Technological Leapfrogging and Manufacturing Value-added in sub-Saharan African

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Abstract

This study examines the impact of technological leapfrogging on manufacturing value-added in SSA. The study utilizes secondary data spanning 1990 to 2018. The data is analyzed using cross-sectional autoregressive distributed lags (CS-ARDL) and cross-sectional distributed lags (CS-DL) techniques. The study found that technological leapfrogging is a positive driver of manufacturing value-added in SSA. That is, increase in technological leapfrogging boosts manufacturing value-added in *SSA. This implies that the SSA does not need to repeat the process of dirty and wasteful old technologies in their bid to spur industrialization and manufacturing upgrading. This study reveals that technological leapfrogging does not hurt manufacturing productivity in SSA. Rather, the sub-Saharan African countries can plan out a proactive technological leapfrogging agenda to spur industrialization and manufacturing development in the manner of the Asian Tigers. It only requires the governments of SSA to reinforce their absorptive capacity and beef up productivity through proper utilization of the existing technology. The productive activities of the domestic firms will stir new innovations and discoveries that will eventually translate into indigenous technology that will sustain productivity in the long run.*

Keywords: Technological leapfrogging, value-added, export intensity, innovation.

JEL Codes: D56, H20, I10

1. Introduction

The latest revolution in the global manufacturing market has intensified technological leapfrogging drive in developing countries in no small measure. Technological leapfrogging is a process whereby developing countries jump over several stages to move from low technology production to highly-modern technologies production processes (Bhagavan, 2011). It is part of the efforts to find a lasting solution to the development gap between the developing and the developed countries. In other words,

economists are contemplating whether technological leapfrogging can be part of the catch-up strategies that will facilitate the development process in the developing countries.

Therefore, this study seeks to investigate the prospect of industrialization in sub-Saharan Africa through the mirror of the technological leapfrogging strategy. Put differently, can technological leapfrogging be a panacea to the deindustrialization problem in sub-Saharan African countries (SSA)? One of the distinguishing features of the region's economy is the persistent deindustrialization menace, which partly responsible for the high level of import, low export, high unemployment rate, brain drain, institutional failure, and the general macroeconomic dysfunction that are bedeviling the SSA economy.

One of the factors that has been identified with the gap between the latecomers and the industrialized nations in the economic literature is the disparity in technological advancement between the two groups (Lee, 2019). Before now, the argument is that the developing countries should emulate the steps of the developed countries by copying their institutional settings, economic policies, and planning system through which the developed countries achieved their economic fortunes. But this idea to an extent has proved wrong by the failure of intervention programs like the 1980s structural adjustment program, the Washington Consensus and others.

Part of the pertinent questions raised by some scholars are; can developing countries be effective at creating, owning, developing, and harnessing homegrown technology? Can developing countries adapt modern technologies into innovation cycles? (Swart, 2011). This implies that the sub-Saharan African (SSA) may need upgrading concerning the ability to initiate home-grown technology and adapt foreign technology productively. Hence, this study seeks to determine the effect of technological leapfrogging on manufacturing value-added in SSA.

The rest of the article is organized as follows. In section two, conceptual clarification, theoretical review, and empirical review are done. Section three, presents the methodology which comprises of model specification, data sources and description, and technique of data analysis. Sections four puts on view the empirical analysis and discussion of results, while fifth section presents the conclusion and recommendations.

2. Literature Review

This section of the study presents the review of literature on the subject matter of this article. This covers the conceptual issues, theoretical literature and the empirical literature to provide theoretical and empirical footing for the study.

2.1 Conceptual Clarification

2.1.1 Technological Leapfrogging

Leapfrogging refers to a process whereby a country that is low or poor in technical know-how suddenly and rapidly transforms into a technologically advanced country through the adoption of innovations. This implies that the country in question passes over the intermediate stages of technological evolutions and operates directly with the new technology. The concept of leapfrogging originated from the economic argument about 'creative destruction. The creative destruction hypothesis proposes countries that hold to traditional technologies will have less urge for innovation. The old technologies and their owners will be out of relevance when formerly poor technology countries come up with new and more efficient technologies that surpass the old ones.

However, in an environment where there is no incentive and enablement for technological innovations; technological leapfrogging attracts a different meaning. In other words, the adoption of new technology in a country that lacks the absorptive capacity to acquire foreign technology and adapt it for domestic advantage; is a consumption leapfrogging and not an innovative leapfrogging.

2.1.2 Manufacturing Value-added

Manufacturing value added (MVA) of an economy refers to the total estimate of the net- output of all residents' manufacturing activities. This can be obtained by adding up all manufacturing output produced in the domestic economy minus the intermediate inputs. For instance, International Standard Industrial Classification (ISIC), revision 3, (2008) defines manufacturing value-added as the net output of the manufacturing sector after adding up all outputs and subtracts intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion, and degradation of natural resources (UNIDO, 2016).

Manufacturing value added (MVA) can be expressed as a proportion of gross domestic product (GDP). This will indicate the fraction of GDP that is accounted for by the manufacturing sector. Similarly, we can estimate the MVA per capita by dividing MVA in constant 2010 USD by the

population of a country. Manufacturing value-added is usually used by researchers and policymakers to determine the level of the industrialization of a country. The share of MVA in GDP reflects how healthy and self-reliant an economy is. Statistical data on manufacturing value-added helps to classify countries according to their level of industrial development.

2.2 Theoretical Review

2.2.1 Technology, Learning and Innovation Theory (Nelson and Winter, 1982)

Various schools of thought in the literature have made tremendous efforts to explain the factors that drive manufacturing productivity in an emerging economy. According to this strand of the literature, innovation, and technological change, and the resultant improvement in the domestic capability to produce more outputs at lower cost and inputs are the drivers of manufacturing productivity. It looks forward to the government to put more effort into improving the learning process and also encourages firms to prioritize R & D by devoting huge investment for R & D projects and programs. The theory believes that comparative advantages are not endowed or given but created. Furthermore, this school of thought believes that the liberated and successful economies of the world are those that were able to restructure their productivity from low value-added production to high value-added activities (Salazar-Xirinachs et al. 2014).

2.3 Empirical Review

Technological leapfrogging is a crucial factor of industrialization and manufacturing development in the modern economic system and in the international manufacturing environment. There is limited empirical literature on technological leapfrogging due to data unavailability and measurability difficulties that associate with technological leapfrogging in developing countries. However, some of the successfully studies that have been carried out on the subject are reviewed in this section.

Swart (2011), investigated the present and future technological strength of Africa through two critical questions; one, can sub-Saharan Africa be effective at creating, owning, developing, and harnessing homegrown technology. Two can sub-Saharan Africa adapt non-African technologies into innovation cycles. The study utilized the descriptive statistics method and the analysis revealed that the African markets need to be strengthened in terms of the welfare-generating capabilities of the markets. African governments will need to be more effective, proactive, and responsive to stop exploitative trends that characterized the external interventions that are infiltrating the African markets.

James (2013) studied the diffusion of information technology (IT) in the historical context of innovations from developed countries. The study involved selected developed and developing countries using the S-shaped curve model of diffusion of technology developed by Rogers. The analysis revealed that the model works well for developed countries, but works poorly in developing countries. The reasons are identified to include the concentration of innovations in the rich countries and the devotion of research and development (R and D) to rich rather than poor country's problems. However, the result is different in the mobile phone industry where the developing countries are found to be ahead of the developed countries due to the fierce leapfrogging by the developing countries in the mobile phone market. Cherif and Hasanov (2019) studied the principles of industrial policy. The study used descriptive statistics and observed that the economic breakthrough of the Asian miracle countries was by chance and an outcome of technology and innovation policies (TIP). The study identified three policy thrusts that worked for the Asian tigers which are; the support of domestic producers in sophisticated industries (beyond the initial comparative advantage), export orientation, and the pursuit of fierce competition with strict accountability.

Fong (2009) examined technology leapfrogging for developing countries through a literature survey across different relevant areas. The study brings up the following observations; technology leapfrogging is not going to be an easy venture for developing countries. Rather, developing countries should first leapfrog in wireless technology areas because it is easier there. Wireless technologies are relatively quicker and less costly. Technological leapfrogging is not a short time duration of the adventure. Rather it takes a fairly long time for leapfrogging to yield dividends. The experience of the Asian tigers was called a miracle, even though it took several decades before it materialized.

Nilsen (2010) carried out a study on the learning-by-doing or technological leapfrogging: production frontiers and efficiency measurement in Norwegian salmon aquaculture. Using the maximum-likelihood estimator approach. The study observed that new firms within age 3 to 5 years with new technologies perform better than older firms with respect to technical efficiency, and thereby support the technological leapfrogging hypothesis. So, it can be deduced from the foregoing literatures that proactive policy measures can expedite the adoption of the new technologies in the developing countries, without necessarily repeating the evolutionary stages of the obsolete technologies that the developed countries went through.

3.1 Theoretical Framework

This study examines the impact of technological leapfrogging on manufacturing value-added in sub-Saharan Africa. The study adopts the Romer (1990) Model of endogenous technical progress to provide theoretical underpinning for the study. The indispensable role of technology in the growth process has long been acknowledged by economic theorists. For instance, the neoclassical growth model built on exogenous technological progress as the ultimate engine of long-run economic growth (Solow, 1956, Swan, 1956). However, David Romer (1990) proposed the endogenous model which was the first model that presents a rigorous growth model with endogenous technical progress. The model is premised on three fundamental assumptions namely; economic growth is determined by technological progress and capital accumulation; technological progress emanates from thoughtful actions by private agents who respond to market incentives; technological knowledge is a non-rivalrous input. The mathematical form of the model is given as;

$Y = F(A, K, L)$, where A denotes the state of technology, K the stock of physical capital, L labor input, and $F(.)$ is C^2 with $\frac{\partial F(.)}{\partial X} > 0$ and $\frac{\partial^2 F(.)}{\partial X^2} < 0$ for all $X \in \{A, K, L\}$.

This model establishes a functional relationship between technological progress and the out level in an economy.

3.2 Method of Estimation

The effectiveness of leapfrogging strategy at spurring manufacturing activities in sub-Saharan African countries is the focal point of our analysis in this sub-section. This analysis is based on the work of Wang, Wei and Wong (2009) which investigated the nexus between leapfrogging strategy and economic growth in China. This study adapts the study for manufacturing sector in SSA to ascertain the efficacy of technological leapfrogging strategy for industrialization and manufacturing sector development in the African sub-region. The mathematical relationship between the dependent variable and the independent variables is given as;

$$MVA_{it} = \beta_{i0} + \beta_{i1} MVA_{it-1} + \beta_{i2} LFRG_{it} + \beta_{i5} \mathrm{SPH}_{it} + \beta_{i6} HC_{it} + \beta_{i7} GEF_{it} + \beta_{i8} FDN_{it} + \varepsilon_{it} \quad (1)$$

Where, i = 1, 2, 3…n, t = 1, 2, 3……T. $MVA_{i,t}$ is the dependent variable, which is manufacturing value-added, $MVA_{i,t-1}$ is one year lag of the dependent variable representing the previous year's level of manufacturing value-added. The focus variable is technological leapfrogging ($LFRG_{it}$) and it is measured as share of advanced technology products in total exports (Wang, Wei and Wong, 2009).

The explanatory variables include production sophistication (SPH_{it}), Human capital (HC_{it}), government effectiveness (GEF_{it}), and financial deepening (FDN_{it}). Production sophistication is captured by production sophistication index calculated as weighted average of a country's per capita GDP where the weights are manufacturing export intensity (MEI) of individual country which is calculated as the market share in world manufacturing export. It is a country's exports of manufacturing divided by the world's total exports of manufacturing (Cherif and Hasanov, 2019; Anand, Mishra, and Spatafora, 2012). Production sophistication in this study is a proxy for innovation and technological advancement that propels manufacturing value-added growth. Human capital (HC_{it}), human capital is used as proxy factor endowment aspect of manufacturing in the model; and government effectiveness (GEF_{it}) is a proxy for the government policy concerning manufacturing and leapfrogging. ε_i is the error terms. However, in Wang, Wei and Wong (2009) model the financial sector is left out. Therefore, we incorporate financial deepening (FDN_{it}) as a control variable representing the financial sector development in the model (financial sector development is a key facilitator of manufacturing value-added).

This study will utilize cross-sectional autoregressive distributed lags (CS-ARDL) and cross-sectional distributed lags (CS-DL) techniques. The two methods are complementary in nature. In other words, CS-ARDL is suitable for short-run relationship in a heterogeneous panel while CS-DL is appropriate for estimating average long-run coefficients. The two models allow for heterogeneity among the cross-sectional units and error cross-sectional dependence in a panel framework. The cross-sectional units in this study are heterogeneous as they operate at different levels of development, technology, political system, and macroeconomic environment. The assumption of homogeneity in the context of the cross-sectional units of this study, may leave much to be desired. The likelihood of error cross-sectional dependence due to unobserved common factors is high, because the countries are exposed to common international shocks.

The traditional ARDL model assumes homogeneity among the units (countries) and cross-sectional independence of the error terms. Whereas, error terms are likely to be cross dependence due to the presence of unobserved common factors in the models. Therefore, the traditional ARDL model is modified to take care of slope heterogeneity and error cross-sectional dependence in the model. The modified version of ARDL is known as CS-ARDL which is stated as;

$$Y_{it} = \sum_{j=1}^{r} \beta_{ij} Y_{i,t-j} + \sum_{j=0}^{p} \theta'_{ij} X_{i,t-1} + \forall_i + \mu_{it} \quad (2)$$

$$\mu_{it} = \tau_i' f_t + \varepsilon_{it} \quad (3)$$

Where, f_t is an $m \times 1$ vector of unobserved common factors; τ_i' is the corresponding factor loading and $\varepsilon_{it}$are the idiosyncratic errors. According to Chudik, Mohaddes, Pesaran, and Raissi (2017) and Chudik, Alexander, Pesaran and Tosetti (2011) those idiosyncratic errors could be serially or cross-correlated or uncorrelated with the common factors. Unobserved common factors are the sources of error cross-section dependence and it drive the variables differently across the countries.

$$X_{i,t-1} = \pi_i' f_t + v_{it}$$

Where, $X_{i,t-1}$, are the vector of the explanatory variables. The assumption here is that, the explanatory variables could be influenced by the unobserved common factors (f_t), $\pi_i'$is the nXm matrix of factor loadings and $v_{it}$are the idiosyncratic errors that associated with $X_{i,t-1}$which are believed to be uncorrelated with ε_{it}.

$$\mu_{it} = \sum_{i=1}^{mfs} \rho_{it}^{s} f_{it}^{s} + \sum_{i=1}^{mfw} \rho_{it}^{w} f_{it}^{w} + e_{it} \quad (4)$$

According to Chudik et al. (2011), the common factor structure can be expressed as a combination of finite number (wfs) of strong factors (f_{it}^{s}) that can be correlated with the regressors of the original model, and a finite number (mfw) of weak, semi-weak and semi-strong factors (f_{it}^{w}) which may be affecting a segment of some countries among the sample. Chudik, Mohaddes, Pesaran and Raissi (2017), gave the example of strong factors or shocks to include structural changes, instance of global financial cycle changes, interest rates, and commodity price shocks.

The weak, semi-weak and semi-strong factors can be attributed to spillovers of domestic industrial activity, domestic consumption, geographical proximity, research and development, climate factor, agricultural productivity and natural resources (Eberhardt and Vollrath, 2016; Eberhardt, Helmers and Strauss, 2013 and Holly, Pesaran and Yamagata, 2010).

Chudik, Mohadders, Pesaran and Raissi (2013) proposed another technique of estimating the long-run coefficients directly known as the 'Distributed lag' (DL) method. With this approach equation 2 can be rewritten as;

$$Y_{i,t} = \delta_i X_{i,t} + \pi'_i(L)\Delta X_{i,t} + \hat{\varepsilon}_{i,t} \quad (5)$$

Where, $\hat{\varepsilon}_{i,t} = \vartheta(L)^{-1}\varepsilon_{i,t}$; $\vartheta_i(L) = 1 - \sum_{j=1}^{p}\vartheta_{i,j}L^j$; $\delta_i = \rho_i(1); \rho_i(L) = \vartheta_i^{-1}(L)\varphi_i(L) = \sum_{j=0}^{\infty}\rho_{i,j}L^j$; $\varphi_i(L) = \sum_{j=0}^{r}\varphi_{i,j}L^j$; and $\pi_i(L) = \sum_{j=0}^{\infty}\sum_{s=j+1}^{\infty}\rho_s L^j$

Obtaining a consistent estimate of the average log-run coefficients $\delta_i$requires the following conditions; the roots of $\vartheta_i(L)$should lie outside the unit circle. The coefficients of π_i(L) are assumed to be exponentially decaying. And there is no reverse causality from lagged dependent variables to independent variables. After the long-run coefficients $\hat{\delta}_i$are estimated, the values will be used to estimate the average long-run effects by averaging $\hat{\delta}_i$across the units (i) using a simple formula;

$$\hat{\delta}_{MG} = N^{-1}\sum_i^N \hat{\delta}_i$$

4 Empirical Analysis and Discussion of Result

The result of the analysis of the relationship between manufacturing value-added and technological leapfrogging is reported in table 1. The table contains two sets of results; the CS-DL and CS-ARDL results. CS-ARDL usually reports two estimations namely, the short-run coefficients and the long-run coefficients together with the speed of adjustment that is usually referred to as cointegration in the CS-ARDL context. The long-run coefficients in the CS-ARDL framework are computed outside the model's apparatus using the estimated short-run coefficients. Therefore, the long-run coefficient estimated through CS-ARDL is not a reliable long-run estimator because the model does not return a consistent estimator if heterogeneity is present in the model due to the inclusion of the lagged dependent variable. One good thing about CS-ARDL is that it estimates the speed of adjustment which reveals whether there is cointegration in the model or not.

Table 1 Estimation Based on CS-DL Approach

CS-DL (p=1, 2, 3)		**CS-ARDL**
Variables	**Coefficients**	**Coefficients**
LFGN	0.1169003***	0.0510871
	(0.0296537)	(0.0552834)
FDPN	0.0222863**	0.218844
	(0.0100793)	(0.017128)
TE	-0.6722463	-0.394687
	(1.019763)	(2.584075)

GDP	0.6471854***	0.3631497
	(0.2366478)	(0.1145543)
GCF	0.025226**	0.0180857
	(0.0136972)	(0.221671)
SPH	-0.0872533	-0.0324361
	(0.0316972)	(0.1731145)
HC	0.7174998***	-0.5551111
	(0.2713632)	(0.5173925)
GEFF	-0.0027168	-0.2138504
	(0.0864205)	(0.1145543)
Cointegration		-1.102649
CD Statistics	37.29	16.02
CD p-value	0.0000	0.0000
Obs	728	728

Source: author's computation

Note: CS-DL and CS-ARDL estimates. Standard error in parentheses, variables are measured in logs. Control for cross-sectional dependence (CSD): CCE Common Correlated Effects (for one 1 lag). ***, **, * denote significant at 1, 5 and 10% respectively.

The focus variable in this analysis is technological leapfrogging because the study seeks to ascertain the impact of technological leapfrogging on manufacturing value-added in SSA. In the CS-DL result, the coefficient of technological leapfrogging is positive (0.1169003) and significant at a 1% level of significance. This implies that technological leapfrogging spurs manufacturing productivity in SSA. More specifically, it implies that a one percent increase in technological leapfrogging increases manufacturing value-added by 0.12% in SSA. This result supports the observation of Cherif and Hasanov (2019) about the Asian Miracles who they claimed got their miracles through the support of domestic producers in sophisticated industries. This implies that the SSA does not need to repeat the process of dirty and wasteful old technologies in their bid to spur industrialization and manufacturing upgrading. This study reveals that technological leapfrogging does not hurt manufacturing productivity in SSA. Rather, the sub-Saharan African countries can plan out a proactive technological leapfrogging agenda to spur industrialization and manufacturing development in the manner of the Asian Tigger's.

Financial deepening is positive and significant in this analysis. The average long-run coefficient of the relationship between manufacturing value-added and financial deepening is estimated at '0.0222863', and it is significant at the 5% level of significance. Akinmulegun and Akinde (2019)

observed a similar relationship between financial deepening and manufacturing processing for Nigeria. The result indicates that financial sector development and diversification is required for SSA industrial development. Gross domestic product (GDP), gross capital formation, and human capital are positively signed and statistically significant in this analysis. While total employment rate, production sophistication, and government effectiveness are negative and not significant.

In the CS-ARDL analysis, none of the variables is statistically significant. Although some are rightly signed, but none is significant perhaps due to the heterogeneity problem and endogeneity issue accentuated by the inclusion of lagged dependent variables in the model. All the CS-ARDL standard errors for the explanatory variables are higher than the corresponding standard errors in the CS-DL model. In other words, CS-ARDL estimators exhibited higher variance than CS-DL estimators which implies that CS-DL is more efficient at estimating long-run coefficients than CS-ARDL.

Robustness Analysis

The robustness analysis of this model is done by the addition and subtraction of variables from the original model and observe the resultant changes on the signs and magnitudes of the estimated coefficients in the model.

Table 2 Estimates Based on CS-DL Approach

CS-DL (p=1, 2, 3)			
	Model (A)	**Model (B)**	**Model (C)**
Variables	**Coefficients**	**Coefficients**	**Coefficients**
LFGN	0.0101346**	0.0793217***	0.1169003***
	(0.0054554)	(0.0328842)	(0.0296537)
FDPN	-	0.0304547**	0.0222863**
		(.0157504)	(0.0100793)
GDP	-	0.5159022***	0.6471854***
		(0.1897809)	(0.2366478)
GCF	-	0.0225565*	0.025226**
		(0.0139247)	(0.0136972)
SPH	-	-0.0720157	-0.0872533
		(.0354235)	(0.0316972)
HC	-	-0.3526655	0.7174998***
		(0.3743572)	(0.2713632)
GEFF	-	-	-0.0027168
			(0.0864205)
TE	-	-	-0.6722463
			(1.019763)

CD Statistics	49.73	28.14	37.29
CD p-value	0.0000	0.0000	0.0000
Obs	702	728	728

Source: author's computation

Note: cross-Sectional Distributed Lags (CS-DL) estimates. Standard error in parentheses, variables are measured in logs. The reported coefficients are long-run parameters. Control for cross-sectional dependence (CSD): CCE Common Correlated Effects (for one 1 lag). ***, **, * denote significant at 1, 5 and 10% respectively.

Table 2 contains the results of three equations of CS-DL models with a different combination of explanatory variables. Model (A) regresses only technological leapfrogging as an independent variable on manufacturing value-added, model (B) increased the number of the explanatory variables to six including the focus variable (technological leapfrogging) and model (C) is the original model previously analyzed in table 1. Technological leapfrogging is positive and statistically significant in the three models. In other words, technological leapfrogging is positive and significant when it was regressed on MVA as a lone independent variable and it remains significant and positive when five more explanatory variables were added in the model (B). These two analyses bear out the result of the initial model where technological leapfrogging was regressed on manufacturing value-added amidst seven other explanatory variables, which is label as the model (C) in table 2. The magnitude of the estimated coefficients for the technological leapfrogging parameters ranges from 0.1169003 to 0.0101346 across the three analyses. The marginal differences in the coefficients of technological leapfrogging across the three analyses signifies the robustness of the parameters of the original model and the consistency of CS-DL estimators. Therefore, it can be concluded that technological leapfrogging promotes industrialization and manufacturing development in sub-Saharan Africa.

The robustness of this analysis is further evident by the signs and magnitudes of other explanatory variables like financial deepening, gross domestic product, and gross capital formation. Financial deepening, gross domestic product, and gross capital formation are positively signed and statistically significant in model (B) and (C). The marginal differences in the values of their coefficients also confirmed the robustness of the estimates.

5 Conclusion and Recommendations

The high wave of technological advancement that started from the mid-twentieth century till the late twenty-century tremendously transformed the global economic landscape, the domestic macroeconomic environment, and the process of carrying out economic transactions across nations. Therefore, the resultant efficiency and ease of doing business put pressure on all organizations and countries to imbibe the new initiatives. The greatest of the pressure is on the developing countries including the SSA who are behind the industrialized nations in terms of technological know-how. So, the developing countries can only avoid being left out or marginalized particularly in the international markets; if they join up with the advanced countries in the new stream of technological drive (technological leapfrogging) or start the development of their technological apparatus from scratch.

However, the argument about whether the developing countries should leapfrog or start their technological formation from scratch is still opened to debate. But this study found that technological leapfrogging is a positive driver of manufacturing value-added in SSA. This implies that SSA can copy the foreign existing technologies and adapt them for domestic uses, rather than going through the evolutionary process of the old technologies that are relatively less efficient. If the governments of SSA could reinforce their absorptive capacity and beef up productivity through proper utilization of the existing technology. The productive activities of the domestic firms will stir new innovations and discoveries that will eventually translate into indigenous technology.

Refrences

Akinmulegun, S. O. & Akinde, J. A. (2019). Financial deepening and manufacturing sector performance in Nigeria (1981-2017). *Journal of Economics and Finance,* 10(4), 18-27.

Anand, R., Mishra, S., and Spatafora, N. (2012). Structural transformation and the sophistication of production. *IMF Working Paper.* WP/12/59

Bhagavan, M. R. (2011). Globalization of technology – technological leapfrogging by developing countries. *Stockholm Environment Institute, Stockholm.*

Cherif, R. and Hasanov F. (2019) The return of the policy that shall not be named: principles of industrial policy. *IMF Working Paper*

Chudik, A., Mohaddes, K., Pesaran, M. H., and Raissi, M. (2017). Is there a debt-threshold effect on output growth? *Review of Economics and Statistics,* 99(1):135–150.

Chudik, A. M., Pesaran H., and Elisa Tosetti. (2011). Weak and strong cross-section

dependence and estimation of large panels. *The Econometrics Journal* 14(1):C45–C90.

Chudik, A., Kamiar M., M., Pesaran H., and Raissi. M. (2013). Debt, inflation and growth: robust estimation of long-run effects in dynamic panel data models. *Cambridge Working Papers in Economics Debt.*

Eberhardt, M., Helmers, C., and Strauss, H. (2013). Do spillovers matter when estimating private returns to R and D?'. *The Review of Economics and Statistics,* Pp*. 436-448.*

Fong, M. W. L. (2009) Technology leapfrogging for developing countries. *Global Information Technology Encyclopedia of Information Science and Technology, Second Edition*

Holly, S., Pesaran, M. H., And Yamagata, T. (2010). A spatial-temporal model of house prices in the USA. *Journal Of Econometrics, 158, Pp. 160-173.*

James, J. (2013). The diffusion of it in the historical context of innovations from developed countries. *Springerlink.* 111:175–184

Korpela K. (2018). Can Rwanda leapfrog to the digital economy with ICT enabled development? A case study of a developing country determined to modernize without the traditional model. *Lund University School of Economic and Management*

Lee K. (2019). The art of economic catch-up: barriers, detours, and leapfrogging in innovation systems. *Cambridge University Press.* DOI 10.1017/9781108588232.

Long V. (2014). A technological capabilities perspective on catching up: the case of the Chinese information and communications technology industry. *Industrial Economics and Management Royal Institute of Technology, KTH S- 100 44 Stockholm, Sweden*

Nilsen O. B. (2010). Learning-by-doing or technological leapfrogging: production frontiers and efficiency measurement in Norwegian salmon aquaculture. *Aquaculture economics and management, 14(2), 97-119, doi: 10.1080/13657301003776649*

Salazar-Xirinachs, Nübler and Kozul-Wright (2014). Industrial policy, productive transformation and jobs: theory, history and practice. *Text book publication*

Swart, D. (2011). Africa's technology futures: three scenarios. *The Frederick S. Pardee Center for the Study of the Longer-Range Future Boston University.*

UNIDO (2019). Demand for manufacturing: driving inclusive and sustainable industrial development. Vienna.

UNIDO (2019) Economics of technological leapfrogging. *Inclusive and Sustainable Industrial Development Working Paper Series, WP 17/2019*

Wang Z, Wei S and Wong (2009) Does a leapfrogging growth strategy raise growth rate? Evidence across countries and within China. *Joint Symposium of U.S-China Advanced Technology Trade and Industrial Development. October 23-24, 2009*

World Bank and China Development Bank (2017) Technological leapfrogging: the key to Africa's development? *Third Investing in Africa Forum 2017.*