A Comparative Assessment of the Urbanization – Fertility Nexus in Most Urbanized Countries of Sub-Saharan Africa

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Abstract: *There is a near-consensus in the literature that urbanization is incompatible with large family size owing to factors such as high cost of urban living, opportunity cost of having children in urban centers and increasing awareness of benefits of small family size. However, a cursory glance at the data on sub-Saharan Africa cast doubt on the incompatibility of urbanization with high fertility rate. Hence, this paper investigates the urbanization-fertility nexus in the two most urbanized countries of SSA – Nigeria and South Africa. Exploiting time series data for both countries within a Fully Modified Ordinary Least Square (FMOLS) framework, the incompatibility hypothesis is refuted in both countries. Specifically, the analysis suggests that in Nigeria and South Africa, increasing degree of urbanization is positively related with fertility rate with the magnitude of the relationship being higher in Nigeria than South Africa. These findings imply that policies aimed at improving urbanization process and reducing fertility rates are crucial in both countries.*

Keywords: Urbanization; Fertility rate; Nigeria; South Africa; Sub-Saharan Africa

JEL Classifications: I15, J11, J13, O18, P25

Introduction

Evidences have shown that unabated growth in population through high fertility rate constitutes a significant contributing factor to socioeconomic challenges of extreme poverty, unemployment, environmental damages, poor health, food insecurity and depletion of natural resources (Tamirat et al., 2021; Kousar et al., 2021; Behrman & Gonalons-Pons, 2020). These consequences are in particular enormous in developing

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economies with weak economic structures. With its multifaceted links to the broad goals and the specific targets of the sustainable development goals (SDGs), fertility has in fact been documented a significant threat to the achievement of the 2030 sustainable development plan (Jatana & Currie, 2020; United Nations, 2020). Thus, owing to its diverse implications for inclusive growth and sustainable development (Cabeza-Garcia et al., 2018; Ashraf et al., 2013)., the issue of fertility has been focal in global development plans and understanding the influencers of fertility is crucial for valid policymaking (Jatana & Currie, 2020; United Nations, 2020)

The unveiling of dominant role of urbanization in demographic transition including change in the pattern of mortality, fertility and population structure has brought to the fore the investigation of the linkages between urbanization and fertility. Following the experience of the western economies, an interconnections between urbanization and fertility was established with a near-consensus that increasing urbanization process is associated with declining fertility rate This is premised on the argument that urban living is not only connected to higher financial cost of childrearing but due to the available socioeconomic benefits associated with urban living, urbanization also raises the opportunity cost of having children (Notestein, 1953; Schultz, 1985; Galloway et al. 1998; Zhang, 2002; Kulu and Washbrok, 2014).. However, in recent time, conflicting arguments have emerged in the literature. An important one of such arguments is that the reducing effect of urbanization on fertility rate is only peculiar to the developed western economies. The validity of the negative urbanization-fertility nexus in the developing economy thus remains a hot debate (Lerch, 2018; Martine et al. 2013;). Due to factors such as unplanned nature of urbanization process, low literacy and poverty, studies have cast doubt on the validity of the inverse urbanization-fertility rate nexus in the developing economies.

This study therefore seeks to contribute to the ongoing investigation by reconsidering the relationship in the two most urbanized countries in sub-Saharan Africa (SSA) region – South Africa and Nigeria – using macro data. In line with the observed changes in global demographic trends, the shift towards smaller families has also witnessed some stalls in the subcontinent. In fact, demographic transition has not only been slower in SSA relative to other developing regions, the moderate decline in fertility has either stopped, leveled off or started to reverse in most SSA countries (Schoumaker, 2009, 2019; Shapiro and Hinde, 2017; Bongaarts, 2013; Bongaarts and Casterline, 2013; Machiyama, 2010). Evaluation of the correlation between urbanization and fertility is important for the SSA region given the sprawling nature of urbanization process and high level of fertility rate in the region. The rapid and uncontrolled process of urbanization and relatively higher fertility rate constitute disturbing menace in the sub-region and significant obstacles to achieving sustainable development (United Nations. 2019; World Bank, 2015). Based on United Nations' population projection, the world human population is expected to reach the milestone of 10 billion by the year 2055 and a huge proportion of the growth is expected

to happen in developing regions characterised by high fertility rate. The projection is particularly important for SSA in that the sub-region's 13% share of the global population is expected to rise to about 30% by year 2055. Faced with diverse socioeconomic challenges and limited economic resources, the projection is indeed unsustainable for the sub-region in terms of economic and natural resources as well as the environment. Thus, a study of the possible linkages between the two development threats is worth considering particularly in the two most urbanized countries which simultaneously double as the two largest economies in the sub-continent.

In both South Africa and Nigeria, urbanization process has taken a drastic turn, growing from 9 and 44.6% respectively in 1960 to 51.2% and 66.8% respectively in 2019. Although the proportion of the population living in urban centers is higher in South Africa than Nigeria, the growth rate is however higher in the latter (World Bank, World Development Indicators (WDI), 2020). Nigeria together with India and China are expected to account for 37 per cent of the projected 2.5 billion increase in global urban population between 2014 and 2050. In the same vein, the proportion of South Africa urban dwellers is projected to rise to 71 and 80% by 2030 and 2050 respectively (United Nations, 2019).

While there has been significant improvement to urban living in South Africa, the same cannot be said of Nigeria. In a bid to recover from the challenges of inequality legacies of the apartheid system which has contorted development trajectories in most South African urban cities and metropolis, policy programs such as the Cities Support Program (CSP) was formulated. Similarly, in order to mitigate the associated challenges of rapid urbanization particularly that of increasing demand on infrastructure, the World Bank -supported Integrated Urban Development Framework (IUDF) was developed. These policies are geared towards cities reform and improvement in urban living through the creation of inclusive, productive and sustainable environment (World Bank, 2018). In spite of the recorded successes of the programs evidenced in recovery from the ruins of apartheid and significant improvement to urban living, urbanization in South Africa has been linked to various socioeconomic challenges including unemployment, increased crime rate, housing dearth and environmental degradation (Smit et al., 2017; Rogerson et al., 2014).

In Nigeria on the other hand, urbanization process has left much to be desired. In particular, the urbanization-fertility relation remains a puzzle in Nigeria. Contrary to the popular opinion, the total fertility rate remains relatively high in Nigeria in spite of rapid urbanization process. Lack of adequate planning and control in Nigeria urbanization process pose a huge challenge to urban development in the country. The rural-urban drift is largely unabated with thousands of rural youngsters and adults consistently migrating to the urban cities and metropolis. The unchecked human migration to urban centers with limited socioeconomic opportunities has led to a rise in unemployment, crimes, pollution, overcrowding, and acute housing problem with attendant pressure on limited and collapsing infrastructure (Aliyu & Amadu, 2017; Momoh et al., 2018; Oyeleye, 2013).

In tandem with flawed urbanization process, the subject of high fertility in SSA is also a reckoned menace to sustainable development in the region. While progress has been made in global fertility reduction over the past decades, total fertility rate in SSA remains much higher than in any other part of the globe doubling the rates in most other regions of the world (World Bank, WDI, 2020). Although total fertility rate have fallen in both Nigeria and South Africa, much significant progress has been made in the latter relative to the former. The average fertility rate has markedly decline from a high of 6.04 per woman in 1960 to 2.4 in 2018 in South Africa, while the rate of progress has been much slower in Nigeria with a minimal decline from 6.3 to 5.4 over the same period (World Bank, WDI, 2020). Thus, this study seeks to determine if urbanization process has played any role in fertility differential between the two countries given the differences in urbanization process.

While we are not denying the existence of a sizeable documented investigations of the urbanization-fertility relation in SSA and country specific analyses on South Africa and Nigeria (Salahuddin et al., 2019; Cullis et al., 2019), a comparative assessment of how urbanization influences women's reproductive behavioiur is limited. Hence, this study adds to the ongoing discussion on the influence of urbanization on women decision to have children in SSA by considering the nexus for two of the most urbanized countries in the sub-region. A comparative analysis of such development issues will offer a more robust understanding on the subject matter.

Empirical Literature

Owing to the onset of the demographic transition in the Western countries, a substantial proportion of the extant studies has its focus in the high and upper- middle income countries of America and Europe. In recent time however, there has been significant diffusion of the literature with significant attention recorded in the developing and emerging countries. Although the demographic transition experience of the Western economies suggested that rural-urban drift has a reducing effect on women decision to give birth, contrary findings have also emerged in recent time thereby leading to divergent conclusions.

Accounting for rural-urban heterogeneity, Dimbuene and Agbada (n.d) investigated the relationship between urbanization and fertility decision in a pooled analysis involving 70 developing countries. Sourcing data from 175 Demography and Health Survey (DHS), the estimated regression showed that urban residency is associated with factors that cause delay in women decision to start family and hence reduce fertility rate.

Transcending beyond the rural-urban dichotomy, Kulu and Washbrok (2014) explored the fertility-urbanization relation in different parts of British urban centers based on population density and area size. The estimated results showed that reduced

fertility rate in Britain is indeed associated with increasing rate of urbanization with the reduction being higher in the central cities than the urban areas suburbs. The variation in fertility by spatial context was hinged on differences in economic and cultural factors. It was argued that fulfilling the prerequisite for starting family is costlier in central cities than in suburbs. The findings of Simon and Tanura (2009) likewise supported the incompatibility between urbanization and fertility rate in the US. The authors argued that high housing rent and other costs of urban living have posed great constraints on having more children in urban cities and towns. Focusing on selected Western and Southern European countries, Kurek and Lange (2012) findings also corroborated the inverse relationship between urbanization and fertility both at the national and provincial levels.

The review also revealed the diffusion of the searchlight of the literature to the emerging and developing economies of Asia. In a much recent comparative analysis of the relationship in the global South regions, Lerch (2019) argued that disparity in level and rate of urbanization has accounted for the fertility differential in the studied regions, hence the lower rate of fertility declines in SSA relative to Latin America, Middle East and North Africa. In an analysis of Chinese fertility rate at the national and provincial levels, Guo et al. (2012) found that although urbanization was not the sole predictor of decline in fertility decline in China during the study, it however contributed significantly to fertility decline alongside other factors such as the Chinese One Child birth control policy. Specifically, urbanization accounted for as much as 22% of fertility decline between 1982 and 2008 in China with the effect being stronger in the latter years. Still on the Chinese economy, a descriptive cross-sectional study by Wang et al. (2019) showed that urbanization plays a significant role in women decision not to have a second child in the Hunan province of China.

Furthermore, Islam (2017) similarly argued that difference in place of residence significantly explains the fertility differential between rural and urban women in Oman. In another contribution, Pourezza et al. (2019) meta-analyzed findings from past investigations in the Middle East and North Africa (MENA) region. The analysis identified among other factors that urbanization has played an influential role in attitudinal change in favour of small family size. Investigating socioeconomic determinants of fertility decision in Pacific Island countries recently, Lal et al. (2021) found that urbanization amongst other factors account for decline in fertility in the region.

Due to the trend of high fertility in Africa, the urbanization-fertility nexus has also been investigated in the continent and also the sub-continent of SSA in particular. Masanja (2014) examined how women of Mwanza region of Tanzania get modernized through migration to the cities and how the modernism translates to change in their reproductive behaviour. The study concluded that attitudinal changes of urban migrants represent an important factor of fertility decline in Tanzania. Investigating the nexus in Ghana, White et al. (2008) showed that place of residence plays a dominant role in family size decision of Ghanaian women. In particular, White and

his colleagues found that migration to Ghana urban center constitutes a significant explanation for observed decline in fertility rate in Ghana during the period of analysis. Fanaye and Headey (2010) found similar results for Ethiopia. Hollos and Larsen (1992) findings of the analysis of the nexus between urban life and demand for children within a cultural context in Nigeria affirmed that there exist urban constraints to large family size, hence migration of rural Ijaw women in Southern Nigeria to urban centers tend to lower their desire for many children relative to their counterparts in the rural areas.

In spite of the near-consensus on the negative urbanization-fertility rate relation, a turn in the direction of the relationship has also been documented in a quantum of studies. Ajus (2010) findings in a study on the influence of urbanization on demand for children in Transylvania region showed a reversal of sign in the direction of the relationship between the variables. Contrary to popular opinion, increased rate of urbanization is positively linked to overall fertility rate in the region.

Following a review of related research on the subject matter, we uncovered that although the urbanization – fertility nexus has been studied in the context of Africa and SSA economies, the empirical evidences are few. Moreover, to the best of our knowledge, recent evidences on SSA are scarce in the literature.

Methodology

Data and variables

To investigate the possible relationship between urbanization process and female decision to give birth in Nigeria and South Africa, we used annual data collected between 1981 and 2019. Following notable research which had investigated the macroeconomic determinants of fertility rates such as Amarante (2014), Khan and Tehseen (2017), Kashepoor (2018) and Lal et al. (2021, we proxy the dependent variable as total fertility rate (TFR) while we adopted urban population growth rate as a measure of degree of urbanization. In order to avoid estimation error that may arise from misspecification of regression model, empirical analyses of cause-effect relationship must control for the effect of other variables that may be correlated with the dependent variable. So, following studies such as Wang (2013), Gries & Grundman (2015), He (2018) and Grimm et al. (2022) we adopted as control variables; female school enrolment rate (SCHLF) as a measure of level of female education; GDP growth rate (GDPG) to proxy the level of economic development and infant mortality rate (INFMR) to account for children health status. In addition, inflation rate is added to account for change in price level in the economies (He, 2018; Dela Cruz et al., 2022). The intuition that inflation is correlated with fertility is based on the implication of changing price on cost of living.

For uniformity, data was obtained only from the World Development Indicator database of the World Bank.

Theoretical Framework and Model Specification

The theoretical basis for this study is the quantity-quality (Q-Q) trade-off fertility theory founded on the works of Gary Becker and his colleagues (Becker, 1960; Becker & Tomes, 1973; Becker & Lewis, 1976). The theory is premised on the argument that fertility declines witnessed at the turn of the 19th century in Europe is due to increasing cost of child bearing. It argues that the increase in the cost of child bearing leads to a trade-off between the quantity and quality of children, such that there exists a negative relationship between the cost of child-bearing and fertility rate.

Two types of child-bearing costs were particularly identified by Becker and his colleagues - opportunity cost and direct cost. The opportunity cost argument stems from improvement in human capital accumulation driven by economic development. Owing to improvement in human capital such as skill and schooling, parents particularly women are better qualified for employment in higher paying jobs. This in turn increases the opportunity cost of child bearing such that household's decision to trade-off employment for raising children is confronted with high income opportunity cost (Becker, 1960; Mincer, 1963; Becker & Lewis, 1976; Lawson & Mace, 2010).

On the other hand, the theory described direct cost of child bearing as those associated with providing for the family, items such as food, clothing and shelter. Intuitively, the higher the number of children, the larger the size of the family and the associated direct cost of provision. This also is considered a critical precursor to the observed fertility transition in developed countries. However, as argued by Guinnane (2011), due to industrial revolution of the 19th century, the direct cost of child-rearing in terms of food and clothing did not really change for Europe during the time of Becker's writing. In fact, food and clothing prices fell significantly during that period (Guinnane, 2011). Thus, the observed decline in fertility could not have been due to increase in cost of food and clothing but rather the hike in housing prices due to increasing rate of urbanization across Europe in that period (Haine, 2000; Wehler, 1995 as cited in Wang, 2013). Guinnane (2011) particularly emphasized the location differential in housing price between rural and urban areas and the observed difference in fertility rates in the two locations. While housing price was relatively higher in urban centers, fertility decline was likewise higher in urban centers. Hence, fertility transition characterizing the European industrialization era is believed to have been fueled by the accompanying rapid process of urbanization in that period.

Following from the above and the various studies which have identified the role of urbanization in fertility transition in line with the Becker's Q-Q model such as Li

et al. (2008), Wang (2013) and Gries & Grundman (2015), the functional form of the analysis model is represented as follows;

$$Fer = (Urbg, Schlf, Flfp, Gdpg, Infm, Inf) \qquad (1)$$

The estimated linear econometric equation is therefore stated as;

$$Flex_{it} = \mu_0 + \mu_1 Urbg_{it} + \mu_2 Schlf_{it} + \mu_3 Flfp_{it} + \mu_4 Gdpg_{it} + \mu_5 Infm_{it} + \mu_6 Infl_{it} + \varepsilon_{it} \quad (2)$$

The variables are as earlier discussed and are the estimated coefficients of the model.

Estimation technique

For the evaluation of the possible nexus between rate of urbanization and fertility decision in Nigeria and South Africa, this study adopted the fully modified ordinary least square method (hereafter FMOLS). While econometric literature is replete with various suggestions on estimation techniques for time series models, not all is efficient in cointegrating regressions. For example, application of the ordinary least square (OLS) in cointegrating series may produce inconsistent and biased estimates due to its inability to mitigate the potential challenge of serial correlation and heteroscedasticity (Philips and Hansen, 1990). Hence, estimators with capacity to estimate cointegrating relationships in time series model were developed. An important one being the FMOLS. FMOLS estimator was developed to correct the associated deficiencies of OLS by modifying the least squares to account for serial correlation effect and heteroscedasticity which are inherent among variables having cointegrating relationships (Philips and Hansen, 1990; Philips, 1993).

Based on the initial work of Philips and Hansen (1990), FMOLS offers a framework which permits the estimation of cointegrating time series having integration of order 1 (I(1)), that is, variables which are made stationary after first differencing. However, the framework was extended in Philips (1993) to allow for the estimation of models with full rank i(1) variables as well as models having combinations of I(1) and I(0) regressors. In all, FMOLS has enjoyed an extensive application in both time series and panel data analyses owing to its capacity to produce asymptotically unbiased and normally distributed estimated coefficients (Philips and Hansen, 1990, Pedroni, 2000, Kao and Chiang, 2000). Moreover, FMOLS has been adjudged advantageous for efficiency in small sample size. Therefore, FMOLS is employed in this study to estimate the long-run relationships among the dependent variables and the adopted regressors.

FMOLS Pre-Estimation Test

There are certain requisites which are critical to the use of FMOLS. First, it is of utmost importance that both the dependent and explanatory variables are stationary. Moreover, for the purpose of estimating long-run relationship, it is important to ensure that the concerned variables are capable of forming an equilibrium relationship over a long-run period (Engle and Granger, 1987; Pesaran et al., 2001).

Unit Root Test

Estimation of non-stationary time-series will produce biased results such that that the regression results will suggest the existence of significant relationships among the variables when in real sense, the variables are uncorrelated. In such situations, the regressions are said to be spurious and inferences based on such results are misleading (Cavaliere et al., 2015). Thus, we tested for the stationarity of the data employed in this study. Specifically, we adopted the Augmented Dickey- Fuller (ADF) tests and the results are presented in Table 1 below.

Table 1: Augmented Dickey-Fuller (ADF) Unit Root Test

VARIABLES	NIGERIA		SOUTH AFRICA	
	I(0)	I(1)	I(0)	I(1)
Fertility Rate (FER)	2.7995	-3.3743**	-6.2260*	
Urbanization Rate (URBG)	-5.4526**		-0.9303	-2.9735**
Female School Enrolment Rate (SCHLF)	-3.0962**		-9.7929*	
Female Labour Force Participation Rate (FLFP)	-1.7396	-.5.9533*	0.7923	-3.8879*
GDP growth Rate (GDPG)	-4.1062*		-4.4632*	
Infant Mortality Rate (INFM)	0.8953	-3.1799**	-0.6974	-2.9940**
Inflation Rate (INF)	-2.8865	-5.5869*	1.2068	-5.6106*

Note: I(0) and I(1) indicate stationarity at level and at first difference respectively.

* and ** represent 1% and 5% level of significance respectively

Source: Authors; Computation

For all the series, the ADF test was performed using lag 9 as suggested by Eviews12 statistical software package. Using the computed t-statistics and the reported probability values, only URBBG, SCHLF and GDPG are stationary at level among the Nigerian series while the rest of the series are stationary after transformation by first differencing. For South Africa, FER, SCHLF and GDPG series are stationary at level while all other series are stationarity at first difference.

Cointegration Test

For correct application of FMOLS, in addition to ascertaining the stationarity of the variables of interest to avoid biased estimates from spurious regressions, it is also of utmost importance that the selected series share co-movement over a long period of time (Philips and Hansen, 1990: Philips 1993; Philips and Moon, 1999). In other words, it is not only important that two or more variables are able to form equilibrium relationship, it is also of necessity that the relationship is sustained in the long-run. This is known as level relationship or cointegration among the variables. There are similarly various econometric tests popularized in the literature for estimating cointegrating relationships among economic series. For this study, we adopted the Johansen cointegration to assess the existence or otherwise of a long-run relationship among FER, URBG, SCHLF, FLFP, GDPG, INFML and INF in both Nigeria and South Africa. The Johansen test uses the results of the trace statistics and maximum eigen values to examine the cointegration ranks among selected series (Kao & Chiang, 2000; Pedroni, 2000). The results are presented in Table 2 below.

Table 2: Johansen Cointegration Test

Hypothesised No of CE(s)	NIGERIA			SOUTH AFRICA		
	Eigen values	Trace statistics	Prob. value	Eigen values	Trace statistics	Prob. value
None	0.9746	382.87	0.0000	0.9985	267.52	0.0000
At most 1	0.9651	250.69	0.0000	0.9123	130.19	0.0000
At most 2	0.7017	129.88	0.0000	0.8471	74.49	0.0004
At most 3	0.6130	86.33	0.0000	0.7387	43.26	0.0304
At most 4	0.5908	52.15	0.0000	0.5563	15.75	0.3668
At most 5	0.3712	19.99	0.0098	0.2211	5.31	0.9051
At most 6	0.0872	3.29	0.0699	0.0479	1.13	0.9343

Source: Authors' computation

Based on the probability values, the result of the Johansen cointegration test show that the null hypothesis of no long-run relationship among the employed variables is rejected at all the hypothesised cointegration equations (CEs) for Nigeria. However, for South Africa, the null hypothesis could not be rejected for hypothesised four, five and six cointegrating equations. In all, the results confirm the presence of cointegration among the regressors. Ascertaining the existence of cointegration among the variables, the study proceeded to estimate the FMOLS model.

Fully Modified OLS (FMOLS) Estimation and Discussion of Result

The result of the FMOLS regression is presented in Table 4 under each country's name heading. The results show the estimated parameter and the statistical level of significance of each regressor.

Table 3: Result of FMOLS Regression

Dependent Variable: FER

Regressors	NIGERIA			SOUTH AFRICA		
	Coefficients	Standard Error	t-statistics	Coefficients	Standard Error	t-statistics
URBG	1.2345*	0.4171	2.9600	0.2733*	0.0180	15.1619
SCHLF	0.0020*	0.0005	4.1178	-0.0042*	0.0012	-3.4565
FLFP	-0.0025**	0.0010	-2.4931	0.0016	0.0026	0.6256
GDPG	-0.0077**	0.0031	-2.4671	-0.0063*	0.0019	-3.3713
INFM	2.0669*	0.1807	11.4401	0.2468*	0.0214	11.5310
INF	-0.0021**	0.0009	-2.3308	0.0016	0.0013	1.2202
R-square	0.9761			0.9829		
Adjusted R^2	0.9714			0.9765		
JB statistics	1.6918 (0.4292)			5.8512 (0/0536)		
Wald Test	F-stat. 138.65 (0.0000) Chi2 stat. 837.87 (0.0000)			F-stat. 241.41 (0.0000) Chi2 stat. 1448.46 (0.0000)		

Note: * and ** indicate 1% and 5% level of statistical significance

JB statistics represent Jarque-Berra statistics

Authors' computation on fertility rate.

The coefficient of the principal regressor URBG which measures the effect of urbanization process on fertility rate is positive and statistically distinguishable from zero at 1% level of significance in both models. These results imply that the rate of urbanization in Nigeria and South Africa has an increasing effect on fertility rate with the magnitude being higher for Nigeria. In particular, a percentage increase in urban population growth in Nigeria will raise fertility rate by 1.2345 while in South Africa, a percentage rise in urban population growth will cause fertility rate to increase by 0.2733. Although the results are in variance with the popular argument that for reasons such as higher opportunity cost of having children, high cost of living in urban cities and enlightenment due to improved literacy, urban life is incompatible with large family size, the results are however compatible with the realities in the studied countries, especially Nigeria. In spite of the high degree of urbanization in Nigeria, average total fertility rate remains high in the country. Based on the World Bank data on fertility, Nigeria and South Africa rank 8th and 86th among 200 countries. Although the magnitude varies between Nigeria and South Africa, substantial proportion of urban dwellers in both countries are poor and urban poverty has been

worsened by the flawed urbanization process (Eshiet, 2008; Smit et al., 2017). Due to struggle and desperation for survival, rural dwellers unabatedly move to the urban centers, most of whom are illiterate or semi-illiterate. This has led to the expansion of urban slums filled with poor and uneducated residents who are not influenced by the urban fertility incompatibility factors. The available statistics shows that about 54% and 24% of Nigeria and South Africa urban population respectively live in slum in 2018. (World Bank, WDI, 2020)

Also, unabated influx of people to the urban cities and peripheries with limited economic opportunities has also exacerbated the challenge of unemployment in those countries. With the challenge of unemployment in urban cities, vulnerable and low-income self- employment are very common. In Nigeria for instance, about 86% of employed women are in self-employment as at 2019 while 85.2% are in vulnerable employment in the same period (World Bank, WDI, 2020). Thus, increasing urbanization rate might not have reducing effect on women decision to give birth given that a substantial proportion of female working population is involved in self-employment and vulnerable jobs with limited opportunity costs in terms of child rearing. This is in resonance with the findings of Wusu (2012), who asserts that Nigerian women in self-employment are able to make their own fertility decisions without having to consider the implications for their jobs.

As for other correlates of fertility rate, literacy rate proxied by female school enrolment has positive effects on fertility in both countries. The results are however statistically insignificant. Female labour force participation rate has a negative effect on fertility in Nigeria, while it has an increasing effect in South Africa. In none of the model is the effect statistically distinguishable from zero. On the contrary, income level measured by output growth has negative long-run relationships with fertility rate in both countries. Although the magnitude of the relationship is small, it however has statistical significance in both countries. The reducing effect of income on women decision to give birth is corroborated in the findings of Atama et al. (2021) which argue that as the economy develops women tend to move to the secondary sector with lesser compatibility with child rearing. The long-run coefficients for infant mortality in both models reveal that infant mortality contributes to increasing fertility in both countries. The size of the effect is higher in Nigeria with a percentage increase in infant mortality raising fertility rate by 2.0669 in Nigeria and by 0.2468te in South Africa. These findings are not quite surprising given the higher prevalence rate of infant mortality in Nigeria relative to South Africa. While in infant mortality in South Africa fell from 32.5 in 2010 to 27.5 per 1000 live births in 2019, in the same periods it fell from 84.6 to 76.2 per 1000 live births in Nigeria. This is in line with the findings of Bongaarts (2020) and Westoff et al., (2013) that concerns borne out of lower survival rate of children is a significant predictor of high fertility in the sub-continent of Sahara Africa.

Post Estimation Test

To check the robustness of the employed model of analysis for this study, we performed some diagnostic tests including Wald coefficient restrictions, normality test and correlogram of residual test. The post estimation tests results are reported in the lower panel of Table 4. along with the R-square and the adjusted R-square statistics. In particular, we performed the Wald coefficient restrictions to ascertain the significance of the regressors in the model. We tested the null hypothesis that the estimated coefficients of the two models are jointly zero. Based on the reported F- and Chi2 statistics and their associated probability values, the null hypothesis was rejected for both models. Also, owing to the underlying assumption of normality of data in parametric testing, we also tested the model for normality. The reported Jarque Berra statistics and its associated probability value confirm that the data follow an independent and identically distributed (i.i.d) random process, thus the null hypothesis of normality is accepted. In addition, the correlogram Q-statistics test confirm that both models are rid of serial correlation up to lag 16. Testing the model at the suggested lag 16, the auto correlation (AC) and partial autocorrelation (PAC) values are close to zero and the Q-statistics are statistically insignificant at all the estimated lags except lag 1 of the model for South Africa (see appendix for the graph)

Conclusion

Using annual time series data, this study aimed at a comparative assessment of the urbanization-fertility nexus in the two most urbanized economies of SSA – Nigeria and South Africa – at the aggregate level. The study is motivated by the trend of high fertility rate in spite of the rapid urbanization process in the sub-region. In addition, a chunk of the SSA literature was carried out at the micro level and the literature is also lacking in comparative studies. Hence this study seeks to close the existing gaps in the literature.

The findings show that contrary to the near-consensus in the literature, urbanization is positively related to fertility rate both in Nigeria and South Africa. The comparative analysis of the two countries further shows that there is a differential effect in the relationship with the magnitude of the positive relationship being relatively higher in Nigeria. The study therefore concludes that the observed incompatibility between urbanization and fertility is strongly linked to the urbanization process. In the absence of control and adequate planning in urbanization process as it is being experienced in the studied countries, urban slum will be expanded and dominated by poor illiterate dwellers who are not affected by the fertility incompatibility factors of urban centers.

The study therefore recommends that policymakers should prioritise urban development and reforms in order to harness the associated benefits of urbanization. In

addition to urban reforms, policies geared towards small family size should likewise be promoted to curtail the population explosion through high fertility rate.

While this study has made a further contribution to the fertility literature, however, due to availability of data constraint, the study was only able to use annual time series data for the selected SSA countries This challenge constrained the use of longitudinal data which would have offered more insight on the issue of fertility in SSA. Due to the complexity associated with the issue of fertility, macro data collected annually is limited in providing comprehensive understanding on patterns of change and dynamics of fertility behaviour. However, while the identified gap will of certainty enrich the extant literature, it does not by any means undermine the relevance of this study.

Declarations

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Conflicts of interest/Competing interests

There is no conflict of interest/Competing interests

Availability of data and material

The data that support the findings of this study are openly available in the website of World Bank (https://databank.worldbank.org/source/world-development-indicators).

Code Availability

Not applicable.

Authors' Contributions

Olufunmilayo Jemiluyi: Conceptualization, Writing – original draft preparation, Software, Methodology, Review and Editing,
Leward Jeke: Resources, Review and Editing, Validation, Supervision

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Appendix

Correlogram result (Nigeria model)						
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.|*. |	.|*. |	1	0.204	0.204	1.6690	0.196
.| . |	.*| . |	2	-0.036	-0.081	1.7233	0.422
.| . |	.| . |	3	-0.060	-0.037	1.8757	0.599
.*| . |	.| . |	4	-0.067	-0.052	2.0719	0.723
.*| . |	.*| . |	5	-0.115	-0.100	2.6653	0.751
.*| . |	.*| . |	6	-0.167	-0.140	3.9682	0.681
.*| . |	.| . |	7	-0.103	-0.064	4.4810	0.723
.*| . |	.*| . |	8	-0.127	-0.137	5.2806	0.727
.| . |	.| . |	9	-0.023	-0.015	5.3085	0.807
.| . |	.| . |	10	0.027	-0.022	5.3465	0.867
.*| . |	.*| . |	11	-0.097	-0.171	5.8708	0.882
.| . |	.| . |	12	0.008	-0.001	5.8748	0.922
.|*. |	.|*. |	13	0.191	0.134	8.0731	0.839
.| . |	.*| . |	14	-0.008	-0.153	8.0769	0.885
.*| . |	.*| . |	15	-0.169	-0.188	9.9558	0.823
.*| . |	.*| . |	16	-0.194	-0.199	12.545	0.706
*Probabilities may not be valid for this equation specification.						