

Modelling the Relationship Between Foreign Direct Investment and TFP Growth in a Developing Economy: Evidence from Nigeria

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Abstract
Most developing countries have been seeking to attract foreign direct investment (FDI) with the aim of increasing capital inflow through technological spillover and transfer of managerial skills. FDI can increase economic growth and development of a country by creating employment, and by doing so, increase economic activities that will lead to growth. Nigeria is one of the countries that strive to attract more FDI inflows so as to improve her economy, and the country has adopted policies that drive the motive to attract FDI inflows. This study explores the effect of FDI on sectoral growth over the period 1990–2022. Vector error correction model (VECM) technique is used to test the effect of FDI inflows on the agriculture, industry and services sectors. The results showed that FDI has a significant positive effect on the services and industry sectors, but a negative effect on the agricultural sector. For policy, Nigeria needs to keep robust bilateral investment treaties with her main FDI partner countries, since those countries are the main sources of FDI inflow to the country. Lowering taxes imposed on businesses and relaxing exchange rate regulations would encourage investors to invest in the country. As FDI flows into different sectors and has a different effect on the sectors, it is recommended to have incentives tailored for these different sectors.
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1. Introduction

The role of Foreign Direct Investment (FDI) as a source of capital is important for Africa and particularly for Nigeria owing to the prevailing huge financing gap and widening current account and fiscal deficits. This has been exacerbated by the low gross national savings and the binding budget constraint facing most African economies. Scholars such as Todaro and Smith (2003) argue that the inflow of FDI could fill the gap between the desired investment and domestically mobilized savings. Moreover, since the majority of African countries do not have ready access to international financial markets they have to rely on alternative sources of finance which include FDI and aid (Adeleke, 2014). Kosova (2010) highlights that from the mid-1990s FDI has become the major source of external finance for developing countries and is twice as large as official development aid.

FDI is also viewed as an important channel for the transmission of technology for many developing countries. This is because FDI often entails the transfer of knowledge from one country to another by establishing production units using advanced technologies in the recipient country (Borensztein et al, 1998). A number of studies such as Klenow and Rodriguez-Clare (1997) and Hall and Jones (1999), show that differences in technological growth are key to explaining divergences in economic growth among countries. Empirical literature has also identified the importance of the host country's absorptive capability in absorbing the spillovers of foreign firms' technology. This implies that FDI contributes to productivity growth when a sufficient absorptive capability of the advanced technologies is available in the developing host countries (Lai et al, 2006). In particular, Sub-Saharan Africa is lagging not just in terms of volume but also in terms of technological content in its manufacturing activity (UNCTAD, 2003).

The development experiences of a number of fast-growing East Asian economies have also buttressed the notion that FDI is vital for bridging the resource and technological gaps in African economies. Many African countries have therefore, intensified their efforts to attract FDI by providing a number of generous tax and non-tax incentives to multinational companies (Carkovic and Levine 2002). On the other hand, a number of scholars find that differences in productivity growth account for the huge cross country variations in growth (Acemoglu, 2009; Caselli 2005; Easterly and Levine 2001; Parente and Prescott 2001). Since FDI is regarded as an important channel for technology transfer a study of the impact of FDI on productivity growth is of great significance to policy makers in Africa as it provides evidence on one key factor that can help African countries to develop.

The role of FDI in Africa is particularly important as it has been shown that FDI can create positive externalities under certain conditions (Kobrin, 2005). These host country factors determine the extent to which host countries can absorb and hence benefit from FDI (Krogstrup and Matar, 2005). It is therefore, important to determine whether those conditions exist in Africa and what African countries need to do to create favorable conditions and hence benefit from FDI inflows. The increase in the volume and share of FDI inflows into Africa provides motivation to empirically investigate the role of FDI and its developmental impact. More importantly, as mentioned by Amighini et al. (2015), assessing the role of FDI and the conditions under which FDI is likely to be beneficial or detrimental to development has far-reaching policy implications for African governments. Firstly, it enables African governments to review and evaluate the efficiency, effectiveness and sustainability of the incentives being provided to multinational companies. Secondly, in the light of growing discussions among African policymakers on the need for the continent to industrialize it is pertinent to provide clarity on the developmental role of FDI so as to enhance evidence-based policy formulation.

FDI affects growth of developing countries positively via the transfer of capital, know-how, and technology. It increases activity not only in FDI beneficiary firms but also the effect can spread to other firms in the country and sectors through technology spillover, human and capital formation and increasing competition, thus raising productivity for the whole economy. Consequently, this paper studied the impact of FDI on TFP growth of Nigeria.

2 Literature Review

2.1 Theoretical Framework

The theoretical framework that reinforced the methodology of this study is based on the new partial equilibrium FDI-growth model by Neuhaus (2006). It is a partial equilibrium, as it did not include the domestic capital sector, but only considered all capital and technology transfers produced by foreign firms. According to Neuhaus (2006), the FDI-growth model is intended to explain the effect FDI has on the economic growth of the host country, and the way in which this affects technological progress in the economy. Neuhaus (2006) described the model to be the Solow type growth model, because the model includes elements of technological change that was initiated in the endogenous models of capital deepening.

The theoretical framework intends to describe the transition of a developing country to an industrialised country as a result of the inflow of FDI. This framework is of interest as an enhanced model from the 1990s endogenous FDI-growth models. It not only concentrates on the second-round transmission channel of FDI on economic growth, but also oversees the immediate effects FDI has on economic growth, through Greenfield investments and ownership participation. According to Neuhaus (2006), there is no other model that describes both the direct and indirect transmission channel of FDI on economic growth. This framework fits well for a study on the effect of FDI on sector growth in Ghana. Neuhaus (2006) adapted this framework to 13 transitioning European countries. The study revealed that FDI was not only highly significant, but also that it was on a high scale.

According to Neuhaus (2006), the new FDI-growth model was motivated by literature where growth was positively affected by FDI through capital accumulation and technological opportunity, which ultimately enhanced growth of the host country. Neuhaus (2006) states that the spillover effect of FDI occurs when a new foreign firm arrives with new developmental ideas for technological advancement for local firms. This technological know-how is adopted by domestic firms to improve products and create better ones, and that is seen as the relevant channel for the long-term effect of FDI on economic growth (Neuhaus 2006). Firstly, the FDIgrowth model explains the role of capital deepening in aggregate output. Using the production function with the assumption that there is a single firm producing a homogenous product, the function is presented as:

$$(t) = AL^{t-}(t)^{\alpha} \tag{1}$$

The function entails that Y(t) is the output produced at time t at constant efficiency A and with labour L, plus the existing capital of K(t), α is output elasticity. Capital deepening means that only capital stock can be used to show the process. The different changes of capital over a period can be depicted by:

$$K(t) = \left\{ \sum_{j=1}^{N(t)} \left[q^{k\,j(t)} \,.X_j\,(t) \right]^{\alpha} \right\}^{1/\alpha} \tag{2}$$

The capital equation shows that at time t, capital stock is made up of j=1,….,N(t) different types of capital goods. The physical amount of capital j that is used in the production process will be shown by $Xj\ (t)$, and the quality state of the capital j will be denoted by $q\ (t)$. In the equation, $q\ (t)$ simply shows the value the capital stock can add to the production process, k shows the highest quality rank at which a particular capital stock j can be available. The capital variety j in a developing country shown by kj will be less compared to the available capital variety at a global level, which can be denoted by $kj*$. When the quality in variety of capital increases at global level, then it will also improve for individual firms, resulting in a change in q, and meaning that $kj*$ will increase by one to $kj* + 1$. This means that there is an improvement in the quality level for capital stock j, and that the variety quality brought in by foreign firms is always higher than any other, which can result in even more than one benefit for the variety of quality available to a domestic individual firm. Every time a foreign firm introduces a new type of capital product, which is available at quality k, then the overall N(t) increases. In the case of the improvement of quality for the existing capital stock, only (t) will increase, but N(t) remains the same (Neuhaus 2006).

The model is built on the ideas of both Romer (1990) and Aghion and Howitt (1992), and combined these to evolve into this growth model. The Romer (1990) model was all about capital accumulation through increasing capital stock, and Aghion and Howitt (1992) supported the idea of capital deepening by improving the quality of the different capital varieties. In combining these two types of capital deepening models, Neuhaus (2006) states that capital stock j is independent of the quantity added by another capital stock $j*$. This means that it is not possible for j to replace or complement $j*$. Henceforward, it can be illustrated by substituting equation 2 into 1, which will be the principal equation of the model, that capital stock affects aggregate production and ultimately growth (Neuhaus 2006). The equation is presented as follows:

$$K(t) = AL^{1-\alpha} \sum_{j=1}^{N(t)} \left[q^{kj(t)} . X_j(t) \right]^{\alpha} \tag{3}$$

Neuhaus (2006) called equation (3) the "direct transmissions channel", where FDI could have an effect on the economic growth of a host country through capital deepening. Neuhaus further extended the model to show that through the indirect transmission channel, the technological advancement of FDI could affect economic growth through technological progress. Technological progress could have two types of effect on economic growth. One is the effect through the invention of new varieties of capital, and the other is the improvement of existing varieties of capital. After a while, when a country has accumulated enough capital stock, it needs to move on to improving the quality of the varieties of capital stock, which come from the introduction of new technologies that foreign firms introduce.

2.2 Empirical Framework

The present study followed the new FDI-growth model as a foundation of the econometric model. Following the growth model of Mankiw, Romer and Weil (1992) and Bassanini, Scarpetta and Hemmings (2001), they successfully introduced human capital into the Solow growth model. Neuhaus (2006) introduced FDI into the growth model to explain the effect of FDI on economic growth. FDI is not yet another variable in the model, but replaces the human capital variable; therefore, the model is an augmented version of the Mankiw et al. (1992) growth model. The theory considers that the positive spillovers of FDI could enhance economic growth through human capital and technology enhancement. Since then, FDI has been successfully integrated into the growth model. Mankiw et al. (1992) used the following production function:

$$(t) = (t)\ (t)(A(t)L(t))^{1-\alpha-\beta} \tag{4}$$

Where Y(t) is aggregate output, K(t) is domestic capital stock, H(t) is human capital, L(t) is labour input and A(t) has two components. The first component can be a measure for the state of the economy and can be measured by different variables like inflation, trade openness and government size. The second component is a reflection of exogenous technological progress. Output elasticities are denoted by α and β. The assumption of the model is that all technological progress is labour-augmenting; any enhancement of technology affects aggregate output in the same effect as an increase in labour. This model does not only show the change in the domestic and foreign capital, but also shows the change that exogenous technological progress has on capital stocks. The model entails that if there is no technological progress; there will not be growth, and just a mere capital accumulation (Neuhaus 2006). After replacing human capital H(t), the new production function can be written as follows:

$$(t) = (t)\ (t)\ ((t)(t))^{1-\alpha-\beta} \tag{5}$$

Where $K_d(t)$ is domestic capital stock and $K_f(t)$ is foreign capital stock. However, the effect of FDI inflow will be tested on the three key sectors (i.e. services, industry and agricultural sector) of the Nigerian economy. In line with empirical framework and studies, the three models to be estimated are expressed in logarithms as follows:

$$\ln AGrowth_t = \beta_0 + \beta 1 \ln FDI_t + \beta_2 \ln HK_t + \beta_3 \ln GFCF_t + \beta_4 \ln OPEN_t + \beta_5 \ln EXR_t + \beta_6 \ln INF_t + e_t \tag{6}$$

$$\ln SGrowth_t = \beta_0 + \beta 1 \ln FDI_t + \beta_2 \ln HK_t + \beta_3 \ln GFCF_t + \beta_4 \ln OPEN_t + \beta_5 \ln EXR_t + \beta_6 \ln INF_t + e_t \tag{7}$$

$$\text{lnIGrowth}_t = \beta_0 + \beta 1\ln FDI_t + \beta_2 \ln HK_t + \beta_3 \ln GFCF_t + \beta_4 \ln OPEN_t + \beta_5 \ln EXR_t + \beta_6 \ln INF_t + e_t \quad (8)$$

where sectoral growth is denoted by growth for the three key sectors in Nigeria, FDI is the foreign direct investment inflows, gross fixed capital formation (GFCF) which is a proxy for infrastructural development or investment in physical capital, EXR is the exchange rate, and INF represents inflation, β_0, β_1–β_6 are parameters to be estimated, whereas e_t is a stochastic error term to be independently and identically distributed. Three variables are expected to have a positive relationship with sector growth except for inflation (INF), which could have an ambiguous effect on growth. It is expected that FDI has a positive relationship with growth as evident in many empirical studies (Fedderke, & Romm, 2006; Kisswani, Kein, & Shetty 2015; Tan, & Tang, 2016; Adeleke et al., 2014), but a few found that FDI has no effect on growth (Yu & Liu 2011). According to Sen (2011), FDI has a positive effect on service sector growth, but studies found that FDI usually does very little to the growth of the agricultural sector (Posu et al. 2010; Ullah et al. 2011). According to the empirical studies, trade openness and gross capital formation have a significant effect on economic growth, whereas overly high inflation is found to have a negative effect on growth (Carkovic & Levine 2002). All the variables are illustrated in the research model in figure 1. Equations 6, 7, and 8 are models for the agricultural sector, the service sector and the industry sector respectively.

3 Data and Methodology

3.1 Data source

Data were sourced from World Development Indicators (WDI) database on the World Bank and the Penn World Table (PWT) Statistics for Nigeria. Annual time series data were collected on total factor productivity, foreign direct investment, human capital development, physical capital, Trade openness, exchange rate and inflation, for the period 1990-2022.

3.2 Methodology

The study presents an empirical investigation into the relationship between foreign direct investment and TFP growth in Nigeria using an econometric technique. The methodology involves regressing TFP growth on its explanatory variables through the following procedures: Testing for stationary properties of the variables using the Augmented Dickey Fuller and Phillip-Perron unit roots tests, followed by Johansen's co-integration test to check for the existence of co-integrating and long run relationships. Consequently the vector error correction model (VECM) was employed to estimate the error correction term and causal relationship respectively. Finally, stability and diagnostic test were also conducted to determine the robustness of the model adopted. Following literatures reviewed, the model was adopted to take the following form.

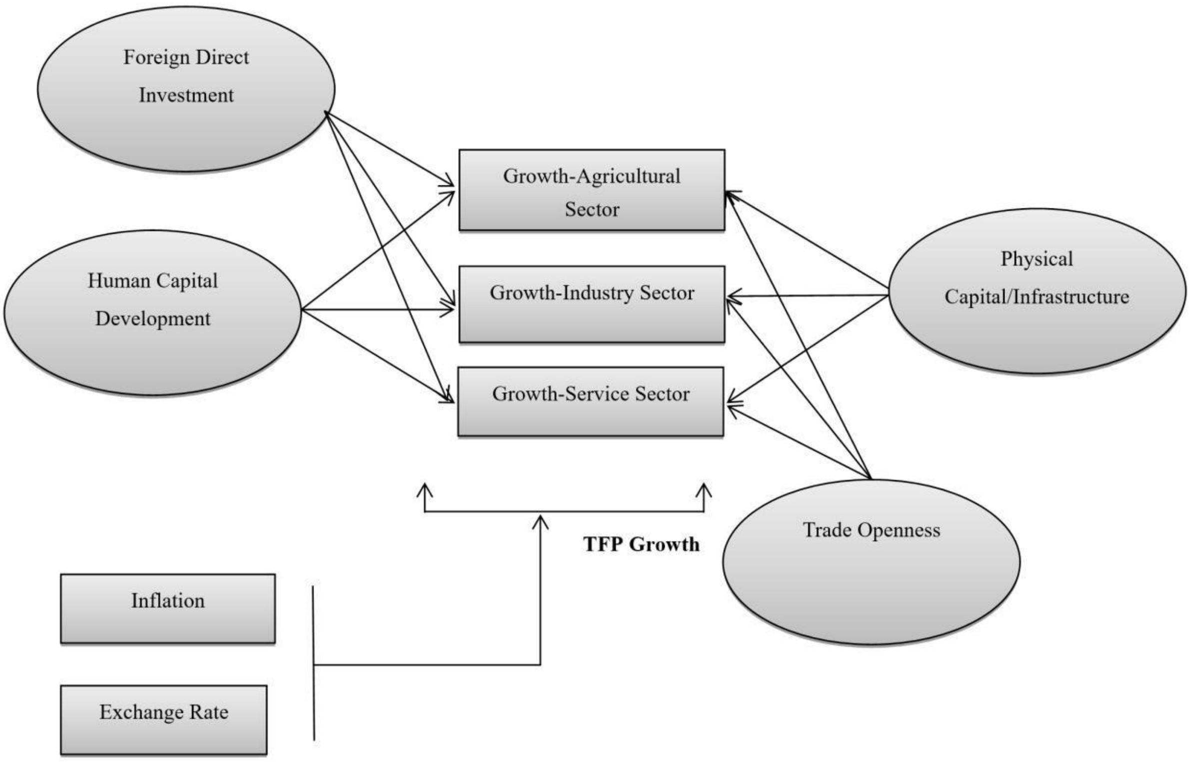


Figure 1 Research Model

3.3 Econometric model Estimation

It is a standard practice for every effective research that requires the use of econometric technique to highlight the significance of investigating the data generating process that are fundamental to the variables before estimating the parameters and carrying out various hypothesis testing. This procedure is meant to avoid the problem of spurious regression results.

Unit Root Test

In compliance with recent development in macroeconomic time series modeling, unit root tests of the variables in the model will be executed to determine their time series properties. The order of integration of each series will be established using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The ADF test equation is given as:

$$\Delta x_t = \alpha + \delta x_{t-1} + \ldots \sum^{k}_{i=1} \delta_i \Delta x_{t-1} + \ldots \delta_m \Delta x_{t-m} + \varepsilon_t \quad (10)$$

$$\Delta x_t = \alpha + \beta_t + \delta x_{t-1} + \ldots \sum^{k}_{i=1} \delta_i \Delta x_{t-1} + \ldots \delta_m \Delta x_{t-m} + \varepsilon_t \quad (11)$$

Equation (10) includes an intercept and no trend, while equation (11) includes intercept and time trend α_0 is a constant, δ is a coefficient of autoregressive process, Δ is the difference operator, t is a time trend, x_t is the variable under consideration, k is the number of lags and ε_t is the stochastic error term. The lagged differences of the variables are augmented to the test model in order to mitigate autocorrelation problems in the disturbance term. The Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC) are used to determine the optimal lag length k in the above equations.

The Phillip-Perron test equation is similar to the Augmented Dickey-Fuller test but the lag m, is omitted to adjust for the standard error in view to correct for heteroskedasticity and autocorrelation. Consequently The PP test equation is specified as:

$$\Delta x_t = \alpha + \delta x_{t-1} + \ldots \sum \delta_i \Delta x_{t-1} + \ldots \delta_m \Delta x_{t-m} + \varepsilon_t \quad (12)$$

The tests rely on rejecting the null hypothesis of a unit root (the series are non-stationary) in favor of the alternative hypothesis of no unit root (the series are stationary). If the absolute values of the ADF and PP test statistics are greater than the critical values, we reject the null hypothesis of non-stationary and conclude that the series is stationary. On the other hand, if the absolute values of the ADF and PP statistics are less than the critical values, we fail to reject the null hypothesis and conclude that the series is non-stationary.

Co-Integration Test Analysis

After authenticating that the series are integrated of order one denoted as I(1), it is now feasible to check for cointegration among TFP growth, FDI and other variables in the model via the Johansen's multivariate framework. The Johansen cointegration test is carried out in assessment of a vector autoregressive model (VAR) of the form:

$$\Phi(Z)X_t = \Psi_t \quad (13)$$

Where $X_t = [Q_t, R_t]'$, $\Phi(Z)$ signifies the long run multiplier matrix, Φ symbolizes coefficients of the short run dynamics and Z signifies a lag operator. When two or more series are non-stationary, it is important to study whether their linear combination is stationary. This apparent fact is identified as cointegration test. The occurrence of cointegration implies that there is a long run relationship between variables in the model. The idea behind the occurrence of cointegration is that even though TFP growth and its determinants may develop over time, a constant cointegration equilibrium relationship must occur among them. Mainly TFP growth is achievable if the variables do not drift too far apart over the long term. In other words, the variables can deviate from each other over the short term but policy and/or market forces restore them back over the long term.

In defining the number of co integrating vectors in the regression model, we use the Johansen likelihood ratio (LR) test technique. This method allows us to test for the occurrence of non-unique cointegration relationships. The usage of two statistical tests i.e. the trace test and the maximum eigen value test statistics were proposed. The trace test ($\boldsymbol{\lambda}_{trace}$) is defined as:

$$\lambda_{trace}(r) = -T \sum_{j=i+1}^{n} \ln(1 - \hat{\lambda}_i) \quad (14)$$

Whereas the maximum eigen value tests ($\boldsymbol{\lambda}_{max}$) is defined as:

$$\lambda_{max}(r, r+1) = -T\ln(1 - \hat{\lambda}_{r+1}) \quad (15)$$

Where T = number of usable observations

$\boldsymbol{\lambda}_i$ = Eigen values or estimated characteristics root

$\boldsymbol{\lambda}_{trace}$ test the null hypothesis

r = 0 against the alternative of r > 0
λ_{max} test the null hypothesis
r = 0 against the alternative of r =1

In other words, the trace statistics test the null hypothesis of (r) co-integrating relation in contradiction of the alternative of k co-integrating equation. On the one hand, the maximum Eigen value statistics test the null hypothesis of (r) co-integrating vector against the alternative of (r +1) co-integrating relation. If the null hypothesis of no co-integrating vector is rejected, it implies that there is a long-term relationship between the variables in the model.

Vector Error Correction Model (VECM)

With the detection of an existence of cointegration in the VAR, estimation of the VECM can take place. This model shows both long run equilibrium and short run dynamics. The dynamics can be estimated by using the following equation:

$$\Delta Y_t = \beta_1 \Delta X_t + \gamma_1 (Y_{t-1} - \lambda X_{t-1}) + \varepsilon_t \quad (16)$$

The coefficient that implies the long-run relationship between variables X and Y is x_{t-1}, while the error correction term is $Y_{t-1} - \lambda_{xt-1}$, where γ shows the long run relationship between X and Y, while β_1 shows the short-run relationship between the variables. According to the error correction model, variable Y must change between t-1 and t as an outcome of changes in the values of the dependent variable X between t-1 and t. Any change in variable Y will also be the reason for part correction to any disequilibrium at time t. The analysis of error correction is based on the examination of the coefficient of the error correction terms, corresponding to the first variable in the cointegrating equation (Mazenda 2012). To examine the relationship between cointegration and the error correction is to study the properties of the VAR model. To illustrate by using the bivariate model, the error correction model can be shown by:

$$\begin{bmatrix} \Delta X_t \\ \Delta Y_t \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} \Delta X_{t-1} \\ \Delta Y_{t-1} \end{bmatrix} + \begin{bmatrix} \delta_1 \\ \delta_2 \end{bmatrix} [y_{t-1} - \beta x_{t-1}] + \begin{bmatrix} \varepsilon_{xt} \\ \varepsilon_{yt} \end{bmatrix} \quad (17)$$

Where both error terms ε_{xt} and ε_{yt} are white-noise disturbances and may be correlated. Short- and long-run of the two variables X_t and Y_t change in response to stochastic shocks represented by ε_{xt} and ε_{yt}, and also in response of the deviation from the long-run equilibrium. The long-run equilibrium is achieved when $Y_{t-1}=\beta_{xt-1}$. The short-run adjustments are represented by δ_1 and δ_2, which interpret the speed of adjusted parameters.

Diagnostic and Stability Test

To ascertain the robustness of the model used, standard practice calls for Stability and diagnostic test. The aim of this test is to investigate the stability of the coefficient estimate as the sample size increases. We want to find out whether the estimates will be different in enlarge samples and whether they will remain stable over time. The stability of the estimated model is examined using the methodology of Cumulative Sum (CUSUM) and the Cumulative Sum of Squares (CUSUMQ) test proposed by Brown et al (1975). It states that, if the plot of CUSUM and CUSUMQ keep on within 5% significance level (depicted by two lines), then the coefficient estimates are said to be stable. The diagnostic test is based on serial correlation, normality of the residual and heteroskedasticity test statistics.

4. Analysis of the Results

4.1 Unit root results

For the sector analysis, this section presents discussions of all estimated results and findings from different tests. We present analyses of the results from the augmented Dickey–Fuller and Phillips–Peron tests for unit root in the variables. The second section presents the VAR and cointegration results from the Johansen cointegration test, carried out from the estimated VAR to show the long-term relationship among the selected variables. Results from analyses of the diagnostic tests executed on the VAR are also presented, in order to check for stability and normality and Section four presents an analysis of the long-term and short-term dynamics from the VECM.

The present study followed the unit root test procedure discussed in the previous section. The augmented Dicky–Fuller (ADF) and Philips–Peron (PP) tests were performed to investigate unit root in the series further. The results of the augmented Dicky– Fuller and Philips–Peron tests are reported below in table 1 and 2. Both tests were carried out at levels with trend and intercept. The automatic lag selection by Swarz info criterion was used.

Table 1 Unit root results at level

ADF			
Variable	Specification through DSR procedure	ADF 5% Critical Value	ADF Stat
STFP	Trend and Constant	-3.4536	-2.3733
ITFP	Trend and Constant	-5.6383	-2.5367
ATFP	Trend and Constant	-4.4363	-1.4368
FDI	Trend and Constant	-3.5806	-0.4501
PK	Trend and Constant	-2.9718	-0.5173
HK	Trend and Constant	-2.9718	1.1294
TOP	Trend and Constant	-2.9718	-1.3299
RER	Trend and Constant	-3.8388	-1.3663
INF	Trend and Constant	-1.9533	-1.7360
PP			
Variable	Specification through DSR procedure	PP 5% Critical Value	PP Stat
STFP	Trend and Constant	-3.4563	-2.3534
ITFP	Trend and Constant	-5.6638	-2.5648
ATFP	Trend and Constant	-4.4343	-1.4537
FDI	Trend and Constant	-2.9718	-2.4113
PK	Trend and Constant	-2.9718	-0.6658
HK	Trend and Constant	-2.9718	1.0836
TOP	Trend and Constant	-2.9718	-1.4427
RER	Trend and Constant	-3.8647	-1.3748
INF	Trend and Constant	-2.8373	-1.6548

Table 2 Unit root results at First Difference

ADF			
Variable	Specification through DSR procedure	ADF 5% Critical Value	ADF Stat
STFP	Trend and Constant	-2.6474	-4.7464
ITFP	Trend and Constant	-2.3573	-5.4337
ATFP	Trend and Constant	-1.9486	-5.3262
FDI	Trend and Constant	-2.9762	-3.6552
PK	Trend and Constant	-2.9762	-4.4951
HK	Trend and Constant	-1.9538	-7.0216
TOP	Trend and Constant	-2.9762	-4.6912
RER	Trend and Constant	-2.5373	-4.4363
INF	Trend and Constant	-2.9718	-3.7092
PP			
Variable	Specification through DSR procedure	PP 5% Critical Value	PP Stat
STFP	Trend and Constant	-2.3536	-4.8373
ITFP	Trend and Constant	-2.3554	-5.4546
ATFP	Trend and Constant	-1.9648	-5.3648
FDI	Trend and Constant	-2.9762	-6.5582
PK	Trend and Constant	-2.9762	-4.4971
HK	Trend and Constant	-2.9762	-4.2177
TOP	Trend and Constant	-2.9762	-4.6915
RER	Trend and Constant	-2.8377	-4.3663
INF	Trend and Constant	-2.9718	-3.7263

Before making any econometric estimation, it is necessary to conduct a unit root test to check the stationarity of variables in the model. This helps to avoid the problem of spurious regression and make meaningful estimations. We use Augmented Dicky Fuller and Phillip-Perron test to check for unit root or non-stationarity of the variables and subsequently, we apply differencing if variables are found non-stationary. Results from table 1 and table 2 show that, all variables were not stationary at level but became stationary after differencing them. Therefore, cointegration can be performed to investigate the long-run relationship between variables.

4.2 VAR and cointegration analysis

In order to establish a long-term relationship among variables, the Johansen cointegration approach was followed. For the procedure to be carried out there was a need to determine the optimal lag length of the VAR. Various information criteria were used to determine the maximum optimal lag length. In this study, three models were estimated for the agricultural, industry and services sector to establish the effect of FDI inflows on sectoral growth of Nigeria. The Johansen cointegration test requires an estimation of VAR equation.

In the agricultural model, variables ATFP, FDI, PH, HK, TOP, RER, and INF are entered as endogenous variables, and a dummy variable as an exogenous variable, to account for structural breaks in the variables. In the industry model, all variables are entered as endogenous variables, while in the services model, there is an inclusion of the dummy variable as an exogenous variable.

Diagnostic tests

Diagnostic tests were carried out on the residuals to check the validity of the VAR. These tests were performed to validate that the fitted model was reliable and fit. To avoid biased results, the model had to be tested for serial correlation, heteroscedasticity, normality and stability. The four tests performed were White's heteroscedasticity test, Jarque–Bera's normality test, the Lagrange multiplier (LM) test and the stability test. Results from the three tests are reported in table 3 below and the stability graphs are presented in figures 1, 2 and 3.

Table 3 Diagnostics Test Result

Test	Null hypothesis	Model	F-statistic	Probability
LM test	No serial correlation	Agriculture	46.55	0.15
		Industry	46.91	0.11
		Services	42.93	0.20
Jarque– Bera	There is normal distribution	Agriculture	26.38	0.32
		Industry	27.27	0.27
		Services	36.90	0.25
White test	No conditional heteroscedasticity	Agriculture	29.55	0.12
		Industry	32.35	0.14
		Services	30.41	0.08

All three sectoral models were tested. The Lagrange multiplier (LM) test was used to test for serial correlation. The results from the test showed that at lag 1, there was no serial correlation in the estimated VARs. Since the probability was more than 0.10, we failed to reject the null hypothesis of no serial correlation. The Jarque–Bera test showed that residuals were normally distributed. This stemmed from the evidence that the p-values were high and more than 0.10, with very high test statistics and, therefore, the residuals were normally distributed and the null was not rejected.

The third test was the White (1980) test for heteroscedasticity with no cross-terms. All three models satisfied that the residuals were linear and that the variance of the errors was constant across observations. The p-values were acceptable over 0.05; therefore, we failed to reject the null. The last diagnostic test was the stability graph (figure 1, 2 and 3) where the three graphs showed that the lines lie inside the critical band width, and none lay outside the band with.

It can be concluded from the stability check that the specified VARs were both stable and well specified. However, based on the above diagnostic tests of the VAR, cointegration was carried out to check for a long-term relationship among the variables. The Johansen cointegration results are reported and analysed in tables 4, 5 and 6 below.

Johansen Cointegration Test Results

Following the Johansen cointegration procedure, a long-run relationship among variables was tested from the estimated VARs of the three sectors. A summary of results of the cointegration tests are reported in table 4, 5 and 6.

Table 4: Agriculture sector cointegration results

Null hypothesis H0	Alternative H1	Trace statistics	0.05% critical value	Max-Eigen statistics	0.05% critical values
R=0	R≤1	171.36*	102.73	77.926*	48.07
R≤1	R≤2	122.39*	95.75	46.84*	40.08
R≤2	R≤3	75.55*	69.82	30.94	33.88
R≤3	R≤4	44.61	47.86	28.36	27.58
R≤4	R≤5	16.24	29.80	11.68	21.13
R≤5	R≤6	4.5	15.49	4.26	14.26
R≤6	R≤7	0.31	3.84	0.30	3.84

Source: Author's calculations from Eviews 10.
* denotes rejection of the hypothesis at the 0.05 level

Table 5 Industry sector cointegration results

Null hypothesis H0	Alternative H1	Trace statistics	0.05% critical value	Max-Eigen statistics	0.05% critical values
R=0	R≤1	127.37*	103.73	87.38*	53.47
R≤1	R≤2	104.99*	95.75	41.67*	40.08
R≤2	R≤3	63.29	69.82	28.39	33.88
R≤3	R≤4	34.89	47.86	17.43	27.58
R≤4	R≤5	17.46	29.80	10.03	21.13
R≤5	R≤6	7.43	15.49	7.40	14.26
R≤6	R≤7	0.03	3.84	0.03	3.84

Source: Author's calculations from Eviews 10.
* denotes rejection of the hypothesis at the 0.05 level

Table 6 Industry sector cointegration results

Null hypothesis H0	Alternative H1	Trace statistics	0.05% critical value	Max-Eigen statistics	0.05% critical values
R=0	R≤1	126.82*	98.36	88.48*	46.23
R≤1	R≤2	122.71*	95.75	51.17*	40.08
R≤2	R≤3	71.54*	69.82	30.03	33.88
R≤3	R≤4	41.51	47.86	24.10	27.58
R≤4	R≤5	17.41	29.80	12.59	21.13
R≤5	R≤6	4.81	15.49	4.68	14.26
R≤6	R≤7	0.14	3.84	0.14	3.84

Source: Author's calculations from Eviews 10.
* denotes rejection of the hypothesis at the 0.05 level

A summary of the cointegration results from the tables shows that cointegration was found among the variables in all sectors, which means that there was a long-term relationship among them. All three models indicated a linear deterministic trend, and were estimated under the assumption that there was intercept but no trend in the cointegrating equation in the VAR. The Johansen cointegration test used both the trace and Max-Eigen test statistics. These two test statistics can yield different numbers of cointegration among variables.

The agricultural and industry models showed three cointegrating equations from the trace statistic and two cointegrating equation from the Max-Eigen statistics, the service model showed two cointegrating equation from each of the trace and Max-Eigen statistics. With the complexity of explaining multiple cointegrating equations, this study adopted the Max-Eigen value statistics to estimate the VECM, since it has a more precise alternative hypothesis that pinned down the number of cointegrating vectors (Enders 2004). For this reason, it can be concluded that there was a long-term relationship among the variables, and the VECM model could be estimated to detect the long-term and short-term dynamics of these variables.

Long-run VECM results

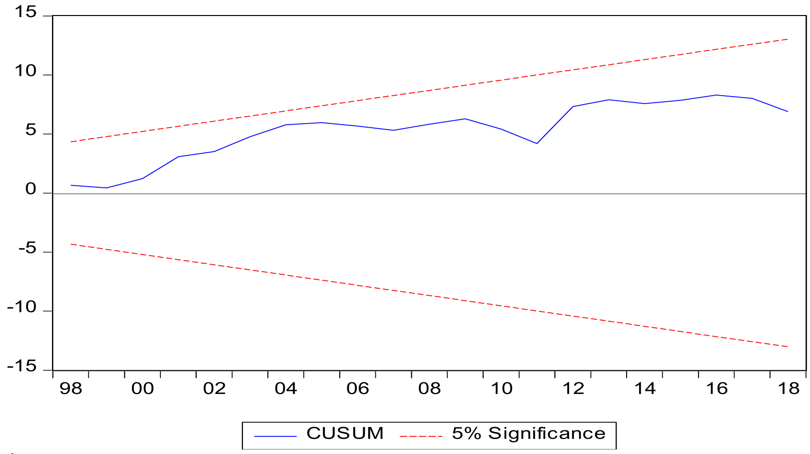
The VECM model was specified after detecting the cointegration among variables. It specified the long- and short-run relationships, and used the coefficients to show the long-run effect among variables. In order to ensure convergence was achieved after iterations, cointegration restrictions were imposed to the parameter matrices. With the adoption of one cointegrating equation, at least one restriction had to be imposed on the long run parameter. Therefore, the dependent variables (ATFP, ITFP, and STFP) were restricted to 1. The agriculture model had three restrictions, one in the long -run and two in the short-run. The services model also had three cointegrating restrictions. The industry model had four restrictions. All the restrictions in the three models were binding, and satisfied the identification rank condition. The restrictions on the speed of adjustment (short-run) coefficients were the result of the insignificance effect the variables had on the short-run adjustments. A summary of the long-run parameters is reported in Tables 7, 8, and 9.

4.3 FDI and TFP in the Agricultural Sector

Table 7: Agriculture normalized long-run estimates

Dependent variable is ATFP	
Independent variables	Coefficient
C	11.89
FDI	-0.024 (-5.22)
PK	0.544 (3.26)
HK	0.286 (4.63)
TOP	0.584 (2.43)
RER	-1.626 (-7.21)
INF	0.056 (7.25)

Source: Author's calculations from Eviews 10



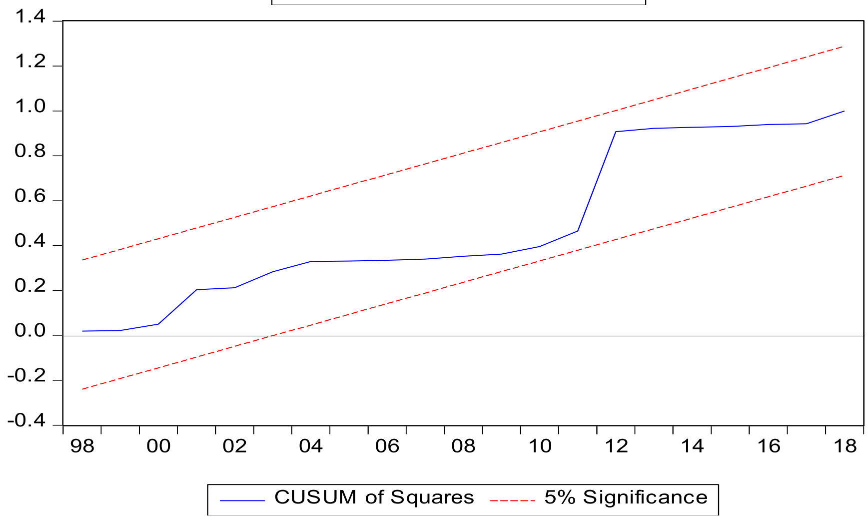


Figure 1 Agricultural sector model stability result

Long-run estimates of the agricultural sector showed that FDI had a negative long-run relationship with the growth of the agriculture sector. The result showed that 1USD million (translated from -0.024) units increase in FDI, decrease the agricultural TFP by 0.024 percent. Empirical studies found that FDI tended to be insignificant for the growth of agriculture, because FDI inflows had little spillover potential for the sector. Theories on the relationship between FDI and growth are usually formulated for the manufacturing industry (Alfaro 2004). On the other hand, an increase of 1 percent in gross fixed capital formation (physical capital) would increase the sector's TFP by 0.54 percent. This is a significant effect on the agriculture sector, as it relies on the input of land; therefore, the development and purchase of land can grow the output of the sector. Nigeria is committed to trade agreements with countries like the United States in exporting their agricultural products; therefore, the development of the agriculture sector is important.

Empirical evidence has shown that open economies will experience higher economic growth than closed economies. The results for the long -run showed that a percentage increase in the rate of openness would increase the TFP of the agriculture sector by 0.58 percent. Nigeria has seen significant growth in trade after 1998. The country exports agricultural products like Cocoa beans, cocoa paste, coconuts, Brazil nut and Cashews to countries like the India, Switzerland, China, South Africa, and the United Arab Emirates. These are the top five countries to which Nigeria is committed to trade agreements with and exports its products. Results show that the real effective exchange rate has a negative long-run relationship with growth of the agriculture sector. An increase of 1 percent in the real effective exchange rate (real depreciation of the Nigerian currency) will decrease the growth in the sector by 1.62 percent in the long-run. A strong currency may reduce export competiveness of the sector, but would increase the value for money when importing goods and services. The long-standing Balassa–Samuelson hypothesis by Balassa (1964) and Samuelson (1964) individually argued that there is a positive relationship with the appreciation of the real effective exchange rate and growth. Many empirical studies, such as Kalyoncu et al. (2008) concur with the hypothesis that depreciation has a negative effect on output and employment.

Further to this, the results of the VECM depicted that agriculture growth had a long-run significant relationship with inflation. In contradiction of inflation relative to growth theories, some evidence has found that high inflation could be positive for economic growth. Keynes (1935), however, claims that some inflation is necessary to prevent the paradox of thrift in the economy, meaning that when consumers' income rises, their savings may rise faster than will consumption, and that will decrease the aggregate demand and eventually economic growth. Since output in the agricultural sector is seasonal, short-run disturbances will mostly determine the supply curve in the sector. Therefore, farmers may be attracted to produce more output as prices increase. Given this, the results indicate that an increase of 1 percent in inflation could lead to an increase of 0.056 percent in the TFP of the sector.

4.4 FDI and TFP in the Industry Sector

Table 8: Industry normalized long run estimates

Dependent variable is ITFP	
Independent variables	Coefficient
C	20.60
FDI	0.386 (6.27)
PK	0.493 (5.83)
HK	0.372 (4.62)
TOP	-0.293 (-2.73)
RER	0.437 (6.89)
INF	-0.509 (-3.66)

Source: Author's calculations from E-views 10

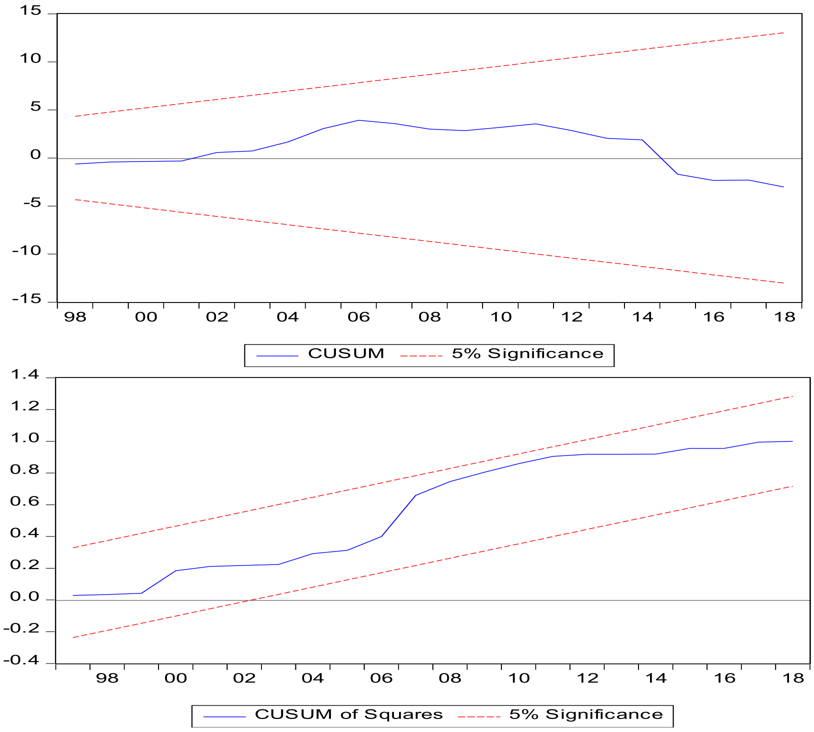


Figure 2 Industry sector model stability result

Results from table 8 above for the industry sector model reported that FDI had a significant long-run relationship with the TFP of the sector, implying that a 1USD million unit increase in FDI would increase the industry TFP by 0.386 percent. Ghana has seen growth in some mining industry, one of the largest industries to contribute to the GDP. Therefore, FDI has played a positive role in the growth of the industry sector. A physical capital and human capital increase of 1 percent would cause a 0.49 and 0.37 percent increase in the TFP respectively of the industry sector. The implication of this positive effect is imperative for the industry sector. Improvement in human capital, Improvement and purchase of equipment, land and construction of roads is important to the development and growth of the industry sector.

In contrast to empirical literature, the rate of openness has a negative effect on the TFP of industry. This shows that an increase of about 1 percent in the level of openness would result in a decrease of about 0.29 percent in the level of the TFP. However, evidence has shown that trade provides growth opportunities but also exposes them to external shocks. Rodrik (1997) argues that open economies are subject to external shocks and they are vulnerable to output volatility. Rodrik further notes that most open economies have large governments that are able to handle the shocks, but that this might not work for developing economies.

Real effective exchange rate had a positive effect according to the long-run results, showing that an increase of 1 percent would cause an increase of 0.43 percent in the TFP of the industry sector. The depreciation of the Nigerian currency has a positive effect in growing the economy of the industry sector. The industry sector will export more and show increased competitiveness with other countries. Alternatively, the deprecation of the increases the cost of imports, and also increases input cost of locally produced goods that depend on imported inputs. Therefore, the relationship between real effect exchange rate and growth can be either positive or negative.

Inflation proved to have a negative effect on the sector in the long-run, by showing results of a percentage increase to cause a decrease in the TFP of the industry sector by 0.50 percent. Unstable and high inflation declines business confidence of a country, as businesses cannot be sure what their product prices and costs will be, due to the volatile inflation. In addition to this, foreign investors will be discouraged when trying to find a new market and finding that prices will be high; thus, both domestic and foreign manufacturers will have less competitive advantage. Nigeria has set out an inflation targeting strategy as part of their monetary policy tool, to target low inflation. The inflation targeting strategy has been successful in keeping the inflation rate in target for the past few years, and therefore it is best to keep inflation low and positive for the economy. The industry sector is the second largest sector in Nigeria that depends on export and imports, as well as multinationals. Growing business confidence in the sector requires the sector to be kept healthy for more growth, which is necessary for keeping key macroeconomic variables in place.

4.5 FDI and TFP in the Service Sector

Table 9: Services normalized long-run estimates

Dependent variable is STFP	
Independent variables	Coefficient
C	12.91
FDI	0.142 (6.10)
PK	0.389 (5.73)
HK	0.182 (3.70)
TOP	-0.327 (-3.73)
RER	0.437 (3.34)
INF	-0.327 (-5.80)

Source: Author's calculations from E-views 10

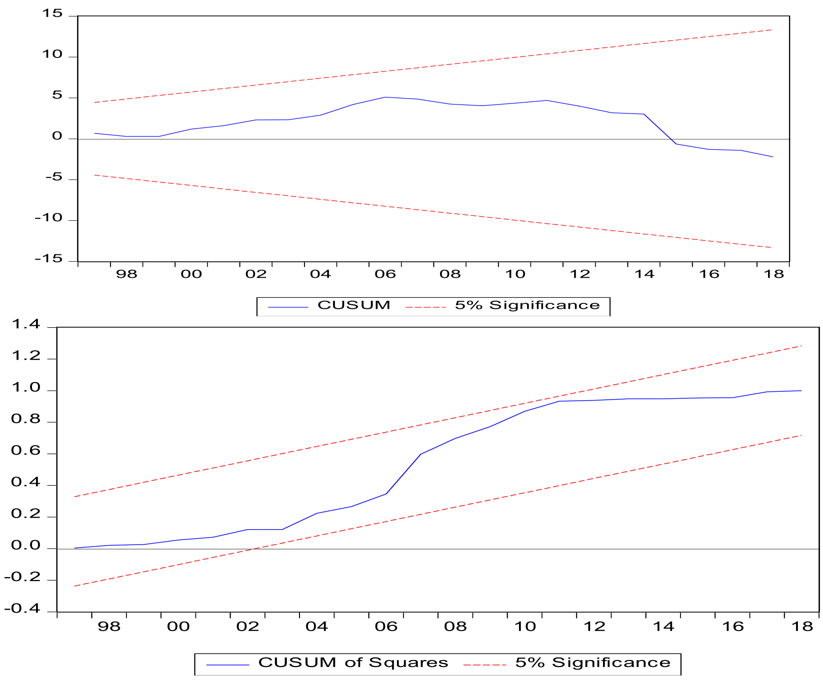


Figure 3 Service sector model stability result

Results for the services sector indicated that FDI had a significant long-run effect on the TFP of the services sector. Results showed that USD million units increase in FDI would increase the TFP of the services sector by 0.142 percent. The benefit of FDI in the services sector has been positive for the country, since the Nigerian economy started to move away from the primary sector towards the tertiary sector. This sector is also the largest recipient of FDI among all three key sectors in Nigeria, as FDI has caused a spillover of managerial skills and technology to the services sector. Services offered by the services sector play a role as inputs in both the industry and agriculture sectors. Therefore, the increase in FDI in the services sector will not only benefit the growth of the services sector, but will spill over to the other sectors too.

An increase of 1 percent in physical and human capital will cause a 0.389 and 0.182 percent increase respectively in the TFP of the services sector. An economy uses accumulated capital stock together with labor force to provide goods and services, and increase production. Therefore, an increase in gross fixed capital formation will grow the services sector by increasing national income, and ultimately economic growth. Further to this, the results from the long-run estimates showed that trade openness had a negative relationship with the growth of the services sector. The results indicate that a 1 percent increase would decrease the sector's TFP by 0.327 per cent. The results are not supported by theory that trade openness leads to an increase in growth. However, results like this can mean that trade openness will not benefit the services sector in the long-run.

Real effective exchange rate has a positive effect according to the long-run results. This entails that 1 percent increase in real exchange rate will cause an increase of 0.437 percent in the sector's TFP. Currency depreciation works well for exports, as they will increase and induce growth. Inflation shows a negative effect on the long-run TFP for the sector. An increase of 1 percent in inflation would cause a decrease of 0.327 percent in the TFP of the service sector. High inflation is not ideal for growth in the services sector, where an increase in prices will lead to less demand for services.

In consolidation of the long-run estimates, FDI attested to have a positive relationship with sectoral growth for industry and services. However, FDI had a negative long-run effect on agricultural growth, which is similar to empirical studies that found the effect of FDI on agricultural sector to be insignificant. Developing economies have started to rely less on the primary sector, and are moving to the secondary and tertiary sectors as a base for economic growth. Theory states that FDI would have a positive effect on growth, but Alfaro (2004) states that this differs from sector to sector, and most empirical studies found that FDI has little or no effect on agricultural growth. However, the positive effect of FDI on industry and services growth shows that foreign investors are moving their motive to invest from resource seeking to market seeking. Industry and services proved to have bigger markets in the economy by growing faster than the agriculture sector over the years. The speeds of adjustment (short-run estimates) coefficients are presented in table 10 below.

Table 10: Speed adjustment and short-run results

Agriculture model		Industry model		Services model	
Variable	Coefficient	Variable	Coefficient	Variable	Coefficient
ATFP	-0.05 (-1.49)	ITFP	-0.03 (-1.61)	**STFP**	-0.02 (-1.12)
FDI	-1.23 (-1.59)	FDI	1.16 (5.15)	**FDI**	6.69 (3.97)
PK	0	PK	0	**PK**	-0.00 (-0.04)
HK	0	**HK**	0	**HK**	0
TOP	0		0		0
RER	-0.04 (-1.66)	**RER**	0	**RER**	0
INF	0.36 (4.14)	**INF**	-0.47 (-1.37)	**INF**	-0.68 (-3.11)

The purpose of speed adjustment is to show the dynamic adjustment of the variables towards the long-run equilibrium. In the present study, restrictions were imposed on the short-run adjustment coefficients based on their significance effect in the long-run adjustments. The agriculture model showed that TFP would be corrected by about five percent per year, so as to restore equilibrium. The negative sign in the table above shows that TFP will move closer towards equilibrium. The industry and service TFP would be corrected by three and two percent per year, respectively. All speed adjustments are significant, with the negative t-values. Short-run restrictions were imposed on variables that were taken to have an insignificant effect on growth in the short run. FDI has a positive significant relationship with sector TFP in the industry and services, but has a negative effect on the agriculture sector TFP. A similar case as in the long-run, it was evident from results of the short run that FDI had a significant effect on the agriculture TFP, but it had a negative effect on the industry and services sector.

5. Conclusion and policy recommendation

5.1 Conclusion

The purpose of this study was to investigate the effect of FDI in sectoral growth in Nigeria for the period 1990–2022. The three key sectors included in the study were agriculture, industry and the services sector. The significance of investigating the effect of FDI on sectoral growth was that there limited studies have so far been conducted on the effect FDI inflows have on growth of different sectors in Nigeria.

This study used Neuhaus's (2006) new FDI-growth model as a scheme to show the effect FDI has on TFP growth on three sectors. The theoretical framework proved that FDI could affect growth through human capital. The study used econometric techniques to follow the Johansen approach to analyze the long-run and short-run effect of FDI on sectoral growth in Nigeria. Unit root tests were performed using the augmented Dicky–Fuller and Philips– Peron tests, and variables were found not to be stationary at level. Variables became stationary after being differenced once. As the Johansen approach requires, three VAR equations were estimated for agriculture, industry and the services. The Johansen cointegration test was performed on the estimated VARs to check for long-term relationships. Results established that there was a long-term relationship between variables. Cointegration restrictions were imposed on the parameter matrices to ensure convergence. The VECM models were specified for long-and short-run estimates after discovering cointegration among variables.

Results from the econometric analysis showed that, at the time of the research, FDI had a negative long-run relationship with growth of the agriculture sector. The results for industry sector revealed that FDI would increase growth in the sector. Growth of the services sector would increase when there is an increase in FDI in the long -run. Diagnostic tests performed on the estimated VARs proved the VARS to be stable and normal.

5.2 Policy recommendation

A number of empirical studies found that FDI inflows have an insignificant effect on the growth of the agriculture sector. Despite this, it is proclaimed that multinationals in the agriculture sector could contribute to enhancing export promotion. FDI and trade are known to be complements of each other; hence, an increase in FDI in a sector would induce export growth and employment in that sector. An increase in employment by attracting FDI in a sector would assist in reaching the first of the Millennium Development Goals (MDGs), in which Nigeria took part with a number of other nations in order to reduce poverty, amongst other goals. However, results from the present study concluded that FDI had an insignificant relationship with growth in the agriculture sector, both in the long run and the short-run. This can be attributed to the fact that the agriculture sector has less potential in gaining from what FDI offers to grow the economy, namely technology, and spillovers. FDI inflows into Nigeria are mostly concentrated in the manufacturing and the services sectors. Nevertheless, the agriculture sector could benefit from the increase of FDI through the other sectors. Agro-processing subsector products are inputs in the manufacturing sector, where the growth of the agro-processing sector will be a positive growth for the agriculture sector.

Conversely, a sector like industry would benefit substantially from an increase in FDI inflows. The industry sector is the second largest receiver of FDI in Nigeria out of all three key sectors. Subsectors include manufacturing, mining, construction, electricity, water and gas. These subsectors have attracted Greenfield investments in abundance in the past years. The new endogenous growth model by Neuhaus (2006) states that FDI Greenfield investment could have a positive effect on growth through the transmission channel, by stating that foreign companies directly use new advanced production technologies, and if these new technologies are used in the intermediate production process of capital, they can improve the existing capital stock by increasing it or improving the quality of the capital in the host country. New, advanced technology for the industry sector would increase its growth.

The services sector is the number 1 recipient of FDI, not only in Africa, but also in Nigeria. The growth in FDI inflows into the sector has played a role in making the sector to contribute more than other sectors towards the overall GDP for some time. In that regard, the sector's growth makes Nigeria even more desirable to potential investors.

Nigeria needs to keep robust bilateral investment treaties with other countries, since those countries are the main sources of FDI inflow into the country. Lowering taxes imposed on businesses and relaxing exchange rate regulations would encourage investors to invest in Nigeria. As FDI flows into different sectors and has a different effect on the sectors, it is recommended to have incentives tailored for these different sectors. For now, Nigeria has incentives offered in service industry for foreign investors, a few of which could be developed for other subsectors in the services sector, as it is the largest recipient of FDI. Existing multinationals need aftercare and reassurance to keep their investment in the country, so there can be less disinvestment and more FDI inflow across Nigeria borders.

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