Does Emigration Contribute to Industrial Development in Africa? New Empirical Insights and Policy Directions

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Structured abstract

Purpose

The developmental implications of emigration for Africa's industrialization remain contested. While remittances and diaspora networks may foster upgrading, they can also fuel labor distortions and brain drain. Persistent challenges—limited manufacturing capacity, high-skilled outflows, and divergent experiences—underscore the need to reassess the migration–industrialization nexus. This study examines how emigrant skill composition shapes industrial outcomes, offering evidence to inform policies that align migration with Africa's transformation agenda.

Design/methodology/approach

Using a dynamic panel of 35 African countries (1980–2019), emigration is disaggregated by educational attainment to capture heterogeneous effects. An instrumental variables technique addresses endogeneity, allowing robust causal inference on how different skill levels influence industrial growth trajectories.

Findings

Emigration at all skill levels supports industrial development. High-skilled migration boosts medium- and high-skilled human capital and secondary school enrollment, though effects on low-skilled labor are limited. Secondary education emerges as a key mechanism linking migration to industrial growth, highlighting the importance of human capital investment.

Research limitations/implications

Findings stress the need to strengthen education and adopt policies that convert brain drain into brain circulation, advancing SDG 9. Future research should integrate micro-level data to capture informal labor markets.

Originality

This study shifts the debate from generic remittances toward a disaggregated analysis of emigrant skills. By examining how low-, medium-, and high-skilled migration affects human capital and schooling, it uncovers pathways through which migration can accelerate or hinder upgrading. This skill-sensitive lens provides new evidence and actionable insights for aligning migration with sustainable industrial development.

Keywords: Emigration; Industrial development; Human capital; Africa.

JEL codes: F15, F22, O15, O41

Abstract

The developmental implications of emigration for Africa's industrialization remain contested. While remittances and diaspora networks may foster upgrading, they can also fuel labor distortions and brain drain. Persistent challenges—limited manufacturing capacity, high-skilled outflows, and divergent experiences—underscore the need to reassess the migration–industrialization nexus. This study examines how emigrant skill composition shapes industrial outcomes, offering evidence to inform policies that align migration with Africa's transformation agenda. Using a dynamic panel of 35 African countries (1980–2019), emigration is disaggregated by educational attainment to capture heterogeneous effects. An instrumental variables technique addresses endogeneity, allowing robust causal inference on how different skill levels influence industrial growth trajectories. Results show that emigration, across all education levels, positively affects industrial development. High-skilled emigration contributes to the accumulation of medium- and high-skilled human capital and raises gross secondary school enrollment, though it has a limited impact on low-skilled human capital. Secondary enrollment emerges as a key channel through which emigration fosters industrialization. The findings underscore the role of human capital investment in leveraging the developmental effects of migration. Policy recommendations urge African governments to align with UNCTAD and SDG 9 by promoting education and adopting migration strategies that convert brain drain into brain gain, thereby fostering economic resilience and sustainable industrialization.

Keywords: Emigration; Industrial development; Human capital; Africa.

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1. Introduction

The role of emigration as a driver of industrialization is the subject of recent debates (Anderson et al., 2022; Okey, 2019; Daway-Ducanes, 2019) and allows us to distinguish two major opposing trends. One trend argues that emigration contributes to the development of sending countries (Okey, 2019; Gnimassoun and Anyanwu, 2019; Docquier and Rapoport, 2012; Agrawal et al., 2011). According to Fackler et al. (2020), the countries that experience emigration increase their levels of industrial patents, and according to the United Nations Conference on Trade and Development (UNCTAD, 2018), migration leads to the transfer of labor from the agricultural sector to the manufacturing and service sectors, thereby promoting structural transformation. Moreover, emigration can destroy the pre-industrial society and free up labor to the most productive sectors, and then stimulate industrial structural transformation (Gniniguè and Tchalim, 2021). Emigration can also foster the accumulation of physical capital, human capital, and technical progress (Anderson et al., 2022; Ali et al., 2021; Gnimassoun and Anyanwu, 2019), migrant remittances (Gnimassoun and Anyanwu, 2019; Kugler et al., 2018), foreign direct investment (Gove and González, 2022; Kugler et al., 2018, Boly et al. 2014), trade (Okey, 2019; Ehrhart et al. 2014), scientific networks (Okey, 2019; Papakonstantinou and Inklaar, 2014), improved domestic institutions (Gnimassoun and Anyanwu, 2019; Docquier et al., 2016).

In contrast, another trend argues that the departure of an individual leads to brain drain and is therefore detrimental to the development of the sending country (Ali et al., 2021; Stark and Byra, 2012, Haque and Kim, 1995). Drawing on endogenous growth theories (Romer, 1986; Lucas, 1988), this trend argues that emigration leads to a decrease in human capital and thus, it is an obstacle to the development of sending countries. While Okey's (2019) empirical tests found that emigration positively and significantly affects industrial development in Africa, Daway-Ducanes' (2019) empirical tests found that migrant remittances negatively affect manufacturing growth in developing countries.

Moreover, with the highest emigration rate in the world (Okey, 2019), Africa remains the continent with the least developed industrial sector (Tregenna, 2016), while industrialization can enable Africa to effectively fight poverty and achieve sustainable development (Morris and Fessehaie, 2014). Indeed, over the period from 1980 to 2014, the average contribution of the industrial sector to GDP is 26.16%, and that of the manufacturing sector is 11.95% for all African countries (World

Development Indicators WDI, 2020). The overall average emigration rate to Organization for Economic Co-operation and Development (OECD) countries is 1.62% of the total African population and is driven largely by the emigration rate of highly educated individuals, estimated at 17.60% of the African population of high educational attainment for all African countries from 1980 to 2010 (OECD, 2013). At the same time, the emigration rate of the less educated is the lowest and estimated at 1.49% of the African population of low education level, followed by that of the medium educated individuals at 2.16% of the African population of medium education level. In addition, countries such as Congo, Gabon, Botswana, Libya, and Algeria have a low average emigration rate of highly educated individuals estimated at 9.90% of the highly educated population of these countries, and a high contribution to average industrial production estimated at 55.98% of GDP.

However, countries such as Mauritius, Sierra Leone, and Mozambique are ranked among the countries with a high rate of emigration of highly educated individuals, estimated at an average of 51.18% of the population of the high educational level of these countries and a low share of industrial value added, which is in the order of 20.90% of GDP. Given the above, the fundamental question of this research is: What is the effect of emigration on industrial development in Africa? The general objective of this research is to analyze the effect of emigration on industrial development in Africa. Specifically, it is to analyze the overall effect of emigration on industrial development in Africa, on the one hand, and to examine the effect of emigration according to the level of education on industrial development in Africa, on the other hand. The article also aims to analyze the effect of emigration on industrial development in Africa through human capital.

The contribution of this research to the economic literature is twofold. First, it is methodological and lies in the estimation technique used and in the consideration of the effect of emigration on industrial development across different levels of human capital in Africa. Indeed, the work of Okey (2019) analyzed the effect of emigration on industrial development in Africa using OECD (2013) migration data constructed by Brücker, Capuano, and Marfouk over the period from 1980 to 2010. The generalized method of moments is applied to a dynamic specification. Using the interactive term in the model, Okey (2019) also analyzes the channels of the effect of emigration on industrial development through foreign direct investment, migrant remittances, exports, scientific networks, and democracy without considering the crucial role of the human capital channel. Gnimassoun and Anyanwu (2019), on the other hand, examine the effect of the diaspora on economic development

in Africa. Like Okey (2019), they use the same data over the same period. To analyze the transmission channels of the effect of emigration on economic development in Africa, including human capital, Gnimassoun and Anyanwu (2019) use the instrumental variables method to correct for the endogeneity bias associated with emigration rates. Building on Gnimassoun and Anyanwu (2019) in the analysis of transmission channels, this research uses the instrumental variables method, which is a better identification strategy compared to the generalized method of moments. In addition, this approach not only analyzes the human capital channel but also the effect of emigration on different skill levels.

Following Beine et al (2008), who examined the effect of brain drain on human capital formation, this research measures human capital by the different qualifications of the workforce. Thus, high-skilled workers are those with higher education, middle-skilled workers are those who have completed upper secondary school, and low-skilled workers are those who have not completed upper secondary school (Bein et *al.,* 2008). These skill levels are calculated as a percentage of the population aged 15 years and older and the data mobilized are from Barro and Lee (2013). To check the robustness of the results, an alternative measure of human capital, which is the gross secondary school enrollment rate, is also used. The data used for this variable comes from the World Bank (2020). This consideration of different skill levels allows for a detailed understanding of the level of human capital that channels the effect of emigration on industrial development in Africa. In the same vein, Barro and Lee (2013) argue that taking into account the level of education provides a better approximation of the human capital stock and should be useful for empirical work. The second contribution builds on the results. Knowledge of the effect of emigration on the industrialization of African countries through the different skills of workers will allow us to rethink emigration policies for industrial development and for the structural transformation of the economies of developing countries, including Africa.

The remainder of this article is organized as follows: after presenting the migration policy environment in section 2, a literature review is discussed in section 3, followed by methodology, results in sections 4 and 5, and a conclusion in section 6.

2. The migration policy environment in Africa

To optimize the potential of migration flows on the development of African countries, the African Union (AU) adopted in 2006 the Migration Policy Framework for Africa, in which the regional

economic communities are responsible for the implementation of commitments, programs, policies, and strategies on migration. This Framework had the objective of promoting migration and development, addressing migration challenges such as border management, irregular migration, forced displacement, human rights of migrants, inter-state cooperation, and economic and political partnerships. An assessment was made in 2016 to guide member states in the new dynamics of migration flows. The African Union is thus putting in place an action plan (2018-2030) that takes into account the AU's priorities, Agenda 2063, the Sustainable Development Goals, and international migration management policies and standards. These include labor migration, diaspora engagement, border management, irregular migration, forced displacement, and internal migration.

Particular attention has also been paid to migration and trade, migration and development, data and research on migration, human rights of migrants, migration, poverty and conflict, migration and health, migration and the environment, migration and gender, migration and children, adolescents and youth, migration and the elderly, and inter-state cooperation and partnerships. In the same vein, aware of the need to address the challenges and opportunities that migration presents for countries of origin, UNCTAD, with the support of the United Nations, is contributing to the development of the first global compact for safe, orderly, and regular migration (UNCTAD, 2018). The aim of this agreement, signed in December 2018 in Marrakech, is to show the beneficial aspects of migration for both sending and receiving countries. This migration policy environment should spark research interest in the contribution of migration flows to development.

3. The effect of emigration on industrial development: controversial results

The literature on the effects of emigration on sending countries distinguishes two major opposing trends with a common starting point in the debate between the brain drain view and the brain gain view (Okey, 2019). Thus, the optimistic literature suggests that emigration can promote investment in the education of sending countries and increase the expected return on human capital (Douglas, 2015; Beine et *al.,* 2008), which is the main driver of industrial development (Rodrik, 2013). Thus, emigration can contribute to human capital formation in sending countries. Indeed, with a view to future emigration, families may invest in the education of their children (Mountford, 1997; Beine et *al.,* 2001), which consequently provides them with additional human capital and contributes to industrial development in case they do not migrate. These authors also suggest net gains from brain

drain for the home country. According to Fackler et al (2020), the developmental effects of knowledge transfers in home countries mitigate the negative effects of human capital loss due to emigration. Moreover, the economic literature emphasizes the importance of return migration in knowledge transmission with positive effects on human capital and industrial development. This view is shared by Faini (2007), who argues that skilled migrants acquire more scientific and industrial knowledge and will transfer it to their home countries. The access of domestic firms to technologies and skills that strengthen the human capital of sending countries through scientific networks, such as the example of annual summer schools, is evidence of the effect of emigration. Therefore, emigration can be an opportunity for the industrial development of sending countries through human capital.

On the other hand, according to the skeptical view of the literature, even though emigration positively affects sending countries through remittances, return migration with additional skills acquired abroad, and creation of scientific and business activities, the welfare of those left behind would decrease since the social return to education exceeds its private return (Bhagwati and Hamada, 1974; McCulloch and Yellen, 1977). Thus, the brain drains those results from emigration contributes negatively to human capital in the home country (Stark and Byra, 2012) and thus negatively affects industrial development. Haque and Kim (1995) corroborate this assertion that brain drain undermines economic growth in the home country by reducing the growth rate of effective human capital remaining in the economy. Indeed, brain drain can lead to a decline in the average level of education with adverse consequences for the average human capital needed for economic development in sending countries. As a result, emigration represents an important obstacle to the industrial development of countries of origin.

Empirically, Beine et al (2008) analyze the effect of brain drain on human capital formation in 127 developing countries using data on emigration rates by education level from Docquier and Marfouk (2006). Using the instrumental variable method and ordinary least squares, the results reveal that the emigration of skilled individuals positively affects gross human capital formation in the starting step. Second, Beine et *al* (2008) show a positive net effect in countries combining low levels of human capital and low migration rates, in contrast to those with high levels of human capital and high rates of high-skilled migration. Over a sample of 45 African countries and a period from 1980 to 2010, the generalized method of moments allowed Okey (2019) to show that emigration positively and significantly affects industrial development in Africa. Moreover, low and medium-

skilled emigrants affect industrial development more. The results also revealed that scientific networks represent the channel for this positive effect of emigration on industrial development in Africa. Using a dynamic specification, Gnimassoun and Anyanwu (2019) show that the higher the level of education of emigrants, the greater the effect of the diaspora on the level of economic development in Africa. Emigration has also contributed to the improvement of human capital, which is an important transmission channel of the diaspora effect on economic development in Africa. Similarly, according to Docquier (2017), emigration generates positive effects on per capita income in low- and middle-income countries. Papakonstantinou and Inklaar (2014) found a positive relationship between the rate of emigration and the development of knowledge-intensive manufacturing industries in a sample of 104 countries from 1980 to 2000.

However, some recent work has highlighted the adverse effects of brain drain on the human capital of sending countries (Okoye, 2016; Palma, 2014). According to Palma (2014), brain drain leads to a loss of talent in Venezuela. Okoye (2016) arches evidence of the negative effects of brain drain on human capital in 23 low- and middle-income countries. Based on endogenous growth theory (Romer, 1986; Lucas, 1988) and some recent empirical work (Han and Lee, 2020; Pelinescu, 2015), this loss of human capital is a hindrance to industrial development in sending countries. On the other hand, in the process of industrialization, human capital plays a very important role (Rodrik, 2013) since it is the technological dimension of human capital that allows for technological imitation and adaptation, innovation, and technical progress (Nelson and Phelps, 1966) necessary for industrial development. Empirical evidence from Okey (2019) for African countries and Njangang and Nounamo (2020) for the European Union and African countries provides evidence of the importance of human capital in industrial development. In this context, the loss of human capital due to brain drain delays industrial development.

Moreover, migrant remittances play a crucial role in the contribution of emigration to the industrial development of sending countries. Indeed, in the context of failing financial markets, migrant remittances alleviate financial constraints by increasing access to finance and thus promote private investment and industrialization (Okey, 2019) and accelerate manufacturing development (Dzansi, 2013). Under these conditions, migrant remittances can promote access to finance and help alleviate the financial constraints faced by the industrial sector in countries of origin. Remittances can also be used to invest in children's education and improve human capital in sending countries (Mim and Mabrouk, 2014; Mesnard, 2004; World Bank, 2006) and then contribute to industrial

development. Thus, migrant remittances help increase human capital and spending on education (World Bank, 2006). In the same vein, Mesnard (2004) argues that migrant remittances promote the emergence of a positive link between capital accumulation and the economic development of countries of origin. Indeed, migrant remittances can allow for investment in education in the sending countries, thus providing them with additional productive capacities and contributing to industrial development. On the other hand, remittances can create dependency on the recipients instead of working for their development (Chami et *al.*, 2005; Lipton, 1980) with adverse effects on industrialization. These funds, invested in human capital, can increase the rate of emigration when the labor market is failing in the country of origin. Moreover, due to a lack of childcare for migratory reasons on the part of the parents, migrant remittances can negatively affect the education of children and thus the level of human capital (McKenzie and Rapoport, 2010), with negative consequences for the industrialization of the sending countries.

According to Adeoye et *al.* (2020), migrant remittances stimulated industrialization in 46 African countries from 1980 to 2017 at the first stage of financial development. Similarly, in 49 African countries for the period 1980-2014, Efobi et al. (2019) show that migrant remittances stimulate industrial development at the early stage of industrialization. Dzansi (2013) also reports that migrant remittances contribute positively to manufacturing development in 40 remittance-dependent economies. According to Mim and Mabrouk (2014), migrant remittances exert a positive and significant effect on children's schooling, enabling low-income households to finance their children's schooling. Similarly, human capital is an important channel for transmitting the positive effect of these funds on economic development (Mim and Mabrouk, 2014). In the same vein, Mim and Ali (2012) conclude that these funds act effectively on economic development through human capital. By improving the human capital of countries of origin, remittances then contribute to the industrial development of these countries. Under these conditions, remittances can be used to support the industrialization of sending countries. In revanche, Daway-Ducanes (2019) studies the effect of migrant remittances on manufacturing growth in 56 developing countries from 1992 to 2016. They find that remittances harm manufacturing growth in economies that experience real exchange rate appreciation.

4. Methodology

4.1. Model

To achieve the objective of this research, the first step is to analyze the effect of emigration on the different levels of human capital. Knowledge of this relationship will allow for a detailed understanding of the type of human capital that drains the effect of emigration on industrial development in Africa. Drawing on the work of Mim and Mabrouk (2014), who examined the effect of migrant remittances on human capital, the empirical model is as follows:

$$\boldsymbol{KH_{it} = \gamma_0 + \gamma_1 EMI_{i1980} + \gamma_2 Z_{it} + \theta_{it}} \qquad \textbf{(1)}$$

$\boldsymbol{KH_{it}}$ represents the different levels of human capital or the different skill levels of workers: low, medium, and high. High-skill workers are those with higher education, middle-skill workers are those who have completed high school, and low-skill workers are those who have not completed high school (Barro and Lee, 2013). These skill levels are calculated as a percentage of the population aged 15 and older. An alternative measure of human capital, which is the gross secondary school enrollment rate, is also used (Mim and Mabrouk, 2014). $\boldsymbol{EMI_{i1980}}$ constitutes the explanatory variable of interest represented by the different emigration rates at the beginning of the period (1980-1984), which are: the total emigration rate, the emigration rate of the low level of education, the emigration rate of the medium level of education, and the emigration rate of the high level of education. Indeed, taking into account the emigration rate at the beginning of the period is necessary since it takes time for migration to have an incentive effect on human capital. This is why, based on the work of Beine et al (2008), we have considered the emigration rate at the beginning of the period, which can affect the incentives to invest in education through its effects on human capital, and therefore, it can contribute to industrialization and economic growth in the long run. The emigration rate is the sum of emigrants from an African country to OECD countries at a given point in time, divided by the native population of that country aged 25 and over. It comes from the OECD (2013) database constructed by Brücker et *al.* (2013) on emigration by education level, calculated from census data of 20 OECD destination countries. The emigration rate by education level ($\boldsymbol{m_{i,t}}$) is calculated as follows:

$$m_{i,t} = \frac{M^{i}_{OCDE20,e,t}}{R^{i}_{e,t} + M^{i}_{OCDE20e,t}} \quad (2)$$

With, $M^{i}_{OCDE20,e,t}$ the total stock of immigrants from country i living in OECD 20 (denoted as OECD20) by education level (e) at time (t). $R^{i}_{e,t}$ the total number of residents in the source country (i) by education level (e) at time (t).

$$M^{i}_{OCDE20e,t} = \sum_{j=1}^{20} M^{i}_{j,e,t} \quad (3)$$

Where $M^{i}_{j,e,t}$ is the number of emigrants coming from country (i) and residing in a country (j) (OECD country) by education level (e) at time (t). Emigration is expected to contribute positively to human capital accumulation (Gnimassoun and Anyanwu, 2019) insofar as emigration may promote knowledge transfers from host to home countries. Z_{it} gathers the control variables of the human capital equation, which are: public spending on education and remittances from migrants. Like Gniniguè and Ali (2022) for the case of West African countries and Mim and Mabrouk (2014) on 30 countries in the world, public spending on education and migrant remittances can positively affect human capital in Africa. They can promote human capital accumulation to the extent that they improve the quality of education through investment in this sector. θ_{it} is the term of error.

The second step is to examine the effect of human capital on industrial development in Africa. To do this, the basic theoretical model is that of Mankiw et al. (1992), which is as follows:

$$Y_{it} = K^{\alpha}_{it} H^{\beta}_{it} (A_{it} L_{it})^{1-\alpha-\beta} \quad (4)$$

With Y output measured here by the growth rate of industrial value-added, K is the stock of physical capital, H represents the stock of human capital, L is labor, and A represents the factor reflecting the technological level and the efficiency of the economy, $\alpha + \beta < 1$. By posing: $k_{it} = \frac{K_{it}}{A_{it}L_{it}}$, $h_{it} = \frac{H_{it}}{A_{it}L_{it}}$ and $y_{it} = \frac{Y_{it}}{A_{it}L_{it}}$ the reduced form of the model is :

$$\frac{Y_{it}}{A_{it}L_{it}} = y_{it} = \left(\frac{K_{it}}{A_{it}L_{it}}\right)^{\alpha} \left(\frac{H_{it}}{A_{it}L_{it}}\right)^{\beta} \left(\frac{A_{it}L_{it}}{A_{it}L_{it}}\right)^{1-\alpha-\beta} \quad (5)$$

Equation (4) becomes:

$$y_{it} = k^{\alpha}_{it} h^{\beta}_{it} \quad (6)$$

Linearizing equation (6), we obtain:

$$\boldsymbol{lny_{it} = \alpha lnk_{it} + \beta lnh_{it}} \quad \textbf{(7)}$$

To take into account the effect of other variables on industrialization, equation (7) can be extended by introducing them. This model can take the following form:

$$\boldsymbol{y_{it} = \alpha_0 + \alpha_1 y_{i1980} + \alpha_2 KH_{it} + \alpha_3 X_{it} + \lambda_{it}} \quad \textbf{(8)}$$

$\boldsymbol{y_{it}}$ represents the dependent variable measuring industrialization, which is the growth rate of industrial value added relative to GDP. $\boldsymbol{y_{i1980}}$ is the dependent variable at the beginning of the period (1980-1984). This variable not only makes it possible to take into account the phenomena of hysteresis of industrialization but also to test the hypothesis of convergence in industrialization in Africa. Indeed, the convergence hypothesis in the literature on convergence models, in terms of growth, assumes a negative effect on initial income. Under these conditions, if the coefficient of initial industrial value added is negative and significant, then there is convergence in industrialization among African countries. The explanatory variable of interest is human capital ($\boldsymbol{KH_{it}}$). Human capital is measured by different skill levels (Barro and Lee, 2013) and the gross secondary school enrollment rate (Mim and Mabrouk, 2014; Gniniguè and Ali, 2022). Human capital is an enabler of the industrial sector (Squicciarini and Voigtländer, 2015; Rodrik, 2013) in that industrialization requires very high skills. $\boldsymbol{X_{it}}$ represents the control variables and $\boldsymbol{\lambda_{it}}$ the error term. Gross fixed capital formation (GFCF), population growth rate (TCPOP), credit to the private sector (CRED), and trade openness (OUV), are the different control variables chosen. Investment measured by gross fixed capital formation is assumed to contribute positively to industrial development (Gui-Diby and Renard, 2015) insofar as an investment generates demand for manufacturing products and domestic investment is more likely to reinvest in the home country. The rate of population growth can positively affect industrialization since labor is a driver of production. Trade openness can help or hinder industrial development (Gui-Diby and Renard, 2015) due to the international division of labor and specialization in the production of goods and services. Financial development should stimulate industrial development (Gui-Diby and Renard, 2015) since credit to the private sector can finance the industrial sector. The empirical model is then written (Equation 9):

$$y_{it} = \beta_0 + \beta_1 y_{i1980} + \beta_2 KH_{it} + \beta_3 TCPOP_{it} + \beta_4 FBCF_{it} + \beta_5 CRED_{it} + \beta_6 OUV_{it} + \mu_{it} \quad (9)$$

4.2. Data, descriptive statistics, and estimation method

4.2.1. Data

The data used covers 35 African countries and covers the period from 1980 to 2019. The choice of the study period is explained by the availability of data on emigration rates and human capital at different skill levels. The data on emigration rates come from the OECD (2013) database constructed by Brucker et al. (2013) and are available at five-year intervals from 1980 to 2010 (Table 1).

Table 1: Descriptive statistics of the selected variables

Variables	Sources	Unit of measurement	Obs.	Means.	SD
The growth rate of industrial value added	WDI	Percentage (%)	231	4.371	6.802
Overall emigration rate	OECD	Total African population aged 25 and over	252	1.627	2.269
Emigration rate of high education level	OECD	Percentage of highly educated African population 25 years and older	252	17.605	14.302
Emigration rate of medium education level	OECD	The African population of average education level aged 25 years and over	252	2.167	2.994
Low education emigration rate	OECD	African population with low education level aged 25 years and over	252	1.149	1.988
Low human capital	BL	Population aged 15 years and over	252	15.231	8.299
Average human capital	BL	Population aged 15 years and over	252	9.125	7.964
High human capital	BL	Population aged 15 years and over	252	2.578	2.936
High School Gross Enrollment Rate	WDI	Percentage of population of formal secondary school age	231	39.424	23.755
Migrant remittances	WDI	Percentage of GDP	231	5.563	20.329
Public expenditure on education	WDI	Percentage of GDP	194	4.553	2.434
Credits granted to the private sector	WDI	Percentage of GDP	266	22.817	24.070
Commercial opening	WDI	Percentage of GDP	264	71.168	32.710
Population growth rate	WDI	Percentage of the total population	280	2.464	0.982
Gross fixed capital formation	WDI	Percentage of GDP	257	20.151	7.597

Data on human capital come from the Barro and Lee (2013) database and the World Bank database (World Development Indicators (WDI, 2020)). Data on different levels of human capital are mobilized from the Barro and Lee (2013) database and are available at five-year intervals from 1950

to 2010. Data on human capital measured by the gross secondary school enrollment rate are from the World Bank database. All other variables are from the World Bank database and are calculated on five-year averages (1980-1984, 1985-1989, 1990-1994, 1995-1999, 2000-2004, 2005-2009, 2010-2014, and 2015-2019). Since it is the non-cylindrical panel data and emigration of the early period (1980-1984) that are used in this research, the study period is extended to 2019 to obtain eight (08) as the time dimension. The average industrial value added is 26.17% of GDP for all African countries from 1980 to 2019, with large fluctuations measured by its standard deviation (Table 1).

Furthermore, the variation in industrialization in Africa across countries and over time is shown in Figure 1. Indeed, between 1980 and 1989, the industrial sector in countries such as Gabon, Botswana, and Congo contributed the most to GDP, while the manufacturing sector contributed the most to GDP in countries such as Zambia, South Africa, and Zimbabwe. From 2010 to 2019, Congo ranked first in terms of the contribution of the industrial sector to GDP, and Swaziland ranked first in terms of the contribution of the manufacturing sector to GDP. In the same vein, the variation across countries and over time in the different emigration rates in Africa is presented in Figures 2 and 3. It can be seen that from 1980 to 1989, countries such as Mauritius, Tunisia, and Mozambique led respectively in overall emigration; emigration of the low educated and emigration of the medium and high educated (Chart 2, Chart 3). Between 2005 and 2014, overall, low and high education emigration rates were highest in Mauritius; Mozambique leads in medium education emigration (Charts 2 and 3).

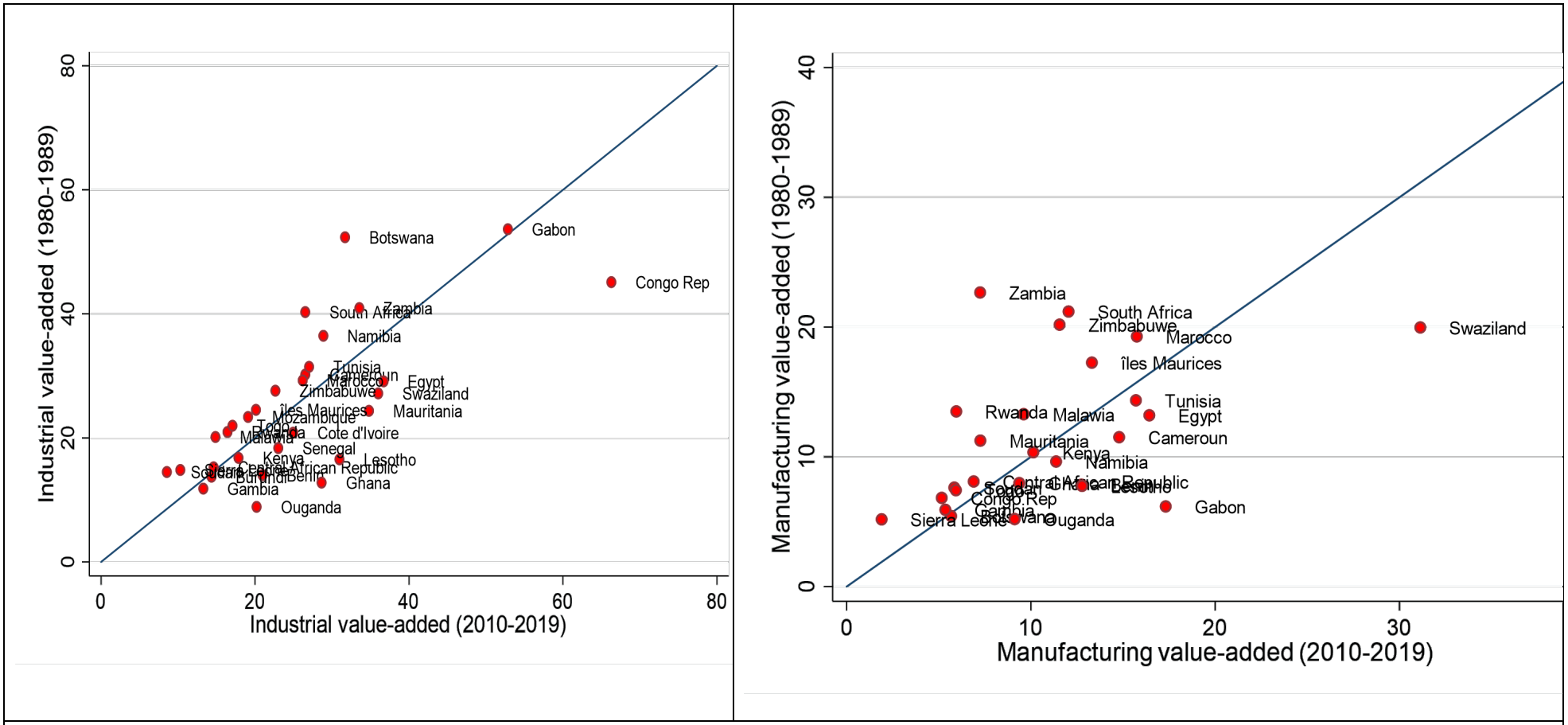

Chart 1: Trend of top and bottom ten-year averages of industrial and manufacturing value added in Africa
Source: Authors

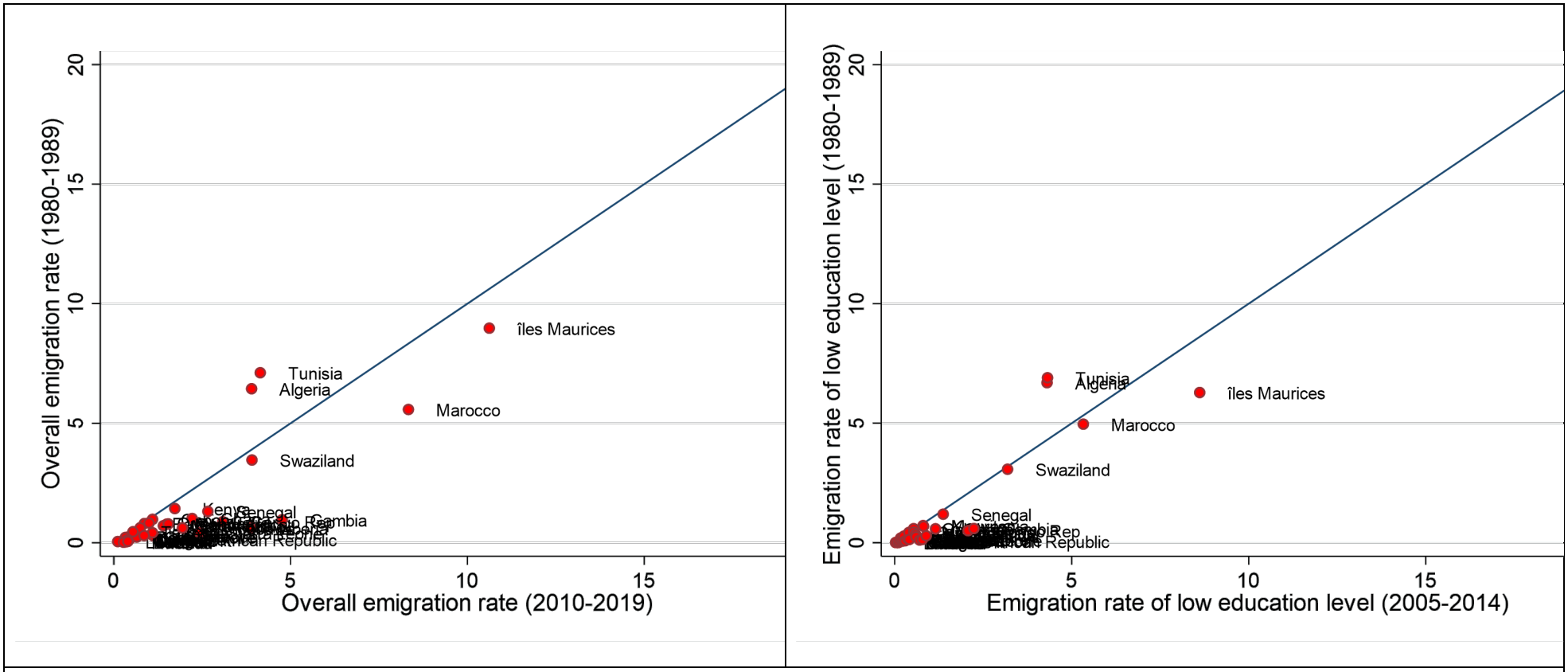

Chart 2: Trend of top and bottom ten-year averages of overall emigration rates and low educational attainment in Africa
Source: Authors

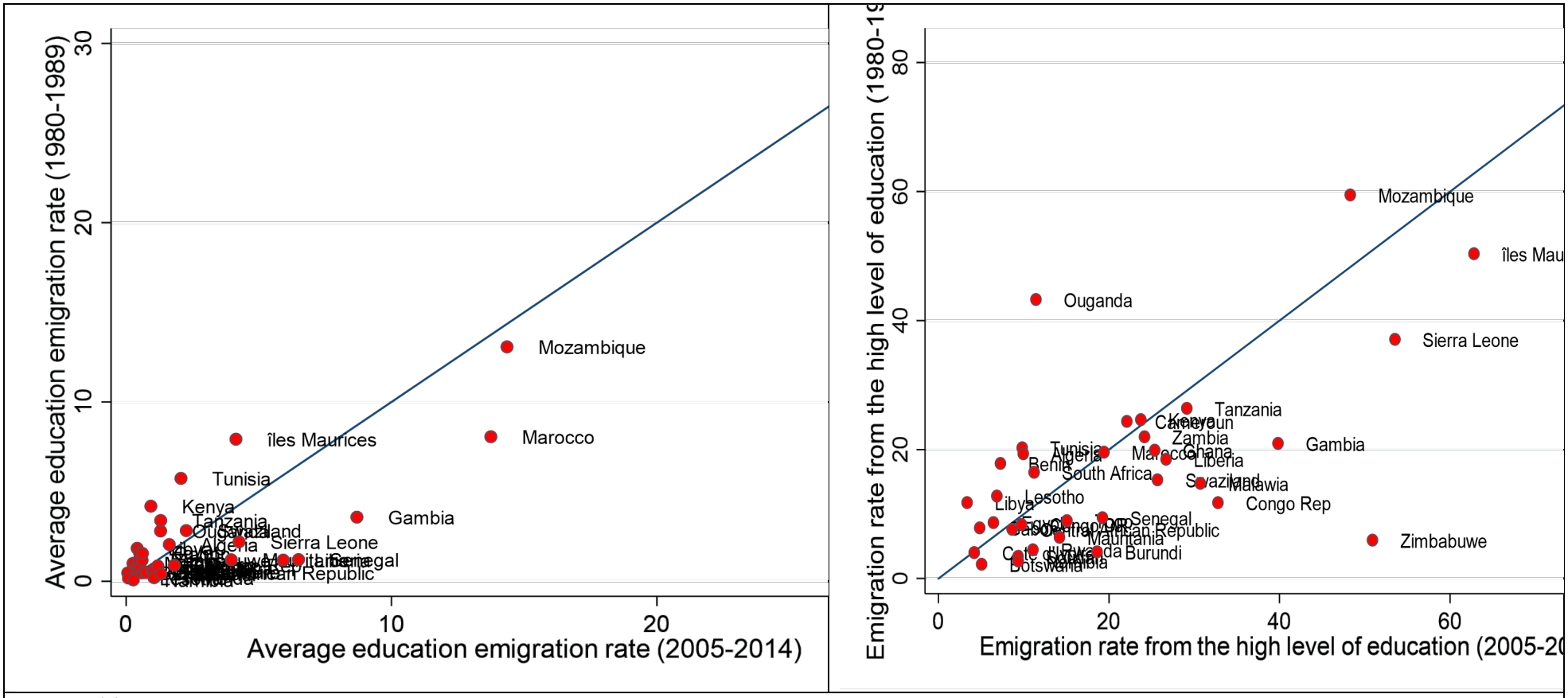

Chart 3: Trend of top and bottom ten-year averages of medium and high education emigration rates in Africa
Source: Authors

4.2.2. Estimation strategy

The effect of emigration on human capital is modeled by equation (1). This equation is estimated using the fixed effects model based on specification tests. Indeed, even though the literature on the effects of emigration reveals that different emigration rates are potentially endogenous (Gniniguè and Tchalim, 2021; Gnimassoun and Anyanwu, 2019; Okey, 2019; Beine et *al.,* 2008), the fixed-effects model is appropriate because it is the emigration of the initial period that is used. For equation (9), the instrumental variables technique is applied to the model. The first lags of human capital are used to instrument this variable. Indeed, to check for spatial dependence effects between African countries in the choice of estimation method and stationarity tests, the inter-individual dependence test of Pesaran's (2004) CD-test is used, given the structure of our panel data. This test is appropriate since the panel contains a small time dimension (T) compared to the individual dimension (N) (N > T). Pesaran's (2004) CD-test shows spatial dependence across countries in Africa (Table 2). In this case, traditional estimation methods, notably ordinary least squares and fixed effects or random effects, give biased results, unlike the instrumental variables approach, which allows us to correct not only spatial dependence but also the endogeneity problem (Mamba, 2021).

Since the time dimension of the panel data is eight (08), the analysis of stationarity and cointegration tests is not important. Indeed, according to Hurlin and Mignon (2005), the analysis of stationarity tests on panel data is of interest when the time dimension is greater than 20 years. For the estimations, the instrumental variables method is then used in this research to take into account the endogeneity problem linked to the different emigration rates as well as the problem of cross-sectional dependence. To avoid the problem of multicollinearity between the different emigration rates and following the work of Gniniguè and Tchalim (2021), Gnimassoun and Anyanwu (2019), and Okey (2019), all regressions are carried out by progressively considering each of the different emigration rates. Similarly, the different measures of human capital will be progressively considered in the regressions. Finally, population size (Beine et *al.,* 2008), life expectancy at birth, and GDP per capita of African countries (Hall and Jones, 1999) are used as the instruments of emigration rates.

Table 2: Inter-individual dependency test (CD-test) of Pesaran (2004) on some variables

Variables	CD-test	Corr	abs(Corr)
The growth rate of industrial value added	-0.99	-0.015	0.466
Overall emigration rate	34.75***	0.523	0.766
Emigration rate of high education level	3.08***	0.046	0.516
Emigration rate of medium education level	1.**98****	0.030	0.648
Low education emigration rate	19.**97*****	0.301	0.647
Low human capital	35.**38*****	0.533	0.602
Average human capital	37.**32*****	0.562	0.681
High human capital	28.**40*****	0.428	0.677

5. Results and discussion

Columns (1), (2), and (3) of Table 3 show the results of the effect of each emigration rate on the level of low human capital, and columns (4), (5), and (6) of Table 3 show the effect of each emigration rate on the level of medium human capital. Note that the total emigration rate, the emigration rate of individuals with low education, and the emigration rate of individuals with medium education positively and significantly affect the levels of low and medium human capital. On the other hand, the emigration rate of the high education level has no statistical effect on the low human capital levels, while it positively affects the medium human capital. Columns (1), (2), and (3) of Table 4 present the results of the effect of each emigration rate on the level of high human capital, and columns (4), (5), and (6) of Table 4 show the effect of each emigration rate on the gross secondary school enrollment rate. The results reveal that the total out-migration rate, the out-migration rate of low-education individuals, the out-migration rate of middle-education individuals, and the out-migration rate of high-education individuals positively and significantly affect high human capital and the gross enrollment rate in secondary education. These results suggest that the out-migration of highly educated individuals contributes to the accumulation of high skill levels. The positive effect of emigration on human capital accumulation is similar to that obtained by Gnimassoun and Anyanwu (2019) for African countries and to that obtained by Beine

et al. (2008) on 127 developing countries. However, these results are contrary to those of Palma (2014) for Venezuela and Okoye (2016) in 23 low- and middle-income countries. The positive effect of emigration on human capital is consistent with the brain gain theory and can be explained by the transfer of skills and knowledge from emigrants to their sending countries.

Table 3: Effect of different emigration rates on low and medium human capital

Variables	(1) Low human capital	(2) Low human capital	(3) Low human capital	(4) Low human capital	(5) Average human capital	(6) Average human capital	(7) Average human capital	(8) Average human capital
Total emigration	0.177***				0.129***			
	(0.029)				(0.026)			
Emigration of high educational level		0.011				0.163***		
		(0.035)				(0.062)		
Emigration of the middle level of education			0.085***				0.090**	
			(0.031)				(0.036)	
Emigration of low educational level				0.148***				0.086***
				(0.022)				(0.021)
Migrant remittances	0.065	0.070	0.057	0.034	0.010	0.015	0.030*	0.015
	(0.496)	(0.866)	(0.559)	(0.765)	(0.017)	(0.017)	(0.018)	(0.017)
Public expenditure on education	0.075	0.082	0.037	0.028	0.157**	0.551***	0.479***	0.435***
	(0.097)	(0.074)	(0.126)	(0.094)	(0.065)	(0.076)	(0.078)	(0.076)
Constant	2.413***	2.300***	2.172***	2.584***	1.462***	0.802***	1.314***	1.478***
	(0.141)	(0.140)	(0.087)	(0.145)	(0.121)	(0.206)	(0.121)	(0.128)
Observations	199	199	199	199	199	199	199	199
Country	35	35	35	35	35	35	35	35

Standard deviation in parentheses; significance level:*** p<0.01, ** p<0.05, * p<0.1

Table 3 and Table 4 also showed that public spending on education positively and significantly affects the level of average human capital, the level of high human capital, and the gross secondary school enrollment rate in Africa. Similar results were obtained by Gniniguè and Ali (2022) for West African countries and Mim and Mabrouk (2014) for countries with high education expenditures. Indeed, by improving the quality of educational infrastructure and the quality of teacher service through additional training, public spending on education contributes to human capital accumulation through the education of children in Africa. As for migrant remittances, they do not have a statistically significant effect on human capital accumulation. Gniniguè and Ali (2022) for

West African countries and Mim and Mabrouk (2014) for countries with high education expenditures find similar results. The latter result is explained by the fact that remittances are used for consumer needs and therefore are not sufficiently used for investment in human capital (Gniniguè and Ali, 2022; Ali et al., 2021).

Table 4: Effect of different emigration rates on high human capital and secondary school enrollment

Variables	(1) High human capital	(2) High human capital	(3) High human capital	(4) High human capital	(5) Secondary human capital	(6) Secondary human capital	(7) Secondary human capital	(8) Secondary human capital
Total emigration	0.316***				0.157***			
	(0.023)				(0.021)			
Emigration of high educational level		0.126***				0.093**		
		(0.047)				(0.044)		
Emigration of middle level of education			0.242***				0.072**	
			(0.039)				(0.031)	
Emigration of low educational level				0.228***				0.111***
				(0.020)				(0.017)
Migrant remittances	0.010	0.016	0.019	0.017	0.026*	0.026	0.021	0.035
	(0.015)	(0.016)	(0.015)	(0.016)	(0.015)	(0.017)	(0.017)	(0.016)
Public expenditure on education	0.207***	0.380***	0.415***	0.203***	0.226***	0.323***	0.272***	0.229***
	(0.050)	(0.066)	(0.050)	(0.061)	(0.078)	(0.081)	(0.085)	(0.081)
Constant	0.582***	0.158	0.069	0.697***	3.441***	2.926***	3.234***	3.482***
	(0.068)	(0.166)	(0.050)	(0.089)	(0.125)	(0.188)	(0.134)	(0.132)
Countries	35	35	35	35	35	35	35	35

Standard deviations in parentheses; significance level:*** p<0.01, ** p<0.05, * p<0.1

Columns (1), (2), (3), and (4) of Table 5 present the effect of different measures of human capital (low human capital, medium human capital, high human capital, and gross secondary enrollment ratio) on the growth rate of industrial value-added, respectively. It can be seen that, regardless of the measure used, human capital positively affects the industrialization of African countries. Similarly, the growth rate of industrial value added at the beginning of the period, gross fixed capital formation, and trade openness contribute positively to industrialization in Africa (Table 5). In contrast, the population growth rate and domestic credit harm industrialization in Africa (Table 5).

Table 5: Effect of human capital on industrial value added

Variables	(1)	(2)	(3)	(4)
	Industrialization	Industrialization	Industrialization	Industrialization
Initial industrialization	0.880***	0.894***	0.891***	0.881***
	(0.035)	(0.034)	(0.034)	(0.035)
Low human capital	0.008***			
	(0.002)			
Average human capital		0.006**		
		(0.003)		
High human capital			0.026***	
			(0.008)	
Secondary education				0.003**
				(0.001)
Gross fixed capital formation	0.013***	0.011***	0.010***	0.010***
	(0.003)	(0.003)	(0.003)	(0.004)
Population growth	-0.038**	-0.027	-0.033*	-0.017
	(0.018)	(0.019)	(0.019)	(0.024)
Domestic credits	-0.003***	-0.003***	-0.003***	-0.003**
	(0.001)	(0.001)	(0.001)	(0.001)
Commercial opening	0.002***	0.002***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	1.255***	1.216***	1.288***	1.141***
	(0.122)	(0.126)	(0.126)	(0.164)
Observations	147	147	147	138
Hansen (p-value)	0.231	0.123	0.140	0.131
Endogeneity test	10.071**	9.837**	10.323***	19.457***
Country	35	35	35	35

Standard deviations in parentheses; *** p<0.01, ** p<0.05, * p<0.1

These results show that human capital accumulation results in improved industrialization in Africa. This result is similar to that of Okey (2019) on industrialization in African countries and (Gniniguè and Tchalim, 2021) on industrial structural transformation in West Africa. Furthermore, the convergence hypothesis in terms of industrialization in African countries is invalidated because the growth rate of initial industrial value added has a positive and significant effect on industrialization. This result can be explained by the level of industrial development that differs from one country to another. The results of the effect of different emigration rates on industrialization in African countries are presented in the annex. These results show that an increase in the different emigration rates results in an improvement in the level of industrialization in Africa (Appendix 1 and Appendix 2). Results obtained by Okey (2019) for African countries and by Papakonstantinou and Inklaar (2014) on a sample of 104 countries corroborate the results of the positive effect of emigration on

industrial development in Africa. In addition, Docquier (2017) and Gnimassoun and Anyanwu (2019) find similar results on the effect **of** emigration on economic development in low- and middle-income countries and African countries, respectively. However, Gniniguè and Tchalim (2021) find that emigration contributes negatively to industrial structural transformation in West Africa. These two results are complementary in that emigration contributes to the internal development of the industrial sector, but is not yet able to attract labor to this sector (Gniniguè and Tchalim, 2021).

Given the above, it can be said that overall emigration, middle-education emigration, and low-education emigration positively affect the different levels of human capital and the secondary gross enrollment ratio in Africa. By contributing positively and statistically to the accumulation of high human capital, medium human capital, and secondary school gross enrollment ratio, the emigration of highly educated individuals has no statistical effect on low human capital in Africa. Moreover, the various measures of human capital show up as a driver of industrialization in Africa. It can be concluded that low human capital, medium human capital, high human capital, and gross secondary school enrollment, channel the effects of the total emigration rate, the low education emigration rate, and the medium emigration rate on industrialization in Africa. The emigration of highly educated individuals contributes to industrialization in Africa through high human capital, medium human capital, and gross secondary school enrollment. Human capital as a transmission channel of the effect of emigration on industrialization is similar to the results obtained by Gnimassoun and Anyanwu (2019).

6. Conclusion

This research examines the effect of emigration on industrial development in Africa. It also analyzes this effect through human capital. To do so, data from World Development Indicators (WDI, 2020), Brücker et *al.* (2013), and Barro and Lee (2013) are used. A fixed effects model is used to estimate the effect of emigration on human capital. To analyze the effect of human capital on industrialization, the instrumental variable estimation technique is used to take into account the problem of endogeneity of different measures of human capital and spatial dependence across African countries. Human capital is measured by the different skill levels, and emigration is measured by the different emigration rates by education levels. The results revealed that emigration improves the industrial level in Africa. Furthermore, the overall out-migration, middle education

out-migration, and low education out-migration positively and significantly affect the different levels of human capital and gross secondary school enrollment in Africa. While positively and statistically contributing to the accumulation of high human capital, medium human capital, and secondary school gross enrollment ratio, the emigration of highly educated individuals has no statistical effect on low human capital in Africa. Furthermore, the results showed that, like the different levels of human capital, the gross secondary enrollment ratio contributes positively to industrial development in Africa. It can be concluded that low human capital, medium human capital, high human capital, and secondary school gross enrollment ratio channel the effects of total emigration rate, low education emigration rate, and medium emigration rate on industrialization in Africa. The emigration of highly educated individuals contributes to industrialization in Africa through high human capital, medium human capital, and gross secondary school enrollment. These different outcomes have economic policy implications. While controlling migration flows in an orderly, safe, and regular manner as recommended by UNCTAD, African countries need to invest in human capital to enhance the effect of emigration on industrialization.

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Annexes: Effect of emigration on industrialization

Appendix 1: Effect of emigration on industrialization using low and medium human capital

Variables	(1) Industrialization	(2) Industrialization	(3) Industrialization	(4) Industrialization	(5) Industrialization	(6) Industrialization	(7) Industrialization	(8) Industrialization
Initial industrialization	0.638***	0.621***	0.563***	0.734***	0.596***	0.579***	0.562***	0.764***
	(0.081)	(0.082)	(0.053)	(0.127)	(0.064)	(0.064)	(0.050)	(0.129)
Total emigration	0.247***				0.199***			
	(0.081)				(0.047)			
Emigration of low educational level		0.204***				0.162***		
		(0.071)				(0.039)		
Emigration of the middle level of education			0.094**				0.093**	
			(0.046)				(0.037)	
Emigration of high educational level				0.315**				0.356**
				(0.153)				(0.156)
Low human capital	0.029*	0.027	0.081***	0.083**				
	(0.030)	(0.052)	(0.023)	(0.033)				
Average human capital					0.044*	0.053*	0.082***	0.079**
					(0.031)	(0.031)	(0.025)	(0.037)
Gross fixed capital formation	0.088	0.095	0.187***	0.132	0.105	0.108	0.143**	0.076
	(0.100)	(0.103)	(0.063)	(0.098)	(0.080)	(0.081)	(0.063)	(0.106)
Population growth	-0.016	-0.032	-0.037*	-0.013	-0.008	-0.018	-0.010	0.017
	(0.032)	(0.032)	(0.021)	(0.033)	(0.028)	(0.028)	(0.022)	(0.038)
Domestic credits	-0.222***	-0.224***	-0.118***	-0.122***	-0.206***	-0.208***	-0.124***	-0.130***
	(0.056)	(0.059)	(0.028)	(0.039)	(0.042)	(0.043)	(0.028)	(0.043)
Commercial opening	0.037(0.085)	0.021	0.149***	0.120	0.045	0.033	0.164***	0.132*
		(0.091)	(0.050)	(0.074)		(0.074)	(0.050)	(0.080)
Constant	1.699***	1.946***	0.467**	0.601	1.497***	1.686***	0.514***	-0.691
	(0.509)	(0.606)	(0.193)	(0.564)	(0.352)	(0.391)	(0.195)	(0.576)
Observations	194	194	194	194	194	194	194	194
Hansen (p-value)	0.170	0.1583	0.106	0.7381	0.3287	0.336	0.687	0.113
Endogeneity test	27.197***	26.190***	26.352***	13.589**	36.819***	36.495***	18.312***	27.531***
Country	35	35	35	35	35	35	35	35

Standard deviations in brackets; *** p<0.01, ** p<0.05, * p<0.1

Appendix 2: Effect of Emigration on Industrialization Using High Human Capital and Gross Secondary Enrollment

Variables	(1) Industrialization	(2) Industrialization	(3) Industrialization	(4) Industrialization	(5) Industrialization	(6) Industrialization	(7) Industrialization	(8) Industrialization
Initial industrialization	0.679***	0.655***	0.577***	0.746***	0.615***	0.583***	0.523***	0.860***
	(0.099)	(0.098)	(0.059)	(0.128)	(0.086)	(0.084)	(0.059)	(0.291)
Total emigration	0.308***				0.186***			
	(0.114)				(0.052)			
Emigration of low educational level		0.249**				0.143***		
		(0.097)				(0.040)		
Emigration of the middle level of education			0.093				0.049	
			(0.058)				(0.045)	
Emigration of high educational level				0.316**				0.286*
				(0.153)				(0.159)
High human capital	0.100	0.093*	0.046*	0.060*				
	(0.072)	(0.033)	(0.025)	(0.031)				
Secondary education					0.003	0.027	0.076*	0.071
					(0.053)	(0.051)	(0.041)	(0.053)
Gross fixed capital formation	0.120	0.127	0.144**	0.080	0.117	0.114	0.166**	0.156
	(0.105)	(0.108)	(0.064)	(0.098)	(0.097)	(0.097)	(0.080)	(0.103)
Population growth	-0.018	-0.038	-0.032	-0.006	-0.006	-0.018	-0.014	0.012
	(0.036)	(0.036)	(0.021)	(0.033)	(0.030)	(0.030)	(0.024)	(0.036)
Domestic credits	-0.228***	-0.229***	-0.123***	-0.131***	-0.181***	-0.179***	-0.096***	-0.119**
	(0.063)	(0.066)	(0.029)	(0.040)	(0.049)	(0.049)	(0.036)	(0.048)
Commercial opening	0.023	0.036	0.188***	0.161**	0.113	0.111	0.220***	0.182**
	(0.118)	(0.127)	(0.050)	(0.073)	(0.080)	(0.080)	(0.060)	(0.082)
Constant	1.788***	2.078***	0.543***	0.494	1.178***	1.266***	0.124	0.884
	(0.573)	(0.692)	(0.201)	(0.577)	(0.428)	(0.446)	(0.246)	(0.622)
Observations	194	194	194	194	190	190	190	190
Hansen (p-value)	0.659	0.303	0.265	0.405	0.475	0.488	0.294	0.738
Endogeneity test	13.756**	20.483***	20.225***	7.260**	24.212***	24.250***	5.260*	13.589**
Country	35	35	35	35	35	35	35	35

Standard deviations in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Mission

To strengthen local capacity for conducting independent,
rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa.

The mission rests on two basic premises: that development is more likely to occur where there is sustained sound management of the economy, and that such management is more likely to happen where there is an active, well-informed group of locally based professional economists to conduct policy-relevant research.

Bringing Rigour and Evidence to Economic Policy Making in Africa

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