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Dynamics of population, urban agglomeration, and economic growths in Sub-Saharan Africa: Evidence from panel data

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This study analyses population, urban agglomeration (UAG), and economic growths dynamics in Sub-Saharan Africa (SSA) using the World Bank panel data ranging from 1970 to 2019. The study utilized a panel fixed effect (FE) model after verifying the suitability of the model using a Hausman test. The estimation result from the panel FE model reveals remarkable findings which conform to some extent, the theoretical a priori expectations. The result shows that growth in rural as well as urban population growth and total trade (TRD) have negative relationships with UAG. On the other hand, gross domestic product (GDP, a better proxy for income) and foreign direct investment (FDI) have a positive association with UAG in the economies of SSA thereby validating the existence of the Williamson–Kuznets hypothesis. Based on the findings, it is advised amongst other policy recommendations that the governments of the Sub-Saharan African countries should pursue inward-looking policies targeted toward encouraging the local processing of agricultural raw materials—possibly to finished products to boost foreign exchange earnings through trade in other to engender sustainability in both the economic growth and UAG in the region.

1 | INTRODUCTION

Urban areas or cities are the major positive and prospective force in mirroring the level of development, prosperity, and sustainable growth as they drive investment, innovation, and consumption in both developing and developed economies (Moreno, 2017). Generally, the relationships among population dynamics especially from the angle of growths in rural and urban population, agglomeration of the urban area and economic growth have not been properly established in the literature. There have been ongoing debates in the literature on the links among rural–urban drift, economic growth as well as urban agglomeration (UAG).

While some notable studies like Ahrend, Lembcke, and Schumann (2017), Fang and Yu (2017), and Wei, Taubenböck, and Blaschka (2017) believe that rural–urban drift causes a substantial growth in the general economy which leads to more opening of spatial areas in the cities (UAG); other studies such as Tripathi and Kaur (2017), Oded and Fan (2007), and Ferreira, Monge-Naranjo, and Pereira (2016a) argued that increased influx to the urban area from rural domains has negative consequences on economic growth which rather retards agglomeration of an urban area with high tendency of driving cities to slums (Li, Chiu, & Lin, 2019).

An UAG is seen as spatial population within the delineations of adjoining territory occupied at the levels of urban density irrespective or regardless of definite administrative boundaries (Moreno, 2017). It is the integration of suburban areas and "city proper" within the contours of administrative or city boundaries (UNICEF, 2012). Though UAG can be sometimes controversial in its definitions and delineations in terms of geographical space as it can also be linked with urbanization; and can equally be seen as integrated cities that are vastly and spatially developed (Fang & Yu, 2017).

UAG can be promoted by three distinct forms of economic concentration and relatively heightened by "industrial clusters"

(Malmberg & Maskell, 2002). These distinctive forms of agglomeration are found within the stable trading activities among firms, "localized network" which leads to exchange of ideas or technological know-how to foster structural and economic transformation; and external economies of scale within the urban area of the city (Malmberg & Maskell, 2002). In Sub-Saharan Africa (SSA), UAG has been on the rise over the past decades as shown below.

In Figure 1, the UAG has risen from about 7.72 million population in 1970 to 9.69 million population in 1980. In 1990 and 2000, UAG has increased from 11.66 and 13.09 million population, respectively. This rising trends in UAG have continued uninterrupted as it further increases from approximately 14.35 million population in 2010 to over 15.37 in 2017 with a higher propensity on continues increase (World Bank, 2019).

However, a significant rise in the total population has been recorded in the economies of SSA with substantial growth in urban population doubling against the rural population as the rural dwellers tend to migrate to the nearest urban areas in search of quality infrastructural development, employment, healthcare and general wellbeing (Bloch, Fox, Monroy, & Ojo, 2015). In SSA, there have been upsurge drifts from the rural areas to urban areas which tend double the total population of the urban population against the rural population. The following figure presents the rural–urban dichotomy in SSA.

Figure 2 shows that the population of the urban area (UPOP) is greater than that of the rural population (RPOP) given that urban population growth shares a larger proportion from the total population growth when compared with the rural population growth in SSA. Though the Figure 2 equally indicates that urban population tends to grow higher with relative variability than that of the rural population. For instance, urban population has increased steadily from approximately 4.77million population in 1970 to about 5.05million population in 1978 before declining to just about 4.74 million population in 1979. However, urban population growth has maintained the minimum value of about 3.85 million population and the maximum number of approximately 5.01 million population between 1980 and 2017. On the other hand, the rural population has fluctuated between 2.11 million population on approximate and almost 2.37 million population between 1970 and 2007 before declining further in more recent years. Additionally, the rural population has continued to fall slowly from about 1.97 million population in 2008 to approximately 1.83 million population (World Bank, 2019).

In what seems not to be clear in the literature is the arguments on the factors that can positively influence UAG. While Mahamud, Samat, and Noor (2016) attribute that the factors that affect urbanization equally influence UAG which includes but not limited to employment opportunities, social factors, increase in income in urban centres, industrialization, education spread, modernization, and infrastructural developments. These factors can equally be companied with other negative factors such as an increase in crimes, growing of slums as well as frustration among the rural–urban migrants and economically displaced individual within the urban areas (Mahamud et al., 2016). In SSA, an increase in the gross domestic product (GDP), total trade (TRD), and foreign direct investment (FDI) have contributed in different ways to economic growth and development.

Despite the recorded growth in the GDP, TRD, and FDI in SSA; UAG seems not growing in the same proportion. Correspondingly, the value of the GDP in SSA has been growing from approximately \$64.57 billion in 1970; \$272.12 billion in 1980, \$336.95 billion in 1990, \$396.81 billion in 2000, \$1.37 trillion in 2010 up to \$1.68 trillion in 2017. Even though the hypothesis that relates to economic growth and UAG is termed the Williamson–Kuznets curve/hypothesis. The hypothesis is an inverted U-shaped curve which posits that the urban areas experience agglomeration (widening or growth of urban areas) at the early phase of economic growth, reaches its peak and assumed a declining rate in agglomeration at the later stage or phase of economic growth (Galor & Tsiddon, 1996).

Consequently, this study is motivated by the incommensurable low levels of UAG despite the increasing rate of urban to rural drifts and population growth as well as TRD volumes, FDI and growth in GDP in SSA region when compared with other regions over the years. However, the study is based on the forty-eight (48) economies that made up of SSA (*see the list of countries in Appendix Table A1*).

Against this background, this study tends to contribute to the ongoing debates by answering the following research questions: (1) to what extent do growth in population from rural–urban drift and economic growth influence UAG in SSA? (2) What are the effects and to what extent have TRD and FDI impact on UAG in SSA within the scope of the study? (3) Does the Williamson–Kuznets hypothesis hold for Sub-Saharan African countries? However, these study objectives can be estimated using the panel fixed effect (FE) (or random effect [RE]) model after conducting a Hausman test to ascertain the preferred model.

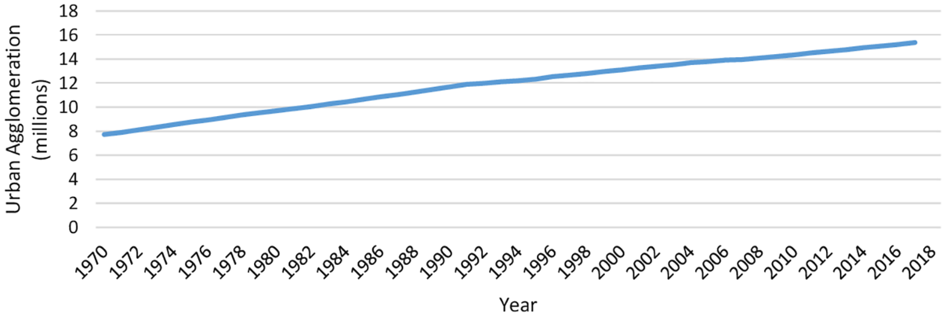

FIGURE 1 Trends in urban agglomeration in SSA (1970–2017)

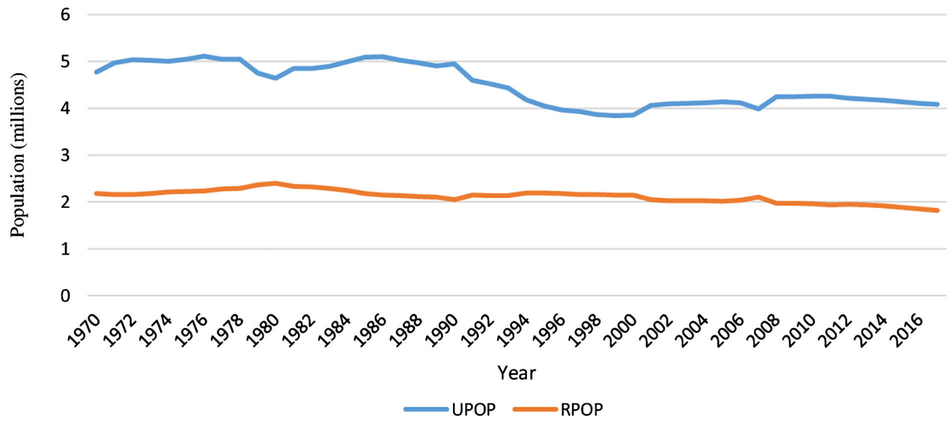

FIGURE 2 Trends in urban and rural population in SSA (1970–2017)

2 | REVIEW OF RELATED LITERATURE

The theories of urbanization and UAG are not prevalent in the literature as they are likened to multidimensional concepts. Under the UAG, more notable conjecture, or hypothesis in explaining the dynamic nexus between income and UAG is the "Williamson–Kuznets hypothesis." First presented in 1955 was a Kuznets hypothesis or curve which attributed income and development as having an inverted U-shaped curve which demonstrates that inequality and personal income tend to be on the rising side at the early stage of development, become at a maximum at the peak of the development stage, and thus decline at the later stage of development.

Eventually, Kuznets (1955) substantial breakthrough in drawing a relationship between income and development through personal income and inequality motivated Williamson (1965) to further enquire into the Kuznets findings. Williamson (1965) adopted the findings of Kuznets (1955) in examining the spatial nature of inequality and economic development in both developing and developed countries. However, the findings of Williamson (1965) showed that indeed, inequality tends to grow in size at the initial developing stage of every economy, reaches its peak at turning-point before declining at the later stage of the economic development. Therefore, corroboration of Kuznets (1955) theoretical framework by Williamson (1965) resulted in the popular theory or hypothesis in the area of Urban Economics and UAG known as the "Williamson–Kuznets hypothesis."

Under the empirical front, many studied have been carried out in more recent years on the relationship amongst UAG, urban and rural population growth, urbanization, economic growth, trade and FDI. In Chelyabinsk megacity of West-Central Russia, Shmidt, Antonyuk, and Francini (2018) conducted an empirical investigation to determine the dynamics of socio-economic development, population growth and UAG using survey method. The study, on one hand, concluded that population growth in the cities and municipal areas in Chelyabinsk district of Russia stimulate development of suburban areas, increases transportation and society network thereby leading to UAG. On the other hand, it was revealed that UAG leads to opening up of connecting suburban areas to ensure effective use land in enhancing efficiency in the transportation system, municipal and housing infrastructure as well as control for production diversification issues in urban areas.

Also, Jayasooriya (2018) analyzed the effect of UAG on economic growth in emerging economies while using 31 regions in China as case studies. The study employed time-series data sourced from Chinese Statistical Bureau between 2004 and 2015 and thus engaged the FE model with a generalized method of moments (GMM). However, the result showed that UAG and economic growth have positive nexus while urban population growth has a significant positive effect on economic growth in China. Also, the estimation of the FE model showed that Williamson hypothesis holds for the 31 regions in China.

Similarly, Cavalcanti, Mata, and Santos (2018) examined the effects of rural–urban migration, urban poverty and land use regulation on UAG and slums growth in Brazil using urbanization data ranging between 1980 and 2000. The study utilized the models of structural heterogeneous general equilibrium analysis and pooled ordinary least squares (OLS) in determining the real causes of growth in slums and UAG in the urban areas. The result showed that land use regulation, urban poverty, rural–urban migration, and income inequality have significant effects on UAG and growth of slums especially in Sao Paulo, Brazil.

Still, in China, Wei et al. (2017) carried out an empirical analysis with a view of quantifying the dynamics of UAG in 28 cities of southern Chinese Pearl River Delta while utilizing population map of city-scale dasymetric methodological approach. The central objective of the study was targeted toward examining the relationship between population spreading or growth and UAG in the 28 cities of southern Pearl River Delta in China. The study made a remarkable achievement in providing a more practical approach in delineating UAG or city sprawl with the help of high-resolution remote sensing data against the former medium resolution as well as quantifying and measuring UAG. The result from the city-scale dasymetric modelling showed that UAG and population growth have a positive relationship and this is imperative in planning urban areas and cities toward achieving sustainable development agenda.

In Nigeria, Akinbode, Okeowo, and Azeez (2017) estimated the causal relationship between population dynamics from the angle of growth in population and economic growth using time series data sourced from the Central Bank of Nigeria (CBN) spanning from 1970 to 2014. The study utilized the Johanson Cointegration test to ascertain the long-run relationship after conducting the unit root (stationarity) test aimed to determine the stability of the data for regression analysis. Also, vector error correction model (VECM) was employed to examine the speed at which economic growth adjusts to the long-run equilibrium by 6% per annum. However, the result from the VECM model and Granger-causality test showed a unidirectional causality running from growth in population to economic growth without feedback.

Using about 51 M cities In India, Tripathi and Kaur (2017) analyzed the relationship between rural to urban migration and UAG using OLS with census data obtained from the national sample survey (NSS) unit of India. The estimation results showed that level of employment and unemployment state of affairs as characterized in cities, poverty levels as well as inequality influence rural–urban migration. The study also noted that the level of employment opportunities in the cities drive up rural to urban migration and thus lead to a positive but insignificant increase in economic growth.

In France, Cottineau, Finance, Hatna, Arcaute, and Batty (2016) regressed population growth, economic growth, urban population density, and households wages and income effects on the cities agglomeration using a panel data model. The panel estimation result showed that economic growth contributes significantly to agglomeration in cities of France with internal economies in terms of wages amongst urban dwellers. In Brazil, Ferreira et al. (2016) found that migration from the agricultural sector (rural areas) to non-agricultural sector (urban areas) contributes significantly to economic growth and insignificantly to UAG. However, findings from the model of structural transformation showed that agglomeration does occur in the cities due to economic and population growth but the emergence of slums in the cities is also another side of the agglomeration resulted from new unskilled entrants into the cities from the agricultural sector in the Brazilian economy.

In Colombia, Posada and García (2015) used a cross-sectional dataset from the Colombian Great Integrated Household Survey (GIHS) from 2001 to 2014 to study the impact of UAG on economic development in the area while adopting the fixed-effect model. The study found a positive correlation between agglomeration and economic growth as well as other variables in the FE model such as inequality, crime, employment and education. In the United States of America (USA), Jedwab, Christiaensen, and Gindelsky (2014) examined the links between rural–urban migration and UAG about the differences in wages in rural and urban areas using panel data from 33 developing economies in Africa and Asia between 1960 and 2010. The study showed that urban population growth as a result rural–urban migration has accelerated urbanization, UAG and economic growth in the urban areas of the developing economies under review. The study equally highlighted that over congestion in the urban areas without consequential growth will mitigate the internal economies of scale from agglomeration and thus triggers phenomenon associated with urbanization.

In India, Tripathi (2014) tried to establish connections amongst the growing number of slums, income per capita, and UAG using microeconomic approach while incorporating other macroeconomic indicators such as employment and unemployment statistics. The data sourced from the Indian unit of NSS were estimated using OLS and the result showed that the growth in per capita income is positively linked with UAG, increase in consumption expenditure per capita and poverty alleviation but negatively affecting slums in the cities of India. Though the study utilized mainly microeconomic indicators in its analysis, it advocated for the adoption of the macroeconomic approach in studies pertaining UAG, rural–urban migration, economic growth and slums in the cities to achieve a far-reaching result.

In Barcelona, Spain; Castells-Quintana and Royuela (2013) studied the relationships amongst growth in urban concentration, agglomeration and economic growth using African and Asian countries, and Latin American cross-country data sourced from World Development Report (2011) for the dynamic panel regression analysis. The panel estimation result from dynamic models revealed a positive nexus between UAG and economic growth with reverse causality across the countries under review. Also, the result showed that UAG fosters economic growth across the economies. The study by Quigley (2009) equally corroborated these findings of Castells-Quintana and Royuela (2013) by revealing that UAG and economic growth have a strong relationship between developing and developed countries around the world.

Therefore, given the myriad of studies in this area and following an extensive survey of the related studies, it is pertinent to reiterate that this study is poised to answer the following questions: (1) To what extent do growth in population from rural–urban drift and economic growth influence UAG in SSA? (2) What are the effects and to what extent have TRD and FDI impact on UAG in Sub-Saharan Africa within the scope of the study? (3) Does the Williamson–Kuznets hypothesis hold for Sub-Saharan African countries? However, these study objectives can be estimated using the panel FE or RE model after conducting a Hausman test to confirm the suitability of the model.

3 | MODEL SPECIFICATION AND ESTIMATION TECHNIQUE

This is a panel data study of about forty-eight (48) countries in SSA over the period 1970–2017 with accurate panel data generated from World Bank (that is: world development indicators). One of the major justifications for FE model is that it accommodates the heterogeneous characteristics or variability associated with individuals, countries, organizations, firms, and so on (Greene, 2012). Given the heterogeneous nature of the economies in the Sub-Saharan African region, a large number of periods (T) and several countries (N) under review, this study considers adopting a panel data analysis with the FE model. Though another justification for adopting a FE model is given that it eliminates omitted variable bias which could emanate from unobservable heterogeneity and thus controls for all individual time-invariant characteristics across countries (Edeme & Nkalu, 2019; Torres-Reyna, 2007).

The rationale for conducting a Hausman test is to verify if the error terms associated with an individual entity is correlated to other entities. Consequently, the Hausman test follows a null hypothesis (H_0): RE model is preferable against the alternative hypothesis (H_1): RE model is not preferable or FE model is preferable (see Greene, 2012). Therefore, the panel FE model follows a theoretical econometric equation as thus:

$$Y_{it} = \alpha_{it} + \beta_1 X_{it} + \mu_{it}, \tag{1}$$

where Y_{it} is the dependent variable, i = entity, while t = time. α_i is the intercept for each unknown entity (i = 1, 2, …, N). β_1 is the independent variable's coefficient, X_{it} is the independent variable (t = 1, 2, …, T), and μ_{it} is the stochastic error term. Thus, in line with the objectives of the study, the Equation (1) can be expanded to incorporate the empirical path of the variables of interest into a mathematical functional relationship:

$$\text{UAG} = f(\text{UPOP}, \text{RPOP}, \text{GDP}, \text{FDI}, \text{TRD}), \quad (2)$$

where UAG is the urban agglomeration, UPOP is the urban population growth, RPOP is the rural population growth, GDP is the gross domestic product (proxy for economic growth), FDI is the foreign direct investment, and TRD is the total trade. The functional relationship as expressed in Equation (2) is transformed into an econometric equation as follows with the UAG and GDP variables expressed in natural logarithm form to control for the exponential values.

$$\text{InUAG}_{it} = \beta_0 + \beta_1 \text{UPOP}_{it} + \beta_2 \text{RPOP}_{it} + \beta_3 \text{InGDP}_{it} + \beta 4 \text{FDI}_{it} + \beta_5 \text{TRD}_{it} + \mu_{it}, \quad (3)$$

where i represents the number of countries in SSA (that is, i = 1, 2, …, N), while t denotes the periods covered by the study (1970–2017), that is, t = 1, 2, …, T. Where all other variables have been explained earlier (see Equations (1) and (2)). In sum, the fixed-effect model specification for this empirical study (Equation (3)) will invariably or ordinarily account for the issues relating to autocorrelation, multicollinearity and heteroscedasticity in the panel estimation.

4 | THE ESTIMATION RESULTS AND DISCUSSIONS

4.1 | Descriptive statistics

In dealing with time-series data, it is important and conventional to present the descriptive statistics to ascertain the behavioural pattern of variables to be estimated. These descriptive statistics give insight on certain characteristics of the data or variable to avert any structural defect in the regression output. These statistics include but not limited to the mean value, median, maximum, standard deviation, skewness, kurtosis, Jarque-Bera (JB), probability, summation, the sum of standard deviation down to the number of observations.

Table 1 presents a summary of the descriptive information or statistics as characterized by the individual variables. For instance, the mean value of FDI to SSA over the years (1970–2017) is about $1.59 billion; $4.56 billion for the maximum value with the total value (summation) of approximately $76.43 billion. In the descriptive statistics table, maintained a constant figure of 48 observations which reveal the number of years covered by the study (between 1970 and 2017). In general, all the variables—FDI, GDP, rural population (RPOP), TRD, UAG and urban population are distinctively and uniquely normalized in the descriptive statistics table and all devoid of any structural or technical defect. It is pertinent to note that skewness and kurtosis are measures of normality, and the information from the descriptive statistics table shows that data are normally distributed. Haven presented the descriptive statistics of all the variables to be regressed, it is pertinent to further pre-test, screen or validates the variables by conducting correlation and panel unit roots (stationarity) tests to ensure a quality estimation output, analysis and policy recommendations.

4.2 | Panel stationarity/unit roots test

There is two broad categories of panel unit root process—common or homogenous unit root process; and individual or heterogeneous unit root process (Baltagi, 2008). Both the panel unit root processes are channelled toward determining the robustness of the stationarity of panel data before proper estimation of the regression model. However, the study utilized the Levin–Lin–Chu (LLC) of common or homogenous unit root process and the Im–Pesaran–Shin (IPS) of the individual or heterogeneous unit root process to ascertain the unit-roots. The following table presents the outputs of the stationarity tests with their relevant and corresponding statistics.

Table 2 presents the stationarity test results in both Levin, Lin, and Chu (2002) *(otherwise referred to LLC)*; and Im, Pesaran, and Shin (2003) *(otherwise referred to IPS)*. The LLC follows a homogenous (common) panel unit root process in determining the stationarity of variables in econometrics empirical models, while the IPS follows the heterogeneous (individual) panel unit root process (Greene, 2008). The justification for adopting both the LLC and IPS is to ensure robustness in the panel unit root test result.

Under the LLC panel unit root test result, UPOP variable is not stationary in level form but stationary in first difference I (1) (in absolute term); while other variables such as RPOP, GDP, FDI, and TRD are all stationary in level I(0). In summary, all the variables under the LLC test result are stationary in level form except UPOP variable that is stationary in first difference.

Again, under the IPS test result, UPOP, FDI, and TRD are stationary in first difference I(1), while the RPOP and GDP variables are both stationary in the level form I(0). However, these divergent results formed the basis for rejecting the null hypothesis of no unit-roots for all panel time series in the model since the panel unit root tests' statistic values are greater than the probability values at different percentage levels (1%, 5%, and 10%) of significances. Therefore, given that the variables are all stationary and integrated at different orders (in level forms I(0) and in first difference I(1)), it is not necessary to conduct cointegration test, rather, a Hausman test is very pertinent here to determine whether panel FE or panel RE is the most suitable model for the panel estimation. Therefore, the different orders (in level forms I(0) and in first difference I(1)) could inadvertently stand as a strong justification for adopting panel FE model for the estimation with the support of the Hausman test result.

4.3 | Results presentation, discussions, and evaluation of hypotheses

The following table presents the concise result generated from the estimation result.

TABLE 1 Descriptive information/statistics

	FDI	GDP	RPOP	TRD	UAG	UPOP
Mean value	1.592	5.881	2.118	51.54	11.89	4.497
Median value	1.263	3.541	2.143	51.44	12.16	4.346
Maximum value	4.560	1.832	2.400	68.61	15.37	5.108
Minimum value	0.098	6.410	1.817	39.74	7.719	3.846
Standard deviation	1.094	5.351	0.136	8.122	2.254	0.438
Skewness	0.646	1.192	−0.169	0.241	−0.247	0.091
Kurtosis	2.493	2.924	2.541	1.862	1.858	1.374
Jarque-Bera	3.852	11.37	0.649	3.055	3.097	5.353
Probability	0.146	0.003	0.723	0.217	0.212	0.068
Summation	76.43	2.823	101.67	2,474.1	570.6	215.8
Sum Sq. Dev.	56.31	1.345	0.871	3,101.06	238.9	9.028
Observations	48	48	48	48	48	48

Abbreviations: FDI, foreign direct investment; GDP, gross domestic product; RPOP, rural population; TRD, total trade; UAG, urban agglomeration; UPOP, population of the urban area.
Source: Computed and compiled by the authors from the EViews 9.

TABLE 2 Panel stationarity (unit root) tests results

	Levin–Lin–Chu (LLC)			Im–Pesaran–Shin (IPS)		
Variables	In level	First difference	Status	At level	First difference	Status
Urban population (UPOP)	−3.587	6.350**	I(1)	−2.018	−3.147***	I(1)
Rural population (RPOP)	−4.837**	−22.52***	I(0)	−3.257***	−4.829***	I(0)
Gross domestic product (GDP)	−12.36***	−28.29***	I(0)	−4.038***	−4.951***	I(0)
Foreign direct investment (FDI)	11.63**	−7.085***	I(0)	3.221	−4.002***	I(1)
Total trade (TRD)	−7.178***	−18.32***	I(0)	−2.434	−4.329***	I(1)

Note: ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.
Source: Computed by the authors using World Bank data of various years.

Table 3 presents the estimation output from the panel fixed-effect model and the Hausman test result.

4.3.1 | Hausman test result/analysis

This test result is at the lower part of the Table 3 and the main idea behind conducting a Hausman test is to draw a comparison between the suitability of two models (Baltagi, 2008). The Hausman test result depicts that the chi-square probability value (0.0000) is not statistically significant at 0.05 (that is, less than 0.05) level. This leads to rejection of the null hypothesis (H_0) that RE model is not preferable and thus accepting the alternative hypothesis (H_1) that the FE is a preferable and consistent model. Consequently, given that the FE model is properly validated and formally adopted for the estimation of this empirical study, the following section presents the outcome of the FE estimation.

4.3.2 | The panel fixed-effect result discussions and hypotheses evaluation

The dependent variable is the UAG and the independent variables include the UPOP, RPOP, GDP, FDI, and TRD. The coefficients of the independent or predictor variables (UPOP, RPOP, GDP, FDI, and TRD) from the FE estimation output measure or indicate how much the dependent or outcome variable (UAG) changes when the independent variables change individually by one unit. From the above table, 48 observations stand for the number of countries in the Sub-Saharan African region. The values of *R*-Squared (R^2) and adjusted *R*-Squared (R^2) are relatively high and tend to 1 unit, however, these denote goodness-of-fit of the regression line.

The UPOP, a key measure of growth in urban population area for this study, indicates a negative association with the UAG in SSA. The result indicates that a 1% point increase in urban population decreases UAG by approximately 17.2% holding other factors constant. This result shows that increase in urban population, contrary to the a priori expectation, has a negative and statistically significant effect on UAG in SSA as shown by the values of coefficient and t-statistic (that is, about −6.60). This result suggests that, even though it is expected that increase in urban population ordinarily should drive UAG, the reverse is the case in SSA due to some unaccounted factors and low levels of development rate amongst the countries in SSA. The evidence has shown from the above result that growth in population in an urban area in SSA exerts a negative influence on UAG due to perceived insignificant contributions of the urban populace to positive growth in the spatial opening of urban areas in the region. This result

TABLE 3 Panel fixed effect (FE) result outcome/dependent variable: urban agglomeration (UAG)

Variable	Coefficient	Standard error	*t*-Statistic	Probability
Constant (C)	−0.137733	0.572494	−0.240584	0.8110
Urban population (UPOP)	−0.172046	0.026040	−6.606889	0.0000
Rural population (RPOP)	−0.170978	0.091007	−1.678740	0.0472
Log (GDP)	0.145363	0.014463	10.05062	0.0000
Foreign direct investment (FDI)	0.003845	0.013804	0.278564	0.7819
Total trade (TRD)	−0.003082	0.001467	−2.100118	0.0418
Observations = 48. R^2 = 0.96, Adjusted R^2 = 0.95, F-Statistic = 169.9				
Hausman test result				
Test summary	Chi-square statistic	Chi-square *d.f.*	Chi-square probability	
Cross-section random	72.450	6	0.0000	

Source: Authors' computation using EViews 9 econometrics software.

addressed one of the research questions (see part of question 1) earlier raised in the last paragraph of the introduction section.

Again, the RPOP as seen as another key variable in the above estimation result has a negative relationship or association with UAG in SSA. The result shows that a 1% unit increase in the rural population would reduce UAG by 17% on the average, holding every other variable constant. As expected, growth in urban population has little or nothing to contribute to the growth of UAG expect if the spillover effect can spray across urban areas due to rural–urban migration. In the result, rural population growth has a negative but statistically insignificant effect on UAG in SSA judging by the size of the *t*-statistic (−1.67). This is true since the greater percentage of the rural population in Sub-Saharan African countries is made up of younger and ageing population, while the greater proportion of the active population tends to migrate to the nearby urban areas in search for more meaningful livelihood and gainful employment opportunities. Also, this result addressed one of the research questions (see part of question 1) earlier raised in the last paragraph of the introduction section.

The GDP, a measure of income in the study has a positive relationship with the UAG in SSA. In line with the expectation, GDP exerts a positive and statistically significant effect on UAG in SSA. The result shows that a 1% point increase in GDP would lead to about 14.53% increase in the UAG in SSA, holding other factors fixed. This result implies that GDP has the highest contribution and it is the most significant contribution to the growth in the UAG in SSA. This result is unique and in support of the popular hypothesis in the urbanization and UAG known as the Williamson–Kuznets hypothesis. This hypothesis emphasizes that income and UAG share a strong positive relationship—as an increase in income causes an increase in UAG. Hence, this result validates the existence of the Williamson-Kuznets hypothesis in SSA judging by the significant and positive relationship that exists between the two variables. These findings are in line with the studies by Ahrend et al. (2017), Tumbe (2016), Tripathi (2014), and Greenstone, Moretti, and Hornbeck (2007) that equally validated the theory. Thus, these findings answered one of the research questions (see part of question 3) earlier raised in the last paragraph of the introduction section.

Furthermore, FDI inflow to SSA has a positive relationship with UAG. As shown in the result, a 1% point increase in FDI leads to about a 3% increase in the UAG in SSA. As expected, the FDI inflow to the region, even though statistically insignificant, is contributing to the development of urban areas via agglomeration given its ties with growth in GDP. The result simply implies that increase in FDI inflow to the Sub-Saharan African region has a positive effect on UAG in the region with the statistically insignificant result as evidenced by the value of the *t*-statistic (≈0.279). This result also addressed one of the research questions (see part of question 2) earlier raised in the last paragraph of the introduction section. Put succinctly, the quantum of FDI from the developed world to the SSA region exerts a positive influence in spatially developing the urban areas in SSA in terms of agglomeration as shown by the values of the coefficient, *t*-statistics, and standard error.

Also, the volume of the TRD in SSA has a negative association with UAG in the region. Judging from the result, a 1% point increase in TRD leads to approximately 3% decrease in the UAG in the Sub-Saharan African region holding every other variable constant. Given the result, the effect of TRD on UAG through negative, but statistically significant as shown by the values of the t-Statistics and the standard error. The implication of the negative influence of TRD on the growth of UAG in SSA could be given by the greater proportion of agricultural raw materials and semi-finished products dominating of export markets within the region of SSA. This result equally answered part of the earlier research question (also see part of question 2) in the last paragraph of the introduction section.

4.3.3 | Diagnostic tests results

In sum, other post-estimation tests have been carried out to check for the presence of autocorrelation, multicollinearity, heterogeneity, and endogeneity issues. The results of these post-estimation diagnostics especially the endogeneity problem have been checked and satisfied good enough from any econometric issues. Also, the presence of serial correlation was not identified from the Breusch–Pagan LM test of cross-section dependence test result.

5 | CONCLUSION AND POLICY RECOMMENDATIONS

This empirical study tackled the growing questions in the area of population–economic growth dynamics, rural–urban migration, and UAG in the literature especially in the developing region like SSA. The total number of forty-eight (48) economies in SSA were covered with panel dataset sourced from the World Bank database (that is, the World Development Indicators, 2019) spanning from 1970 to 2017. The study checked for the stationarity of the panel data using both common (homogenous) and individual (heterogeneous) unit root process where all the panel data. Given the heterogeneous characteristics of the economies in the SSA, a panel FE model was adopted (against the random fixed model) after determining the suitability of the model using a Hausman test. The regression result highlighted that urban and rural population growth, as well as TRD, have negative effects on UAG in SSA, growth in GDP and FDI exert a positive influence on UAG thereby validating the existence of the Williamson–Hypothesis in SSA. Based on the estimated result and the empirical findings, the following policy recommendations are needed to addressing the current lacuna in both the literature and in the SSA region:

The governments of the Sub-Saharan African countries should pursue inward-looking policies targeted toward encouraging the local processing of agricultural raw materials—possibly to finished products to boost foreign exchange earnings through trade in other to engender sustainability in both the economic growth and UAG in the region. Also, policies geared toward encouraging infant and local manufacturing industries should be pursued vigorously to encourage local production to boost both internal consumption and exports through trade in other to stimulate more growth in economic growth (GDP) and UAG in the region.

Again, effective management and utilization of the FDI inflow the economies of SSA region should be taken into consideration to control for leakages, financial misappropriation, and diversion that are common in economies of SSA. In both rural and urban areas, the governments of the economies in SSA should pursue optimal welfare packages for both the rural and urban inhabitants and dwellers to control for unwarranted economically induced rural–urban migration thereby contributing meaningfully to UAG in the region. Finally, the governments in the economies of SSA should as a matter of importance, incorporate skill acquisition program in their basic education to equip both rural and urban population with the necessary tools to drive local manufacturing and meaningful contributions to total production, economic growth and UAG.

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APPENDIX

See Table A1.

TABLE A1 Countries in Sub Saharan African region

S/N	Country
1.	Angola
2.	Benin
3.	Botswana
4.	Burkina Faso
5.	Burundi
6.	Cabo Verde
7.	Cameroon
8.	The central African Republic
9.	Chad
10.	Comoros
11.	Congo—Dem. Rep.
12.	Congo—Rep.
13.	Cote d'Ivoire
14.	Equatorial Guinea
15.	Eritrea
16.	Eswatini
17.	Ethiopia
18.	Gabon
19.	The Gambia
20.	Ghana
21.	Guinea
22.	Guinea-Bissau
23.	Kenya
24.	Lesotho
25.	Liberia
26.	Madagascar
27.	Malawi
28.	Mali
29.	Mauritania
30.	Mauritius
31.	Mozambique
32.	Namibia
33.	Niger
34.	Nigeria
35.	Rwanda
36.	Sao Tome and Principe
37.	Senegal
38.	Seychelles
39.	Sierra Leone
40.	Somalia
41.	South Africa
42.	South Sudan
43.	Sudan
44.	Tanzania
45.	Togo
46.	Uganda
47.	Zambia
48.	Zimbabwe

Source: Compiled by the Authors from World Bank database.