. The results for unit root tests are presented in Table 2. 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 in order to estimate empirical models.

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: */ **/*** indicate stationarity at 10%, 5% and 1% significance levels.*
TFP_{pt} *is total factor productivity of the primary sector;* TFP_{mt} *is total factor productivity in manufacturing sector and* TFP_{st} *is total factor productivity for the service sector.*
Sources: Computed by the authors. An earlier version of this Table was presented in Eita and Pedro (2020).

5.2 Cointegration – ARDL bounds test results

Table 3 presents cointegration test results. The results in Table 3 shows that the F-test statistics is greater than the upper bound critical values for all sectors. It is statistically significant at 1 percent significant level. That means the null hypothesis of no cointegration is rejected for all sectors and this means that there is cointegration between the variables as specified in the empirical models.

Table 3: Cointegration or bounds test results

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

Note: TFP_{pt} is total factor productivity of the primary sector; TFP_{mt} is total factor productivity in the manufacturing sector and TFP_{st} is total factor productivity for the service sector.
Source: computed by the authors. An earlier version of this Table was presented by Eita and Pedro (2020).

5.3 Estimation results

Table 4, 5 and present estimation results. The results are estimated as per the specification of equation (1), (2) and (3). The results in Table 4 show that an increase in inflation is associated with a rise in total factor productivity. A one percent increase in inflation causes total factor productivity to increase by 0.01 percent. This positive effect of inflation on total factor productivity is not consistent with theoretical expectations. However, it can explained partially by the fact that there is under development in the primary sector (which is mainly agriculture and fishing). Total factor productivity in the primary sector responds negatively to an increase in openness of the economy, official development assistance and exchange rate depreciation. The negative response of total factor productivity to an increase in the three variables is not in line with theoretical expectations. In line with theoretical expectation, a one percent increase in foreign direct investment causes total factor productivity of the primary sector to rise by 2.27 percent. The short run results indicate that the coefficient of the error correction of term is negative and statistically significant. This indicate that there is adjustment to equilibrium. The positive effect of inflation is consistent with the results of Olomola and Osinubi (2018) for Nigeria, Mexico and Turkey. Although the negative effect of openness, exchange rate depreciation and official development assistance is not in line with theoretical expectations, it is line with the results of Akinlo and Adejumo (2016) for Nigeria. The positive effect of foreign direct investment on total factor productivity is consistent with the findings of Akinlo and Adejumo (2016) for Nigeria, Malikane and Chitambara (2018) for 45 African countries as well as Adnan et al (2019) for some Asian countries (Bangladesh, Pakistan, India and Sri Lanka).

Table 5 presents the results of the manufacturing sector. The results indicate that total factor productivity of the manufacturing sector respond negatively to an increase in inflation. This negative coefficient of inflation is in line with economic theory. Total factor productivity of the manufacturing sector respond positively to an increase in openness, depreciation of the exchange rate and official development assistance. A rise in these three variables by one percent will cause total factor productivity in the manufacturing sector to increase by 0.4, 0.35, 0.01

and 1.96 percent. The short run results show that the error correction term coefficient is negative and statistically significant, indicating that there is adjustment to equilibrium. These results are in line with those in the literature such as Adnan et al (2019), Malikane and Chitambara (2018), Olomola and Osinubi (2018), Abdullah and Chowdhury (2020).

The results of the service sector are presented Table 6. The results of Table 6 show that total factor productivity in the service sector responds negatively to an increase inflation, openness, depreciation of the exchange rate and official development assistance. The results indicate that a one percent increase in the four variables will cause total factor productivity to decrease 0.001, 1.23, 3.12 and 1.89 percent. The negative effect of inflation on total factor productivity is consistent with economic theory. However, the negative response of total factor productivity increase in openness, exchange rate, and official development assistance is not in line with *a priori* expectations. The effect of foreign direct investment on total factor productivity is positive and consistent with theoretical expectations. A one percent increase in foreign direct investment causes total factor productivity in the services sector to rise by 0.03 percent. The short run shows that there is adjustment to equilibrium because the sign of the coefficient of the lagged error term is negative and statistically significant. It is important to note that the negative effect of inflation on total factor productivity is line with those of Adnan et al (2020), Akinlo and Adejumo (2016). The negative effect of openness and exchange rate depreciation compares favourably (although no in line with many studies) with previous studies (such as Akinlo and Adejumo, 2016; Adbullah and Chowdhury, 2020). The positive effect of foreign direct investment on total factor productivity is supported by previous studies in the literature (Malikane and Chitambara, 2018; Adnan et al, 2019).

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

(a) Long run results

Dependent variable: TFP_{pt}

Variables	**Coefficient**	**t-statistic**	**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: $\Delta\, TFP_{pt}$

Variable	Coefficient	t-statistic	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: : */ **/*** indicate 10%, 5% and 1% significance levels. Δ is first difference operator.*

Source: computed by the authors. This table was also presented in Eita and Pedro (2020).

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

(a) Long run results

Dependent variable: TFP_{mt}

Variables	Coefficients	t-statistic	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-statistic	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: : */ **/*** indicate 10%, 5% and 1% significance levels. Δ is first difference operator.*

Source: Computed by the authors. The earlier version of this table was presented in Eita and Pedro (2020).

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

(a) Long run results

Dependent variable: TFP_{st}

Variables	Coefficient	t-statistic	Probability
INF	-0.001	4.20	0.003***
OPEN	-1.23	-2.24	0.050**
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	Coefficient	t-statistic	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: : */ **/*** indicate 10%, 5% and 1% significance levels. Δ is first difference operator.*

Source: Computed by the authors. The earlier version of this table is presented in Eita and Pedro (2020).

The short run results were subjected to diagnostic statistics. The results indicate that short run results passed all diagnostic statistic such as serial correlation, heteroscedasticity, normality and stability test. 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 objective of this paper is to investigate the drivers of total factor productivity in Angola. The investigation was conducted through an extensive review of the relevant theoretical and empirical literature. It differs from previous research in the sense that the analysis is conducted for various sectors of the economy and not at an aggregate level. The analysis is conducted for primary, manufacturing and service sectors. This is the first study to investigate the determinants or drivers of total factor productivity in the Angolan economy. The ARDL estimation technique was used to estimate the empirical model for the three sectors of the Angolan economy.

The results indicate that the effect of the determinants of total factor productivity is sensitive to the sector selected. For example, total factor productivity in the primary sector respond positively to an increase in inflation rate. Total factor productivity in the primary sector responds negatively to increase in variables such as openness, exchange rate and official development assistance. Total factor productivity in the primary increase if there is a rise in foreign direct investment. The implication of the results is that total factor productivity in the Angolan primary sector can be improved by attracting foreign direct investment. Contrary to the theoretical and empirical literature, total factor productivity in the primary sector will not improve in response to an increase variables such openness, exchange rate depreciation, and official development assistance.

The results of the manufacturing sector indicates that a rise in openness, exchange rate depreciation, foreign direct investment, official development assistance will cause total factor productivity to improve. A rise in inflation reduces total factor productivity of the manufacturing sector. The results implies that the manufacturing sector's total factor productivity in can be improved through an increase in openness, and exchange rate depreciation. The manufacturing sector's total factor productivity will improve if Angola can achieve and maintain price stability.

The service sector's total factor productivity responds negatively to an increase in inflation, openness, exchange rate, and official development assistance. However, the service sector's total factor productivity increases if there an increase in foreign direct investment. This suggest that the service sector's total factor productivity in can be improved by attracting foreign direct investment and price stability. Contrary to theoretical and empirical literature, the services sector's total factor productivity will not improve in response to an increase in openness, exchange rate depreciation, and official development assistance.

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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