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Original Paper

Is Inequality Slowing Down Africa's Industrialization?

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Abstract

Africa has also experienced a decline in the level of industrialization for at least three decades. Examining the dynamics of industrialization, and its effect on inequality, therefore remains a strikingly topical issue. This paper assesses the effects of industrial transformation on inequality in Africa over the period 1980-2016. Using a sample of 48 African countries, we estimate a dynamic panel data model using the Generalized Method of Moments in System (GMM-S). Our results show that strong industrialization would reduce inequality in Africa. The robustness of the results is tested using a PSTR (Panel Smooth Transition Regression) model and a PTR (Panel Transition Regression) model. The study recommends that economic, social and environmental disparities be taken into account in the process of industrial transformation on the continent.

Keywords

Africa, GMM-S, Industrialization, Inequalities

1. Introduction

Africa is characterized by continued deindustrialization due to infrastructure deficits, the dominance of the informal sector in labor markets, and barriers to the movement of people and goods. Yet the continent's development prospects place considerable emphasis on prosperous, inclusive, and sustainable structural transformation.

Multiform inequalities exist in African cities these recent years. They can be broken down into three categories. First, there are economic inequalities marked mainly by the difference in income, for which the Gini coefficient remains an effective indicator. Second, social inequalities are captured by the percentage of the urban population living in slums and shantytowns. Finally, environmental or ecological inequalities are explained by the unequal sharing of natural resources in the city, the absence of green space and the degree of urban pollution. While income inequality is more visible in terms of its magnitude, other forms of inequality are not taken into account. Gini index data from around the world suggest that African cities have the highest average inequality. According to UN-Habitat (2010), African cities are by far the most unequal, with a Gini index of 0.529, compared to a Gini index of 0.509 for cities in Latin America and the Caribbean.

Also, large disparities in inequality exist. According to the ECA (2017), among the ten countries with the highest inequality in the world, seven are in Africa. On a Gini index scale of 0-1, they are, Seychelles (0.66), South Africa (0.65), Comoros (0.64), Namibia (0.61), Botswana (0.61) and Zambia (0.58). Similarly, the Central African Republic had an urban income inequality coefficient of 0.76 in 2005, compared to 0.31 in Togo, 0.43 in Uganda, 0.41 in Cameroon, and 0.38 in Ethiopia. According to the UN-Habitat Report (2010), these countries rank as countries with fairly low Gini coefficients. Social inequality is quite high in Sub-Saharan Africa. For example, in Nigeria, 61.9% of the urban population lived in slums in 2010, with an urban population of 78.85%. In South Africa, 28.7% of the urban population lived in slums in 2010, compared to 13.1% in Morocco and 17.1% in Egypt (UN-Habitat, 2010).

Industrialization is associated with a shift from the primary sector to the secondary and tertiary sectors. Industrial transformation then pulls workers from a lower-paying sector into higher-paying sectors. For Cadot et al, (2017) industrial transformation has contributed to a reduction in income poverty in Africa since the late 1990s. However, the industrialization plan decided upon by the African Union authorities, such as the New Partnership for Africa's Development (NEPAD), has not produced the expected effects. Manufacturing Value Added (MVA) as a percentage of GDP has declined in Sub-Saharan Africa from 12.02% in 1995 to 10.6% in 2015 (WDI, 2018). In North Africa, the decline was less pronounced. It fell from 14.22% in 1995 to 13.39% in 2015. East Asia and the Pacific remained at the dominant forefront with an estimated Manufacturing Value Added to 27.77% of GDP in 2015.

Manufacturing value added gradually increased along with GDP per capita in the early 2000s, but then declined, indicating that African countries are not able to maintain the sector's growth momentum. This decline is attributable to the global economic slowdown and the decline in commodity and oil prices, which countries are struggling to fully recover from the global financial crisis. It could also be attributed to the decline in manufacturing productivity, whose average growth rate fell from 7.3 percent in 2000-2008 to 3.5 percent in 2009-2014. A dynamic industrial process would help reduce inequality in Africa. This can happen if and only if an industrialization plan is adopted as well as an urbanization program in Africa.

Our paper is interesting in four ways. Theoretically, it adds to the empirical literature on the impact of industrialization on income, housing and environmental inequalities in Africa. In all likelihood, there are no studies in Africa. However, Africa is a privileged empirical field because of the prospects of emergence. Methodologically, the paper goes beyond previous work. In addition to using the MMG-S, it analyzes the robustness of the results by applying the Panel Smooth Transition Regression model (PTSR) and the Panel Transition Regression (PTR). The application of these models makes it possible to determine econometrically the critical thresholds contributing to the analysis of the impact of decoupling from industrialization on inequalities. Moreover, the use of panel data makes it possible to trace the dynamics of behavior and their possible heterogeneity, and to reduce the risk of collinearity between explanatory variables (Sevestre, 2002). From a strategic point of view, the article approaches industrial transformation through the implementation of decisions aimed at translating the quality of life of populations into the long term. Logically, Africa cannot remain at the bottom of the industrial transformation ladder. However, sustainable industrialization matters for Africa's future. Thus, is there a threshold beyond which industrialization could have a negative or positive impact on inequality in Africa?

The objective of this paper is to assess the effects of industrialization on inequalities in Africa. Three types of inequalities are considered: income inequalities, housing inequalities and environmental inequalities. The application of the S-GMM and the robustness analysis by the PSTR and PTR confirm a U-shape between industrialization and inequality in Africa.

Following this introduction, the second section identifies some stylized facts. The third section presents a state of the art. The fourth section outlines the methodological choices. The fifth section presents and discusses the results. The sixth concludes and suggests policy recommendations.

2. Some Stylized Facts

Two stylized facts emerge from the observation of inequalities and industrialization in Africa.

- **Manufacturing value added remains very low in Africa**

Figure 1 shows that, unlike other regions of the world, Africa has been characterized by low manufacturing value added since 1995 due to poor governance, political instability, a weak institutional environment, poor business performance and, in particular, the lack of effective integration. In addition to these characteristics, there is a shortage of skilled labor, low technological competence, insufficient energy supply, poor infrastructure, and in particular a lack of diversification of the productive structure.

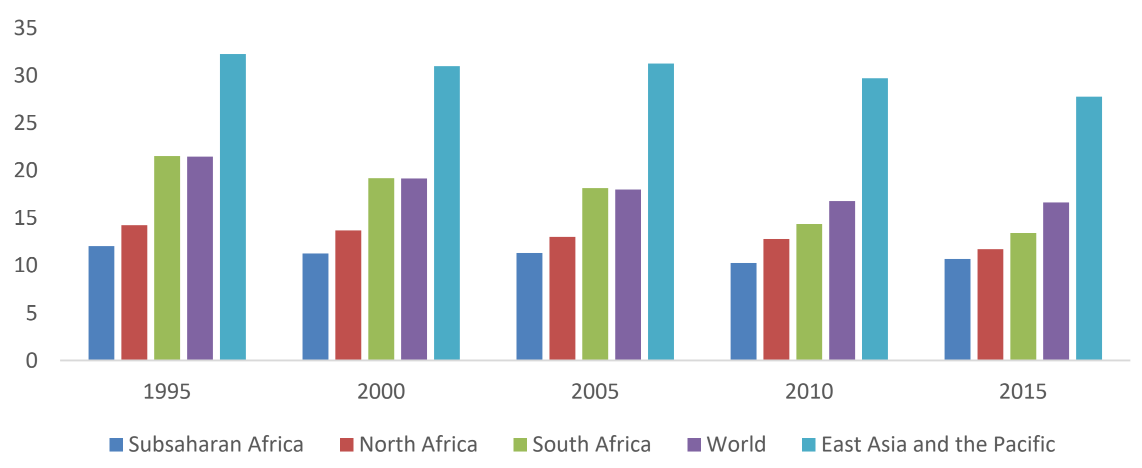

Figure 1. Evolution of Manufacturing Value Added Remains in Africa (1995-2015)

Source: Authors, from World Development Indicators (2018).

- **Socio-economic and environmental vulnerabilities remain a concern**

Industrialization poses problems of housing, living conditions, and inequality. The problems of housing and living conditions suggest that slums are growing considerably in African cities. Sub-Saharan Africa has 199.5 million people living in slums. In some large African cities, nearly 80% of the people live in slums. Figure 2 shows that income inequalities are increasingly observed and are accompanied by housing inequalities, which, due to the lack of a sustainable waste management policy, promote pollution, deteriorate air quality and hinder the management of natural resources. The UN-Environment (2018) points out that Africa produces 62 million tons of urban waste per year or an average of 0.65 per person per day. Despite its low production compared to other regions of the world, Africa is expected to revise its urban waste production to 442 million tons per year by 2025. This high production is the result of the growth of the urban population, which has been poorly managed up to now.

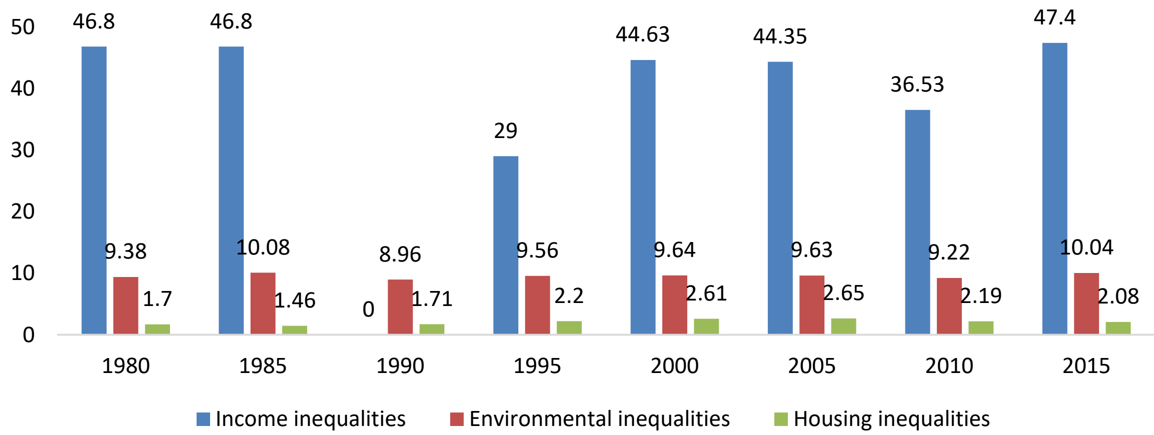

Figure 2. Evolution in Percentage of Inequalities in Africa (1995-2015)

Source: Authors, from World Development Indicators (2018).

3. Literature Review

The theoretical anchoring of the role of industrialization in the resurgence of inequalities can be attributed to Williamson (1965), who, starting from a spatial extension of Kuznets' analysis (1955), lays the foundations of the theory of development phases and illustrates regional disparities through the inverted U curve in three phases: *(i)* the phase of transition to an industrial economy, which is accompanied by an increase in regional disparities; *(ii)* the pre-mature phase, characterized by increased migration flows and the dynamics of market forces, leads to the maintenance of disparities *(iii)* the maturity phase, in which regional disparities show a relatively downward trend as per capita income increases. Later, Krugman (1994) and Krugman and Livas-Elizondo (1996), using a theoretical model, emphasized that industrialization generates disparities through the spillover effects associated with the modernization process of economies. Similarly, Ellison and Gleaser (1997) have shown that the modernization of productive structures generates income inequalities across urban agglomerations.

Empirically, Grant (2002), through a new understanding of the Kuznets curve (1955) based on taxation, finds that the process of industrialization generates an expansion of the tax base that contributes to accentuating income inequalities within the population. Davis and Henderson (2003) and Lee (1997) found that industrialization favors the emergence of urban polarization and increases income inequality. James and Mark (2000), using old data in the form of wage ratios and new data from captures of changes in the aggregate wage distribution, calculate Theil indices for production workers, find that 19th century industrialization did not increase income inequality. Lin et al. (2003), looking at urban employment in China, concluded that industrialization through sustainable urbanization of cities tends to reduce income inequality. Chuan (2008) using Simultaneous Equation Models, finds that industrial development increases farmers' incomes while reducing the income gap between urban and rural areas. Ocampo et al. (2009), Easterly (2003) in their studies of developed and developing countries, reported that industrialization has been accompanied by a lack of reduction in inequality and poverty, a lack of infrastructure and income-generating activities, and an expansion of the informal sector.

Chen (2010) found through SVAR modeling that industrial development has contributed to increased income inequality in China. Hung and Kucinsha (2011), Luo and Zhu (2009) found that to generate the decline in inequality and poverty in China, the effect of the industrialization process is through economic growth. Lustig et al. (2013), Pamuk (2008) found that the industrialization process in the Newly Industrialized Countries has significantly promoted the decline of income inequality. Chong and Wu (2014) in order to provide a better perception of inequality in China, construct an empirical model circumscribed on 22 provinces during the period 1997-2010. At the end of the econometric investigations, they found that structural transformation and industrial modernization have contributed to mitigating income inequality. Wang et al. (2015), Wu (2014) in their studies on Chinese provinces, find that industrialization has a non-linear effect on income inequality. Antoci et al. (2014) interested in the environmental externalities generated by the industrialization process, used a Solow-type model. They found that the industrialization process has led to a reduction in inequality, poverty, as well as an improvement in people's well-being.

Carmignani and Mandeville (2014) in a sample of 53 African countries over the period 1960-2008, find through the MMG-S that the industrialization process based on modern exploitation of natural resources generates violence, wars, population displacement and exacerbates income inequalities. Milotoris and Dribe (2016) using a longitudinal population register based on occupational information, find that the industrialization process is accompanied by residential and nutritional patterns that contribute to increased inequality. Zhang (2016) exploring the effects of urbanization and industrialization on income gaps in 31 cities in China over the period 1997-2013, using panel VAR modeling in a sample of 31 Chinese cities over the period 1997-2003, finds that industrialization has contributed to lower income inequality. Farzanegan and Habibpour (2017) using primary data on urban and rural individuals and households in Iran, reach the result that industrialization forces the country's political authorities to implement targeted taxation that aims to improve incomes and reduce poverty.

Recently, Mehic (2018) in the context of a sample of 27 developed and developing countries during the period 1991-2014, finds through the MMG-S that industrialization generates jobs that help reduce income inequality.

From the non-exhaustive review of the literature on the impact of industrialization on inequality, three remarks can be made. First, most of the studies assess the effects of industrialization on income inequality. They had not looked at any dimension of housing and even less at the environment. Yet, in a long tradition of political economy, housing and the environment are frequently presented as a way of reducing inequality. Second, as Carmignani and Mandeville (2014) point out, industrialization would thus synthesize the desire for strong physical and institutional integration, which would promote the adoption of strict standards of income, habitats, environments, and safety. Finally, the literature seems to ignore the environmental problem. Moreover, the impact of industrialization on disaggregated indices of inequality seems not to have been addressed in Africa. Yet, industrialization is likely to have contradictory effects in Africa.

4. Methodological Strategy

The methodological strategy is presented in three successive steps: the empirical model, the estimation technique and the data.

4.1 The Empirical Model

The model is inspired by Wu and Rao (2016), Kanbur and Zhuang (2013), anchored on Robinson's (1976) demonstration that under the assumption of economic duality measured by two sectors, income inequality either increases or remains unchanged for a relatively long time during the industrialization process. The logarithmic equation of income inequality is described by the model (1) below:

$$I^2 = P_1 I_1^2 + P_2 I_2^2 + P_1(Y_1 - Y)^2 + P_2(Y_2 - Y)^2 \quad (1)$$

Where Y_1 and Y_2 and I_1^2 et I_2^2 are the logarithms of the means and variances in the two respective sectors. P_1 and P_2 are the respective population shares of the two sectors. If the aggregate income is distributed according to equation (2).

$$Y = P_1 Y_1 + P_2 Y_2 \quad (2)$$

$$P_1 + P_2 = 1 \quad (P_1, P_2 \geq 0) \quad (3)$$

Then by substituting equations (2) and (3) into equation (1), we can write:

$$I^2 = AP_1^2 + BP_1 + C \quad (4)$$

with $A = -(Y_1 - Y_2)^2; B = (I_1^2 + I_2^2) + (Y_1 - Y_2)^2$ et $C = I_2^2$

Under the assumption of differential income levels in the rural and urban sector, and the signs of A, B and C, equation (4) shows an inverted U-shaped relationship between income inequality and the share of the population in the urban sector.

We use this demonstration to retain the model to be estimated. Wu and Rao (2016) identify three main explanatory variables for income inequality in Chinese cities: the log of GDP per capita, the share of agriculture in GDP, and the log of Foreign Direct Investment (FDI). Income inequality is approximated by the Gini index. Following the specification of Anyanwu et al, (2016) which incorporates a range of explanatory variables and appears to be suitable for the African context, the compact version of the model to be estimated is specified below.

$$Inequalities_{it} = \alpha Inequalities_{it-1} + U_{it}\pi + X_{it}\gamma + t_t + \delta_i + \varepsilon_{it} \tag{5}$$

Where $Inequalities_{it}$ represents the inequality index of country i at date t captured by three measures. Unlike previous studies, we postulate that industrialization affects inequality along three dimensions: *(i)* the income dimension that describes the income gap between the affluent who can afford better living conditions and those forced to live below the monetary poverty line; *(ii)* the housing dimension that differentiates those living in slums from those living in well-built houses; (iii) the environmental dimension that is the subject of particular renewed interest in development studies with respect to its unrationalized management, creates further inequalities. $Inequalities_{it-1}$ is the index of lagged inequality of one period; U_{it} is the matrix of variables of interest. X_{it} is the matrix of control variables consisting of the log of GDP per capita, domestic investment, FDI inflows, youth unemployment rate, and institutional variables captured by the state of governance and democracy. The exploded models are specified below.

$$Income\_inequalities_{it} = \alpha_0 + \alpha_1 Inequalities_{it-1} + \phi_1 Indus_{it} + \phi_2 Indus_{it}^2 + \gamma_1 GDP/Hbt_{it} + \gamma_2 Dom\_inv_{it} + \gamma_3 \text{FDI/GDP}_{it} + \gamma_4 \text{Unemployment}_{it} + \gamma_5 \text{Gover}_{it} + \gamma_6 \text{Democ}_{it} + t_t + \delta_i + \varepsilon_{it} \tag{6}$$

$$Housong\_inequalities_{it} = \alpha_0 + \alpha_1 Inequalities_{it-1} + \phi_1 Indus_{it} + \phi_2 Indus_{it}^2 + \gamma_1 GDP/Hbt_{it} + \gamma_2 Dom\_inv_{it} + \gamma_3 \text{FDI/GDP}_{it} + \gamma_4 \text{Unemployment}_{it} + \gamma_5 \text{Gover}_{it} + \gamma_6 \text{Democ}_{it} + t_t + \delta_i + \varepsilon_{it} \tag{7}$$

$$Environmental\_inequalities_{it} = \alpha_0 + \alpha_1 Inequalities_{it-1} + \phi_1 Indus_{it} + \phi_2 Indus_{it}^2 + \gamma_1 GDP/Hbt_{it} + \gamma_2 Dom\_inv_{it} + \gamma_3 \text{FDI/GDP}_{it} + \gamma_4 \text{Unemployment}_{it} + \gamma_5 \text{Gover}_{it} + \gamma_6 \text{Democ}_{it} + t_t + \delta_i + \varepsilon_{it} \tag{8}$$

t_t, δ_i, and ε_{it} are respectively the time fixed effects, the country fixed effects and, the rest of the perturbation.

Income inequalities are approximated by the Gini coefficient. Housing inequalities are measured by the proportion of the population living in slums or in non-decent housing. Environmental inequalities are captured by the number of people living on the margins of nature protection or living in insalubrious conditions marked by poor garbage management. The lagged inequality variable allows us to assess the memory effect of past inequalities on present inequalities.

The matrix of variables of interest consists of industrialization approximated by manufacturing value added relative to GDP, and industrialization squared. As shown by Kuznets (1955), these variables allow us to determine the breakpoint and thresholds of the transition variables. We postulate a U-shaped relationship between industrialization and inequality.

The explanatory variables include: *(i)* real GDP per capita which captures the standard of living of the country's population. We postulate that income disparities in Africa increase inequality in urban areas; *(ii)* domestic investment proxied by gross fixed capital formation. Lee et al, (2013) point out that private investment reduces urban inequality; *(iii)* Foreign Direct Investment captured by FDI inflows relative to GDP, tends to sustain high wage inequality between jobs offered by multinationals and domestic jobs in

Africa. Moreover, the "pollution haven" hypothesis will be verified in the context of the estimation of environmental inequalities; *(iv)* the unemployment rate, which is approximated by the number of unemployed young people in relation to the total number of young people. It naturally increases inequalities and its effect depends on the measure of inequalities. Indeed, unemployed young people are better at protecting the environment and thus improving the living environment; *(v)* local governance; *(vi)* democracy, whose indices are between -2.5 and 2.5.

4.2 The Estimation Technique

Assuming that the level of past inequality would influence the level of inequality in the current period, we opt for a dynamic panel whose Ordinary Least Squares (OLS) estimation yields spurious and less convergent regressions. Thus, we first estimate using the Generalized Method of Moments (GMM) which better deals with the difficulties inherent to dynamic panel data. Indeed, under this specification, three main problems are solved in order to obtain robust estimators. First, the problem of endogeneity between the income inequality variable and real GDP per capita, for example, or between environmental inequality and FDI. Second, there is the problem of double causality between the inequality variables and urbanization on the one hand and GDP per capita on the other. Just as industrialization can affect inequality, inequality in urban areas can slow it down. Finally, the problem of multicollinearity, since the autoregressive character of the model and the error term does not have a minimum value, i.e., a low variance.

These problems are solved by the Generalized Method of Moments in Difference (GMM-D). Blundell and Bond (1998) show that the efficiency of the GMM-D of Arellano and Bond (1991) is reduced by the limit imposed on the number of instruments in the model. The GMM-S estimation overcomes this limitation. It combines the difference equation with the level equation. The first difference equation is estimated simultaneously with the level equation by the generalized method of moments. In the level equation, the variables are instrumented by their first differences. Blundell and Bond (1998) tested this method using Monte Carlo simulations. They found that the GMM-S estimator performs better than the GMM-D estimator which only exploits the conditions of the moments of the first difference equation with level lagged variables as instruments.

4.3 Data Sources

The data are from three sources: *(i)* data on macroeconomic variables are from World Bank Database; *(ii)* data on inequality are from Standardized World Income Inequality Database (SWIID) and UN Habitat (2018); *(iii)* data on institutional variables are from PolityIV Project Online (2018). The study covers 48 countries in Africa, which are listed in Appendix 1.

The study period chosen is from 1980-2016, justified by data availability. The descriptive statistics contained in Table 1 show the absence of variation. It is generally accepted that when the data do not fluctuate, the results tend to converge. The correlation matrix (Appendix 2) shows weak interdependencies, which suggests an absence of multicollinearity between the dependent and explanatory variables.

Table 1. Sescriptives Statistiques

Variables	*Observations*	*Means*	*Standard deviation*	*Minimum*	*Maximum*
Income inequalities	*1,776*	*4.180236*	*13.26466*	*0*	*65.8*
Housing inequalities	*1,776*	*1.968736*	*4.484276*	*0*	*31.50345*
Environmental inequalities	*1,776*	*6.166841*	*8.20723*	*0*	*57.98816*
Industrialization	*1,739*	*2.986493*	*9.919929*	*-72.23093*	*128.3681*
Industrialization2	*1,776*	*105.0328*	*549.993*	*0*	*16478.36*
GDP/Habitant	*1,776*	*1.104376*	*7.364146*	*-50.23014*	*140.5011*
Domestic investment	*1,776*	*18.6985*	*23.74753*	*0*	*115.971*
Foreign direct investment	*1,776*	*7.460811*	*8.335728*	*0*	*41.6*
Unemployment	*1,776*	*64.92792*	*50.39488*	*0*	*531.7374*
Normalised governance index	*1,776*	*3.538611*	*.6300974*	*1.789827*	*5.249671*
Normalised democracy index	*1,776*	*3.474647*	*.6854607*	*1.331127*	*5.130958*

Source: Authors.

5. Results

We present results from the baseline models and the robustness analysis.

5.1 The Results of the Basic Models

We estimate the model under three specifications (Table 2), in order to highlight the effects of industrialization on inequality. Overall, the results show that inequalities (income, housing, environmental) in the previous year have a memory effect and significantly increase inequalities in the current year. All else being equal, a one-point increase in the levels of previous income, housing and environmental inequalities increases the levels of income (0.970), housing (0.972) and environmental (0.818) inequalities, creating a vicious circle that is difficult to break.

The results of model (1) indicate that manufacturing value added, domestic investment, and the quality of governance have positive and statistically significant effects on income inequality. A plausible explanation is that industrialization is accompanied by low productivity, limited job creation, large deficits in infrastructure and services, a large informal sector, and weak institutional capacity and systems that impede structural transformation. This situation not only prevents cities from functioning better but also makes it impossible to develop economic development strategies. As a result, the absence of sustainable industrialization has resulted in cities with poorer populations and a prevalence of the informal sector, making sustained growth and economic convergence ineffective. Accelerated industrialization, GDP/capita, unemployment, and democracy contribute to a significant reduction in income inequality. The alignment of an industrial policy specific to African countries strengthens the capacities of economic agents who, in order to meet their needs, engage in both formal and informal activities that contribute, albeit relatively, to reducing income inequalities. Moreover, the strengthening of the industrialization process plays a decisive role in the exploitation of the productive forces of the cities, insofar as the sectors that provide jobs for young people abound and exploit the possibilities of the demographic dividend, thus helping to reduce income inequalities. These results corroborate those of Zhang (2017).

The estimation of model 2 also shows two main results overall. On the one hand, manufacturing value added, domestic investment, governance and FDI have positive and statistically significant effects on housing inequality. The underlying explanation is that industrialization in Africa is essentially unprincipled. As a result, unsuitable investments are favored, which, for lack of a housing policy, increase housing inequalities. In some countries, the establishment of FDI is done to the detriment of anarchic constructions, forcing some inhabitants to settle in slums. On the other hand, accelerated industrialization and GDP per capita contribute to a significant reduction in housing inequalities. Indeed, the alignment of an industrial policy forces companies forced to exploit the productive forces of cities to respond to urban demand by building housing in advance. In addition, compliance with the standards set by UN-Habitat creates sustainable industrialization, less well served and more compartmentalized, which, through residential compartmentalization, reduces housing inequalities. The results obtained corroborate those of Eeckhout et al. (2010).

Table 2. Effects of Industrialization on Disaggregated Indices of Inequalities in Africa

Estimation technique: GMM-System					
Income inequalities		***Housing inequalities***		***Environmental inequalities***	
Incom_ineq(t-1)	*.970036****	*Housing_ineq(t-1)*	*0.972****	*Environmental_ineq(t-1)*	*0.818****
	0.000		*0.000*		*0.001*
MVA1	*.00158**	*MVA1*	*0.0087****	*MVA1*	*.00866**
	0.064		*0.009*		*0.061*
MVA2	*-.00913**	*MVA2*	*-.0245****	*MVA2*	*-.0054****
	0.083		*0.000*		*0.000*
GDP/habitant	*-.02193****	*GDP/habitant*	*-.00179****	*GDP/habitant*	*-.0120****
	0.008		*0.007*		*0.008*
Domestic_invest	*.0438**	*Domestic_invest*	*.02975**	*Domestic_invest*	*-.0080****
	0.063		*0.075*		*0.005*
FDI	*.0121***	*FDI*	*0.0822**	*FDI*	*.00208*
	0.024		*0.054*		*0.312*
Unemployment	*-.0044****	*Unemployment*	*-.0014*	*Unemployment*	*.0106**
	0.000		*0.178*		*0.073*
Normalized_gover	*.0215***	*Normalized_gover*	*0.0189**	*Normalized_gover*	*.00069**
	0.010		*0.083*		*0.087*

Normalized_democ	*-.0530***	*Normalized_democ*	*.0507****	*Normalized_democ*	*.37255****
	0.021		*0.005*		*0.000*
Constant	*.17175*	*Constant*	*0.17001*	*Constant*	*.2316***
	0.331		*0.337*		*0.044*
Observations	*1692*	*Observations*	*1692*	*Observations*	*1692*
Countries	*47*	*Pays*	*47*	*Pays*	*47*
AR(1)	*0.000*	*AR(1)*	*0.000*	*AR(1)*	*0.000*
AR(2)	*0,674*	*AR(2)*	*0.0786*	*AR(2)*	*0.983*

*Note. * p<001; ** p<0,05; *** p<0,01*

Source: Authors.

The estimation of model 3 shows two main results. On the one hand, manufacturing value added, unemployment and the level of democracy have positive and statistically significant effects on environmental inequality. The underlying explanation is that industrialization in Africa is essentially characterized by non-compliance with environmental standards. Consequently, this situation, due to climate change, contributes to the deterioration of air quality and generates moderate, often localized environmental impacts (odors, noise pollution, pollution) and increase the environmental and carbon footprints of cities due to car traffic. It is also noted that the unemployment situation in African cities favors the establishment of small informal industries that cause a nuisance to the immediate environment due to the lack of restrictions on zoning and density, the immediate environment due to pollution, noise and odors. However, accelerated industrialization, GDP/capita, and domestic investments contribute to significantly reduce environmental inequalities. Indeed, the alignment of industrial policy forces firms to exploit the productive forces of cities, and to respond to urban demand without policy support, in the form of a favorable regulatory framework, training and skills-building opportunities, and prioritization of infrastructure that supports value chains. In this way, it enables resilient, green, cross-sectoral, and multilevel governance, better intrinsic democracy, and environmentally friendly urban mobility through multimodal options. The findings corroborate those of Wei et al. (2017).

5.2 Robustness

To guarantee the robustness of our results and to highlight the non-linear effect of the model represented here by the square of industrialization, we estimate two panel, non-linearity models. The first model considers that the transition is abrupt (Panel Transition Regression -PTR) and the second model the transition is smooth (Panel Smooth Transition Regression -PSTR).

Developed by Hansen (1999), PTR models imply that individual observations can be divided into homogeneous classes based on the value of an observed variable. Specifically, these models assume a transition from one regime to another based on the value of a threshold variable. The change is important because it accurately specifies the inflection point between the evolution of the independent variable (industrialization) and that of the dependent variable (inequality). PTR models are criticized for not allowing the observation of change processes, since two extreme values are determined and the change variable is endogenous. The consideration of a gradual change has been highlighted by González et al. (2005) who consider a smooth transition panel data model, namely the PSTR. González et al. (2017) justify the weakness of the PTR by showing that it seems difficult to assert that there is an exact level of constraints to separate two entities in a way that observes the sensitivity of change.

Empirical evidence using the PTR and PSTR models is more widely observed in finance. González et al. (2005) illustrate the imperfections of capital markets on investments. Eggoh and Villieu (2013) re-examine the non-linearity between financial development and economic growth. A few studies in environmental economics have used these models to appreciate the nonlinearity between endogenous and exogenous variables (Heidari et al., 2015). In addition to adding to the empirical literature on nonlinearity between macroeconomic and environmental variables, we test for model linearity before estimating the PTR and PSTR models. This exercise, which has been swept up in several works, allows us to determine the existence of a non-linearity, and to determine the variable causing the non-linearity and on which the study focuses. Several tests of linearity are proposed in the literature (Ramsey, 1969; Tsay, 1989; Hansen, 1996). The test of Tsay (1989) seems to us to be the most appropriate and suggests that in the presence of a quadratic form, we can obtain a reversal of the model trend. The test procedure can be summarized in three steps. First, the rewriting of the initial model by performing an ascending order of the transition variable, allows to regress the observations corresponding to the values lower than the transition value below the threshold. Then, the corresponding model is regressed to the other regime. Finally, the final regression is done recursively. Considering the baseline model estimated by the MMG-S, the Tsay (1989) test can be specified in the form of equation 9.

$$Inequalities_{it} = \begin{cases} \alpha_0^1 + \phi_1^1 Indus_{it} + \phi_2^1 Indus_{it}^2 + \mu_i X_{it} + \varepsilon_{it}^1 \\ \alpha_0^2 + \phi_1^2 Indus_{it} + \phi_2^2 Indus_{it}^2 + \mu_i X_{it} + \varepsilon_{it}^2 \end{cases} \quad (9)$$

In this form, Tsay (1989) postulates the null hypothesis of linearity: $H_0 : \pi_i^1 = \pi_i^2$ $(i = 1 \dots \dots m)$ against the alternative hypothesis: $H_1 : \pi_i^1 \neq \pi_i^2$ (i=1......m). Subsequently, we test the nonlinearity relationship in a regime-switching model. The determination of the two regimes is identified by the threshold effects estimation method with smooth panel transition (PSTR). The PSTR technique allows an endogenous determination of the thresholds. These advantages are essential. They are suitable for explaining the gradual effect of the change in the relationship in relation to a higher and higher level. The crowding-out effect does not appear to be radical, hence the need for a certain degree of gradualism if African states decide to accompany their urbanization policy with some reforms requiring the reduction of inequalities.

To detect the non-linearity relationship between industrialization and inequality, we use a PSTR model as developed by Gonzales et al. (2005). Let us consider y_{it} as the explained value, x_{it} as the explanatory variable and u_{it} as the transition variable. We present the simple case of a PSTR with two regimes and a simple function between industrialization and inequality in Africa. The choice of Africa is justified by the fact that this region concentrates multiple forms of inequality and has undergone a considerable industrialization process. The model takes the following form:

$$Y_{it} = \mu_i + \beta_0 x_{it} + \beta_1^{'} x_{it} g(u_{it}, \gamma, c) + \varepsilon_{it} \quad (10)$$

Where $g(u_{it},\gamma,c)$ is the transition function. This function is continuous and depends on the threshold c of the transition variable u_{it}; γ is the transition parameter. The transition function is a normalized and bounded function between 0 and 1, with extreme values associated with the coefficients β_0 and $(\beta_0+ \beta_1)$. Gonzales et al. (2005) consider this function to be a logistic transition function of the form:

$$g(u_{it}, \gamma, c) = \left(1 + \exp(-\gamma \prod_{j=1}^{m} (u_{it} - c))\right)^{-1} \quad (11)$$

With $\gamma > 0$ et $c_1 \leq c_2 \leq \cdots c_m$. The slope of the parameter γ determines the smoothness of the transition. For m=1, the model exhibits the two regimes separating the lower and upper values of u_{it} with a simple monotonic transition of the coefficients of β_0 and $(\beta_0+ \beta_1)$ when u_{it} increases. As the slope of the parameter increases, the transition becomes rougher and the transition function g (u_{it},γ,c) becomes a function of type g (u_{it},γ,c). When the smoothing parameter tends to infinity, the transition function is equal to unity, i.e., g (u_it,c)=1 if $u_{it}>c$; the transition function is zero (g $(u_{it},\gamma,c)=0$) otherwise $(u_{it}<c)$. When γ is close to 0, the transition function is a constant. In this case, the PSTR tends to the PTR as developed by Hansen (1999). In general, for all values of m, the transition function g (u_{it},γ,c) is constant when γ is close to 0.

The procedure for estimating the PSTR model requires three steps (Gonzales et al., 2005): *(i)* testing the linearity of the model; *(ii)* estimating the parameter; and *(iii)* testing the number of transition functions where the regime number.

Testing linearity in a PSTR model can be done by making the following assumptions:

$$\begin{cases} H_0: \gamma = 0 \\ \quad ou \\ H_0: \beta_0 = \beta_1 \end{cases} \qquad against \qquad \begin{matrix} H_0: \gamma \neq 0 \\ ou \\ H_0: \beta_0 \neq \beta_1 \end{matrix}$$

The null hypothesis is suitably tested by a Wald or Lagrange Multiplier (LM) test which can be supported by the maximum likelihood statistic. If we label SSR_0 the sum of squares of the panel residuals under H_0 (the linear panel data model with individual effects) and SSR_1 the sum of the residual squares under H_1(the PSTR model with two regimes), the Wald test can be written as follows:

$$LM_W = \frac{NT(SSR_0 - SSR_1)}{SSR_0} \sim X^2\,(K) \quad (12)$$

The maximum likelihood test can be written as follows:

$$LR = -2[log(SSR_1) - log(SSR_0)] \sim X^2\,(K) \quad (13)$$

The parameters $(\beta_0, \beta_1, \gamma, c)$ of the baseline model are estimated in two steps. In the first, we remove individual effects by subtracting the means. In the second step, we apply Nonlinear Least Squares (NLLS) on the transformed data to determine the parameter values that minimize the sums of squares of the residuals.

The number of regimes test allows determining the number of regimes of the transition function. In most cases, the existence of a decoupling phenomenon in the presence of one regime is shown. But, in the presence of two regimes, a more pronounced transition is observed. Gonzales et al. (2005) propose a sequential approach to test the null hypothesis of the number of non-linearities in the transition function. In the basic theory of PSTR model estimation, we assume that the linearity hypothesis is rejected. The task is then to test whether there is one transition function $(H_0: r = 1)$ or whether there are at least two transition functions. To test for the number of regimes that link urbanization and inequality, we draw on the procedure of Gonzales et al. (2005). The authors then assume that if the function has the following form:

$$Y_{it} = \mu_i + \beta_0 x_{it} + \beta_1^{'} x_{it} g(u^1{}_{it}, \gamma, c) + \beta_2^{'} x_{it} g(u^2{}_{it}, \gamma, c) + \varepsilon_{it} \qquad (14)$$

We should test the nullity or not of the parameter β_2^'. Thus, the test for nonlinearity is defined by $H_0: \beta_2' = 0.$ Let us note SSR_0 the sum of squares of the residuals under H_0 then denoting a PSTR with a transition function. Let us also note SSR_1 the sum of squares of the residuals under H_1, i.e., the transformed model. Taking these assumptions into account, the regime number is given if the null hypothesis is rejected (Note 1).

Table 3 below reports the results of the PSTR model estimates between industrialization and inequality. Indeed, the Lagrange Multiplier (LM) and Maximum Likelihood (ML) tests reject the null hypothesis of no non-linear effect between industrialization and inequality for the three forms of inequality. It is as if industrialization has a specific impact before a certain threshold and has a different impact after this identified threshold. In the case of industrialization, the results of the PSTR largely confirm those obtained by the GMM-S. First, a negative and significant impact is obtained. A positive and negative impact is secondly obtained. This confirms the U-shaped nature of the relationship between industrialization and inequality. If industrial transformation seems to reduce inequality before a certain stage, it is because the transition from a primary to a secondary and tertiary stage increases people's standard of living and consequently reduces the level of poverty and inequality. This result is confirmed by Cadot et al. (2017).

Industrial transformation reduces income inequality up to the threshold of 24.55%. This is justified by the fact that when a continent industrializes, there is an income catch-up. People working in the primary sector see an increase in their income as their production is purchased locally and processed. The strong local demand then contributes to increasing the purchase price in the field. Progressively, the increased income in the primary sector contributes to an improvement in the standard of living of the population. Also, the more production is purchased locally, the more producers can increase their cultivable area. After the threshold of 24.55% of the industrialization level, an income gap appears. Thus, activities in the secondary sector are changing, the entry of technology, the development of the chemical industry could substitute organic primary products for non-organic products. Africa needs to consolidate the industrial sector through the implementation of policies to valorize and use local production. However, the transition between the two regimes is smooth. This is confirmed by the value of the transition parameter (γ=1.015).

Table 3. Robustness Results with PSTR (Note 2)

	Industrialization and Income inequalities	***Industrialization and environmental inequalities***	***Industrialization and housing inequalities***
Parameter β'_1	*-0.0104***	*-0.080***	*-0.0151***
	(0.04171)	*(0.040)*	*(0.0157)*
Parameter β'_2	*0.2112**	*0.0247***	*0.1576**
	(0.0954)	*(0.0413)*	*(0.0871)*
Parameter c	*24.55*	*21.60*	*32.75*
Estimation of model coefficients			
GDP/Habitant	*-0.1641*	*-0.2179**	*-0.1373**
	(0.1568)	*(0.0564)*	*(0.014)*
Domestic investment	*-0.2011***	*-0.069**	*-0.1506**
	(0.0138)	*(0.050)*	*(0.073)*
Foreign Direct Investment	*-0.497*	*-0.0402*	*0.067*
	(0.517)	*(0.1906)*	*(0.1247)*
Unemployment	*0.1259**	*0.0491***	*0.0232***
	(0.0548)	*(0.0352)*	*(0.019)*
Normalized governance index	*0.264*	*0.436*	*0.808***
	(0.7079)	*(0.4251)*	*(0.032)*
Normalized democracy index	*0.1528*	*-0.795****	*-4.602*
	(0.6363)	*(0.000)*	*(0.341)*
Linearity test			
LM avec m=1	*1.068****	*2.104***	*2.541****
	(0.000)	*(0.041)*	*(0.000)*
LM avec m=2	*1.623****	*1.3401****	*1.389****
	(0.000)	*(0.000)*	*(0.000)*
LR avec m=1	*4.356****	*3.064****	*1.965****
	(0.000)	*(0.000)*	*(0.000)*
LR avec m=2	*13.54****	*5.2014****	*8.365****
	(0.000)	*(0.000)*	*(0.000)*
Testing the number of diets			
LM	*0.468***	*0.8201**	*0.912****
	(0.018)	*(0.091)*	*(0.000)*
LR	*4.562****	*2.1054****	*3.642****
	(0.000)	*(0.000)*	*(0.000)*
Transition parameter γ	***1.015***	***0.926***	***0.806***
Observations	***1702***	***1736***	***1702***

*Note. * p<001; ** p<0,05; *** p<0,01; les p-value are reported in brackets.*

Source: Auteurs.

The structural transformation reduces environmental inequalities before the rate of 21.60%. It is as if industrial production, especially in urban centers, increases air pollution. On a small scale, this pollution is not felt, but when industrial zones are created near urban centers, environmental degradation is felt by the urban population. The people who suffer the most from this degradation are those with limited financial means. It is important to note that of the three industrialization thresholds identified, the industrial transformation will quickly impact the environment. The value of the transition parameter is γ=0.926. This result reveals the dilemma that African governments must resolve. Sustainable consolidation taking into account the protection of the environment induces the establishment of free trade zones.

Industrial transformation reduces the inequalities of habitat before the rate of 32.75%. Indeed, the construction of new factories in peripheral and urban areas will decongest urban centers, thus reducing the rate of informal settlements and the proliferation of slums. After this threshold, the attractiveness of the industrial zone, whose construction has generated positive externalities, will contribute to the spatial occupation of populations. Thus, if no urbanization measures are established to regulate the installation and construction of housing, very quickly neighborhoods are built and housing disparities arise. This result highlights the strong correlation between urbanization and industrialization plans in Africa. Thus, a better functioning of cities requires a better industrialization. Also, better industrialization requires better functioning cities. The transition from negative to positive impact is small as shown by the value of the transition parameter γ=0.806.

The results obtained by du PTR corroborate those of the PSTR, as required by the test procedure, based on the smooth transition test. All control variables are of expected signs despite a differentiation of significance depending on the component of inequality considered. GDP and domestic investment significantly reduce inequality. Unemployment and the quality of governance increase inequality. Foreign direct investment does not affect inequality. Democracy presents results that differ from one form of inequality to another.

6. Conclusion

This paper has assessed the effects of industrialization on disaggregated indices of inequality (income, environmental and housing). Although exacerbated, these inequalities, to the best of our knowledge, have not been the subject of simultaneous empirical investigations. We implement it econometrically on a panel of 48 African countries over the 1980-2016 time horizon using the Generalized Method of Moments in System. The results indicate that industrialization significantly reduces inequality in Africa. To achieve these results, we mobilized a theory anchored on developments related to the Kuznets curve. A dynamic panel data model was used as the econometric basis, with a quadratic (non-linear) specification.

The results of the basic model remained robust by applying the PTR and PSTR models. Their implementation allowed us to determine the critical thresholds of urbanization and industrialization that could reveal a decoupling effect on the different declines of inequalities. Specifically, below the respective thresholds of 24.55%, 21.60% and 32.75%, industrialization significantly reduces inequality. Above these thresholds, industrialization would increase inequality provided that good industrial transformation policies are in place.

Four main recommendations can be made: *(i)* economic, social and environmental disparities must be taken into account; *(ii)* the implementation of sanitation or waste flow management policies must contribute to reducing inequalities between rich and poor neighborhoods; *(iii)* in the search for sustainable cities, the decoupling of socioeconomic, demographic and territorial growth from resource scarcity and environmental degradation requires the management of public actions; *(iv)* the industrial transformation of Africa must be aimed not only at increasing productivity, but also at improving the quality of life of the population.

References

Antoci, A., Paolo, R., Serena, S., & Elisa, T. (2014). Industrialization and environmental externalities in a Solow-type model. *Journal of Economic Dynamics & Control*, *47*, 211-224. https://doi.org/10.1016/j.jedc.2014.08.009

Anyanwu, J. C., Andrew, E. O., & Erhijakpor, E. O. (2016). Empirical Analysis of the Key Drivers of Income Inequality in West Africa. *African Development Review*, *28*(1), 18-38. https://doi.org/10.1111/1467-8268.12164

Arellano, M., & Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies*, *58*, 277-297. https://doi.org/10.2307/2297968

Arellano, M., & Bover, O. (1995). Another Look at the Instrumental-Variable Estimation of Error-Components Models. *Journal of Econometrics*, *68*, 29-52. https://doi.org/10.1016/0304-4076(94)01642-D

BAfD/OCDE/PNUD. (2017). Perspectives Economiques en Afrique 2017, Entrepreneuriat et Industrialisation, Editions OCDE, Paris, 344p.

Blundell, R., & Bond, S. (1998). Initial Conditions and Moment Restrictions in Dynamic Panel Data Models. *Journal of Econometrics*, *87*, 115-143. https://doi.org/10.1016/S0304-4076(98)00009-8

Cadot, O., De Melo, J., Plane, P., Wagner, L., & Woldemichael, M. (2016). Industrialisation et transformation structurelle: l'Afrique subsaharienne peut-elle se développer sans usines? *Revue d'économie du développement*, *24*(2), 19-49. https://doi.org/10.3917/edd.302.0019

Carmignania, F., & Mandeville, T. (2014). Never been industrialized: A tale of African structural change. *Structural Change and Economic Dynamics*, *31*, 124-137. https://doi.org/10.1016/j.strueco.2014.09.002

CEA. (2017). Rapport économique sur l'Afrique 2017: l'industrialisation et l'urbanisation au service de la transformation de l'Afrique, Commission économique pour l'Afrique, Addis-Abeba, Éthiopie, 213.

Chen, X. Y. (2010). Urbanization, industrialization and urban-rural income gap-Based on SVAR model. *Economic Latitude and Longitude*, *6*, 21-24.

Cheong, T. S., & Wu, Y. (2014). The impacts of structural transformation and industrial upgrading on regional inequality in China. *China Economic Review*, *31*, 339-350. https://doi.org/10.1016/j.chieco.2014.09.007

CNUCED. (2009). Trade and Development Report 2009: Responding to the global crisis Climate change mitigation and development. *United Nations, 218p.*

Davis, J. C., & Henderson, J. V. (2003). Evidence on the political economy of the urbanization process. *Journal of Urban Economics*, *53*, 98-125. https://doi.org/10.1016/S0094-1190(02)00504-1

EAC. (2011). 4th EAC Development Strategy (2011/12-2015/16): Deepening and Accelerating Integration (Arusha, EAC).

Easterly, W. (2003). The political economy of growth without development: A case study of Pakistan. In D. Rodrik (Ed.), *Search of Prosperity, Princeton University Press, Princeton* (pp. 439-472).

Eeckhout, J., Pinheiro, R., & Schmidheiny, K. (2010). *Spatial sorting: Why New York, Los Angeles and Detroit attract the greatest minds as well as the unskilled*. CEPR Discussion Paper 8151.

Eggoh, J. C., & Villieu, P. (2013). Un réexamen de la non-linéarité entre le développement financier et la croissance économique. *Revue d'Economie Politique*, *123*, 211-236. https://doi.org/10.3917/redp.232.0211

Ellison, G., & Glaeser, E. (1997). Geographical Concentration in US Manufacturing Industries. *Journal of Political Economy*, *105*(5), 880-927. https://doi.org/10.1086/262098

Farzanegan, M. R., & Habibpour, M. M. (2017). Resource rents distribution, income inequality and poverty in Iran. *Energy Economics*, *66*, 35-42. https://doi.org/10.1016/j.eneco.2017.05.029

Gonzalez, A., Terasvirta, T., & Dijk, D. V. (2005). *Panel smooth transition regression models*. SEE/EFI Working Paper Series in Economics and Finance 604.

Gonzaleza, A., Timo, T., Dijk, D. V., & Yukai. (2017). *Panel Smooth Transition Regression Models*.

Hansen, B. E. (1996). Threshold effect in non-dynamic panels: Estimation, testing and inference. *Journal of Econometrics*, *93*, 345-368. https://doi.org/10.1016/S0304-4076(99)00025-1

Hansen, B. E. (1999). Inference when a nuisance parameter is not identified under the null hypothesis. *Econometrica*, *64*, 413-430. https://doi.org/10.2307/2171789

Heidari, H., Katircioğlu, S. T., & Saeidpour, L. (2015). Economic Growth, CO2 Emissions, and Energy Consumption in the Five ASEAN Countries. *Electrical Power and Energy Systems*, *64*, 785-791. https://doi.org/10.1016/j.ijepes.2014.07.081

Hung, H. F., & Kucinskas J. (2011). Globalization and global inequality: Assessing the impact of the rise of China and India, 1980-2005. *American Journal of Sociology*, *116*, 1478-1513. https://doi.org/10.1086/657456

James, J. A., & Mark, T. (2000). Industrialization and wage inequality in nineteenth-century urban America. *Journal of Income Distribution*, *9*(2000), 39-64. https://doi.org/10.1016/S0926-

6437(00)00003-2

Kanbur, R., & Zhuang. J. (2013). Urbanization and inequality in Asia. *Asian Development Review*. https://doi.org/10.1162/ADEV_a_00006

Krugman, P. (1994). Urban Concentration: The role of increasing returns and transport costs. Proceedings of the World Bank, *Annual Conference on Development Economics.*

Krugman, P., & Livas-Elizondo, R. (1996). Trade policy and the third world metropolis. *Journal of Development Economics*, *49*, 137-150. https://doi.org/10.1016/0304-3878(95)00055-0

Kuznets, S. (1955). Economic growth and income inequality. *American Economic Review*, *45*, 1-28.

Lee, J. (1997). The maturation and growth of infant industries: The case of Korea. *World Development*, *25*(8), 1271-1281. https://doi.org/10.1016/S0305-750X(97)00035-1

Lin, J., Wang, G., & Zhao, Y. (2003). Regional inequality and labor transfers in China. *University of Chicago*.

Mehic, M. (2018). *Industrial employment and income inequality: Evidence from panel data*. https://doi.org/10.1016/j.strueco.2018.02.006

Ocampo, J. A., Rada, C., & Taylor, L. (2009). Growth and Policy in Developing Countries. *Columbia University Press, New York*.

ONU Environment. (2018). Africa Waste Management outlook, United Nations Environment Programme (UNEP), Nairobi, Kenya.

ONU Habitat. (2010). L'état des villes africaines 2010: Gouvernance, inégalité et marchés fonciers urbains, Nairobie, Kenya, 268.

ONU Habitat. (2018). *Logement et amélioration des bidonvilles*. Retrieved from http://www.unhabitat.org

Polity project online. (2016). Political Regime Characteristics and Transitions, 1800-2016. *In University of Maryland*.

Ramsey, J. B. (1969). Tests for Specification Errors In Classical Linear Least Squares Regression Analysis. *Journal of the Royal Statistical Society B*, *31*, 350-371. https://doi.org/10.1111/j.2517-6161.1969.tb00796.x

Robinson, S. (1976). A note on the U hypothesis relating income inequality and economic development. *The American Economic Review*, *66*(3), 437-440.

Sevestre, P. (2002). Économétrie des données de panel. *Dunod, Paris*.

Tsay, R. (1989). Testing and Modelling Threshold Autoregressive Processes. *Journal of the America Statistical Association*, *84*, 231-240. https://doi.org/10.1080/01621459.1989.10478760

Wei, Y-D., Li, H., & Yue, W. (2017). Urban land expansion and regional inequality in transitional China. *Landscape and Urban Planning*, *163*, 17-31. https://doi.org/10.1016/j.landurbplan.2017.02.019

Williamson, J. G. (1965). Regional inequality and the process of national development: A description of the patterns. *Economic Development and Cultural Change*, *13*(4), 1-47. https://doi.org/10.1086/450136

Wu, D., & Rao, P. (2016). Urbanization and Income Inequality in China: An Empirical Investigation at Provincial Level. *Social Indicators Research*, *131*(1), 189-214. https://doi.org/10.1007/s11205-016-1229-1

Zhang, X. Q. (2016). Urbanization, Industrialization and Urban-Rural Income Gap: Inspection by Panel VAR Based on the Provincial Panel Data. *Studies in Sociology of Science*, *7*(1), 1-6.

Notes

Note 1. Gonzales et al. (2005) also propose that an increase in the number of plans is necessary until the null hypothesis is rejected.

Note 2. The estimation results by the PTR are contained in Appendix 3.

Appendixe 1. List of countries

Angola, Benin, Botswana, Burkina Faso, Burundi, Cap vert, Cameroon, Central African Republic, Tchad, Comores, Congo, Democratic Republic of Congo, Cote d'ivoire, Djibouti, Erythrea, Equatoriale Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Maurice, Mozambique, Namibia, Niger, Nigeria, Uganda, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sudan, Swaziland, Sierra Leone, South Africa, South Sudan, Tanzania, Togo, Zambia, Zimbabwe.

Appendixe 2. Correlation Matrice

	Inc_ine	*MVA*	*GDP/Hbt*	*Dom_inv*	*FDI*	*Unemploym*	*Gover*	*Democ*
Income_ine	*1.0000*							
MVA	*0.0209*	*1.0000*						
GDP/Hbt	*0.0316*	*0.0274*	*1.0000*					
Dom_inv	*0.0253*	*0.2776**	*0.0845**	*1.0000*				
FDI	*0.0811**	*0.3840**	*0.0882**	*0.2117**	*1.0000*			
Unemployement	*-0.0050*	*0.2867**	*0.2615**	*0.1669**	*0.2186**	*1.0000*		
Nor_gov_index	*0.0050*	*0.0767**	*-0.0104*	*0.0537**	*-0.0466**	*-0.0696**	*1.0000*	
Nor_democ_index	*0.0016*	*0.1021**	*0.0025*	*0.0888**	*-0.0485**	*-0.0558**	*0.8573**	*1.0000*
	Env_ine	*MVA*	*GDP/Hbt*	*Dom_inv*	*FDI*	*Unemploym*	*Gover*	*Democ*
Environmental_ine	*1.0000*							
MVA	*0.0062*	*1.0000*						
GDP/Hbt	*-0.0276*	*0.1980**	*1.0000*					
Dom_inv	*0.1064**	*0.0491**	*0.0845**	*1.0000*				
FDI	*0.0457*	*-0.0042*	*0.0882**	*0.2117**	*1.0000*			

Unemployement	*-0.0490**	*0.0430*	*0.2615**	*0.1669**	*0.2186**	*1.0000*		
Nor_gov_index	*0.0260*	*0.0178*	*-0.0104*	*0.0537**	*-0.0466**	*-0.0696**	*1.0000*	
Nor_democ_index	*0.0248*	*0.0347*	*0.0025*	*0.0888**	*-0.0485**	*-0.0558**	*0.8573**	*1.0000*
	Hous_ine	*MVA*	*GDP/Hbt*	*Dom_inv*	*FDI*	*Unemploym*	*Gover*	*Democ*
Housing_ine	*1.0000*							
MVA	*0.0327*	*1.0000*						
GDP/Hbt	*0.0234*	*0.1980**	*1.0000*					
Dom_inv	*-0.0218*	*0.0491**	*0.0845**	*1.0000*				
FDI	*-0.0477**	*-0.0042*	*0.0882**	*0.2117**	*1.0000*			
Unemployement	*-0.0401*	*0.0430*	*0.2615**	*0.1669**	*0.2186**	*1.0000*		
Nor_gov_index	*0.0744**	*0.0178*	*-0.0104*	*0.0537**	*-0.0466**	*-0.0696**	*1.0000*	
Nor_democ_index	*0.0460*	*0.0347*	*0.0025*	*0.0888**	*-0.0485**	*-0.0558**	*0.8573**	*1.0000*

Appendixe 3. PTR Results

Transition variable: Industrialization								
Income inequalities			***Environmental inequalities***			***Housing inequalities***		
Variables	*Coef.*	*P>|t|*	***Variables***	*Coef.*	*P>|t|*	***Variables***	*Coef.*	*P>|t|*
0	-0.006*	*0.088*	*0*	-0.1008***	0.003	*0*	-0.0188*	0.063
1	0.1034**	*0.028*	*1*	0.0178	0.382	*1*	0.0182**	0.022
Constante	-1.485	*0.565*	*Constante*	3.344	2.52	*Constante*	*-3.407****	*0.000*
GDP/hbt	-0.044**	0.037	*GDP/hbt*	-0.0011	0.962	*GDP/hbt*	-0.017**	0.025
Dom_inv	0.024**	0.010	*Dom_inv*	0.044***	0.000	*Dom_inv*	0.0043	0.215
FDI	0.239***	0.000	*FDI*	0.0245	0.347	*FDI*	0.0329***	0.001
Unemployment	0.0113434	0.271	*Unemployment*	-0.0054	0.300	*Unemployment*	-0.0049**	0.016
Governance	0.8326479	0.462	*Governance*	0.005*	0.092	*Governance*	0.703***	0.002
Democracy	-0.093873	0.932	*Democracy*	-0.632**	0.026	*Democracy*	-0.1809	0.412
Threshold	24.5583		*Threshold*	21.60		*Seuil*	32.75	
F(8,1684)	*4.60*		F(8,1684)	5.85		F(8,1684)	5.29	
Prob > F	*0.0000*		*Prob > F*	*0.0000*		*Prob > F*	*0.0000*	
Countries	*48*		*Countries*	*48*		*Pays*	*48*	
Observations	*1739*		*Observations*	*1739*		*Observations*	*1739*	

Source: Auteurs.