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LINKING INDUSTRIALIZATION AND EDUCATION IN SUB-SAHARAN AFRICAN COUNTRIES

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ABSTRACT
Several works have studied the consequences of industrialization on macroeconomic variables. However, the relationship between industrialization and education has not yet been studied, especially in sub-Saharan Africa (SSA). The objective of this study is to fill this limitation of the literature by analyzing the direct effect of industrialization on education in 23 SSA countries during the period 2000-2018. Moreover, we analyzed the indirect effect between the two variables through the transmission channels. To achieve our objective, we mobilized the Driscoll and Kraay methods and System GMM. The results reveal that there is a negative and significant relationship between industrialization and education. Moreover, urbanization and per capita income are transmission channels that contribute to mitigating this negative effect. Finally, our results show that the positive impact of the processing sector on education in SSA is conditioned by the achievement of a certain per capita income threshold and a certain urbanization threshold.

Contribution/Originality: This paper is the first macroeconomic study that assesses the effect of industrialization on education. It also highlights the indirect effect of industrialization on education through per capita income and urbanization. Finally, the net effect and the thresholds of the transmission channels through which industrialization positively impacts education was found.

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1. INTRODUCTION

Considering the fact that education is not free, so it is not easy to get. If it is considered as an input to develop the human resources necessary for economic and social transformation, it can also be considered as a consumer good; because it offers utility (satisfaction) to the consumer. Moreover, the hypothesis according to which formal education is useful for improving the productive capacity of a population is that advocated by the theory of human capital.

At the end of the MDG journey, despite the many progress made, it was clear that the world still had many children out of school and of school age (about 57 million according to the UN (2015)). Aware of the failure to achieve this objective, the international community has integrated the objective of ensuring education for all and at all ages into the SDG agenda. According to human capital theorists (Becker, 1962; Lucas, 1990; Mincer, 1958), an educated population is a productive population. According to this theory, an important condition for promoting the development of a country is the improvement of the level of education of the population. It is for this reason that it is important to understand the explanatory factors of the level of education. The analysis of the specific case of SSA countries is justified by the fact that this region is the first in the world to record the highest rate of exclusion from education. With a 21% school exclusion rate, SSA has a higher rate than North Africa (11%) (Institute of Statistics for UNESCO, 2019).

Moreover, more than a fifth of children aged around 6 to 11 are out of school, followed by a third of children aged around 12 to 14 and almost 60% of young people aged around 15 at 17 are out of school (Institute of Statistics for UNESCO, 2019). Several explanations are at the origin of the high rate of exclusion in education in SSA, in particular unemployment, the low level of per capita income, the high level of child labor, social inequalities, the low level of investment in education, poor governance and socio-political instabilities.

However, many studies have shown that industrialization is a solution to economic development through poverty reduction (Cadot, De Melo, Plane, Wagner, & Woldemichael, 2016) and the improvement of human capital (Federman & Levine, 2005). The first studies on the relationship between industrialization and economic development date back to the 1950s. To this end, the work of Rodrik (2008); Rodrik (2009) cited by Goujon and Kafando (2011) showed that industrialization boosts economic growth. Recognizing this relationship, many developing countries, such as African countries, adopted in the 1960s and 1970s an import substitution model of locally producing the goods needed to meet domestic demand and protect local businesses from foreign competition.

According to the UNIDO (2002) and Hausmann, Pritchett, and Rodrik (2005) industrialization is seen as the catalyst for long-term economic growth. According to Cadot et al. (2016) industrialization is a factor in poverty reduction. It also contributes to improving the quality of human capitalfreeman (Federman & Levine, 2005). Moreover, it contributes to the reinforcement of economic diversity and national investments (Duarte & Restuccia, 2010). According to UNCTAD and UNIDO (2011), African countries are committed to a broader agenda that aims to diversify their economies, create more jobs, better withstand shocks and reduce poverty in recent years.

Recent initiatives on the continent in terms of industrial development have had varying levels of success depending on the experience. While some models seem to be more successful than others, few experiences can be directly replicated from one country to another. The potential of the African continent is well established: seven of the ten countries with the strongest economic growth in the world are in Africa (AfDB, 2017).

Industrialize Africa is one of the five accelerators of the African Development Bank, the other four being Light Up and Power Africa, Feed Africa, Integrate Africa and Improve People's Quality of Life. This is why the industrialization of Africa is at the heart of the "High 5s" of the African Development Bank. To industrialize Africa, the African Development Bank is committed to raising capital, reducing investment risks for the private sector and leveraging capital markets. These are all essential measures to implement the continent's industrial agenda and build a 21st century Africa well equipped to take its place in global value chains (AfDB, 2017).

Several works on the theoretical level (Marx & Engels, 1848; Smith, 1776) have demostrated that industrialization is a determinant of development. Implicitly, industrialization improves the well-being of a nation on several dimensions including education. Through the flexibility of the workforce, the increase in incomes that it stimulates, industrialization contributes to creating a growing level of education for all (Kerr, 1962). Therefore, the industrialization of a country or a region influences not only the social and cultural life with educational opportunities, housing and other infrastructures but it also influences the economic life of the populations through the increased income and job opportunities. In contrast, Adam Smith and Marx revealed the potential downsides of industrialization, including growing inequality, increased pollution, and weaker social cohesion. Indeed, some concerns relate to how industrialization can contribute to deschooling by attracting young people to work in factories or by increasing the need for young people to help at home.

The analysis of the effect of industrialization on education has already been an important concern of the literature. For example, the gradual introduction of large-scale steam-powered factories has been observed to promote the development of low-skilled jobs and the decline of semi-skilled jobs in Britain, eventually reducing the literacy rate and education in this country (De Pleijt & Weisdorf, 2016). This consequence is particularly justified because steam engines favored children who performed secondary tasks to help older workers. These included the assembly of broken pieces of yarn on spinning mules in the textile sector (Nardinelli, 1980, 1990). Sanderson (1972) and Nicholas and Nicholas (1992) referred to this situation as the "deskilling hypothesis". Moreover, the same phenomenon has been observed at the level of secondary education in the USA (Goldin & Katz, 1997). However, Tendler (2002) finds that there is heterogeneity within the manufacturing sector and that many jobs are not designed to be profitable for high school education. Even if it should be specified in the case of French or English industrialization that it was not easy to prove that industrialization was the cause of a drop in the literacy rate (Corbin, 1975; Schofield, 1973) because during the period of the rise of industrial activities (early 19th century), Laqueur (1974) declared that there was rather an increase in the said rate

It can be deduced from the above that the relationship between the processing sector and education is not conclusive. The work of Leblond (1970) demonstrated the presence of a low literacy rate in the industrial districts between 1831 and 1843 in northern France. The case of the USA has been studied, among others, by Goldin and Katz (1999). These authors observed that there was a negative association between industrialization and education. However other authors have instead found a positive relationship between the two variables. For the case of Indonesia, Federman and Levine (2005) demonstrated that the processing sector promotes education at all levels. Along the same lines, Sharma, Vashist, and Sharma (2008) found that industrialization has improved education as well as economic and social infrastructure. This was also the case in Mexico for primary education.

In summary, the empirical literature on the the link between the manufacturing sector and education, although scarce, remains ambiguous. Through increased public sector incomes, returns to skills and children's access to school, industrialization can increase education. At the same time, the expansion of manufacturing jobs can reduce education by increasing the opportunity costs of keeping children in school, reducing the return to skills (in case manufacturing jobs are very low-skilled) and by inducing migration and other social disruptions that can hinder school attendance. The lack of consensus on the relationship between the two variables is proof that other work can be carried out on this relationship in order to contribute more to the literature on this subject. It is in this context that our subject finds, among other things, its full justification.

Besides studying the relationship between industrialization and education, it is important to study the channels through which industrialization impacts education. To this end, the literature has enabled us to identify two potential transmission channels. These include urbanization and per capita income.

The work of Kerr (1962) argues that family income can improve as a result of industrialization if workers have the bargaining power to share in productivity gains. Since education is limited by money or represents a normal good, an improvement in parental income leads to an increase in the demand for education. Similarly, industrialization can also increase the supply side of education through increased government revenue. It can be concluded from the above that industrialization generates employment and increases the opportunity cost of pursuing education. Beyond the work of Kerr (1962); Le Brun, Helper, and Levine (2011) argue that industrialization contributes to increased urbanization and can benefit students by bringing them closer to schools and making them more accessible. Nor is it excluded that we are witnessing rapid demography due to urbanization, the construction of infrastructures of which thus leads to poor learning conditions.

The literature on the relationship between industrialization and education is not unanimous. Moreover, the case of sub-Saharan African countries has not yet attracted the attention of previous works. Yet, SSA represents the region where the rate of exclusion in education is the highest of all the regions of the world. The objective of this article is to compensate for this lack of literature by analyzing how industrialization impacts education in SSA countries. Indeed, the processing sector should increase not only family incomes but also those of the public sector. If public sector income stimulates the supply of education, family income should increase the demand for education. However, the particularity of SSA, which records a high rate of school exclusion in the world, gives us the opportunity to analyze whether industrialization contributes to the process of deschooling in this region. In addition, we will seek to further understand this relationship by highlighting the channels through which industrialization impacts education.

This paper has four sections. In addition to section one that includes the introduction, section two of this work is devoted to the methodological approach. As for section three, it highlights the results of the study and section four concludes.

2. DATA AND METHODOLOGY

2.1. Data

We use a panel of 23 SSA countries with data from 2000 to 2018. The data for our variables are taken from the World Bank's indicator database. It is important to specify that the limitation of the study period and the number of countries is linked to the availability of data.

Table 1. Descriptive statistics.

Variables	Obs.	Mean	Median	Std. Dev.	Min	Max
Indust	437	9.512	9.201	4.425	0.230	21.21
Agricult	437	23.793	23.981	12.672	2.085	58.651
Pop	437	2.741	2.766	0.641	0.239	4.627
Water	437	55.018	54.312	13.845	19.897	92.279
Sanitation	437	25.714	22.691	14.269	4.328	74.821
Goveff	437	-0.845	-0.833	0.456	-1.744	0.693
Polist	437	-0.797	-0.666	0.783	-2.664	0.661
Urban	437	15.688	12.812	10.842	4.273	64.201
GDPC	437	1153.371	659.526	1411.072	149.361	8080.862
Education1	437	96.144	99.349	22.821	32.351	149.303
Education2	437	36.053	33.841	18.285	6.192	109.442
Education3	437	5.936	4.644	4.527	0.345	20.484

The dependent variable in this paper is education. This variable is increasingly used in the literature by the three levels of the schooling rate (Federman & Levine, 2005; Goldin & Katz, 1999; Le Brun et al., 2011). As for the main explanatory variable (industrialization), it is captured by the added value of the manufacturing sector. In addition, several authors have already used this measure in their work (Njangang & Nounamo, 2020; Nkoa, 2016). In addition to this variable, other control variables were used as explanatory factors for education (access to sanitation, access to water, agriculture and population growth rate). The sources of the different variables, their definitions as well as the list of individuals in our panel are contained in Tables A1 and A2 in the appendix.

The descriptive statistics and the result of the cross-sectional dependence test of Pesaran (2004) are recorded respectively in Table 1 and Table 2. Table 2 shows that all the variables admit a transverse dependence with regard to their probability which is zero. The paragraph below provides a brief description of the expected signs.

Referring to the work of Goldin and Katz (1999) they found an inverse relationship between the manufacturing sector and education, while the work of Federman and Levine (2005) rather revealed a positive association between the two variables. Regarding access to sanitation and access to water, they all impact education (Santiago, Resende, & Dinar, 2016). As for demography, Bilsborrow (1978) found that it had no effect on education. Finally, the work of Engler and Kretzer (2014) has proven that agriculture has a positive effect on education.

Table 2. Pesaran cross-dependency test (Pesaran, 2004).

Variables	CD-Test	P-Value	Corr.	Abs. (corr.)
Education1	22.141	0.000	0.319	0.609
Education2	52.328	0.000	0.755	0.909
Education3	51.080	0.000	0.737	0.797
Totalrent	14.396	0.000	0.208	0.414
Indust	8.491	0.000	0.122	0.423
Agricult	5.083	0.000	0.073	0.381
Pop	4.157	0.000	0.060	0.532
Water	28.492	0.000	0.411	0.959
Sanitation	20.738	0.000	0.299	0.971

2.2. Methodology

From the recent literature on education (Santiago et al., 2016) we have formulated the following econometric model in order to achieve our objective:

$$Education_{it} = \beta_0 + \beta_1 Education_{it-1} + \beta_2 Indust_{it} + \beta_3 X_{it} + \mu_i + v_t + \varepsilon_{it} \quad (1)$$

Where $Indust_{it}$ and $Education_{it}$ represent respectively industrialization and education for country i in the period t, X_{it} is a vector which includes all control variables, μ_i is an unobserved country-specific effect, v_t is the time specific effect and ε_{it} is the error term.

When all the variables of an econometric model admit a cross-sectional dependence, the use of the technique of Driscoll and Kraay is required. This technique allows us to make estimates from fixed effects and pooled Ordinary Least Squares. For a static panel, the use of this method provides the standard deviations of coefficients which are robust. Our approach is to use OLS as a basic estimation technique. Given the fact that it does not capture fixed effects, we will use fixed effects in the following. Then, our econometric model being dynamic and not static, the use of the previous method is likely to provide biased results because of the lagged dependent variable present in the model as an independent variable ($Education_{it-1}$). And according to the work of Nickell (1981) this lagged variable is correlated with the error term and thus generates the endogenity problem. To take into account the dynamic nature of our panel, the problem of endogeneity or reverse causality, we used a method with instrumental variables: the system Generalized Method of Moments (GMM). This method was proposed by Arellano and Bond (1991); Arellano and Bover (1995) and Blundell and Bond (1998).

3. RESULTS

The tables below provide the results from the different estimates. Table 3 records the results obtained by the OLS and fixed effects methods. With regard to Table 4, it presents the results obtained by the GMM method. Finally, Table 5 reproduces the results presented in Table 4 by introducing potential transmission channels.

3.1. Baseline Results

Table 3 reveals through the use of the grouped OLS method that there is an inverse relationship between education and industrialization. Consequently, an increase in the added value of the manufacturing sector by 1% leads to a drop in the schooling rate by 0.25%; 0.32% and 0.08% respectively for the three levels of education. This result is compatible with that of the fixed effects method, the results of which are recorded in the same table.

Table 3. Industrialisation and education (baseline results).

	Driscoll and Kraay					
Variables	Fixed effects			Pooled OLS		
	Education1	Education2	Education3	Education1	Education2	Education3
Indust	-0.5158* (0.09)	-0.4243*** (0.00)	-0.0580** (0 .01)	-0.2561** (0.02)	-0.3268** (0.01)	-0.0826** (0.03)
Agricul	-0.3097 (0.1)	-0.1190 (0.1)	-0.0582 (0.1)	-0.4305*** (0.00)	-0.0945*** (0.00)	-0.0241 (0.1)
Pop	-4.9971* (0.07)	1.4510* (0.06)	0.6607*** (0.00)	-5.1005*** (0.00)	-5.3027*** (0.00)	-0.3861 (0.5)
Water	-0.1554 (0.4)	1.0026*** (0.00)	0.0807*** (0.00)	-0.2020* (0.07)	0.4074*** (0.00)	0.0739*** (0.00)
Sanitation	1.6317*** (0.00)	0.1341** (0.04)	0.2487*** (0.00)	0.0007 (0.9)	0.4595*** (0.00)	0.1416*** (0.00)
Cons	88.7055*** (0.00)	-19.664*** (0.00)	-4.7779*** (0.00)	133.8988*** (0.00)	21.7121*** (0.00)	0.6430 (0.8)
R^2	0.242	0.4513	0.355	0.058	0.572	0.455
Prob.(F-stat)	0.000	0.000	0.000	0.000	0.000	0.000
Nb. Obs.	437	437	437	437	437	437

Note : The significance thresholds at 1%, 5% and 10% are represented by ***, ** and * respectively. Values below the coefficients and in parentheses represent probabilities.

Previous methods established an inverse relationship between industrialization process and education. However, the possibility of reverse causation, endogeneity, or unobserved heterogeneity can bias the results and call our results into question. To deal with these potential problems, we estimate Equation 1 using system GMMs. The results of this estimate are contained in Table 4.

3.2. System GMM Regression

The analysis of the effect of the manufacturing sector on education through the GMM method gives results which are recorded in Table 4. Like the previous methods, the GMM method finds that industrialization constitutes an obstacle to education. Therefore, an increase in industrialization of 1% leads to a drop in the enrollment rate of 0.11%; 0.06% and 0.03% respectively for the three levels of education. This situation can be explained by the fact that the processing sector attracts young people to the factory and, according to Le Brun et al. (2011) it is difficult to combine school and work in the manufacturing sector. According to the World Bank (2016) the SSA region alone concentrates 41% of the monetary poverty rate in the world and the slightest job opportunity is seized by young people in order to improve their living conditions and that of their family. Obtaining these jobs immediately increases the opportunity cost of education. This result is consistent with the work of De Pleijt (2018) who demonstrated that the demand for education and literacy declined in England following industrialization. Thus, the deskilling hypothesis of Nicholas and Nicholas (1992) is confirmed for SSA countries.

To test the robustness of our results, we regress Equation 1 using the GMM method with more control variables. The results of this estimation are reported in columns 4-6 of Table 4. Government effectiveness and political stability are the additional control variables we use for sensitivity purposes. In summary, the results obtained in columns 4-6 of Table 4 are robust with regard to the significance of their coefficient.

Table 4. The reponse of education to industrialiazation through the GMM regression.

Variables	1	2	3	4	5	6
	Education1	**Education2**	**Education3**	**Education1**	**Education2**	**Education3**
Indust	-0.1110** (0.03)	-0.0681* (0.05)	-0.0306*** (0.00)	-0.1137*** (0.00)	-0.1427*** (0.00)	-0.0649** (0.01)
Agricul	-0.8026*** (0.00)	-0.0245** (0.01)	-0.0076*** (0.00)	-0.0827*** (0.00)	-0.0733*** (0.00)	-0.0079** (0.01)
Pop	-1.8209*** (0.00)	-0.6290* (0.06)	-0.4239*** (0.00)	-1.5649*** (0.00)	-0.7295** (0.02)	-0.3705*** (0.00)
Water	-0.1386*** (0.00)	-0.0293* (0.06)	-0.0077*** (0.00)	-0.1094*** (0.00)	-0.0292** (0.02)	-0.0143*** (0.00)
Sanitation	0.0143 (0.7)	-0.0026 (0.8)	0.0011 (0.6)	-0.0071 (0.8)	-0.0156 (0.51)	-0.0031 (0.4)
Goveff				-1.3145 (0.2)	1.1832* (0.08)	0.8219*** (0.00)
Polist				0.5806 (0.3)	-0.2322 (0.6)	-0.0995 (0.18)
Lag dependant	0.9386*** (0.00)	1.0216*** (0.00)	0.9974*** (0.00)	0.9412*** (0.00)	1.0123*** (0.00)	1.0123*** (0.00)
Cons	22.5369*** (0.00)	5.1348*** (0.00)	2.3424*** (0.00)	19.9513*** (0.00)	8.8303*** (0.00)	3.5026*** (0.00)
AR(1)	0.02	0.02	0.00	0.02	0.02	0.00
AR(2)	0.92	0.13	0.45	0.88	0.13	0.40
Sargan	0.98	0.21	0.92	0.98	0.19	0.93
Hansen	0.99	0.75	0.34	0.727	0.67	0.36
Instruments	17	22	20	23	22	23
N. Obs.	414	414	414	414	414	414

Note : The significance thresholds at 1%, 5% and 10% are represented by ***, ** and * respectively. Values below the coefficients and in parentheses represent probabilities.

In a nutshell, industrialization is at the origin of deskilling in SSA. Considering that industrialization can promote or improve per capita income (Kerr, 1962) and increased urbanization (Le Brun et al., 2011) what role can these factors play in the transmission of the effects of the manufacturing sector on education?

3.3. Effect of Industrialization on Education: The Role of Income per Capita and Urbanization?

Table 5 analyzes the indirect effect of manufacturing sector on education using per capita income and urbanization as potential transmission channels. Hence the introduction of the interaction variables Indust*gdpc and Indust*urban in the econometric model (1). These results are recorded in columns 7-9 for the income channel and those recorded in columns 10-12 relate to the urbanization channel.

Table 5. The role of per capita income and urbanization in the relationship between industrialization and education.

Variables	1	2	3	4	5	6	7	8	9	10	11	12
	Education1	Education2	Education3	Education1	Education2	Education3	Education1	Education2	Education3	Education1	Education2	Education3
Indust	-0.1701**	-0.0773**	-0.0268**	-0.1439*	-0.0762**	-0.0267***	-0.1975*	-0.1806***	-0.0634***	-0.3925*	-0.3712***	-0.0992***
	(0.02)	(0.04)	(0.02)	(0.06)	(0.02)	(0.00)	(0.08)	(0.00)	(0.00)	(0.05)	(0.00)	(0.00)
Agricul	-0.104***	0.0047	-0.0078***	-0.1510***	-0.0351**	-0.0020	-0.1436***	-0.0454***	-0.0094***	-0.1381***	-0.0742***	-0.0074*
	(0.00)	(0.8)	(0.00)	(0.00)	(0.02)	(0.5)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.08)
Pop	-0.0088	-1.334***	-0.3487***	-0.3747	-0.7792**	-0.4542***	-0.6653	-0.9583***	-0.4098***	-1.3150*	-0.7636*	-0.5630***
	(0.9)	(0.00)	(0.00)	(0.4)	(0.04)	(0.00)	(0.2)	(0.00)	(0.00)	(0.05)	(0.07)	(0.00)
Water	-0.052***	-0.043***	-0.0076***	-0.060***	-0.0327**	-0.1278***	-0.0652***	-0.0446***	-0.0127***	-0.1517***	-0.0064	-0.0135***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.6)	(0.00)
Sanitation	-0.0023	0.0282	0.0042	-0.0457	-0.0123	0.0030	-0.0772**	-0.0139	-0.0021	-0.0190	-0.0384*	-0.0043
	(0.9)	(0.3)	(0.1)	(0.1)	(0.5)	(0.3)	(0.02)	(0.4)	(0.5)	(0.4)	(0.07)	(0.3)
Gdpc	-0.0003	- 0.9E^{-3} ***	- 0.6E^{-4} ***				-0.0011*	-0.0012***	-0.0002***			
	(0.3)	(0.00)	(0.00)				(0.06)	(0.00)	(0.00)			
Urban				-0.0305	-0.0106	0.0169**				-0.1578*	-0.1594***	-0.0174
				(0.1)	(0.4)	(0.03)				(0.05)	(0.00)	(0.1)
Indus*gdpc							0.0001**	0.0001***	- 0.3E^{-4} ***			
							(0.04)	(0.00)	(0.00)			
Indust*urban										0.0150*	0.0151**	0.0041***
										(0.06)	(0.01)	(0.00)
Lag Dependant	0.9172***	1.0622***	1.0059***	0.9109***	1.0304***	0.9901***	0.9345***	1.0408***	1.0058***	0.9470***	1.0100***	0.9884***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Cons.	16 .985***	6.1220***	2.0395***	21.023***	6.1907***	2.2756***	20.480***	8.3697***	2.9249***	26.091***	9.8279***	3.5166***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Net effect	-	-	-	-	-	-	-0.0821	-0.0652	-0.0287	-0.1573	-0.1344	-0.0349
Thereshold	-	-	-	-	-	-	1975	1806	2113,33	26.16	24.58	24.19
AR(1)	0.02	0.03	0.00	0.02	0.02	0.00	0.02	0.02	0.00	0.02	0.03	0.00
AR(2)	0.93	0.12	0.44	0.92	0.13	0.46	0.98	0.13	0.46	0.98	0.14	0.54
Sargan	0.62	0.57	0.89	0.64	0.21	0.9	0.6	0.48	0.90	0.93	0.18	0.87
Hansen	0.19	0.78	0.41	0.16	0.77	0.40	0.35	0.7	0.56	0.67	0.56	0.52
Instruments	23	22	20	23	23	20	22	23	20	21	23	20
N. Obs.	414	414	414	414	414	414	414	414	414	414	414	414

Note : The significance thresholds at 1%, 5% and 10% are represented by ***, ** and * respectively. Values below the coefficients and in parentheses represent probabilities.

In addition to the fact that the results obtained from Table 5 validate the inverse relationship between the manufacturing sector and education (columns 1-12), the coefficients of the interaction variables Manuf*gdpc (columns 7-9) and Manuf*urban (columns 10-12) favorably impacts the three levels of education. Moreover, these results reveal that there is a per capita income threshold and an urbanization threshold beyond which the manufacturing sector contributes positively to education in SSA. Considering that the sign of the indirect effect (the interaction variable) is different from the sign of the direct effect (thus reflecting the absence of synergistic effect), net effects can be generated according to recent works (Asongu & Nchofoung, 2021; Asongu & Nwachukwu, 2017). In the calculation process, the net effects of the effect of the interaction of per capita income with industrialization are -0.0821 for primary education (column 7). This value is obtained as (-0.1975 + (1153.37*0.001)). In this calculation, 0.0001 is the interactive effect coefficient, -0.1975 is the direct effect coefficient, and 1153.37 is the average per capita income as shown in the descriptive statistics table. Applying the above calculation in all our transmission mechanisms, it is evident that despite the positive interactive effect of per capita income and urbanization variables in transmitting the effect of industrialization on education, the effect direct negative exceeds this positive interactive effect producing net negative effects of industrialization on education in our sample.

The policy thresholds of per capita income and urbanization variables that cancel out the negative effect of manufacturing on education in our sample are (1975; 26.16), (1806; 24.58) and (2113.33; 24,19) respectively for first, second and third level of education. The threshold of a variable is obtained by setting the derivative of the manufacturing sector with respect to this variable equal to zero. Simply put, the threshold is the ratio of the unconditional to that of the conditional effect. All of these threshold values (income per capita; urbanization) have policy implications here, as they fall within the range of values reported in the descriptive statistics (149.36 < Income per capita threshold < 8080.86 and 4, 27<Threshold of urbanization <64.20). Thus, for industrialization to have a positive impact on education, per capita income would have to be higher than 1975.1806 and 2113.33 US dollars respectively for primary, secondary and tertiary education. Similarly, for industrialization to have a positive impact on education, urbanization would have to be greater than 26.26; 24.58 and 24.19 respectively for the first, second and third level of education.

4. CONCLUSION

Several studies have focused on the determinants of education. However, no study has focused on the relationship between manufacturing and education, especially in SSA countries. This work seeks to fill this limitation of the literature by analyzing this relationship in 23 countries during the period 2000-2018. To carry out our study, we used Driscoll and Kraay estimation techniques and System GMMs. In summary, three main findings emerge from this study. The first result reveals that there is an inverse relationship between the manufacturing sector and the three levels of education. The second result confirms that per capita income as well as urbanization are transmission channels through which SSA can improve the efficiency of the industrialization process towards education. Finally, the positive effect of industrialization on education is linked to the achievement of a certain per capita income threshold and a certain urbanization threshold in Sub-Saharan Africa. Thus, Sub-Saharan African countries need to put in place mechanisms to further increase their per capita income on the one hand and develop sustainable urbanization on the other in order to reap the benefits of industrialization at all three levels of education. Moreover, the acceleration of the industrialization process is a necessity to achieve this.

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APPENDICES

Table A1. List of countries.

Angola	Guinea	Nigeria	Zambia
Burkina Faso	Kenya	Senegal	Zimbabwe
Cameroon	Madagascar	Sierra Leone	
Chad	Malawi	Soudan	
Congo	Mali	South Africa	
Congo, Dem. Rep	Mozambique	Tanzania	
Cote d'Ivoire	Niger	Uganda	

Table A2. Variable definitions.

Variables	Signs	Variables Definition (Measurement)	Sources
Manufacturing	Manuf	Manufacturing, value added (% of GDP).	World Bank (WDI)
Agriculture	Agriculture	Added value of agriculture (% of GDP).	World Bank (WDI)
Population	Popgr	Population growth (annual %).	World Bank (WDI)
Gross Domestic Product per Capita	GDPC	Gross Domestic Product (GDP) per capita growth (annual %).	World Bank (WDI)
Primary education	Primary	School enrollment, primary (% gross).	World Bank (WDI)
Secondary education	Secondary	School enrollment, secondary (% gross).	World Bank (WDI)
Water	Water	People using at least basic drinking water services (% of population).	
Tertiary education	Tertiary	School enrollment, Tertiary (% gross).	World Bank (WDI)
Sanitation	Sanitation	People using at least basic sanitation services (% of population).	World Bank (WDI)
Governent Effectiveness	Goveff	Effectiveness of government (measured by perceptions of the quality of public services, the quality of the public service and its degree of independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to these policies. It is between - 2, 5 and 2.5).	WGI, World Bank
Political stability	Plista	Political stability and absence of violence/terrorism measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism. The estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from around -2.5 to 2.5.	WGI, World Bank
Urbanization	Urban	Population in urban agglomerations of more than 1 million (% of total population).	World Bank (WDI)