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Technology Transfer, Foreign Direct Investment and Economic Growth in Nigeria

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Abstract

The aim of this study is to investigate the long-run equilibrium relationship between various international factors and economic growth, as well as to assess the short-term impact of inward FDI, trade and economic growth on international technology transfer to Nigeria. To achieve this, the study used a time series data from 1970 to 2010. A multivariate co-integration technique developed by Johansen and Juselius (1990) was employed to investigate the long-run equilibrium relationships between the international factors and economic growth. The results of the analysis affirmed the existence of co-integrating vectors in the systems of this country during the study period (Lee and Tan 2006). The short-term impact of inward FDI, trade and economic growth on international technology transfer to Nigeria was also tested via Granger Causality test, based on Vector Error-Correction Model. The results of the test revealed a short-run causal effect either running unidirectionally or bidirectionally among the variables for the country. Policy implications are highlighted at the end of this article.

Résumé

Le but de cette étude était d'étudier les relations d'équilibre à long terme entre les facteurs internationaux et la croissance économique, ainsi que d'évaluer l'impact à court terme des IED, du commerce et de la croissance économique sur le transfert de technologie de la scène internationale vers le Nigeria. Cette étude a été réalisée en utilisant des données de séries chronologiques de 1970 à 2010. La technique de co-

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intégration multivariée développée par Johansen et Juselius (1990) a permis d'étudier les relations d'équilibre à long terme entre les facteurs internationaux et la croissance économique. Les résultats de l'analyse ont affirmé l'existence de vecteurs de co-intégration dans les systèmes de ce pays pendant la période de l'étude (Lee et Tan 2006). L'impact à court terme des IED, du commerce et de la croissance économique sur le transfert international de technologie vers le Nigeria a également été testé par l'intermédiaire d'essais de causalité de Granger, basée sur le Model de Correction des Vecteurs d'Erreur. Les résultats du test ont révélé un effet de causalité à court terme soit en cours d'exécution unidirectionnelle ou bidirectionnelle entre les variables pour le pays. Les implications politiques sont mises en évidence à la fin de ce rapport.

Introduction

Debate in the literature on the perceived benefits of an increased openness to trade is on the increase. Although few scholars advocate the imposition of trade restrictions (Rodriguez and Rodrik 1999), the general feeling seems to be that traditional analyses may well understate the true cost of protectionism since most of the analyses utilized static models, while ignoring the dynamic costs of trade protection (Saggi 2002). Underlying this view is the notion, that, somehow, trade of goods and services, Foreign Direct Investment (FDI) and interaction among countries in various other forms all play a crucial role in improving not only the global allocation of physical resources but also in transmitting technology globally (Dollar 1992; Sachs and Andrew 1995). It is also important to know that technology or knowledge is often transferred at a cost, and most empirical evidence have shown that it is indeed costly to transfer technology internationally (Teece 1976; Mansfield and Romeo 1980; Ramachandran 1993).

The dynamic effects of trade have been studied extensively in the literature. Much of the relevant studies emphasize two intertwined aspects of the relationship between trade and technology: 'that trade alters the allocation of resources in an economy and plays a role in transmitting knowledge internationally' (Saggi 200:194). The benefits from free trade and from allowing the maximum technological advancement are well known. Many studies have shown that free trade enhances the transfer of technology, and technology transfer may still have been very much a positive sum game (Craig and DeGregori 2000). However, due to the general perceived positive spillovers from inward Foreign Direct Investment (FDI), the past two decades have seen most developing and emerging economies change from a radical view of FDI and trade, towards a more friendly view, by using FDI and trade as strategies for positive spillovers to local firms, in their quest for

development (Sasidharan and Ramanathan 2007). Consequently, international trade and Foreign Direct Investment (FDI) are considered to be the two major channels that facilitate the flow of knowledge spillovers (Lee and Tan 2006).

Given the impact of trade, FDI and technology transfers on economic growth and development, a survey on the role of trade and FDI as channels (Saggi 2002) of international technology transfer, domestic investment, and growth is imperative, hence, the specific objectives of this paper are multi-fold: (a) to investigate the long-run equilibrium relationships among the international factors (international technology transfer, FDI flows, and trade) and economic growth (as proxy by GDP) in Nigeria; (b) to assess the short-term impact of inward FDI, trade and economic growth on international technology transfer in Nigeria. The paper also argues that while many scholars have done a decent job of outlining the various potential channels through which international technology transfer occur little is known, both in theory and practice, about the relative importance of each of these channels and how exactly this transmission occurs, hence, the lack of knowledge automatically limits our understanding of the roles that policy plays in facilitating the process of international technology transfer (Saggi 2002).

This study was motivated by the centrality of technology to development and the reliance of technology-poor developing countries on its transfer from industralised or emerging countries. It is also imperative to attract foreign direct investment, which is a critical factor for both technology transfer and economic growth in all developing nations. This paper is divided into five sections. Section one is the introduction, which includes the general background of the study, statement of the problem under study and objective(s) of the study. Section two contains the review of relevant literature. Section three depicts the adopted research methodology. Section four includes the analysis and discussion of findings; and finally, section five presents the conclusion and implication for practice.

Review of Relevant Literature

International Trade, FDI and Economic Growth

Foreign Direct Investment (FDI), usually in form of greenfields investment, mergers and acquisitions, or other cooperative agreements, has been a major source of skills, equipment, productivity and technological transfers, for the most part from developed countries to developing countries. This is based on the notion that domestic firms in developing countries benefit from the FDI externalities through improved productivity, employment, exports and international integration (Costa and De Queiroz 2002; Lall 1997). In supporting the favourable disposition of countries toward encouraging FDI, advocates

of free market economy claim that MNEs generate spillovers which benefit the host economy, which are usually reflected in improved productivity, know-how, and other benefits (Fosfuri *et al*. 2001). According to Meyer (2004), spillovers are usually generated by non-market transactions, especially when knowledge is transferred to host country firms without any contractual relationship with the foreign MNEs.

The theory of the effect of trade policy regime on FDI, trade and growth in a given host country was first presented by Bhagwati (1978) as an extension to his theory of immiserizing growth and further developed by Bhagwati (1985 and 1994), Brecher and Diaz-Alejandro (1977), Brecher and Findlay (1983). Known as the 'Bhagwati hypothesis', it postulates that FDI inflows coming into a country in the context of a restrictive, import-substitution (IS) regime can retard, rather than promote growth. This is because in an IS regime, FDI mostly takes place in sectors where the host developing country does not have comparative advantage, hence, FDI becomes an avenue for foreign companies to maintain their market share and to reap the extra profit created by the highly protected domestic market.

On the other hand, under the export promotion (EP) regime, the main incentives for FDI in a given host country are the relatively low labour costs and/or the availability of raw materials. This allows the foreign investors to operate in an environment that is relatively free from distortions and to increase production of internationally competitive and export oriented product lines (Edwards 1998). In addition, since the production of firms in an EP regime is not limited by the size of the domestic market, there is increased potential for foreign companies to reap economies of scale through international market penetration (Edwards 1998; Kohpaiboon 2002). It is imperative to know that, despite the unique advantages of FDI, local policies of the host country, especially in developing nations, often make pure Foreign Direct Investment unfeasible, so foreign firms choose licensing or joint ventures (Saggi 2002). In all, the relationships between the various channels of International Technology Transfer (ITT) are complex. While trade and FDI are often complements, FDI and licensing may be either complements or substitutes (Hoekman *et al*. 2004). In terms of technology transfer advantage of Trade and FDI, it is important to distinguish the direct effects on the affiliate in the host country and on the host economy, as well as the positive spillover effects through the demonstration to other producers in the host economy of new technologies and management methods. The third area of technology development (namely the deliberate development of new technologies by R&D) is also very crucial in technology transfers (Grossman and Helpman 1995).

In relation to the direct effects of technology transfer by the multinational firm, the dominant model in contemporary literature is the Dunning Eclectic or Ownership, Location and Internalisation (OLI) model (Markusen 1995). According to this model, firm-specific assets (such as product patents and processes and know-how) can be used at no extra cost in more than one plant and therefore in more than one country. Furthermore, the preference for internal rather than arm's length transfer of technology across countries may be explained by the same public goods characteristic of knowledge capital that explains multi-plant production (Lloyd 1996). According to Granstrand (1998), the resources of a firm can be classified as tangible (physical and financial capital) or intangible. Intangible resources are either disembodied (patents, licenses, brand names and designs) or embodied (for example, competences like management skills). While technology is 'a body' of knowledge about techniques, knowledge is an intangible firm resource and this special characteristic often make it expensive to acquire, although relatively inexpensive to use once acquired. Hence, Granstrand (1998) argued that technology is a 'special kind of knowledge' that shares the general properties of knowledge but also has special characteristics distinguishing it from other types of knowledge (Johnson 2006:11). He however linked technology to artefacts and science, with a high degree of codifiability, used for practical applications and is capable of being protected by patent rights. Given the background of Granstrand's work, many literatures generally found the existence of significant cross-country knowledge spillovers in both disembodied and embodied forms (Lee and Tan 2006).

Some empirical studies (Chakraborty and Basu 2002; Love and Chandra 2004) also supported the theory that trade and FDI function as engines of growth, through government's trade and FDI liberalization policies. This is also collaborated in Tian *et al*. (2004), by stating that increased FDI ratio is likely to lead to rapid economic growth. Hence, Tian *et al*., concluded that FDI and trade should be encouraged in the less developed economies to accelerate technological change and economic growth, since the two serve as motivation for the advanced countries to be more innovative and allow developing countries to draw upon the stock of knowledge created by their innovations. Contrary to these positive conclusions, past studies on the impact of trade, FDI and the diffusion of technology on economic growth have produced mixed results. Basant and Fikkert (1996), Singh (2003) and Young and Lan (1996) are not so optimistic about the importance of trade and FDI in the growth process. Singh (2003), argued that trade contributes to productivity growth in only some unique industries, rather than all industries in an economy. Other studies like Young and Lan (1996), observed that FDI

flows from industrialised countries have more weight in the diffusion of technology than those from developing countries. In addition, Chakraborty and Basu (2002) warn that the impact of FDI on growth is not always positive, a warning that is also shared by Greenaway and Sapsford (1994) and Behzad and Reza (1995) about the impact of trade in the diffusion of technology on economic growth.

Trade and Foreign Direct Investment (FDI) in Nigeria

The Heckscher-Ohlin Theorem states that countries tend to export the goods whose production is intensive in factors with which they are abundantly endowed (Mahe 2005). Due to lack of capacity development, Nigeria relies on the US, the UK and Western Europe for the importation of strategic capital goods like machinery and equipment, where it lacks a comparative advantage, while the greater percentage of her exports, mostly primary products, are targeted toward US markets. Given the importance of trade, international trade can make a decisive contribution to sustainable development by promoting the equitable integration of Nigeria into the global economy, which can significantly boost economic growth (Okejiri 2000). However, trade and investment liberalization will provide maximum benefit to Nigeria 'when it is operating within a sound supporting domestic policy framework and pursued in tandem with political will' (Mahe 2005).

Although tariffs provide the Nigerian government with its second largest source of revenue after oil exports, in order to increase the country's technology capabilities, import policies were revised in March 2003 (Okejiri 2000). This led to the reduction of tariff on strategic imports, mostly raw materials, base metals, and capital equipment, to as low as 2.5 percent. Despite this effort by Government, the poor level of Intellectual Property Rights (IPR) protection due to poor enforcement of intellectual property laws, has been described as one of the barriers to innovation and technology acquisition in the country (Akinlo 2004). Moreover, considering the dilapidated state of Nigeria's infrastructure, the option of locating in a self-contained Free Trade Zone (FTZ) is compelling, where tax concessions and other incentives form an added benefit for improving profitability and project returns. After a slow start, the Nigerian government is again talking up the benefits of FTZs and fresh opportunities are emerging for investors, hence, investors will need little persuasion to set up in a more stable and cost-efficient environment (Eedes 2005). In research conducted by Ibrahim and Onokosi-Alliyu (2008), using co-integration techniques, the paper examined the determinants of Foreign Direct Investment (FDI) in Nigeria during 1970-2006. The results observed that the major determinants of FDI were market size, real exchange rate and political factors.

Furthermore, by performing simulations using impulse response and variance decomposition analysis, the result advised against uncontrolled trade liberalization. In a related research by Akinlo (2004), the paper explored the impact of Foreign Direct Investment (FDI) on economic growth in Nigeria, for the period 1970-2001. The ECM results showed an insignificant impact of both private capital and lagged foreign capital on the economic growth. These results seem to support the argument that extractive FDI might not be growth enhancing as much as manufacturing FDI. In addition, the output of this extensive research showed that export has a positive and statistically significant effect on growth, while financial development has a significant negative effect on growth, which might be due to the high capital flight it generates. Lastly, the research observed that labour force and human capital have significant positive effect on growth, hence, a suggestion for labour force expansion and education policy to raise the stock of human capital in the country (Akinlo 2004).

Given the pattern of FDI flows to Nigeria (mostly in the oil sector) and the apprehensions as regards the benefits from extractive FDI, several factors suggest that the indirect benefits of FDI may be less in extractive (especially the oil) industry. This is due to the fact that the extractive sector (such as oil sub-sector) is often an enclave sector with little linkages to the other sectors. Moreover, the transfer of technology between foreign firms and domestic ones may be less in extractive industries where the technology embodied is often extremely capital intensive (Akinlo 2004). Based on recent trends, there is high expectation that much of these investments would be supported by private international inflows, mainly from China, Russia and the Middle East. There is also expectation of a continued influx of capital from the official donor sector, which will likely be targeted towards longer-term large-scale infrastructure investments, as well as Nigeria's budget (Leigh 2008).

Research Methodology

This research employed time series data of the selected country, from 1970 to 2010. Multivariate co-integration analysis, Granger-causality tests within the framework of Vector Error-correction Model (VECM) were used to analyse the dynamic relationships among technology transfer, FDI, international trade, output and domestic investment (Johansen and Juselius 1990).

Data Sources

The following sources of data were used in this article: the Import of Machinery (IMPM) data were collected from the United Nations Commodity Trade Statistics (UNCTS) Database, Nigeria National Bureau of Statistics, and the World Trade Organisation (WTO) Statistics database. Real Gross

Domestic Product per capital (GDP), Export and Import data were sourced from the United Nations Statistics Database (UNdata), the United Nations Conference on Trade and Development (UNCTAD) handbook of statistics, and World development indicators (WDI) ONLINE (World development indicators online). FDI and Domestic investment figures were from the United Nations Conference on Trade and Development (UNCTAD) FDISTAT Database, International Monetary Fund (IMF), and the United Nations Statistics Database (UNdata). Other sources were the International Monetary Fund (IMF) Database, International Financial Statistics (IFS) of the World Bank; publications of central bank of Nigeria and other agencies of government. The results were produced using EVIEWS 6.0.

Econometric Model

According to Asteriou and Hall (2007), econometric methods (models) can help to overcome the problem of complete uncertainty, by providing guidelines on planning and decision-making, as well as a way of examining the nature and form of the relationship among the variables. However, since models need to meet certain criteria in order to be valid, building up a model is not easy. Hence, sound decision-making is required on the variables to include in the model, so as not to cause unneeded variables mis-specification problems (too many variables) or omitted variables mis-specification (Asteriou and Hall 2007). Thus the following models were formulated:

$IMPM_t = a_1 + a_2 FDI_t + a_3 GDP + aDI + aEXP01 + aIMP + å\ldots$ equation (1)
FDI = b + bIMPM + bGDP + bDI+ bEXP01 + bIMP + å... equation (2)
GDP = c+ cIMPM + cFDI + cDI + cEXP01 + cIMP + å… equation (3)
DI = d+ dIMPM + dFDI + dGDP + dEXP01 + dIMP + å… equation (4)
EXP01 = e+ eIMPM + eFDI + eGDP + eDI + eIMP + å… equation (5)
IMP = f+ fIMPM + fFDI + fGDP + fDI + fEXP01 + å… equation (6)

Where

IMPM = Imports of machinery for host country
FDI = Foreign Direct Investment inflow to host country
GDP = Real Gross Domestic Product for host country
DI = Domestic investment of host country
EXP01= Exports of host country
IMP = Imports of host country
å = disturbance
a1…a7= unknown population parameters

The econometric model used in this analysis was based on past theoretical and empirical research of Kim and Seo (2003) and Lee and Tan (2006), and Madsen (2007). The model, as specified above, was in the form of a vector auto-regressive model (VAR) as used in Lee and Tan (2006:397). The researchers tried to identify the impact of technology transfer into the Nigerian economy through equation (1); while the impact of FDI, international trade and technology transfers towards output (GDP) was determined through equation (3). However, since Akaike Information Criterion-AIC (Akaike 1974) is one of the most commonly used in time series analysis, and for the fact that both AIC and Schwarz Bayesian Criterion-SBC (Schwarz 1978) are provided by EViews in the standard regression results output, both were considered in selecting the models for this study (Asteriou and Hall 2007).

Results and Findings

The estimated results of unit roots test

Due to the significance of the unit root in determining both the co-integration and causality analyses, the series in this study was tested for unit roots via the standard Augmented Dickey- Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests.

Table 1: The results of Augmented Dickey-Fuller (ADF) Test (Ho: a unit root)

	Level		First Difference	
Variables	Constant without Trend	Constant with Trend	Constant without Trend	Constant with Trend
Nigeria Model Variables				
DI	0.124335	-0.309808	-3.145541**	-3.361598***
EXP01	2.514984	1.442281	-3.301828**	-3.687529**
FDI	0.993062	-0.704361	-5.639046*	-6.088482*
GDP	0.172443	-3.352558	-6.807686*	-6.722904*
IMP	-0.282022	-0.737150	-4.567816*	-4.563187*
IMPM	1.268557	-0.224709	-5.805208*	-6.405380*

Note: Asterisks *, ** and *** denote statistical significant at 1%, 5% and 10% respectively. Lags are selected automatically by EViews 6.0.

These tests were performed using a statistical package known as EViews 6.0. The package automatically selects the number of lagged dependent variables in order to correct for the presence of serial correlation (Asteriou and Hall 2007). The standard ADF test was conducted for unit roots in the

levels (for both constant without trend and constant with trend) and first difference (for both constant without trend and constant with trend), given the automatically selected Schwarz Info Criterion and the maximum lags, in order to determine the number of unit roots in the series of Nigerian variables. The result is reported in Table 1. Although, the test was started with level, the result showed consistent results by rejecting the null (Ho: a unit root) hypothesis of a unit root at first difference, against the one-sided alternative whenever the ADF statistic is less than the critical value, at a statistically significant values of one percent, five percent and ten percent. Hence the researchers' conclusion is that the series is stationary.

Similar to the ADF test, the PP test for the country was conducted for unit roots in the levels (for both constant without trend and constant with trend) and first difference (for both constant without trend and constant with trend).

Table 2: The results of Phillips-Perron (PP) Tests (Ho: a unit root)

	Level		First Difference	
Variables	Constant without Trend	Constant with Trend	Constant without Trend	Constant with Trend
Nigeria(N) Model Variables				
DI	0.439370	-0.148130	-2.65569***	-2.604309
EXP01	2.320468	0.972072	-3.30182**	-3.74274**
FDI	1.763926	0.704361	-5.641124*	-6.086636*
GDP	0.018424	-2.356968	-6.769487*	-6.689742*
IMP	-0.809650	-1.275888	-4.613034*	-4.607808*
IMPM	1.599318	-0.295587	-5.888616*	-6.383675*

Note: Asterisks *, ** and *** denote statistical significant at 1%, 5% and 10% respectively. Lags are selected automatically by EViews 6.0.

The lag truncation was specified to compute the Newey-West heteroskedasticity and autocorrelation (HAC) consistent estimate of the spectrum at zero frequency, via the default Bartlett Kernel estimation method (Asteriou and Hall 2007). The results are reported in Table 2. The results presumed a rejection of null (Ho: a unit root) hypothesis of a unit root at first difference, against the one-sided alternative whenever the PP test statistic is less than the test critical values at a statistically significant values of one percent, five percent and ten percent. Hence, the researchers' conclusion is that the series is stationary.

The KPSS tests, for the country, was also conducted for unit roots in the levels (for both constant without trend and constant with trend) and first difference (for both constant without trend and constant with trend), via the default Bartlett Kernel estimation method and the Newey-West bandwidth; the results are reported in Table 3.

Table 3: The results of Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test

	Level		First Difference	
Variables	Constant without Trend	Constant with Trend	Constant without Trend	Constant with Trend
Nigeria Model Variables				
DI	0.325089**	0.14051***	0.293300	0.158950**
EXP01	0.507892**	0.14550***	0.195006	0.178243**
FDI	0.745004*	0.13006***	0.315861	0.117715
GDP	0.736431**	0.072152	0.116336	0.105210
IMP	0.414510**	0.112198	0.173065	0.133714
IMPM	0.648086**	0.14437***	0.321293	0.109837

Note: Asterisks *, ** and *** denote statistical significant at 1%, 5% and 10% respectively. Lags are selected automatically by EViews 6.0.

Lags are selected automatically by EViews 6.0. unlike the ADF and PP tests, the null (Ho: model is stationary) hypothesis of a stationary model was rejected at levels, hence, the degree of integration of these variables was further confirmed by the KPSS test as the result of the test showed that the null hypothesis of KPSS test is non-stationary, which is the reverse of those of ADF and PP tests (Masih and Masih 1996).

The test results of multivariate co-integration analysis

One of the major objectives of this study was to investigate the long-run equilibrium relationships among the international factors (international technology transfer, FDI flows, and trade) and economic growth (as proxy by GDP) in Nigeria. The multivariate co-integration technique developed by Johansen & Juselius (1990) was employed to determine these relationships, since the variables in the system of the country (Nigeria) were I(1), and may possess some kind of long run relationship. The test results are reported in Table 4.

After a series of selection processes using the likelihood ratio test with a potential lag length of 1 through 4, the results of the multivariate co-integration analysis reported in Table 4 indicated the existence of co-integrating vectors in the systems of this country. Based on the trace statistics, the researcher observed from the results that there were four co-integrating vectors in the model of Nigeria (at a lag interval of 1 to 3). Although only the trace statistics results are needed for the pantula principle method of model selection for co-integration testing, both the trace and the maximal eigenvalue statistics in the analysis indicated the existence of four co-integrating vectors for the Nigerian system (Asteriou and Hall 2007).

Table 4: Johansen's test results for Multiple Co-integrating Vectors

Order of Co-integration		Trace		Maximum Eigenvalue	
Null	Alternative	Statistics	C. V. (0.05 level)	Statistics	C.V (0.05 level)
		Nigeria Model			
		Variables: IMPM, FDI, GDP, DI, EXP01, IMP (*P*=2)			
r = 0	r ≥ 1	300.2901 *	117.7082	117.2672*	44.49720
r ≤ 1	r ≥ 2	183.0229 *	88.80380	70.35526*	38.33101
r ≤ 2	r ≥ 3	112.6676 *	63.87610	55.84345*	32.11832
r ≤ 3	r ≥ 4	56.8241 *	42.91525	35.06454*	25.82321
r ≤ 4	r ≥ 5	21.75966	25.87211	17.18951	19.38704
r ≤ 5	r = 6	4.570152	12.51798	4.57015	12.51798

Note: r indicates the number of co-integrating vectors. Asterisk (*) indicates rejection at the 95% critical value. C.V. denotes Critical Value.

The interpretation of this result (Table 4) implied that Nigerian models have a long-run equilibrium relationship with one another and were adjusting in the short-run via four identified channels (Lee and Tan 2006). As stated earlier, if two variables are co-integrated, the finding of no-causality in either direction is ruled out and the typical trends are eliminated from the variables involved. Although, the existence of co-integrating vectors (co-integration) in the systems of this country presumed the presence or absence of Granger-causality, it does not indicate the direction of causality between the variables. Hence, the direction of the Granger-causality was detected through the vector error-correction model (VECM) derived from long-run co-integrating vectors (Granger 1969; Lee and Tan 2006). It is important to point out here that temporal precedence does not imply a cause and effect relationship, but establishing the order of the temporal precedence can be very useful in understanding the nature of the relationships and policy recommendations necessary to ameliorate the situation (Onafowora and Owoye 2006).

The estimated results of Granger-causality tests

The second objective of this study was to assess the short-term impact of inward FDI, trade, and economic growth on international technology transfer into Nigeria during the selected period of study. The assessment involved testing the short-run Granger-causality among the variables for the country.

For a Vector Autoregressive (VAR) first-differences system with co-integrated variables, as depicted by the models in this analysis, the Granger-causality test was conducted in the environment of Vector Error-Correction Model (VECM) and the inclusion of the relevant error-correction terms, so as to avoid mis-specification and omission of important constraints.

Table 5: Granger Causality results based on Vector Error-Correction Model (Nigeria Model)

Dependent Variable	Independent variable [Wald Test Chi Square (Significance level)]						
	ΔIMPM	ΔFDI	ΔGDP	ΔDI	ΔEXPO1	ΔIMP	ECT_{t-1} terms
ΔIMPM	------	0.774603	13.2586*	6.84582***	9.0264**	3.618038	20.3855*
		0.8555	0.0041	0.0770	0.0289	0.3058	0.0004
ΔFDI	4.581385	-------	13.27705*	13.39065*	16.9366*	10.123**	25.2264*
	0.2051		0.0041	0.0039	0.0007	0.0175	0.00001
ΔGDP	2.813294	16.6522*	------	7.57411***	2.172380	7.059***	23.0014*
	0.4213	0.0008		0.0557	0.5374	0.0700	0.0001
ΔDI	1.645923	0.036294	4.743651	------	5.298446	0.434144	4.623892
	0.6490	0.9982	0.1916		0.1512	0.9331	0.3281
ΔEXP01	6.668***	2.62633	21.9823*	17.17398*	-------	15.1570*	32.0661*
	0.0832	0.4529	0.0001	0.0007		0.0017	0.00001
ΔIMP	8.8948**	9.6301**	2.902335	2.600274	6.994***	--------	17.3805*
	0.0307	0.0220	0.4069	0.4574	0.0721		0.0016

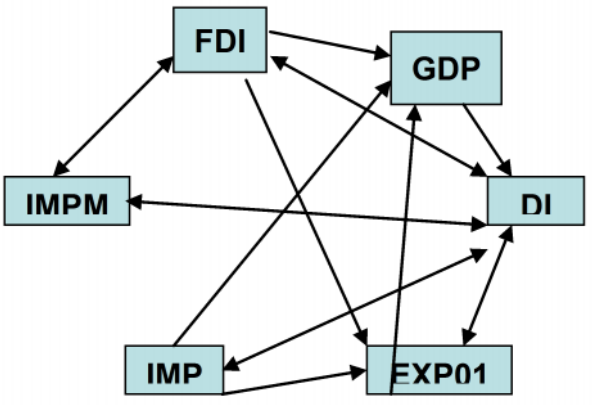
Note: Asterisks *, ** and *** denote statistical significant at 1%, 5% and 10% respectively; this system consists of 4 (four) co-integrating vectors; hence, a joint Wald test is conducted on the 4 (four) error-correction terms (ECTs). The estimated result is reported in the last column (ECT_{t-1} terms) of the Table.

The Wald test chi square of the explanatory variables (in first-differences) indicates the 'short-run' causal effects, whereas the 'long-run' causal relationship is implied through the significance or otherwise of the lagged 'group' error correction term (ECT terms) which contains the long-run information (Lee and Tan 2006). Table 5 shows the Granger-causality result

based on the VECM for the Nigerian models. The Wald test Chi Square (at various significance levels of one percent, five percent and ten percent), for the lag values of the independent variables indicated a short-run causal effect either running unidirectionally or bidirectionally between the variables. The joint Wald test conducted on the four (Nigeria) error-correction terms (ECTs), as reported in the last column (ECT terms) of Table 5, exemplified the burden of short-run endogenous adjustment (to long-run trend) to bring the system back to its long-run equilibrium (Lee and Tan 2006).

For clarity's sake, the summary of the results (Table 5) from all the models, at various levels of significant, was used to construct the lead-lag linkages for Nigeria. This is shown in Figure 1. In a deviation from previous studies (Ibrahim and Onokosi-Alliyu 2008; Ikiara 2003; Okejiri 2000), this study failed to confirm a short-run causal relationship between FDI and technology transfer in Nigeria during the study periods. Also, the study was unable to confirm whether technology transfers promote growth in Nigeria. This might be due to the low absorptive capacity and human capital development in Nigeria over the period (Heston *et al.* 2002; UNDP 2007). Although this study was unable to establish that FDI plays a crucial role in mediating technology transfers into Nigeria, domestic investment and trade impacted positively on technology transfer. However, FDI had a bidirectional significant influence on output and also on import of other goods and services, which might not be machinery and equipment. In addition, this analysis further revealed that, despite the positive impact of domestic investment on growth, FDI and trade, the reverse was the case for domestic investment.

Figure 1: Short-run lead-lag linkages summarized from VECMs for Nigeria Variables.



This general lack of inducement for domestic investment might be due to inconsistent government policies, poor infrastructural development, political instability and low human capital development (Ibrahim and Onokosi-Alliyu 2008; Ikiara 2003). The results of this study were similar to an earlier research by Okejiri (2000) and Akinlo (2004) on the impact of foreign direct investment (FDI) on economic growth in Nigeria. The ECM results of these studies showed that lagged foreign capital has a small, and not a statistically significant effect, on technology transfer. The three results seem to support the argument that extractive FDI might not be technology- or growth-enhancing as much as manufacturing FDI (Okejiri 2000). Finally, all the variables in the Nigerian system were adjusting to equilibrium in the long run, with the exception of domestic investment (DI), which failed to do the adjustment in the long run.

Conclusion

The aim of this study was to investigate the long-run equilibrium relationships among the international factors and economic growth, as well as to assess the short-term impact of inward FDI, trade and economic growth on international technology transfer to Nigeria. Since the variables in the Nigerian system were I(1), and may possess some kind of long-run relationship, a multivariate co-integration technique developed by Johansen and Juselius (1990) was employed to investigate the long-run equilibrium relationships among the international factors and economic growth. The results of the multivariate co-integration analysis affirmed the existence of co-integrating vectors in the Nigerian systems, with four co-integrating vectors in the models. These results implied that the variables in the Nigerian models had a long-run equilibrium relationship with one another and were adjusting in the short-run via four identified channels (Lee and Tan 2006).

Unfortunately, the existence of co-integrating vectors (co-integration) in the systems of this country only presumed the presence or absence of Granger-causality; it does not indicate the direction of causality between the variables. Hence, the direction of the Granger-causality was detected through the vector error-correction model (VECM) derived from long-run co-integrating vectors (Granger 1969; Lee and Tan 2006). Hence, the Wald test Chi Square (at various significance levels of one percent, five percent and ten percent), for the lag values of the independent variables indicated a short-run causal effect either running unidirectionally or bidirectionally between the variables for the country. For instance, in a deviation from previous literature (Ibrahim and Onokosi-Alliyu 2008; Ikiara 2003; Okejiri 2000), this study was unable to confirm a short-run causal relationship between FDI and technology transfer in Nigeria. Also, the study was unable to confirm

whether technology transfers promote growth in Nigeria. Finally, all the variables in the Nigerian system were adjusting to equilibrium in the long run, with the exception of domestic investment (DI), which failed to do the adjustment in the long run.

Implications for Practice

To reap the full benefits of FDI and technology transfer, nations should understand the magnitude of technology transfer, such as its determinants and modes of transfer. Hence, host governments should reposition their existing policies and institutions, rather than merely attracting FDI and technology. Governments should focus additionally on effective transfer of technology, which includes the diffusion and generation of technology locally (Lee and Tan 2006). It is important for Nigerian policy makers to know that, contrary to expectations, trade and FDI may not lead to growth, rather they may increase both markets and economic risks. Consequently, adequate provision should be made for all risks associated with FDI and trade, since increased risk premium discourages investment due to enhanced and unbalanced competition in the new 'globalised world'.

According to Solow (1956), the most important determinant of growth is technological change. Hence, Nigeria should focus on the impact of policies on technological change, as well as the diffusion of knowledge from developed countries. Efforts should also be made to internalize knowledge transfers within the country. Based on corroborated findings from the literature, trade in intermediate goods is an important channel of the transmission of technology (Heston *et al.* 2002). Therefore, for policy makers, imports of components for assembly may become the easiest way to acquire high technology, since it makes it possible for them to enter new production lines characterized by strong global demand growth and potential productivity gains (Lemoine and Ünal-Kesenci 2004). Furthermore, it is important for policy makers to know that, taking part in the labour-intensive stages of production, due to their competitive advantage, does not automatically lead to the technological spillovers needed to move up the production chain and to ensure a sustainable trajectory of economic development (Lloyd 1996).

Finally, due to the insignificant impact of FDI on technology transfer and the inactive domestic investment, Nigeria should, as a matter of urgency, diversify from primary products-induced FDI to science and technology-induced FDI. The process technologies should also be upgraded through the modernization of production facilities in the form of new plants and machinery, as well as adaptations of imported technology and improvement of quality (Okejiri 2000). In general, the results of this study should be adopted with

care. The Wald tests Chi Square on VECM may be interpreted as within-sample causality tests since they indicate only the Granger-exogeneity of the dependent variable within the sample period. However, they do not provide information regarding the relative strength of the Granger-causal chain among the variables outside the sample period. This consideration is recommended as an area for future research studies.

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