Infrastructure and Manufacturing Value Added in Sub-Saharan African Countries

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Infrastructure and Manufacturing Value Added in Sub-Saharan African Countries

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Abstract

This paper examines the nexus between infrastructure and manufacturing value added (MVA) in sub-Saharan Africa (SSA). It employs panel data for 34 SSA countries spanning 2003 to 2018. The empirical results obtained from the static and dynamic panel estimation techniques applied suggest that infrastructure is essential for the improvement of manufacturing value added in SSA. Furthermore, our findings reveal that the infrastructure-MVA nexus varies by infrastructure types (electricity, transportation, information and communication technology (ICT) and water and sanitation) and across the different sub-regions that make up SSA. This study therefore posits that massive investment in infrastructure is a viable policy option for enhancing the growth and development of the manufacturing sector in SSA.

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1. Introduction

Economic diversification has become a recurring policy objective of successive governments in many sub-Saharan African countries, especially the resource dependent ones. This is due to the increasing realisation that the highly concentrated structure of their production and exports hurt their global competitiveness and raise their vulnerability to the vagaries of the international market. To achieve the objective of economic diversification, it has been largely recognized that the manufacturing sector offers a leeway. Indeed, the economic success of the Asian Tigers is often cited as a testament to this assertion (Gulati, 1992; Asien, 2015).

The manufacturing sector also plays a key role in the industrialization and growth process of any country. This is because the sector offers unique opportunities for capital accumulation, promotes economies of scale by driving technological progress while providing spillover effects through linkages to other economic sectors, displays a higher level of productivity and has more capacity to generate employment compared to other sectors (Efobi and Osabuohien, 2016; Martorano, Sanfilippo and Haraguchi, 2017; Anyanwu, 2018). Again, by fostering productivity and sustainable economic growth, the manufacturing sector can also foster reduction in poverty and inequality (Ndulu, 2006; Lavopa and Szirmai, 2012). Despite the apparent importance of the manufacturing sector, particularly for SSA countries where structural and development indicators are appalling, the performance of the manufacturing sector has to a large extent been abysmal.

Boosting the performance of the manufacturing sector and consequently promoting industrialization – which are integral aspects of development policy in many SSA countries – would require the removal of major impediments to manufacturing value added growth. One of such bottlenecks is infrastructure deficit. Extant literature attests to the huge infrastructural gap in SSA compared to other developing regions (Yepes, Pierce and Foster, 2008; Foster and Briceno-Garmendia, 2009; Gutman, Sy and Chattopadhyay, 2015, Kodongo and Ojah, 2016; World Bank, 2017). Infrastructure is not just an input in the production process; it also complements other factor inputs (Kodongo and Ojah, 2016). Thus, it provides productivity enhancements.

Reliable infrastructure is crucial for powering businesses, lowering transactions costs, improving market access and the efficiency of other productive factors (Luo and Xu, 2018). In particular, energy infrastructure (electricity) – the lifeblood of manufacturing – is necessary for adding value to raw materials and intermediate products as they are being progressively transformed into final consumer products (Anyanwu, 2018). Transport infrastructure allows for movement of people and manufactured products in a cost efficient manner. Information and communication technology (ICT) aids production and exchange by easing the dissemination of information among economic agents (Ismail and Mahyideen, 2015). In sum, infrastructure can boost both the input and the output process in a production system (Efobi and Osabuohien, 2016) allowing for competitiveness in the production of industrial goods. All of these are germane for enhancing manufacturing value added and overall economic performance.

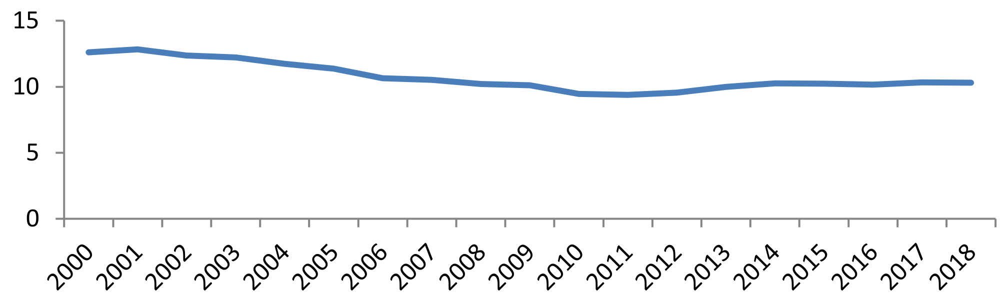
Within the African context, the bulk of the existing literature has focused on the growth effects of infrastructure and the role of infrastructure in manufacturing value added (MVA) in SSA has scarcely been accounted for. This is however, the kernel of this study. Examining the infrastructure-manufacturing value added nexus is fundamental to the achievement of the Sustainable Development Goal (SDG) 9 which is to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. For a comprehensive understanding of the effects of infrastructure on MVA in SSA, we consider the impact of various infrastructure types such as electricity, transport, ICT and water and sanitation on MVA. For robustness, we conduct the research on the effects of infrastructure on MVA in SSA for each of the sub-regions that make up SSA (East, West, Southern and Central Africa sub-regions). We also deployed both static and dynamic panel estimation techniques to implement our objective. Our results show that infrastructure is indispensable to the growth of the manufacturing sector in SSA. The significant effects of infrastructure on MVA, however, vary across the regions of SSA and across the infrastructure type considered.

Given this introduction, the rest of the study proceeds as follows. Section 2 presents an overview of manufacturing value added in Africa. A brief review of the literature is documented in section 3 while section 4 contains the model specification and data sources and description. Section 5 presents the empirical results and section 6 contains the conclusion and recommendation.

2. Overview of Manufacturing Value Added in Africa

Overtime, the performance of the manufacturing sector in SSA has not shown any significant improvement. In fact, it has mostly followed a downward trajectory since the 1990s. For the period 2001-2005, average annual MVA in SSA was 12.11%; it reduced to 10.19% between 2006 and 2010 and further dipped to 9.88% between 2011 and 2015.

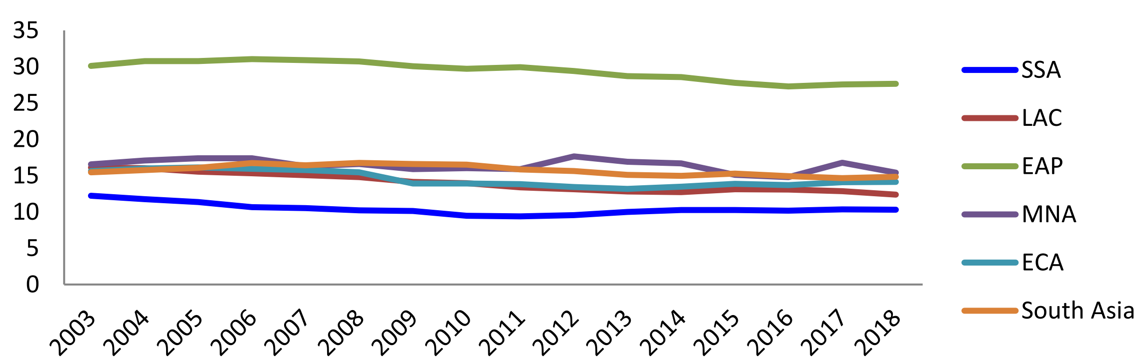
Figure 1: Manufacturing value added (% of GDP) for SSA



Source: Authors using data from World Development Indicators (2018)

The manufacturing sector in SSA also lags behind other developing regions of the world as shown in Figure 2 below. Available data from the World Development Indicators (WDI) reveals that the average annual MVA as a percentage of GDP in SSA is very low at 10.40% between 2003 and 2018 compared to 14.02% in Latin America and the Caribbean (LAC), 15.72% in South Asia, 16.40% in Middle East and North Africa (MNA) and 29.43% in East Asia and Pacific (EAP). Although manufacturing value added (as a percentage of GDP) is declining in all regions, the rate of decline has been faster in SSA.

Figure 2: Manufacturing value added (% of GDP) by regions



Source: Authors using data from World Development Indicators (2018)

3. Literature Review

The seminal paper of Ashauer (1989) underscores the critical role of infrastructure for private sector productivity and output. Specifically, the study which triggered an extensive research on the (macro and micro) economic impact of infrastructure, examined the relationship between public capital and aggregate productivity in the US economy for the period 1949-1985 using a simple production function specification. The empirical findings suggest that the stock of public infrastructure capital is a significant determinant of total factor productivity. However, the economic significance of this result has been largely considered as implausible and not robust to the use of more sophisticated econometric techniques (Aaron, 1990; Tatom, 1991; Baltagi and Pinnoi, 1995).

Hulten and Schwab (1991) find that public infrastructure has no effect on total factor productivity (TFP) growth in U.S. manufacturing at the regional level. However, the findings of Rietveld, Kameo, Schipper and Vlaanderen (1994) suggest that infrastructure is a significant variable in explaining the regional differences in the development of manufacturing industry in Central Java, Indonesia. Also, using time-series cross-section data from 1970 to 1993, Stephan (1997) assessed the impact of road infrastructure on private production. The empirical results show a strong correlation between road infrastructure and output in German manufacturing at the regional level of the Bundeslander. Although over time, the explanatory power of road infrastructure in explaining the observed pattern in TFP growth over time is rather limited. The authors concluded that differences in road infrastructure seem to account for the productivity gap in manufacturing between East and West German regions.

Nadiri and Mamuneas (1994) empirically investigates the extent to which public sector infrastructure and R&D capitals influence cost structure and productivity performance using data on twelve (12) two-digit U.S manufacturing industries. Their empirical findings reveal that both types of capital have significant productive effects although their effects on the cost structure vary across industries. Also, adopting a general equilibrium approach, the findings of Holtz-Eakin and Lovely (1995) lend credence to the positive impact of public capital on manufacturing variety proxied by the number of manufacturing establishments.

In the study on the effect of infrastructure on the Indian manufacturing sector, Sharma and Sehgal (2000) utilizing data spanning 1994-2006 find that infrastructure has a strong positive effect on total factor productivity, output and technical efficiency although its effect on labour productivity is significant but negligible. In the same vein, using time series data spanning 1965-1966 and 1998-1999, and estimating a cost function model for India's manufacturing sector, Goel (2002) shows that infrastructure enhances manufacturing sector productivity and lowers costs in India.

Paul, Sahni and Biswal (2004) estimate a translog function which incorporates public capital infrastructure for 12 two-digit manufacturing industries. Their results obtained using annual time-series data for 1961-1995, reveal that there is strong evidence that public infrastructure plays an important role in the productivity of Canadian manufacturing industries and it is a substitute for private capital in the Canadian manufacturing sector. Also, employing a constant elasticity and substitution-translog cost model to determine the relationship between Canadian public infrastructure and private output, Brox and Fader (2005) finds similar results – the services of public capital enhance the productivity of private capital.

Hulten and Isaksson (2007) posit that the relative importance of infrastructure in explaining differences in income and productivity levels depends on the stages of development. Following this, Isaksson (2010) examined whether energy infrastructure matters for cross-country differences in manufacturing levels and industrialization using data for 79 countries for the period 1970 to 2000. Additionally, the sample of countries was divided on the basis of income levels to account for the stages of development. The results suggest that energy infrastructure explains the differing rates of industrialization. Specifically, energy infrastructure is positive and significant across all income groups but its impact is greatest for the poorest economies and fast-growing Asian tigers.

Ahmed (2016) investigates the impact of social infrastructure on the manufacturing productivity using firm level data from Pakistan. Capturing the effect of regional disparities in investment in social goods and controlling for a potential selection bias from firms' location decisions, the study finds that social infrastructure indicators – health and education – positively and significantly affect firm level productivity in Pakistan's manufacturing industries. However, this

result only holds for urban districts. For rural regions, both health and education show a negative impact on firm productivity. Also, using data from Chinese manufacturing firms, Wan and Zhang (2017) find that infrastructure has a positive and significant effect on firm productivity.

The empirical findings of Mitra, Sharma and Véganzonès-Varoudakis (2016) from their assessment of the importance of infrastructure and information & communication technology (ICT) on total factor productivity (TFP) and technical efficiency (TE) of the Indian manufacturing sector using data from 1994-2010 indicate that infrastructure and ICT has a significant effect on the manufacturing productive performance, both in terms of total factor productivity (TFP) and technical efficiency.

Anyanwu (2018) in his empirical assessment of the role of human capital in manufacturing value added development in Africa show that accessibility to ICT technology and infrastructure proxied by mobile phone and fixed phone subscriptions has no significant effect on manufacturing value added development in Africa. Furthermore, the disaggregated result on education mostly categorized as social infrastructure was mixed. Specifically, the empirical result indicated that primary education has an inverted U-shaped relationship with manufacturing value added; secondary education is negatively and significantly related to manufacturing value added while tertiary education is a significant positive driver of manufacturing value added development in Africa. Furthermore, Abokyi, Appiah-Konadu, Sikayena and Oteng-Abayie (2018) however conclude that electricity consumption has a negative effect on manufacturing output in Ghana. The results they attributed to the fact that while the electricity supply in Ghana may be improving, the share of industrial sector's consumption, on the average, has nosedived continuously.

Overall, while the central role of infrastructure development for accelerating manufacturing sector performance has been acknowledged in the literature, there are findings which suggest that infrastructure at worst has a negative impact or at best, no impact on manufacturing. Noticeably from the highlighted literature, empirical research on the nexus between infrastructure and MVA in SSA are remarkably thin.

4. Model Specification

The basic empirical model employed to examine the nexus between infrastructure and manufacturing value added is specified as follows:

$$y_{it} = \alpha_0 + \beta z_{it} + \gamma' X_{it} + \nu_i + \upsilon_{it} \qquad i = 1,...,N(individual);\ t = 1,...,T(time) \qquad (1)$$

Where y_{it} denotes manufacturing value added for country *(i)* at time *(t)*. z_{it} represents infrastructure development indicators and X_{it} are the set of control variables which include credit to private sector, gross fixed capital formation used to represent domestic investment, human capital proxied by primary school enrolment, foreign direct investment, money supply (monetary policy instrument), general government final consumption expenditure (fiscal policy instrument) as well as governance measures such as control of corruption, rule of law, socioeconomic conditions, government stability, democratic accountability and bureaucratic quality. v_i is the individual country fixed effect parameter and v_{it} is the error term which is assumed to be normally distributed with zero mean and constant variance.

Endogeneity problems arising from simultaneity may potentially bias the estimation results. Indeed, it is logical to expect that infrastructure can spur manufacturing value added while the growth and development of manufacturing sector may call for new investment in infrastructural facilities. Although the fixed effects method can obviate the problem of heterogeneity, its usefulness in the presence of endogeneity challenge is limited. Therefore, this study also employs the Generalised Methods of Moment (GMM) – a dynamic panel data estimation technique suitable for tackling the endogeneity issue.

4.1 Data Sources and Description

This study employs data for 34 SSA countries for the period 2003 to 2018. The data are culled from the African Development Bank (2019), World Development Indicators (2018), the KOF Globalisation Index (2019) and World Bank Worldwide Governance Indicators (2019) as well as International Labour Statistics Database (2018).

Specifically, data on infrastructure – aggregate infrastructure index, electricity composite index, transport composite index, ICT composite index and water and sanitation composite index are sourced from the Africa Infrastructure Development Index (AIDI), 2019. The transport composite index is computed from total paved roads (kilometre/10,000) inhabitants and the road

network in kilometres (km). Electricity composite index is calculated from total electricity production of a given country and energy imported from abroad (both public and private energy generated). The index is measured in kilowatt-hours produced per inhabitant. ICT composite index comprises of total phone subscriptions per 100 inhabitants (fixed-line telephone subscriptions as percentage of population and mobile cellular subscription as percentage of population), number of internet users per 100 inhabitants and international internet bandwidth (Mbps) while water and sanitation composite index is computed from improved water access as percentage of population with access and improved sanitation facilities as percentage of population with access.

MVA as a percentage of Gross Domestic Product (GDP), the dependent variable, and other explanatory variables such as money supply (% of GDP), domestic credit to private sector (% of GDP), foreign direct investment (% of GDP), real GDP (measured in dollar), general government consumption expenditure (% of GDP), gross fixed capital formation (% of GDP) and primary school enrolment (the measure of human capital (% gross)) are sourced from World Development Indicators (2018). Also, governance measures namely government effectiveness, political stability and absence of violence/terrorism, regulatory quality, rule of law, voice and accountability as well as control of corruption were sourced from Worldwide Governance Indicators provided by the World Bank; employment in manufacturing sector was obtained from the International Labour Statistics (2018) while Globalisation Index was obtained from KOF Globalisation Index (see Gygli, Haelg, Potrafke and Sturm, 2019). To avoid the problem of multicollinearity, we compute an index of governance from six indicators using the Principal Component Analysis (PCA). This method has been used extensively in the literature (see Sharma and Sehgel, 2010; Dragos, Mare and Drule, 2016; Emara and Chiu, 2016).

5. Pre-Estimation Test Results

5.1 Descriptive Statistics

Table 1 presents the summary statistics of the variables used in this study. From the table, it can be observed that the mean value of manufacturing value added as percentage of GDP (mva_gdp) in SSA stood at 9.86% with minimum value of about 0.23% and maximum value of 35.22%. This suggests that manufacturing value added in SSA for the period has been quite low. With regards to infrastructure in SSA, the aggregate infrastructure index (aidi_index) averaged about

19.05, ranging from about 0.37 to 94.32 with standard deviation of about 16.76. The implication of these figures is that infrastructural development in most SSA countries is largely on the same level although there are few countries with some level of progress in the provision of infrastructural facilities.

Table 1: Summary Statistic Results

Variables	Obs	Mean	Std.Dev.	Min	Max	p1	p99	Skew.	Kurt.
mva_gdp	544	9.862	6.061	0.233	35.215	0.996	34.000	1.680	7.213
aidi_index	544	19.047	16.763	0.369	94.324	2.227	84.410	2.332	8.714
transp_index	544	9.596	10.243	0.915	52.651	1.071	51.023	2.311	8.453
elec_index	543	0.885	1.784	-4.510	4.539	-2.919	4.485	-0.203	2.602
ict_index	544	5.466	10.103	0.000	76.938	0.000	58.669	3.439	17.815
wss_index	544	47.981	20.359	6.044	97.557	14.289	96.875	0.597	2.854
rgdp	544	3.65e+10	8.68e+10	7.10e+08	4.70e+11	7.70e+08	4.30e+11	3.733	15.968
pse	544	104.801	19.281	42.721	149.271	51.38	147.566	-0.164	3.335
man_emp	544	528.493	803.424	3.841	4425.19	4.133	4085.32	2.963	12.590
ggfce_gdp	544	14.895	6.568	0.437	44.313	3.208	37.315	1.123	5.384
bm_gdp	544	32.756	21.742	3.161	115.015	7.218	104.454	1.763	5.771
gfcf_gdp	544	22.976	8.726	2.000	56.029	5.108	48.601	.666	3.790
fdi_gdp	544	5.304	9.782	-6.057	103.337	-3.751	50.636	5.582	43.555
kofgi	544	49.516	7.723	27.885	71.74	31.782	71.129	0.507	3.907
dcps_gdp	544	21.946	26.103	0.796	160.125	2.215	147.512	3.390	15.271
coc	544	-0.58	0.633	-1.525	1.217	-1.454	0.996	0.828	2.961
goveff	544	-.0.657	0.592	-1.746	1.057	-1.655	0.882	0.696	3.050
ps_abvt	544	-0.515	0.820	-2.524	1.039	-2.250	0.975	-0.308	2.380
regqual	544	-0.592	0.568	-2.236	1.127	-2.064	0.991	0.299	3.768
ruloflaw	544	-0.612	0.626	-1.852	1.077	-1.784	0.95	0.409	2.813
voc_acct	544	-0.500	0.690	-1.697	0.998	-1.555	0.944	0.329	2.097
govindex	544	0.000	1.000	-2.896	3.029	-2.593	2.790	0.299	3.768

Note: mva_gdp, aidi_index, transp_index, elec_index, ict_index, wss_index, rgdp, pse, man_emp, ggfce_gdp, bm_gdp, gfcf_gdp, fdi_gdp, kofgi and dcps_gdp represent manufacturing value added as a percentage of GDP, aggregate infrastructure index, transport composite index, electricity composite index, ICT composite index, water and sanitation composite index, real GDP, primary school enrolment, manufacturing employment, general government fixed consumption expenditure (% of GDP), broad money supply (% of GDP), gross fixed capital formation (% of GDP), foreign direct investment (% of GDP), KOF globalization index, and domestic credit to private sector (% of GDP) respectively. Also, coc, goveff, ps_abvt, regqual, ruloflaw, voc_acct, govindex represent control of corruption, government effectiveness, political stability and absence of violence/terrorism, regulatory quality, rule of law, voice and governance index respectively.

Source: Authors' Computation

5.2 Correlation Analysis Results

Table 2 presents the result of the pairwise correlation analysis. As shown in the Table, all infrastructure indices (aggregate infrastructure index, transport, electricity, ICT and water and sanitation) are positively correlated with MVA although transport and ICT are not statistically

significant at the 5% level. Also, real GDP, primary school enrolment, general government final consumption expenditure, money supply, KOF globalisation index, domestic credit to private sector and governance index are all positively correlated with MVA. Among these variables, primary school enrolment, general government final consumption expenditure, KOF globalisation index and domestic credit to private sector are statistically significant at 5% level. Manufacturing employment, gross fixed capital formation and foreign direct investment are negatively and significantly associated with manufacturing value-added. A quick look at the correlation among the variables shows that there is absence of problem of multicollinearity as the coefficients of correlations among the most of the variables are relatively low.

Table 2: Pairwise Correlation Results

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) mva_gdp	1.000															
(2) aidi_index	0.112*	1.000														
(3) transp_index	0.034	0.843*	1.000													
(4) elec_index	0.309*	0.669*	0.478*	1.000												
(5) ict_index	0.018	0.692*	0.414*	0.379*	1.000											
(6) wss_index	0.190*	0.827*	0.764*	0.610*	0.394*	1.000										
(7) rgdp	0.032	0.271*	-0.042	0.284*	0.275*	0.114*	1.000									
(8) pse	0.210*	0.127*	0.083	0.127*	0.037	0.289*	-0.104*	1.000								
(9) man_emp	-0.103*	0.007	-0.123*	0.060	0.092*	-0.131*	0.769*	-0.194*	1.000							
(10) ggfce_gdp	0.204*	0.333*	0.388*	0.227*	0.138*	0.361*	-0.095*	0.215*	-0.228*	1.000						
(11) bm_gdp	0.022	0.764*	0.740*	0.508*	0.434*	0.649*	0.138*	0.041	0.036	0.393*	1.000					
(12) gfcf_gdp	-0.301*	0.162*	0.225*	0.077	0.126*	0.045	-0.096*	-0.055	0.043	0.086*	0.212*	1.000				
(13) fdi_gdp	-0.215*	-0.010	0.007	0.045	-0.038	-0.053	-0.127*	0.007	-0.074	0.052	0.016	0.178*	1.000			
(14) kofgi	0.108*	0.715*	0.504*	0.703*	0.511*	0.587*	0.400*	0.103*	0.240*	0.139*	0.620*	0.121*	0.053	1.000		
(15) dcps_gdp	0.134*	0.686*	0.448*	0.485*	0.409*	0.519*	0.508*	0.046	0.228*	0.237*	0.755*	0.042	-0.076	0.651*	1.000	
(16) govindex	0.063	0.541*	0.505*	0.342*	0.307*	0.505*	0.155*	0.088*	0.017	0.232*	0.575*	0.236*	-0.098*	0.623*	0.576*	1.000

* shows significance at the 0.05 level

Note: ***Note: Computed by the Authors***

5.3 Estimation Results

Table 3 presents the results of the effect of infrastructure and various infrastructure types (like electricity, transportation, information and communication technology (ICT) and water and sanitation) on manufacturing value-added in SSA using a static panel estimation technique. We conduct the Hausman test to guide our choice between the fixed and random effects method. Judging by the results of the Hausman specification test, fixed effect estimation results are reported.

The empirical findings show that infrastructure exerts a positive influence on manufacturing value-added in SSA, irrespective of the infrastructure type. However the effects of the different types of infrastructure are insignificant. Extant literature corroborates our findings. For instance, Sharma and Sehgal (2010) find that infrastructure positively affects total factor productivity, output and technical efficiency of manufacturing sector in India; Anyanwu (2017) shows that ICT has a positive influence on manufacturing sector development in North African countries. Orji, Worika and Umofia (2017); Effiom and Benjamin (2018) document the positive economic impact of infrastructure for Nigeria while Paul, Sahni and Biswa (2004) had similar findings for Canada. However, our result is at variance with Abokyi, Appiah-Konadu, Sikayena and Oteng-Abayie (2018) which reports that infrastructure (proxied by electricity consumption) has a negative effect on manufacturing sector output in Ghana.

For a deeper understanding of the effect of infrastructure on manufacturing value-added in SSA, we grouped the 34 countries into different sub-regions – East, West, Central and Southern Africa. The results across each sub-region are at best mixed. For instance, in West Africa, the aggregate infrastructure index has a positive and significant impact on MVA. However, the results obtained from different components are mixed. For example, electricity index has an insignificant effect on MVA, while transport infrastructure index has a significant positive influence on MVA. ICT and water and Sanitation have insignificant effects on MVA (see Table 4).

In the case of East Africa as reported in Table 5, the effect of infrastructure on MVA is generally poor. The aggregate infrastructure index exhibits a significant negative effect on MVA. Although contrary to a priori expectation, the result is not surprising given the generally low level of

infrastructure in East Africa. Specifically, the AfDB infrastructure development ranking in 2018 placed East Africa at fourth position with a score of 14.60 compared to North Africa, Southern Africa and West Africa sub-regions with scores of 72.96, 45.46 and 20.47 respectively (AfDB, 2018). With respect to various infrastructure types, the empirical results indicate that electricity and water and sanitation have positive effects on MVA, although only water and sanitation is statistically significant at the 10% level. Conversely, transport and ICT have negative impact on MVA.

Overall, as reported in Table 6, infrastructure has a significant positive effect on MVA in the Southern Africa region. However, as in the case of East Africa region, the effects of each components of the infrastructure on MVA are mixed. While electricity has a positive and significant effect on MVA, transportation and ICT has negative effects. The positive effect of water and sanitation is statistically insignificant. With regard to Central African region, all the measures of infrastructure have positive effects on MVA. Specifically, aggregate infrastructure index, electricity and transport are statistically significant while ICT and water and sanitation are statistically insignificant (see Table 7).

For robustness and to control for endogeneity as previously stated, we further examined the effects of infrastructure on MVA in SSA using the system Generalized Method of Moments (sGMM). We use lags of the dependent variable as well as those of the independent variables and other control variables as instruments. Specifically, we used lags of the dependent variable as an internal instrument while the lags of independent and other control variables are used as external instruments. The reliability of our instruments is determined using Sagan and Hansen's instrument over-identification tests. As shown by these two tests, the instruments employed are valid. Hence, there is no problem of instrument over-identification.

As reported in Table 8, our findings using the sGMM are more robust as we found significant positive effects of infrastructure on MVA in SSA. However, it is important to note that although transport infrastructure and ICT infrastructure have positive effects on MVA, the effects are not statistically significant. This suggests more investment is still required to spur transport and ICT infrastructure in SSA.

Finally, we present the results of the effect of other control variables on MVA using Table 3. It is observed from the table that growth in the economy as proxied by GDP have a positive effect on MVA. Similarly, primary school enrolment, a measure of the minimum required human capital, and general government final consumption expenditure (a measure fiscal policy) have positive effects on MVA. Surprisingly, money supply, foreign direct investment (a proxy for foreign investment) and gross fixed capital formation (a proxy for domestic investment) have negative effects on MVA. Expectedly, domestic credit to private sector has a positive impact on MVA. This implies that, apart from infrastructure, access to credit is indispensable to the improvement of manufacturing value added in SSA. In most of the models, globalisation has a negative effect on MVA, thereby corroborating the effect of foreign direct investment on MVA. This could imply that manufacturing firms in SSA cannot withstand the competition from their foreign counterparts.

Table 3: Effects of Infrastructure on Manufacturing Value Added in Sub-Saharan Africa

	Aggregate (Total)	Infrastructure	Electricity		Transportation		ICT		Water and Sanitation	
	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects
laidi_index	0.167**	0.008	0.036	0.069**	0.055	0.076	0.001	-0.013**	0.021	-0.005
	(0.083)	(0.052)	(0.034)	(0.029)	(0.071)	(0.058)	(0.010)	(0.006)	(0.117)	(0.093)
lrgdp	-0.389***	-0.107**	-0.219***	-0.111***	-0.209***	-0.107**	-0.155	0.005	-0.205***	-0.103**
	(0.112)	(0.054)	(0.061)	(0.043)	(0.060)	(0.045)	(0.124)	(0.060)	(0.073)	(0.047)
lpse	-0.155	-0.158	-0.145	-0.169	-0.132	-0.159	-0.002	0.055	-0.148	-0.152
	(0.127)	(0.126)	(0.128)	(0.123)	(0.127)	(0.123)	(0.138)	(0.135)	(0.136)	(0.133)
lggfce_gdp	-0.051	-0.075**	-0.064*	-0.061	-0.071*	-0.074**	-0.098***	-0.098***	-0.072*	-0.076**
	(0.039)	(0.038)	(0.038)	(0.038)	(0.037)	(0.037)	(0.038)	(0.038)	(0.037)	(0.038)
lbm_gdp	-0.041	-0.071	-0.058	-0.073	-0.054	-0.060	-0.105	-0.092	-0.062	-0.073
	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)	(0.072)	(0.074)	(0.073)
lgfcf_gdp	-0.006	-0.040	-0.006	-0.037	-0.012	-0.039	-0.040	-0.060	-0.011	-0.039
	(0.041)	(0.041)	(0.042)	(0.042)	(0.041)	(0.041)	(0.040)	(0.040)	(0.041)	(0.041)
lfdi_gdp	0.014	0.005	0.011	0.002	0.011	0.006	0.001	-0.002	0.011	0.005
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
govindex	-0.094**	-0.092**	-0.116***	-0.100***	-0.110***	-0.097***	-0.139***	-0.115***	-0.110***	-0.093***
	(0.038)	(0.036)	(0.038)	(0.036)	(0.037)	(0.036)	(0.037)	(0.035)	(0.038)	(0.036)
ldcps_gdp	0.087	0.077	0.086	0.072	0.088	0.070	0.113**	0.129**	0.088	0.079
	(0.056)	(0.056)	(0.057)	(0.056)	(0.056)	(0.055)	(0.055)	(0.054)	(0.057)	(0.056)
_cons	11.428***	5.643***	7.948***	5.727***	7.625***	5.485***	6.146**	2.119	7.636***	5.560***
	(2.298)	(1.224)	(1.282)	(1.006)	(1.220)	(1.021)	(2.922)	(1.536)	(1.420)	(1.043)
Obs.	516	516	515	515	516	516	501	501	516	516
R-squared	0.099		0.094		0.093		0.087		0.092	.z
Hausman Test	39.43 (0.0000)		83.71 (0.0000)		32.90 (0.0001)		16.20 (0.0630)		46.27 (0.0000)	

Note: Standard errors are in Parenthesis

*** p<0.01, ** p<0.05, * p<0.1

The "l" in front of the variables indicate log.

Source: Authors' computation

Table 4: Effect of Infrastructure on Manufacturing Value Added in West Africa

	Aggregate Infrastructure		Electricity		Transportation		ICT		Water and Sanitation	
	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects
laidi_index	0.527***	0.219**	-0.037	-0.020	0.343***	0.386***	0.021	0.005	0.049	0.095
	(0.144)	(0.097)	(0.034)	(0.034)	(0.097)	(0.075)	(0.014)	(0.011)	(0.282)	(0.212)
lrgdp	-0.427**	0.034	0.168	0.160*	-0.004	0.112**	0.022	0.153	0.152	0.143*
	(0.193)	(0.099)	(0.110)	(0.084)	(0.116)	(0.054)	(0.166)	(0.103)	(0.128)	(0.077)
lman_emp	-0.157*	-0.054	-0.174**	-0.065	-0.099	0.110*	-0.167**	-0.081	-0.166*	-0.027
	(0.080)	(0.075)	(0.084)	(0.076)	(0.082)	(0.059)	(0.079)	(0.074)	(0.088)	(0.075)
lggfce_gdp	0.118**	0.112*	0.082	0.091	0.081	0.075	0.074	0.080	0.098	0.105*
	(0.057)	(0.059)	(0.061)	(0.061)	(0.057)	(0.064)	(0.068)	(0.068)	(0.061)	(0.062)
lbm_gdp	-0.299***	-0.325***	-0.222**	-0.234**	-0.125	-0.185*	-0.381***	-0.336***	-0.239**	-0.252**
	(0.106)	(0.110)	(0.109)	(0.106)	(0.109)	(0.110)	(0.111)	(0.112)	(0.109)	(0.110)
lgfcf_gdp	0.157***	0.155***	0.135**	0.137**	0.127**	0.099	0.172***	0.160***	0.144**	0.143**
	(0.053)	(0.055)	(0.056)	(0.057)	(0.053)	(0.061)	(0.053)	(0.054)	(0.055)	(0.057)
lkofgi	-0.366	-1.050**	-0.343	-0.778*	-0.501	-1.306***	-0.585	-0.791*	-0.501	-1.047**
	(0.433)	(0.408)	(0.465)	(0.416)	(0.433)	(0.353)	(0.444)	(0.432)	(0.457)	(0.436)
govindex	-0.161***	-0.198***	-0.221***	-0.202***	-0.205***	-0.166***	-0.246***	-0.220***	-0.218***	-0.190***
	(0.056)	(0.054)	(0.055)	(0.055)	(0.054)	(0.057)	(0.055)	(0.055)	(0.058)	(0.056)
ldcps_gdp	-0.000	0.026	-0.033	-0.002	-0.015	0.025	-0.000	0.011	-0.018	0.011
	(0.077)	(0.079)	(0.082)	(0.082)	(0.077)	(0.085)	(0.075)	(0.076)	(0.082)	(0.081)
_cons	12.842***	5.222**	0.636	1.805	3.728*	3.122**	5.233	2.360	1.334	2.622
	(3.746)	(2.216)	(2.079)	(1.784)	(2.085)	(1.343)	(3.928)	(2.723)	(2.247)	(1.668)
Obs.	192	192	191	191	192	192	185	185	192	192
R-squared	0.351		0.306		0.349		0.338		0.301	
Hausman Test	16.339 (0.060)		8.570 (0.478)		6.575 (0.681)		26.806 (0.002)		22.668 (0.007)	

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Source: Computed by the Authors

Table 5: Effect of Infrastructure on Manufacturing Value Added in East Africa

	Aggregate (Total) Infrastructure		Electricity		Transportation		ICT		Water and Sanitation	
	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects
laidi_index	-0.350***	0.007	0.020	0.042	-0.319***	-0.012	-0.027	-0.029***	0.253*	0.082
	(0.116)	(0.059)	(0.075)	(0.042)	(0.098)	(0.083)	(0.019)	(0.010)	(0.136)	(0.097)
lrgdp	0.524**	0.110	-0.345**	0.115	-0.196	0.136	0.246	0.264***	-0.188	0.178***
	(0.227)	(0.085)	(0.141)	(0.087)	(0.135)	(0.086)	(0.204)	(0.071)	(0.134)	(0.065)
lman_emp	0.120	-0.091	0.140	-0.081	0.193	-0.107	0.090	-0.248***	0.032	-0.134**
	(0.169)	(0.072)	(0.174)	(0.063)	(0.164)	(0.066)	(0.170)	(0.061)	(0.160)	(0.062)
lggfce_gdp							0.173	-0.229	0.192	-0.055
							(0.140)	(0.149)	(0.131)	(0.151)
lbm_gdp			-0.388**	0.043	-0.400**	0.113				
			(0.166)	(0.137)	(0.156)	(0.126)				
lgfcf_gdp	-0.099	-0.519***	-0.158*	-0.539***	-0.149**	-0.518***	-0.073	-0.479***	-0.056	-0.447***
	(0.074)	(0.084)	(0.080)	(0.087)	(0.075)	(0.086)	(0.090)	(0.077)	(0.084)	(0.078)
lkofgi	-0.764*	0.513	0.116	0.048	-0.126	0.312				
	(0.446)	(0.364)	(0.418)	(0.482)	(0.406)	(0.446)				
govindex	-0.016	0.018	-0.014	0.062	-0.007	0.050	-0.036	0.031	-0.026	0.043
	(0.063)	(0.053)	(0.071)	(0.059)	(0.062)	(0.061)	(0.058)	(0.044)	(0.057)	(0.045)
ldcps_gdp	-0.115	0.079	0.372**	0.022	0.329**	0.001	0.056	0.165***	0.168	0.121**
	(0.106)	(0.062)	(0.170)	(0.103)	(0.163)	(0.107)	(0.109)	(0.062)	(0.119)	(0.059)
_cons	-5.940	-0.575	9.607***	1.132	7.719***	-0.444	-4.397	-1.058	4.477*	-0.417
	(3.832)	(1.280)	(2.768)	(2.023)	(2.508)	(1.263)	(4.623)	(1.388)	(2.555)	(1.491)
Obs.	128	128	128	128	128	128	124	124	128	128
R-squared	0.122		0.100		0.178	.	0.074	.	0.097	.
Hausman Test	26.804 (0.0000)		17.337 (0.027)		23.111 (0.003)		206.55 (0.000)		269.171 (0.000)	

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1
Source: Authors' computation

Table 6: Effect of Infrastructure on Manufacturing Value Added in Southern Africa

	Total Infrastructure		Electricity		Transportation		ICT		Water and Sanitation	
	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects
laidi_index	0.252*	-0.163	-0.012	0.366***	-0.104	-0.080	-0.020	-0.043***	0.096	0.086
	(0.134)	(0.109)	(0.041)	(0.054)	(0.080)	(0.077)	(0.013)	(0.013)	(0.268)	(0.248)
lrgdp	-0.139	-0.244***	0.107	-0.304***	-0.035	-0.052	0.367*	-0.267***	-0.034	-0.045
	(0.167)	(0.046)	(0.106)	(0.039)	(0.097)	(0.089)	(0.193)	(0.043)	(0.098)	(0.091)
lman_emp	-0.130**	-0.049	-0.128**	-0.001	-0.092	-0.084	-0.151**	-0.041	-0.106	-0.098
	(0.061)	(0.050)	(0.062)	(0.041)	(0.062)	(0.060)	(0.063)	(0.045)	(0.077)	(0.072)
lggfce_gdp	-0.058	0.039	-0.085**	0.128**			-0.102***	0.096		
	(0.036)	(0.065)	(0.034)	(0.057)			(0.036)	(0.064)		
lbm_gdp	0.133	-0.883***	0.173**	-0.695***			0.142*	-0.877***		
	(0.085)	(0.147)	(0.084)	(0.125)			(0.084)	(0.139)		
lgfcf_gdp	-0.086**	-0.464***	-0.090**	-0.352***	-0.127***	-0.136***	-0.098**	-0.355***	-0.129***	-0.134***
	(0.043)	(0.092)	(0.043)	(0.075)	(0.043)	(0.042)	(0.043)	(0.085)	(0.044)	(0.043)
lkofgi	-1.985***	0.340	-2.160***	-1.786***	-1.985***	-1.867***	-1.985***	0.306	-1.972***	-1.904***
	(0.423)	(0.493)	(0.419)	(0.447)	(0.426)	(0.406)	(0.428)	(0.420)	(0.431)	(0.415)
govindex	0.024	0.047	-0.001	0.082**	-0.033	-0.017	-0.018	-0.010	-0.021	-0.013
	(0.054)	(0.039)	(0.053)	(0.034)	(0.055)	(0.052)	(0.053)	(0.040)	(0.055)	(0.053)
ldcps_gdp	-0.025	0.806***	-0.048	0.542***	0.055	0.057	-0.039	0.850***	0.048	0.050
	(0.061)	(0.112)	(0.060)	(0.097)	(0.043)	(0.042)	(0.060)	(0.106)	(0.045)	(0.044)
_cons	13.403***	9.404***	9.089***	17.222***	11.882***	11.756***	2.514	8.910***	11.319***	11.321***
	(2.931)	(1.963)	(1.858)	(1.838)	(1.763)	(1.702)	(4.470)	(1.806)	(1.770)	(1.728)
Obs.	144	144	144	144	144	144	144	144	144	144
R-squared	0.496		0.483		0.442		0.493		0.435	
Hausman Test	744.054 (0.0000)		14.350 (0.110)		2.439 (0.932)		1068.54 (0.000)		0.883 (0.997)	

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1

Source: Computed by the Authors

Table 7: Effects of Infrastructure on Manufacturing Value Added in Central African Countries

	Aggregate Infrastructure		Electricity		Transportation		ICT		Water and Sanitation	
	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects
laidi_index	3.045***	1.438***	0.059	0.583***	-0.044	1.029***	0.095**	0.020	0.384	0.367
	(0.806)	(0.475)	(0.205)	(0.111)	(0.478)	(0.312)	(0.047)	(0.039)	(0.994)	(0.710)
lrgdp	-3.989***	0.819***	-2.742***	0.545**	-2.643***	1.336***	-2.673***	1.330***	-2.855***	0.967***
	(0.659)	(0.257)	(0.629)	(0.241)	(0.614)	(0.238)	(0.641)	(0.232)	(0.709)	(0.299)
lman_emp	1.744	0.109	4.535***	0.011	4.651***	-0.021	4.952***	-0.049	4.594***	-0.048
	(1.166)	(0.116)	(1.009)	(0.090)	(1.005)	(0.097)	(0.762)	(0.088)	(0.976)	(0.120)
lggfce_gdp	-0.093	0.770**	-0.173	0.103			0.140	0.917***	-0.186	1.020**
	(0.326)	(0.368)	(0.359)	(0.370)			(0.270)	(0.356)	(0.362)	(0.451)
lbm_gdp	0.859	-2.216***	0.356	-0.633			-0.240	-1.256***	0.346	-1.829***
	(0.521)	(0.530)	(0.563)	(0.487)			(0.456)	(0.465)	(0.555)	(0.625)
lgfcf_gdp	0.362	0.482	0.568*	0.407	0.606***	0.052	0.286	-0.180	0.546*	0.232
	(0.272)	(0.343)	(0.294)	(0.296)	(0.227)	(0.316)	(0.224)	(0.312)	(0.299)	(0.386)
lkofgi	-1.273	-0.840	-1.487	-3.454**	-1.388	0.281	-1.080	3.923***	-1.581	2.498*
	(1.304)	(1.638)	(1.446)	(1.553)	(1.426)	(1.210)	(1.140)	(1.083)	(1.481)	(1.323)
govindex	0.215	-0.423	0.381	-0.376	0.336	-0.239	0.506**	-0.323	0.381	-0.495
	(0.256)	(0.325)	(0.281)	(0.293)	(0.261)	(0.319)	(0.212)	(0.301)	(0.279)	(0.353)
ldcps_gdp	-0.386	0.474	-0.199	0.479*	-0.093	-0.326*	-0.349*	0.171	-0.174	0.490
	(0.249)	(0.291)	(0.269)	(0.262)	(0.204)	(0.189)	(0.205)	(0.256)	(0.273)	(0.338)
_cons	83.550***	-16.276*	50.398***	0.921	47.459***	-30.931***	47.819***	-42.789***	51.864***	-30.781***
	(13.522)	(8.472)	(11.461)	(8.667)	(10.867)	(7.157)	(14.640)	(7.099)	(12.554)	(7.777)
Obs.	80	80	80	80	80	80	76	76	80	80
R-squared	0.495		0.386		0.381		0.613		0.387	
Hausman Test	40.473 (0.000)		40.766 (0.000)		9.829 (0.198)		199.211 (0.000)		111.276 (0.000)	

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1
Source: Computed by the Authors

Table 8: Effects of Infrastructure on Manufacturing Value-Added in SSA

	ONE-STEP SYSTEM GMM				
	lmva_gdp	lmva_gdp	lmva_gdp	lmva_gdp	lmva_gdp
lmva_gdp(-1)	0.860***	0.607***	0.658***	1.002***	0.853***
	(0.108)	(0.210)	(0.202)	(0.177)	(0.108)
laidi_index	0.041**				
	(0.019)				
ltransp_index		0.388			
		(0.307)			
lelec_index			0.104**		
			(0.049)		
lict_index				0.020	
				(0.021)	
lwss_index					0.068*
					(0.038)
	(0.013)	(0.104)	(0.056)	(0.182)	(0.043)
lpse	0.085	-0.058	-0.550	-0.338	0.067
	(0.089)	(0.288)	(0.825)	(0.449)	(0.083)
lggfce_gdp	0.029	0.189	-0.054	0.152	0.055
	(0.040)	(0.136)	(0.232)	(0.301)	(0.149)
lbm_gdp	-0.050	-0.711**	-0.636**	-0.376	-0.064
	(0.064)	(0.349)	(0.297)	(0.333)	(0.117)
lgfcf_gdp	-0.027	-0.100	0.035	-0.420**	-0.016
	(0.078)	(0.184)	(0.094)	(0.182)	(0.053)
lfdi_gdp	-0.020	0.035	-0.040	0.050	-0.015
	(0.017)	(0.046)	(0.047)	(0.035)	(0.018)
govindex	0.031	0.043	-0.122	0.054	0.001
	(0.060)	(0.202)	(0.172)	(0.176)	(0.017)
ldcps_gdp	-0.020	0.142	0.481*	0.189	0.017
	(0.049)	(0.282)	(0.267)	(0.265)	(0.101)
_cons	-0.310	0.475	5.999	5.945	-0.478
	(0.470)	(3.775)	(5.128)	(6.308)	(1.599)
Obs.	423	436	447	410	423
F-stats	113.21	18.54	12.12	10.91	117.79
AR(1)	0.026	0.030	0.023	0.134	0.049
AR(2)	0.146	0.261	0.788	0.345	0.222
Sagan Test	0.070	0.911	0.682	0.357	0.002
Hansen Test	0.456	0.496	0.382	0.655	0.310

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1
Source: Computed by the Authors

6. Conclusion and Recommendation

The importance of the manufacturing sector as an engine of economic growth has been recognised in the literature. Nonetheless, manufacturing value added and output in SSA remains

low. Several factors militate against the growth and development of manufacturing sector. One of which is the level and quality of infrastructure. It has been established that the availability of infrastructure facilities such as electricity, transportation, ICT as well as water and sanitation are good for industrial expansion and economic growth. In the light of this, this study investigated the effect of infrastructure development on manufacturing value-added in SSA. Specifically, the study examined the effects of aggregate infrastructure and that of electricity, transport, ICT and water and sanitation on MVA in SSA. To implement our objective, we deployed both static and dynamic panel estimation techniques.

Briefly, our results show that infrastructure development is indispensable to the growth and development of manufacturing sector in SSA. However, an examination of the effects of different infrastructure type on MVA, especially across each of the sub-regions in SSA, reveals that the effects are mixed. For instance, the effects of infrastructure on MVA in East Africa region are poor. Even in other regions where infrastructure exhibits positive influence on MVA, there is still much to be done as regards the provision of infrastructure facilities such as transportation, ICT, water and sanitation including electricity generation.

In order to achieve the level of manufacturing sector development as canvassed for by international development agencies and as enshrined in Sustainable Development Goals (9), governments in SSA countries need to invest massively in the provision of state-of-the-art infrastructure facilities. Government efforts alone may not be enough to achieve the level of infrastructure development that would guarantee the growth and development of manufacturing sector and possible structural transformation of the economies in SSA. Thus, there is need to partner with the private sector and international development agencies to reduce the infrastructural gap.

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Figures

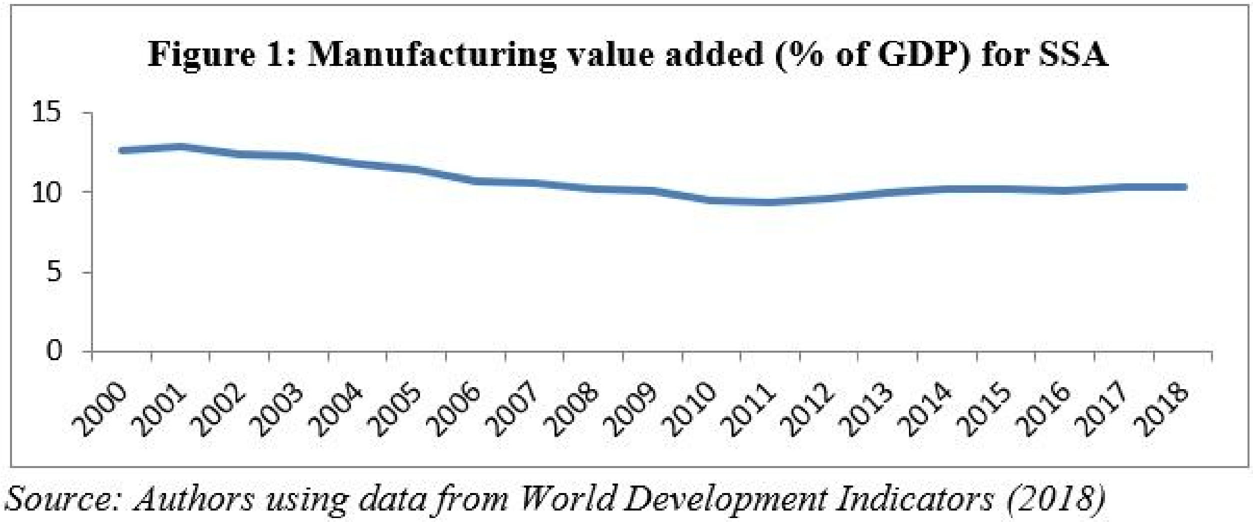

Figure 1

Manufacturing value added (% of GDP) for SSA

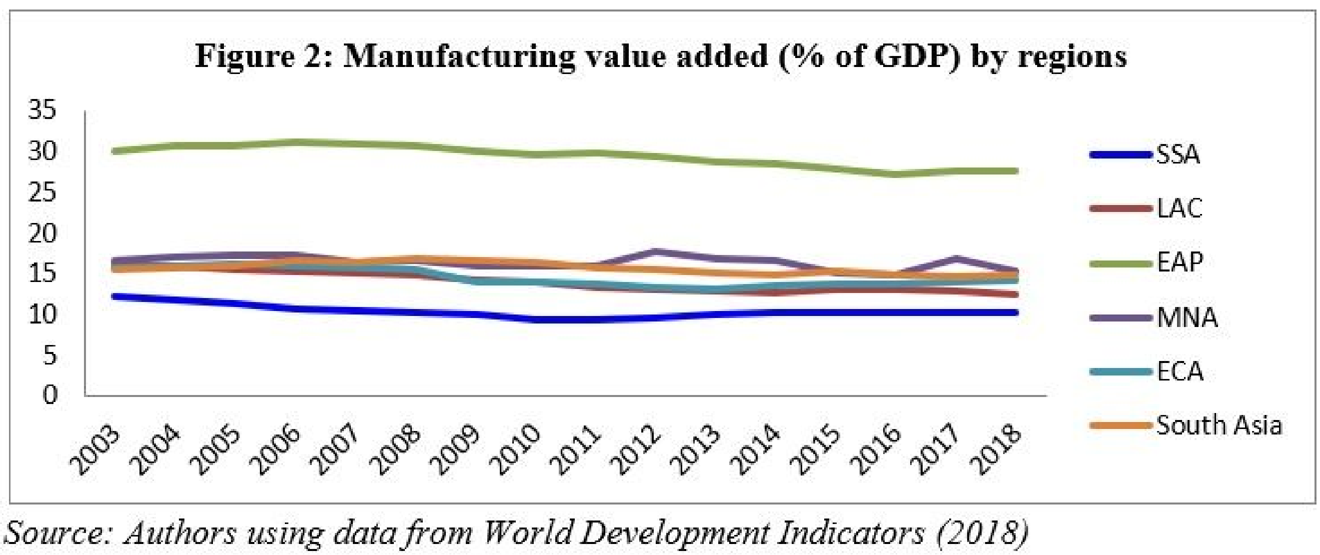

Figure 2

Manufacturing value added (% of GDP) by regions