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Industrialization in Sub-Saharan Africa: the role of telecommunications, electricity and aid to development

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Abstract: This paper examines the contribution of electricity, telecommunication, internet use and official aid to development on the industrialization process in Sub-Saharan Africa. The study is carried out on 30 sub-Saharan African countries over the period 1996-2019, using the Generalized Method of Moments. Strong evidence is provided to support that access to electricity and telecommunication services are the main determinants in Sub-Saharan Africa in the short run by ensuring an acceptable level of industrialization despite official aid to development. Moreover, in the long run, public aid to development becomes very important for industrial development alongside access to electricity, unlike access to mobile phone services or communication. It is advisable to get SSA countries to develop the energy sector and to make qualitative use of official aid. It is also important for these countries to create attractive frameworks for FDI in the field of industrialisation.

Keywords: Industrialization; telecommunications; electricity; SSA; GMM.

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1. Introduction

Economic prosperity and decent living standards in a country need a strong industrial sector. For a developing country, industrialization means more than simply increasing income and the volume of production. It is means modernising primitive production structure and transforming the whole socio-economic tradition associated with it (ONUDI 1990 /1991). The priority given to industry, often to the disadvantage of agriculture for example, can be explained by multiple reasons: faster growth, greater job creation, resolution of the balance of payments, increased savings, and increased flexibility of the economy. It should be noted that the objective of import substitution industrialization strategy adopted by African countries during independence periods was to protect young enterprises. The idea was to keep a domestic market for these goods so that this could be used as a basis for launching an

industrialization program. It was hoped that the replacement of imported goods by locally produced goods would, over time, lead to self-sufficiency. This strategy progressively showed its limits from the 1970s onwards, leading to its serious undermining in the 1980s. This failure was partly due to the fact that the different strategies were based on a short run vision of industrialization.
Nowadays the problem of African industrialization arises in a context of internationalization and globalization of economies, rapid technological change and policies of state disengagement from economic activity (Bikoué, 2010). This is why developing countries in Africa need a real industrial policy. Industrial policy involves a mix of strategic or selective interventions to boost certain sectors or activities, functional interventions to improve the functioning of markets, and horizontal interventions to promote certain cross-sectoral activities (Lall and Tuebal, 1998). Industrial policy is based firstly on the idea that structural transformation, and in particular the development of competitive manufacturing activities, is a necessary condition for sustained and equitable economic growth. Secondly, industrial policy supports the view that public involvement is a necessary means of promoting structural transformation. The recent financial crisis has shown that the private sector is not necessarily more efficient than the public sector. From this point of view, there is no longer a one-size-fits-all approach to industrialization. The industrial strategy must be designed on the basis of the country's situation, taking into account variables such as the current stage of development, the structure of its resources, its size and the dynamism of its population. However, the current situation confirms that weak industrial development is not without consequences in Africa. Thus, according to Delalande (1989), most suppliers of materials, raw or semi-finished materials or services to industry are far from the production areas. Long lead times are therefore required. Another consequence of the absence of an industrial environment is the dependence of consumer markets on agricultural crops of a seasonal nature.

Most of the causes of industrial enterprise failure in Africa stem from fake apprehension about the amount of working capital needed to operate the enterprise. It should also be noted that in all poor economies, enterprises in the informal sector, i.e. unregistered, outside the social and fiscal laws, are often formidable competitors. To this must be added the enormous difficulties of access to energy and Internet in Sub-Saharan African countries. Electricity consumption, for example, was around 487 KWh per capita for Sub-Saharan Africa in 2014, and stood at 757 KWh per capita in South Asia, while the world average was 3131 KWh for the same year[1] . Internet access remains an ongoing challenge. Only 25% of the population in Sub-Saharan Africa has access to the Internet, compared to 56% in South Asia and 83% in OECD countries in 2019. In a context of financial globalization and technological change, the linchpin of commercial exchanges and all kinds of transactions essential to industrial development, the challenge is considerable. Finally, the company cannot really count on the support of the local banking system. Bank credit to the private sector represents only 27% of GDP in 2019 for Sub-Saharan Africa against 47% for South Asia and around 60% for North Africa.

However, despite the strong potential, the industrial sector contributes only very moderately to wealth creation. In 2019, by way of comparison, manufacturing value added per capita is around 268 US dollars for Ivory Coast and 214 dollars for Cameroon, while for the same year Brazil is at 822 dollars, China at 2787 dollars, while the United States and France are respectively at 7092 dollars and 3976 dollars. This situation can be explained in part by the low technological intensity of manufacturing activities. A high proportion of manufacturing value added in Sub-Saharan Africa is linked either to natural resources or to traditional "low-tech" activities, which generally represent limited levels of productivity. However, the industrial sector remains the most important determinant of the structural transformation of the economy because of its impact on the labour market and productivity.

The purpose of this paper is to understand the role that telecommunications and electricity can play in the industrialization process on the one hand, and to assess the effectiveness of financial aid to development in this process on the other hand. The rest of the paper is organized as follow. The

1 World Bank Development Indicators (2019)

literature review will be presented in section 2 followed by the methodological approach in section 3. Section 4 will present the results of the model and section 5 will conclude.

2. Literature review

Industrialization requires the development of adequate infrastructure that can positively affect the whole economy. Economists consider physical infrastructure as a prerequisite for industrialization and economic development. Infrastructure, in general, consists of two parts, namely economic infrastructure such as telecommunications, roads, irrigation and electricity, and social infrastructure such as drinking water supply, health, education and sewage disposal (Murphy et al. 1989). Thus, the question of the role of infrastructure in industrialization has been of increasing concern to economists. This issue was the objective of the work of Satya and al. (2004) who examined the effects of public infrastructure on the performance of 12 Canadian manufacturing industries. A flexible cost function incorporating public infrastructure is estimated for each industry separately using annual time series data from 1961 to 1995. The results highlight the very important role that public infrastructure plays in the productivity of manufacturing industries. This was followed by the analysis of Isaksson (2009), who sought to understand how the importance of public capital affects industrialization for high economic growth. The analysis covered 57 developed and developing countries over the period 1970-2000. The results showed that public capital does explain how some countries have achieved industrialization better than others and that the stage of development of a country influences the action of public capital. Moreover, the return on public capital decreases as income increases. Another conclusion reached by this author is that the growth of public capital explains not only the level of industrialization in the long run but also how fast industry grows. The effect of industrial development on economic growth in Nigeria has been studied by Kenechukwu et al. (2015). They conclude that the influence of industrial product on economic growth is positive but statistically insignificant while national savings positively and significantly affects economic growth. In the same objective, Szirmai and Verspagen (2015), by working on a sample of developed and developing countries over the period 1950-2005, got firstly a positive and significant impact of the industrialization process on economic growth. Secondly by interacting the variable education, they found also a positive and significant effects, showing that industrialization leads to a process of knowledge transfer and innovation.

Umofia et al (2018) analyse the effects of infrastructure on the performance of the industrial sector of the Nigerian economy using time series from 1980-2016. One of the results of this work shows that electricity supply has a positive and insignificant impact on the value added of the industrial sector while gross capital formation as well as government expenditure have a positive and significant impact. By examining links between infrastructure and value added in the manufacturing sector of Sub-Saharan African countries, Nnadozie and Raifu (2020) find thanks to dynamic panel estimation techniques, that infrastructure significantly enhances the value added of the sector. The study also reveals that this contribution to value added varies according to the type of infrastructure (electricity, transport, telecommunications or water and sanitation) and the countries in the sub-region. Azolibe and Okonkwo (2020) examined whether the state of infrastructure development in sub-Saharan Africa actually drives industrial sector productivity using panel data techniques on 17 countries over the period 2003-2018. Their results indicate that the main factor influencing industrial sector productivity in sub-Saharan Africa remains the quality and volume of telecommunications. It also shows that low productivity in the industrial sector is largely due to low levels of electricity infrastructure and under-utilised water and sanitation infrastructure. The role of social and economic infrastructure in the performance of the manufacturing sector in Nigeria has attracted the attention of Ekundayo and Amarachi (2016). They examined the impact of social and economic infrastructure variables on the performance of the manufacturing sector and whether rampant inflation is responsible for the depression of the sector. The results show that teledensity, government expenditure affect positively and significantly the performance measured by the value added of the manufacturing sector. However, the authors also find that health expenditure, electricity production and consumption, and inflation have a negative and insignificant impact on the performance.

Another wave of literature on the subject has focused on the relationship between foreign direct investment (FDI) and industrialization. Jie and Shamshedin (2019) in this vision investigated the effects of FDI on industrialization in Ethiopia using time series over the period 1992-2017. The results show that FDI positively influences industrialization in the short or long run. This issue has been addressed by Essotanam et al (2020) in the context of the West African Monetary Union countries. These authors analysed the effects of FDI on structural transformation by considering the industrial, manufacturing, agricultural and service sectors over the period 1990-2017 using panel estimation techniques. They highlighted the neutrality hypothesis of FDI on the industrial, manufacturing and agricultural productivity sectors. The results show that FDI has a positive effect on the productivity of the service sector and that credit to the private sector is not an important determinant of structural transformation in the WAEMU region.

Adegboye et al (2016) also examined how FDI flow affects industrial performance in Africa using cross-sectional data from 43 African countries over the period 1996-2015. The results show that the impact of FDI flow on industrial performance is positive and statistically significant. However, some expected results are not obtained. The authors expected that an improvement in industrial performance would increase the level of national savings, investment and technology transfer, which would lead to an increase in national productivity, and thus ultimately reduce imports and dependence on external financial borrowing. Clearly, complementary policies are needed to trigger the beneficial effects of industrialization in African countries.

Gui-Diby and Renard (2015) also analyse the effects of FDI on the industrialization process in Africa. They use panel data techniques for 49 countries over the period 1980-2009. The results indicate that FDI does not have a significant impact on the industrialization process of the countries in the sample, although other variables such as market share, financial sector or international trade become important. Nevertheless, the role of FDI in the industrialization process in Africa remains mixed. The same issue was addressed by Iddrisu et al (2015) for the case of Ghana by studying the impact of FDI on the industrial sector as a whole. Time series techniques over the period 1980-2013 were used. The results indicate that FDI, trade openness and gross fixed capital formation contribute positively and significantly in the long run to the performance of the industrial sector. However, the exchange rate has a negative long run effect on the industrial sector.
Empirical work shows that, in general, public infrastructure explains the level of industrialization of countries. However, the level of development of a country influences the action of public infrastructure. It also appears that telecommunications significantly and positively influence the industrialization process than other variables such as infrastructure, electricity or supply. Another striking fact of this literature on the issue of industrialization remains the mixed contribution of FDI to industrialization. The results vary according to the methodology used. In time series analysis, FDI has a significant and positive influence on industrialization, in panel analysis, FDI is either neutral or has no influence on industrialization, and in cross-sectional analysis, the results show that FDI has a significant and positive influence on industrialization.

3. Materials and methods

3.1 *Model specification and estimation technics*

Alongside the work of Azolibe et al (2020), Ongo Nkoa (2016) and Gui-Diby and Renard (2015), most of which analyze the determinants of industrialization, this article proposes to consider the determinants identified in their long-term dynamics in SSA. However, it is assumed that official development assistance cannot guarantee a consistent industrialization of SSA if these prerogatives related to electricity and communication are maintained in the long run. Thus we specify the causal relationship between industrialization and its determinants as follows:

$$y_{it} = f(x_{it})$$

y_{it} is the indicator of the industrialization variable of country i at date t. x_{it} the group of explanatory variables of the industrialization process of country i at date t. Assuming in the sense of Bedji and

Belhadj (2014) and Cosmos and Josephine (2022) that the industrialization process follows a dynamic process, the equation in detail can be specified as follows:

$$VAI_{it} = \beta_0 + \beta_1 VAI_{it-1} + \beta_2 INV_{it} + \beta_3 OUV_{it} + \beta_4 IDE_{it} + \beta_5 TRANS_{it} + \beta_6 KHU_{it} + \beta_7 TPIBH_{it} + \beta_8 EFFG_{it} + \beta_9 QUAL_{it} + \varepsilon_{it} \quad (1)$$

However, in order to highlight the long run effects of the different determinants of industrialization in SSA listed above, the equation that will be estimated next is as follows:

$$VAI_{it} = \beta_0 + \beta_1 VAI_{it-1} + \beta_2 INV_{it} + \beta_3 OUV_{it} + \beta_4 IDE_{it} + \beta_5 TRANS_{it} + \beta_6 KHU_{it} + \beta_7 TPIBH_{it} + \beta_8 EFFG_{it} + \beta_9 QUAL_{it} + \beta_{10} ELEC_{it} + \beta_{11} TELAC_{it} + \beta_{12} USNET_{it} + \beta_{13} APDH_{it} + \beta_{14} Apdhsq_{it} + \beta_{15} Elecsq_{it} + \beta_{16} \text{Telacsq}_{it} + \beta_{17} \text{Usenetsq}_{it} + \varepsilon_{it} \quad (2)$$

Where VAI_{it} is the value added of the manufacturing sector of country *i in* period *t,* expressed as a percentage of GDP, ELEC is the rate of access to electricity of country *i* in period *t* as a percentage of the population, TELAC is the telephone density given by the sum of fixed and mobile telephones per 1000 inhabitants of country *i* in period *t*. INV is the investment or gross capital formation of country *i in* period *t* as a percentage of GDP. ODA is official development assistance per capita of country *i in* period *t*. TPIBH is the gross domestic product per capita of country *i in* period *t*. EFFG and QUAL are the variables expressing respectively the government efficiency and the regulatory quality of each country under consideration in period *t*. OUV is the degree of trade openness given by the sum of exports and imports in relation to the GDP of country *i* in period *t*. FDI and TRANS represent respectively foreign direct investment and migrant remittances as a percentage of GDP of country *i* in period *t*. USNET, the internet usage rate expressed as the number of people with internet access per 1000 inhabitants. KHU, the human capital index of country *i* in period *t*. $Aphdsq_{it}$, $Elecsq_{it}$, $Telacsq_{it}$ and $Usnetsq_{it}$ are respectively the squared values of the public aid variables, the electricity access rate, the telephone density, and the internet usage rate of country *i* at period *t*. ε_{it} is the error term.

3.2 Data sources and description of variables and statistics

The data for all variables in this study are derived from the World Bank's World Development Indicator database. They are of secondary type and collected over a period from 1996 to 2019.

Table 1: Descriptive statistics

Variable	*Obs*	*Mean*	*Std. Dev*	*Min*	*Max*
VAI	*705*	*24.503*	*14.275*	*8.854*	*84.349*
VAM	*636*	*10.285*	*5.024*	*0.233*	*40.064*
ELEC	*643*	*39.388*	*27.518*	*0.408*	*100*
TELAC	*720*	*41.195*	*44.967*	*0*	*218.74*
USNET	*656*	*7.293*	*11.609*	*0*	*64*
INV	*642*	*21.204*	*9.037*	*2.1*	*81.052*
EFFG	*629*	*-0.769*	*0.577*	*-1.884*	*1.057*
QUAL	*630*	*-.671*	*0.52*	*-2.298*	*1.127*
APDH	*718*	*67.126*	*83.577*	*-11.967*	*691.925*
OUV	*668*	*68.069*	*34.763*	*20.723*	*225.023*
IDE	*715*	*4.182*	*9.109*	*-8.703*	*161.824*
TRANS	*653*	*2.951*	*3.531*	*0*	*19.991*
KHU	*660*	*43.884*	*21.207*	*0.606*	*95.596*
TPIBH	*714*	*2.179*	*7.486*	*-29.462*	*140.367*

Source: authors

The table 1 above shows the descriptive statistics of the study variables. The table below shows the descriptive statistics of the variables of the study. It shows that the gross value added of industries (GVA) reaches an average of 24% of GDP with a maximum of 84% and a minimum of 8%. Access to electricity (ELEC) covers only 39% of the total population of sub-Saharan Africa. As for tele accessibility (TELAC), it appears that 41 out of every 1000 inhabitants have access to mobile and fixed telephones in SSA over the period under review. Internet use per 1000 inhabitants is only 7% on average. Investment (INV), trade openness (OUV), migrant remittances (TRANS) and official development assistance (ODA) average 21%, 68%, 2.9% and 67% of gross domestic product respectively. The growth rate of GDP per capita is only 2.17% on average, with a very high maximum observed in Equatorial Guinea in 1997.

4. Results and discussion

The objective of this paper is to highlight the contribution of electricity consumption, access to telecommunication services and official development assistance on industrial value added in Sub-Saharan African countries. Once the determinants have been confirmed and analyzed, the effect of these different variables over the long run was studied.

The following result shows that several determinants explain the industrial value of Sub-Saharan African countries. The determinants analyzed range from migrant remittances (1), human capital and GDP per capita (2) and institutional variables (3) including government effectiveness and quality of governance.

Table 2: Determinants of industrial value added

	(1)	**(2)**	**(3)**
L.VAI	0.868***	0.536***	0.532***
	(0.019)	(0.107)	(0.071)
INV	0.027	-0.429***	-0.043
	(0.018)	(0.058)	(0.041)
OUV	0.001	0.027***	0.046**
	(0.007)	(0.01)	(0.019)
IDE	0.009	-0.01	0.107**
	(0.044)	(0.05)	(0.048)
TRANS	-0.391**	0.42*	-0.522**
	(0.188)	(0.254)	(0.222)
KHU		0.075***	-0.016
		(0.017)	(0.028)
TPIBH		0.416***	0.281***
		(0.079)	(0.055)
EFFG			-4.663**
			(2.278)
QUAL			3.928**
			(1.711)
Cte	3.494***	12.998***	8.025***
	(1.099)	(2.718)	(3.115)
Observations	*570*	*519*	*140*
Instruments	*26*	*24*	*25*
Country	*29*	*29*	*29*
Chi^2	*10665.006*	*281.814*	*355.02*
AR(1)	*0.016*	*0.004*	*0.01*
AR(2)	*0.412*	*0.225*	*0.678*
Hansen	*0.251*	*0.135*	*0.7*

*Standard errors are in parentheses *** p<.01, ** p<.05, * p<.1*

Migrant remittances are one of the most variable determinants among the other groups. By controlling for its effect on industrial value, a 1% increase in migrant remittances leads to a 0.39% decrease in industrialization in SSA expressed by the value added of industries. By integrating variables such as human capital and the growth rate of GDP per capita on the one hand, and institutional variables on the other, several variables can be identified as determinants. A first group of determinants (*investments, migrant remittances and government efficiency*) negatively affect the industrial value added and the second (*the degree of trade openness, human capital, GDP per capita and the quality of institutions, foreign direct investments*) positively explain the latter.

The negative determinants thus show that an increase in investment (INV) of 1% reduces the level of industrialization in SSA by at least 0.4%. Despite controlling for the other variables that led to result 3, migrant remittances still remain negative. The persistence of these effects is explained by the low level of domestic investment in the industrialization process and the very fact that remittances are mostly used to create small income generating activities.

Low government efficiency also negatively affects the level of industrialization. Despite a 1 point increase in the government efficiency index, there is a negative effect of 4.66 points on industrialization in SSA. On the positive determinants of industrial production, Table 2 shows that a 1-point increase in the human capital index in SSA improves the level of industrialization by 0.075 points. This result is significant at the 1% level and is only robust under the control of higher per capita income and good institutional quality. The empirical literature shows that the level of human capital is the channel through which investments can contribute to the improvement of the level of industrialization. Cleeve et al (2015) conclude that human capital, apart from its role in industrialization through investment, helps to develop local firms and ensure long run economic growth.

A 1% increase in per capita income increases the level of industrialization in SSA countries by 0.28% as a result of demand for industries (expressed as an increase in purchasing power). This result, which corroborates that obtained by Ongo (2016), can be explained by the reversal effect according to Rowthorn and Ramaswamy (1999). A 1% increase in foreign direct investment (FDI) and trade openness (OUV) increases the level of industrialization in SSA by 0.17% and 0.046% respectively. The small effect of openness can be explained by the financial liberalization policies adopted in international trade. Kang and Lee (2011), on the other hand, find significant negative effects. The effects of FDI on industrialization are mixed in the economies compared to the results obtained. Unlike Diby and Renard (2015) who do not find conclusive effects of FDI on industrialization, the result obtained for the framework of this study corroborates with that obtained by Iddrisu et al. (2015) for studies conducted on Ghana. Ongo (2016) on the other hand finds that the effects of FDI on industrialization only become conclusive via the consideration of transmission channels such as human capital, investment and trade openness. This position has shown the non-exhaustiveness of the variants promoting the positive contribution of FDI in the industrialization process.

The results in Table 3 highlight the contribution of access to electricity (4), communication services (5) and the internet (6) and official development assistance (7) on industrialization in the sample of SSA countries.

Considering the variable of interest *access to electricity, the* following findings emerge: In a context materialized by an increase in the level of industrialization to 0.86% and 0.62% following respective increases of 1% in access to electricity and GDP per capita, the weak development of human capital leaves negative effects (column 4). Despite a 1 point increase in the human capital index, this reduces the industrialization process to the 10% threshold. In contrast to the previous result, the low level of human capital leads to a reduction in the level of industrialization. This can be explained by the high level of unemployment and the low level of industrialization on average in SSA countries.

Controlling for the simultaneous contribution of electricity and access to telecommunication services (column 5), a 1% increase in the latter provides a positive response of at least 0.71% and 0.093%

respectively to the industrialization process in SSA. These results are significant at the 1% and 10% thresholds respectively. These positive effects on the level of industrialization are explained in the sense of the World Bank (2017a) by the improvement in the quality and conditions of access to telecommunication services and electricity in contrast to the 1980-2015 periods. Azolibe and Okonkwo (2020), on the other hand, find negative and insignificant results judging the low level of electricity generation and its inaccessibility by SSA households.

In the same direction of effects, the purchasing power leading to an increase in domestic demand and exports contributes to improving the industrialization process. A 1% increase in the income per capita and trade openness accelerates the industrialization process in SSA by 0.32% and 0.06% respectively. These results are similar to those obtained by Gui-Dibi and Renard (2015) for the cases of African countries. Furthermore, they conclude that in the long run these variables negatively affect the level of industrialization relative to the U theory of industrialization/de-industrialization. On the other hand, the development of the industrial sector is negatively affected at 0.217% by investments not directed to the industrial sector. As a corollary, the low level of migrant remittances does not allow for a positive stimulation of industrialization.

Table 3: Effects of electricity, communication on industrial value added

	(4)	**(5)**	**(6)**	**(7)**
L.VAI	0.6***	0.365**	0.371**	0.41**
	(0.129)	(0.164)	(0.185)	(0.161)
INV	-0.107	-0.217**	-0.127	-0.219***
	(0.146)	(0.092)	(0.101)	(0.083)
OUV	0.151	0.065*	0.05	0.003
	(0.093)	(0.037)	(0.061)	(0.045)
IDE	0.13	0.151	0.116	0.193*
	(0.11)	(0.116)	(0.118)	(0.1)
TRANS	-0.846	-0.897*	-0.798	-0.034
	(0.634)	(0.498)	(0.604)	(0.466)
KHU	-0.597**	-1.097***	-0.985***	-0.39***
	(0.291)	(0.354)	(0.373)	(0.147)
TPIBH	0.621***	0.322**	0.305**	0.304*
	(0.193)	(0.148)	(0.15)	(0.176)
EFFG	-12.858	-11.265	-12.36*	-5.898
	(8.002)	(6.921)	(7.278)	(4.189)
QUAL	7.837	12.067*	17.345**	7.766**
	(8.411)	(6.307)	(7.267)	(3.515)
ELEC	0.853**	0.71***	0.599**	0.276**
	(0.371)	(0.253)	(0.245)	(0.121)
TELAC		0.093*	0.09*	0.051**
		(0.052)	(0.051)	(0.024)
USNET			0.01	-0.136
			(0.159)	(0.093)
APDH				0.005
				(0.007)
_cons	-6.189	34.899***	35.49***	22.027***
	(13.868)	(8.949)	(8.519)	(6.258)
Observations	*442*	*441*	*439*	*439*
Instruments	*24*	*25*	*24*	*26*
Countries	*29*	*29*	*29*	*29*
AR(1)	*0.006*	*0.004*	*0.015*	*0.008*
AR(2)	*0.543*	*0.427*	*0.516*	*0.942*
Hansen	*0.476*	*0.775*	*0.627*	*0.614*

*Standard errors are in parentheses *** p<.01, ** p<.05, * p<.1*

The industrialization process then becomes very sensitive to a rise in the human capital index. An increase of 1 point in human capital negatively affects industrialization in SSA by 1.097 points. The current level of human capital does not allow for a revival of the industrialization process in the countries considered. In spite of this, an improvement in the quality of institutions, together with access to telecommunications, the internet and official development assistance, is a guarantee for improved industrialization in SSA.

The results of controlling for internet use in the industrialization process are shown in column 6 of the table 3. The effects of human capital, institutional quality, access to electricity and telecommunication services are robust despite the insignificance of the variable relating to internet use (USNET). The simultaneous effects of official development assistance (7), electricity and telecommunications confirm the robustness of the implications of investment, human capital and GDP per capita on industrialization. Under the control of the increase in access to electricity and telecommunications, an increase of 1% of the latter makes it possible to raise the level of industrialization by 0.276% and 0.051% respectively. Under these conditions, the contribution of FDI becomes equally positive on industrial added value in SSA.

Table 3 shows that access to electricity, along with telecommunications and good governance, promotes industrialization in SSA despite the insignificance of official development assistance (ODA). Previous analyses do not show whether the effects are sustainable in the long run or not. By integrating this new temporal variable, we obtain the results of table 4. Columns (8), (9), (10) and (11) of the table make it possible to take into account the long run effects of access to electricity, telecommunications, internet use and official development assistance, respectively. Column (12) shows the simultaneous results of all the long run effects, considering them as variables of interest.

Specifically, two cases can be observed on the long run effects. First, it is apparent from column (8) that in the long run the low electricity production of SSA countries does not raise the level of industrialization. According to the World Bank report (2017a), access to electricity is only 0.04 megawatts per 1,000 people well below the 1/3 in South Asia. For the whole of sub-Saharan Africa, total energy consumption is only around 180 Kwh per capita compared to 13,000 Kwh in the US. The second case is that official development assistance (column 11) whose long run effects make it possible to guarantee an acceptable level of industrialization in SSA.

The analysis of the synchronized effects of the different variables on the level of industrialization, the results of which are presented in column (12), reveals four (4) important scenarios. First, despite the low production of electricity, the increase of official development assistance could change the situation. The contribution official development assistance to the development of electricity networks and their accessibility can help raise the level of industrialization in SSA. Secondly, access to telecommunication services may improve the level of industrialization in the short run, but in the long run it has a negative impact. Thirdly, due to the low level of internet access, the use of the internet does not improve the level of industrialization in the short run. Moreover, in the long run, the effects seem interesting in a dynamic linked to an increase in accessibility to electricity and official development assistance. Fourthly, in the synchronized approach to the effects of the variables considered, official development assistance constitutes a guarantee of industrial development insofar as the institutions are efficient in their management. In the short run, the effects of aid are insignificant, whereas in the long run, the expected effects of aid, along with access to electricity and telecommunications services, form the basis of industrial development in SSA.

In addition to these effects, the contribution of FDI in the promotion of a diversification of the industrial process makes it possible to improve the level of industrialization on condition of a long-run human capital improvement and the good quality of institutions. The efficiency of the financing of the economy, as well as the development of information and communication technologies, can only be guaranteed by good institutional quality. Ongo (2016) suggests that the dynamics of FDI-related results include an increase in investment in terms of quality and the development of transport and telecommunications infrastructures.

Table 4 : Analysis of long run effects

	(8)	(9)	(10)	(11)	(12)
L.VAI	0.344*	0.348**	0.366**	0.378**	0.403**
	(0.201)	(0.167)	(0.186)	(0.158)	(0.195)
INV	-0.401***	-0.215**	-0.131	-0.085	0.027
	(0.11)	(0.095)	(0.102)	(0.101)	(0.132)
OUV	0.024	0.072*	0.038	-0.055	0.051
	(0.036)	(0.038)	(0.068)	(0.056)	(0.056)
IDE	0.121	0.151	0.123	0.194*	0.153
	(0.103)	(0.117)	(0.122)	(0.117)	(0.139)
TRANS	-0.209	-1.018*	-0.72	0.108	-0.914***
	(0.557)	(0.52)	(0.605)	(0.409)	(0.339)
KHU	-0.112	-1.092***	-1.078***	-0.715***	-0.417
	(0.11)	(0.361)	(0.387)	(0.143)	(0.499)
TPIBH	-0.066	0.339**	0.312**	0.361**	0.725***
	(0.162)	(0.147)	(0.151)	(0.182)	(0.148)
EFFG	-5.198***	-11.807*	-11.162	-6.249	-8.112*
	(1.947)	(6.998)	(8.554)	(5.503)	(4.306)
QUAL	2.175	12.229*	18.423***	7.923*	5.579
	(3.121)	(6.439)	(6.949)	(4.8)	(5.897)
ELEC	0.738*	0.698***	0.604**	0.469***	-1.236
	(0.38)	(0.253)	(0.258)	(0.156)	(0.996)
Elecsq	-7.857*				17.061*
	(4.529)				(10.183)
TELAC		0.142*	0.078	0.042	0.361***
		(0.084)	(0.071)	(0.032)	(0.126)
Telacsq		-0.62			-6.645***
		(0.89)			(2.54)
USNET			-0.173	-0.002	-2.423**
			(0.562)	(0.106)	(1.09)
Usnetsq			2.032		21.08**
			(4.889)		(8.842)
APDH				-0.043*	-0.028
				(0.023)	(0.026)
Apdhsq				1.443***	1.153*
				(0.524)	(0.621)
_cons	41.78***	36.777***	39.17***	22.224***	-36.399
	(14.714)	(9.317)	(9.076)	(7.404)	(33.199)
Observations	*442*	*441*	*439*	*437*	*437*
Instruments	*24*	*25*	*24*	*26*	*28*
Countries	*29*	*29*	*29*	*29*	*29*
AR(1)	*0.037*	*0.005*	*0.019*	*0.018*	*0.047*
AR(2)	*0.984*	*0.324*	*0.623*	*0.266*	*0.764*
Hansen	*0.665*	*0.748*	*0.493*	*0.432*	*0.173*

*Standard errors are in parentheses *** p<.01, ** p<.05, * p<.1*

5. Conclusion

This paper analyses the effect of electricity, telecommunication, internet use and official development assistance on the industrialization process in SSA countries during the period of 1996-2019. The results show that the key variables such as electricity, telecommunications, internet use and official development assistance can contribute to the industrialization of SSA countries. Access to electricity and telecommunications services are the main determinants of industrialization in the countries under study. Moreover, from a long run perspective, official development assistance is becoming very

important for industrial development alongside electricity, unlike mobile phone access or communication. The variables like foreign direct investment and official development assistance affect the industrialization differently. Migrant remittances, for example, negatively affect industrial value added, which proves that in reality they only serve to create, in most cases, small income-generating activities. Foreign direct investment contributes significantly to the increase in the level of industrialization and trade openness. On the other hand, official development assistance, when directed towards the development of electricity networks and their accessibility, can help to raise the level of industrialization in SSA. The low rate of access to the internet does not improve the level of industrialization in the short run, but in the long run the effects appear positive in a dynamic linked to the increase in accessibility to electricity and official development assistance. Finally, the weakness of government efficiency negatively affects the level of industrialization, while human capital is the channel through which investments can contribute to its improvement. The quality of institutions remains the only guarantee for the effectiveness of public aid and the improvement of industrialization in SSA. In perspectives, our tutures studies will be focalized on the effect the transition of renewable energy consumption on economic growth and inequality reduction through the industrialization process.

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