Population Review

Volume 57, Number 2, 2018

Type: Article, pp. 47-75

Urban Slums and Fertility Rate Differentials

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Abstract

Over the last 50 years, least developed countries have experienced dramatic population growth due to high fertility rates and poor economic conditions within these countries. In order to tackle this issue, many least developed countries have made remarkable strides to lower their fertility rates. However, while for some countries fertility rates have been on the decline, for other countries such as those in the Middle East and North Africa (MENA) and sub-Saharan Africa (SSA), their fertility rates are still among the highest in the world. Such variations in fertility rates have led to many studies on this issue. However, the possible role of populations with typical high fertility rates, such as those in slums, have been given much less attention. This paper investigates the role of growing slums as a moderating factor that could possibly contribute to explaining the reasons behind the failure of some regions, such as MENA and SSA, to bring down fertility rates to a satisfactory level. Our panel fixed effects and two-stage least square results of 72 developing countries during the period 1990-2014 support the positive effect of slums on fertility rate after controlling for endogeneity, country and time fixed effects, as well other drivers of fertility.

Keywords

Slums; fertility rate; demographic transition; panel fixed effects

JEL classifications: J13; J11; C26

Acknowledgment: Sherif Maher Hassan acknowledges the financial support of the Yousef Jameel Academic Program (YJAP) Ph.D. scholarship.

1. Introduction

The current world population is 7.6 billion, and that number is expected to increase to 8.6 billion by 2030 and 9.8 billion by 2050, if present growth trends persist (United Nations 2017). This population growth, however, has not been uniform. While in many developed countries population growth rates have been relatively slow, about 0.5% per annum, in least developed countries growth rates have been much higher, around 2% (United Nations, 2015a). As a result, least developed countries are expected to continue to accommodate the majority of future population growth, with most of these people moving to cities (United Nations, 2017). This is of concern since many least developed countries are currently facing various social, economic and development challenges, which impair their ability to adequately accommodate this increasing population. Unable to adequately meet the demands of the growing population, many cities in least developed countries have witnessed an increase in the presence of slums over time (Mahabir et al., 2017). Slum communities typically provide more affordable housing and informal jobs to meet the needs of those individuals that are unable to afford the typically high prices of homes in cities, or may not be able to find jobs in the city (Mahabir et al., 2016). However, as will be discussed further in Section 2, the decision as to whether to live in a slum or not is without its own set of tradeoffs, since these communities often endure a much lower quality of life compared to formal populations.

Another common trend in many least developed countries is that of a large youth population. About 25% of the current world population is between the ages of 10 and 24, 89% of which are located in least developed countries (UNFPA, 2016). Such patterns of young populations are also visible in slums in these countries. For instance, a recent survey of 36 slums in Bangalore, India found that 75% of the population were less than 35 years of age, and 36% between the age of 18 and 34 years (Roy et al., 2018). Similarly, in a county-wide survey of Kenya's most populated county, Nairobi (also the county with the largest slum population), 67% of slum dwellers were within the ages of 20 to 34 years (African Population and Health Research Center, 2014). Thus, along with having to meet the needs of a large and growing number of young people, governments in least developed countries must also contend with an increasing number of these persons living in slums.

There are various reasons as to why a country may want a large youth population. One such reason is that this population can provide a large supply of labor to fuel economic growth. An example of such a case is India, which has a large number of young people comprising its working population and a GDP that recently surpassed that of China's, making it the world's fastest-growing large economy (Golley and Tyers, 2013; Focus-economics, 2018). Another reason that countries want a large youth population is that this supply of people forms a rich source of revenue for governments through the collection of taxes (Bloom et al., 2003). Further, this population also provides a unique opportunity to build an educated and civil community through innovations and investments in healthcare, education and employment through public action and private sector involvement (African Union, 2017). Education, in this regard, becomes important in reducing the instance of poverty, as a more educated population is expected to lead to greater diversification of the economy with respect to the range of products, services, and talent that it produces (Collier and Hoeffler, 2004).

However, the introduction of a large youth population, if not planned properly, can also have negative effects on a country's economy. For instance, if most of this young population are not of working age, a substantial amount of a country's resources may have to be used to take care of them. Also, compared to young populations, aged populations typically have lower incomes compared to countries with a younger working population (Mason, 2005). Moreover, the unavailability of this large cohort of young people to find jobs and satisfactory income may result in threats to a country's social and political security (McKee et al. 2017; Graff and Bremner, 2014). Further, if inappropriately timed (e.g. periods of economic depression), this cohort of young people may pose an added strain on the economy through the rapid depletion of a country's resources, and as previously stated, this can lead to an increase in the growth of slums.

One approach that can be used to create a large youth working population is the introduction of a demographic transition via the lowering of fertility and mortality rates (Thompson, 1929). The initial fall in mortality rates due to improvements in factors, such as food production, health services and sanitation leads to the increased survival of young kids. Following this, birth rates also decline, which lead to a subsequent decline in the dependency ratio (i.e., the ratio of the non-working age population to the working-age population) (Bloom and Canning, 2003). In order to achieve this goal, countries have paid close attention to the introduction of family planning programs, improving access to modern contraceptive methods and developing their health care services. However, success in fulfilling this goal has not been uniform across world countries and regions. In many of the world's least developed countries, child survival rates have improved; however, reductions in fertility rates have been very slow, with a demographic transition yet to occur (Gribble and Bremner, 2012). In some least developed countries, in particular, those countries within the Middle East and North Africa (MENA) and sub-Saharan Africa (SSA) developing regions, fertility and population growth rates continue to be the highest among world regions, with fertility rates exceeding the world average of 2.5 children per woman from 2010 to 2014 (World Bank, 2017). There is also a large variation in fertility rates within these regions (World Factbook, 2017). For example, because of developments in family planning policies, countries such as Egypt and the Islamic Republic of Iran have experienced larger fertility rate reductions compared to other MENA countries (McKee et al., 2017).

A related factor that has led to a decline in fertility rates in many least developed countries, and especially African countries, has been the high prevalence of the human immunodeficiency virus (HIV). Work by Juhn and colleagues (2013), for example, using data collected from demographic and health surveys for 13 African countries, show that fertility rates among HIV-infected women are 20% lower than fertility rates of non-infected women. Similar patterns of low fertility rates in HIV infected women have also been reported in other studies (e.g., Zaba and Gregson, 1998; Kongnyuy and Wiysonge, 2008). Some reasons have been put forth to explain reduced fertility rates in HIV infected women, among them, the greater likelihood of this group of women being widowed, separated or divorced (Juhn et al., 2013); the reduction in fecundity due to the increased chance of miscarriages and stillbirths; and the increased risk of coinfection with other sexually transmitted infections (Gray et al., 1998). Moreover, HIV infected men also contribute towards low fertility rates. As Ntozi (2002) states, an HIV-infected male is at much greater risk of becoming sterile or having reduced production of spermatozoa compared to uninfected males.

While the above issues help explain variation in fertility rates with increased HIV prevalence, one must also take in account the role that antiretroviral treatment (ART) and pre-exposure prophylaxis (PrEP) treatment has played in reducing HIV risk. Most research examining the role of such treatments with respect to fertility have reported an increase in female fertility (e.g., Makumbi et al., 2011; Myer et al., 2010). However, such increases have generally been small and continue to be lower than fertility rates among uninfected women (Yeatman 2016). Work by Maier et al. (2009) in Uganda also show that while ART is associated with an increased fertility desire among women, this did not lead to increased fertility. In a 2015 report, a similar finding for the use of PrEP in unaffected men in Kenya and Uganda was found (Were et al., 2015). Specific to slums, research has shown that the use of such treatments may be inconsequential in some cases (e.g., Wekesa and Coast, 2014), a result that could be in part due to the increasing and widespread availability of such programs in many least developed countries (Kaida et al., 2011). While we agree that both the prevalence of HIV and available treatment help explain fertility rate differentials in countries, the non-consensus in reported results among studies suggests that other factors may be at play.

In an attempt to gain a greater understanding of the differences between fertility rates within and among countries and world regions, studies have examined the various determinants of fertility. Much of the research, in this regard, has focused on economic, social and cultural factors influencing reproductive behavior, such as female education and earnings (Macounivch, 1996), ethnic fractionalization and cultural norms (Belanger and Ouellet, 2001), religion (Pew Research Center, 2015), and industrialization (Brewster and Rindfuss, 2000). Other research, such as the work of Puwar and colleagues (2008), has studied the various factors within slums that affect fertility rates. However, the potential role of slums as a factor affecting countries' fertility rates (e.g., magnitude and direction of a causal link) has received much less attention in the literature. Of those studies that have looked at this association, these have mainly discussed the relationship between slums and fertility rates in a qualitative manner. While slums are not a new phenomenon to any specific country, as mentioned before, they are mainly found in least developed countries. Recent research has also shown that a large percentage of the population in these countries live in slums (Mahabir et al., 2018). As such, given both the large and growing population of slum dwellers and the typically high fertility rates of women in these populations (Fernández-Castilla et al., 2008), a more in-depth and an empirical study examining the association between slums and their influence on countries' fertility rates is needed. Such information is expected to play an important role in the design of future intervention to accommodate increased population growth, especially since failure to meet the needs of this growing population could also magnify the presence of slums.

In this paper, we contribute to the growing debate on the various factors that determine countries' fertility rates. More specifically, we design a model to empirically examine the magnitude and direction of the effect of slums on total fertility rate in the developing world. Our study uses a sample of developing countries that have varying degrees of slum populations and fertility rates. We also control for other fertility drivers and account for the issue of reverse causality to present a study that is both robust and objective. The remainder of this paper is structured as follows. Section 2 reviews the topic of slums and discusses fertility rates within these communities. Section 3 presents the data and methodology used in this research and is followed by a discussion and the results in Section 4. Finally, Section 5 concludes the paper with an outlook for future work.

2. Slums as a global challenge

Currently, almost one in every three people in the cities of developing countries live in a slum, with over one billion slums dwellers globally (United Nations, 2015a). A slum, as defined by UN Habitat (2006), is a household or a group of people living under the same roof with one or more of the following characteristics: poor structural quality of housing, overcrowding, inadequate access to safe water, poor access to sanitation, and insecure residential status. The extent and magnitude of these poor conditions can vary from one slum to another, with some slums more adversely affected compared with others (Mahabir et al., 2016). Slum dwellers, because of their limited access to basic amenities (e.g., libraries and schools) and services (e.g., water and electricity), and limited opportunities for economic growth (e.g., bank loans and jobs), have a much lower quality of life compared to other groups in society. These and similar issues make slum dwellers socially, economically and physically vulnerable (Khan and Krämer, 2014; Ebert et al., 2009). Such characteristics of slums, together with the reasons for their formation and growth, have been the subject of many studies (e.g., Mahabir et al., 2016; Fox, 2013).

The geographic distribution of slum dwellers also varies from one country and region to the next. With respect to the urban population, the region with the highest proportion of urban slum dwellers in respect to total urban population is sub-Saharan Africa (55.2%), followed by South Asia (30.6%) and East Asia and the Pacific (25.8%). At the country level, the top eleven countries with the highest urban slum populations are all located in Africa, with South Sudan (95.6%), Central African Republic (93.3%) and Sudan (91.6%) having the largest populations (World Bank, 2014). The continent of Africa, in particular, has the highest number of urban slum dwellers compared to the other continents and is currently the least urbanized continent in the world. However, its urban population is expected to grow in the coming years and is projected to surpass the entire European population by 2030 (UN Habitat, 2006). The African continent is therefore expected to continue to experience the most pressing slum issues in the future.

Slums are a growing global challenge and a highly prioritized development target for national governments and the international development community. Their presence reflects the human settlement dimension of urban poverty. Targeting slums was not explicitly announced as a Millennium Development Goal (MDG). However, it was incorporated in MDG Goal No. 7, "ensuring environmental sustainability" (United Nations, 2005).[1] In September 2015, with the introduction of the United Nations 2030 initiative for Sustainable Development Goals (SDGs), the reduction of slums in all their dimensions became a much more prominent and well-defined objective in the "sustainable cities and communities" goal. This goal, Goal No. 11, advocates for provisions to be made to accommodate the increasing waves of urban dwellers in safer and sustainable cities by increasing public investments, ensuring access to safe and affordable housing, and upgrading slum settlements. However, because this initiative is still very recent, a thorough benchmarking of this goal's success has yet to be completed (United Nations, 2015b).

[1] The Millennium Development Goals (MDGs) are eight international human development goals that were launched by the United Nations in 2000. All of the 191 Member States of the United Nations committed to achieving these goals by 2015. The MDGs ranged from halving extreme poverty to constraining the spread of HIV, among others. In 2016, the United Nations replaced the MDGs with a broader agenda of 17 Sustainable Development Goals (SDGs), to be met by 2030.

As mentioned previously in Section 1, the role that slums play in explaining fertility rate differentials is yet to be fully understood. Lutz and Qiang (2002) suggest that even a small change in fertility rates today could have a major impact on the size and age structure of a population in the mid- to long-term future. Some studies, such as Beguy and colleagues (2017) and Fernández-Castilla and colleagues (2008), have highlighted that slum dwellers have much higher fertility rates when compared with other population groups. In Nigeria, for example, the fertility rates of women in slums are three times higher than women who do not live in slums (Fernández-Castilla et al., 2008). The African Population and Health Research Center (2014) states that slum dwellers in Nairobi and Kenya have fertility rates of 3.5 compared with 2.8 for Nairobi in general and 3.0 for other urban areas in Kenya. However, that study also stated that these rates come second to the fertility rate of 5.2 children per woman in the rural population. Such high fertility rates in slums are expected to steer future population growth due to the multiplier effect of fertility rates, since children born today will, in turn, have children in the future. Further, given that the growth of slum populations has been unprecedented – considering that they now account for more than one-seventh of the total global population (Mahabir et al., 2016) – their hypothesized impact on population growth and total fertility rates is magnified.

Various factors have been suggested to help explain the high fertility rates typical among slum dwellers. Such factors include low educational attainment of women due to income constraints, social isolation and being located at the edge of the cities. In addition, female illiteracy is defined as one of the major triggers of fertility (Schultz, 1997). Another factor is the high infant mortality rate in slums, thereby forcing couples to have more children as a form of compensation (Hale et al., 2006; Agarwal and Taneja, 2005). This is in part due to issues with inadequate water drainage, lack of safe places for children to play outdoors, and chemical pollutants in slums, which all contribute to raising health hazards for children living in slums (Bartlett, 2003; Satterthwaite, 1993). In contrast to these studies, other research, albeit very few, show slums to have lower fertility rates when compared with other formal population groups. The Bangladesh Urban Health Survey (2006) reports that women in Bangladeshi slums have lower fertility rates than women who are not in slums. That study suggested that reasons for the lower fertility rate include the growing popularity of the two-child family, easy access to contraceptives, frequent visits of non-government organization workers who raise awareness of family planning programs, and the lack of space in slum houses.

The abovementioned ambiguities and the limited empirical evidence regarding the impact of slums on fertility rates within and among countries may lead to inappropriate measures and policies being implemented in addressing population-related issues. For example, policy measures implemented to curb population growth rates within countries may be ineffective if they do not address the specific issues in the urban slums that may be leading to high fertility rates. Also, while the introduction of ART and PrEP programs have been successful in reducing the gap between fertility rates between women with and without HIV infection, their impact on the fertility of women within slums is not yet well understood (Section 1). With slum populations on the rise, an understanding of the role that slums play in influencing overall country fertility rates may provide valuable insights on the role of slums as a moderating factor in explaining fertility rates differentials. This paper fills the research gap on fertility dynamics by introducing the role of slums as a possible missing moderating factor that (i) contributes to clarifying fertility rate variations, (ii) assists in explaining the reasons behind the failure of some countries to reduce fertility rates to a satisfactory level, and (iii) provides valuable insights into better understanding the status of populations of slum dwellers (particularly populations in countries that have yet to achieve their demographic transition and do not have the resources necessary to benefit from this large group of kids and young adults).

3. Slums and fertility rate dynamics: an empirical investigation

3.1. Data

Our empirical approach aims to quantify the direction and magnitude of slums' effect on countries' fertility rates. As such, our study hypothesis is the following: *Slums positively impact countries' fertility rates.*

The data used in this study comprises a sample of 72 countries located in the developing world. Most of the countries in our sample, 53, are located in the MENA and SSA regions, while the remaining 19 countries are mostly located in Latin America and South Asia (see Table A.1 in the appendix to the present document, p.72). The much larger number of countries from Africa reflects the current geographic distribution of slums (UN Habitat, 2016). In Latin America, similar to African countries (as discussed in Section 2), the fertility rates vary among countries in this region. For example, the fertility rate in Bolivia is on average about 3 children per woman compared to other countries such as Brazil with low fertility rates of 1.75. Similar variations in fertility rates are visible in South-East Asian countries as well (World Factbook 2017). Thus, our sample of countries captures regional variations in countries' fertility rates in order to gain a broad understanding of fertility rate differentials. Further, and as will be discussed in Section 3.2, we also consider a more limited study, using countries in the MENA and SSA developing regions alone. These regions have the highest fertility rates in the world and such a focused study will allow us to (i) identify those drivers of fertility that permeate at different spatial scales, and (ii) check the relevancy of slums as a moderating factor in explaining fertility rate differentials at these spatial scales.

The limited slum database constrained our study's ability to include more countries. Nonetheless, such a sample offers three main opportunities for testing our hypothesis. First, both SSA and MENA have large shares of young people, a situation that makes them eligible for the introduction of a demographic transition where applicable. These regions also have the highest share of people aged 14 and below relative to all other regions in the world (World Bank, 2017). Yet the demographic transition process is hindered by many reasons, including high fertility rates. This circumstance forces both regions toward what is known as a "demographic trap" that describes the combination of high fertility and low mortality rates. Such a combination delays the opening of the demographic window (Forsyth, 2005).

Second, the MENA and SSA regions have large slum populations that are projected to keep increasing because of mounting growth rates in the urban population, prevailing conflicts and political instability. From 1990 to 2014, for example, the ratio of the urban population living in slums compared to the total urban population was on average 33% and 60% for the MENA and SSA respectively (United Nations, 2016). The increasing growth of slum dwellers, in turn, increases human mobility toward stable neighboring countries and away from conflict and war zones. Further, with modest growth and developmental rates, the ability of these neighboring countries to accommodate immigrants in sustainable urban habitats is diminished (Fox, 2003).

Third, many of the countries in our sample have a large percentage of low-income populations, which, as Shapouri and colleagues (2009) suggest, tend to have higher fertility rates compared with countries that have higher income distributions. Figure A.1 (in the Appendix to the present document, p.71) supports our study's hypothesis of the positive bivariate relationship between slum populations and total fertility rates across different year groups. The dependent variable in our empirical specification is the *fertility rate*, which was sourced from the World Bank (2017). It measures the number of children that would be born to a woman if she were to live to the end of her childbearing years. The developed model embodies the main independent variable of interest, *slums*, that accounts for the ratio of the urban slum population to the total urban population. *Slums* data were sourced from the United Nations (2016). The availability of *slums* data is, however, limited across time and cross-sections. Thus, the current study adopts an approach similar to that used by Bjorvatn and Farzanegan (2013) by employing long-term averages instead of yearly averages. This approach assists in the removal of outliers due to seasonal cycles of slum growth that operate at local scales within countries (Baldacci et al., 2008). Further, demographic variables such as *fertility rate* and *slums* generally tend to take longer times to reach inertia. This situation means that a comparison of such factors at too fine a temporal resolution (e.g., annually) may lead to misleading results. Consequently, *fertility rate* and the explanatory variables were averaged over five-year periods (1990–1994, 1995–1999, 2000–2004, 2005–2009, and 2010–2014) in order to build the panel structure. This approach provides five observations for each country.

In addition to *slums*, our study controls for other socioeconomic factors that are responsible for the observed fertility rates that occur within countries, as shown in Table 1 (p.55). This table also shows the hypothesized impact expected. These factors are interconnected, operating at a range of spatial and temporal scales, and influence fertility rates to a greater or lesser extent. They were also specifically chosen because of the availability of data. The set of fertility control variables in the specification include *income*, *female unemployment*, *female primary education*, *contraceptive*, *infant mortality, child labor, and HIV*.[2] These variables were sourced from the World Bank (2017). The variables' definitions and their descriptive statistics are shown in Table A.3 (in the Appendix to the present document, p.74) and Table A.4 (in the Appendix to the present document, p.75) respectively. We apply different robustness tests to check the accuracy of our results. We also consider an additional set of control variables, including income inequality, poverty, trade, and governance measures. The applied robustness tests are discussed further in Section 3.3. Our model is written using the following form, where the subscript i denotes the country, t the time (five-year averages from 1990 to 2014), X contains the set of control variables, ε is the observation-specific error, and μ is the unobserved individual specific effect

$$Ln\ fertility\ rate_{\ i,t} = cons. + \alpha_1 . slums_{i,t} + \Sigma X_{,ti} + \mu_i + \varepsilon_{i,t} \qquad (1)$$

[2] This study also uses *total unemployment rate* interchangeably with *female unemployment rate*. However, the results do not change. Data on child labor are rare. An alternative indicator, as suggested by the National Research Council (2003), is the ratio of children dropouts from school, indicating those who are actively participating in the economy while being under the legal age for working.

Table 1. Key drivers of fertility rates and their expected outcome

Factors	Impact on Fertility	Details
Maternal educational level	-	Women with better education tend to have fewer children than their uneducated counterparts (Lutz, 2005).
Contraceptive prevalence	-	High prevalence of contraceptive methods reduces fertility. In slums, the lack of contraceptive methods is evident due to inhabitants' limited income and lack of knowledge (Ishida et al., 2009; Barkat et al., 1997).
Child labor	+	Children for some poor families are translated into extra labor suppliers that introduce more income for the family (UNICEF, 2012).
Income	NDE	High income could encourage families to have more children because there are enough resources to educate and feed them (Handa, 2000). On the other hand, poor families may choose to have more children and engage them in economic activities to generate income (UNICEF, 2012)
Infant mortality	+	High infant mortality induces parental fertility as a form of compensation for their loss (Agarwal and Taneja, 2005).
HIV	-	The widespread incidence of HIV discourages reproductive behavior among infected population groups, especially when accompanied by low contraceptive prevalence (Lewis et al. 2004).

(+) - Positive influence; (-) – Negative influence; NDE – No direct effect (can either be negative or positive)

3.2. Methodology

We start our econometric analysis by pooling the panel dataset and estimating it using ordinary least squares (OLS) regression. This method, however, ignores the panel structure of the data and countries heterogeneities, treating all observations as one sample and thus yields a biased and inconsistent estimator (Gujarati, 2004). In order to correct for this bias in the pooled OLS estimator, a panel fixed effect (FE) approach was used to account for the distinct nature of each country and control for the unobserved heterogeneity that is constant over time and correlated with the dependent variable (Baltagi, 2008). This method uses time and country dummies to capture the within-variation across countries and time-related shocks that are common to all countries, such as global financial crises (Bjorvatn and Farzanegan, 2013). This approach is also used to overcome issues with omitted variable bias, which can occur if measures for time-invariant country characteristics that affect fertility rates, such as race, culture, and religion, are not accounted for. One concern in the developed model is the impact of reverse feedback from fertility rates on slums because high birth rates could potentially lead to higher slum populations in the mid- to long-term because of the fertility multiplier effect (Section 2).

To overcome issues with endogenous variables, an Instrumental Variable (IV) method – Two-Stage Least Square (2SLS) estimator – was used. The intuition behind this method is replacing the endogenous variable *slums* at the first stage with an exogenous instrument that is uncorrelated with the error term "validity condition" and correlated with *slums* "relevance condition". Following, these computed values were used to estimate a linear regression model of the dependent variable at the second stage.

For testing the validity and relevance of the instruments, various diagnostics in the estimation tables were reported: (1) the Kleibergen-Paap rk LM under-identification test, (2) the Kleibergen-Paap rk Wald F weak identification test, and (3) Hansen's over-identification J test. The under-identification test examines whether or not the instruments are correlated with the endogenous variables. A rejection of this test's null hypothesis shows that the instruments are relevant. The weak identification test shows if there is a weak correlation between the endogenous and the selected instrumented variables IVs. This statistic is compared to the critical values that were obtained by Stock and Yogo (2005). The critical values for the Kleibergen-Paap rk Wald F statistic are 12.20 for 5% maximal IV relative bias, 7.77 for 10% maximal IV relative bias, 5.35 for 20% maximal IV relative bias, and 4.40 for 30% maximal IV relative bias (Kleibergen and Paap 2006). Acceptance of Hansen's J test null hypothesis shows that the instruments are correctly excluded from the equation and are orthogonal to the error term (Baum et al., 2007). Finally, we apply White's cross-sectional clustered errors that are robust to heteroscedasticity and serial correlation to FE and 2SLS models. Diagnostic test results appear in Tables 2 (p.61), 3 (p.62) and 4 (p.63) in Section 4.

We use the percentage of agricultural land area as an exogenous instrument for *slums*. This measure indicates the size of croplands that could provide adequate housing and also be used as a source of sustenance for people. The extent of availability and affordability of these lands for people would mitigate their settlement at the edge of cities and direct them toward newly cultivated areas. Further, the shares of agricultural land can also be used as an indicator to identify available areas that could be converted to urban land use. Thus, cities can be expanded in order to reconcile the housing and service needs of the rapidly emerging waves of people being drawn to them. Data for agricultural land were sourced from the World Bank (2017). This study uses one-period lagged of the percent of agricultural land and the interaction between this variable and the one period lagged of *slums*. The non-linear transformation of the exogenous variables was suggested by Wooldridge (2000). The underlying argument is that the interaction of an endogenous variable with an exogenous one can be interpreted as being exogenous (Nizalova and Murtazashvili, 2016; Nunn and Qian, 2014).

3.3. Robustness measures

To check the robustness of our results, we control for an extended set of economic and institutional variables. These controls capture changes in income levels and participation in the labor market, which in turn affect people's fertility plans. The controls are *poverty*; the *Gini index* as a measure of income inequality; *trade*, which reflects the extent of economic globalization; and *inflation* as a proxy for macroeconomic stability and cost of living expenses. This study also controls for governance measures, namely *government effectiveness* and *political stability*, in order to provide proxies for the extent of political contestation and the quality of institutions and public services. The descriptions and sources of the extended set of control variables are presented in Table A.3 (in the Appendix to the present document, p.74).

Further, the estimations are repeated using a new measure for the main independent variable, *slums*. In this case, the variable *slums* is used as a percentage of the total population. This approach is in contrast to the prior use of the percentage of slum dwellers in the total urban population. We also use another dependent variable, *population growth,* as a proxy for demographic dynamics besides *fertility rate*. The same methodologies are applied in both instances, using the full set of control variables. The estimation results appear in Table 3 (p.62). The sensitivity of the 2SLS regressions is checked by instrumenting slums with two-period lags of the log transformation of the absolute number of slums dwellers. The proposition here is that fertility in the current period does not affect the past development of slums, especially when the dominator of the initial measure, which contains the urban population, is omitted (Verbeek, 2004; Farzanegan and Hassan, 2016). The same IV diagnostics are used to test the relevancy and excludability of these instruments.

Finally, this study checks whether the results are driven by countries outside the MENA and SSA regions. Thus, the 15 Latin American and Asian countries are excluded from the sample and the estimations are repeated. The results hold regardless of the sample that is used. These estimations are reported in Table 4 (p.63).

4. Results and discussion

Table 2 (p.61) reports the baseline estimates of equation 1 for the period 1990-2014. We use five-year averages to account for the slow-moving nature of demographic variables and to account for missing data within *slums*. All standard errors in the estimation tables are robust against arbitrary heteroskedasticity and serial correlation at the county level.

Model 2.1 presents the initial results of the pooled OLS method. The list of variables includes only the main independent variables that were mentioned in Table 1 (p.55). *Slums* is measured as a percentage of the urban population while the dependent variable is the log transformation of *fertility rate*. The coefficient of s*lums* carries the hypothesized positive sign, yet not significant.

Accordingly, we replicate our results using a PE approach in Models 2.2 and 2.3. In Model 2.2, we allow for country fixed effects only while including the full list of control variables that was discussed previously in Section 3.2. The results support the positive long-run effect of *slums* on *fertility rate*, however, the magnitude is small. Accordingly, a 1% increase in the percentage of urban population living in slums increases *fertility rate* by 0.66% at the 1% level in Model 2.2. This result is nearly the same in Model 2.3 after including time fixed effects, which account for time shocks that are common across all countries.

The remaining Models 2.4 and 2.5 report the IV estimations, wherein we replace *slums* with the percentage of land area used for agriculture and the interaction between one-period lagged of the former variable and one-period lag of *slums* in Model 2.4. In Model 2.5 we check the sensitivity of our results to the change of instruments, thus we use the two-period lags of the log transformation of an absolute number of slums dwellers. The magnitude of the *slums* coefficient rises to 0.83% and 0.87% at a 99% confidence level in Models 2.4 and 2.5 respectively. The IV diagnostics support the relevancy and validity of used instruments.

In both Models, we reject the null hypothesis of the under-identification test suggesting that the instruments are correlated with the endogenous variable *slums.* We accept Hansens's J test, which implies that the instruments are valid and are not correlated with the dependent variable *fertility rate*. The weak identification test values eliminate the possibility that the instruments are weakly correlated.

The increase in *fertility rate* alongside an increase in the number of slum dwellers has previously been justified in studies, such as Mberu and colleagues (2016), Bartlett (2003), and Agarwal and Taneja (2005), all of which highlight that the adverse social, economic, and physical deprivation in *slums* are conducive to increases in fertility rates. These conditions constitute a distinct aspect of slums in terms of health hazards relative to other settlement types. Overcrowding, the lack of basic facilities, such as clean water and sanitation, pollution, and unhygienic housing all contribute toward medical problems in slums, which lead to higher death rates among slum inhabitants, especially among infants. Additionally, the existence of some slums at the edges of cities and poor spatial accessibility within slums promote social isolation, which intensifies the severity of the health threats and causes above-average infant mortality.

High infant mortality, in turn, is widely perceived as an important trigger of fertility as a means to replace deceased children (Section 2). This argument is justified by the positive coefficient of *infant mortality*; however, the impact is not robust across all the specifications. A 1% increase in *infant mortality* increases *fertility rate* by 14% and 12% in Models 2.1 and 2.2 respectively. However, once we account for time fixed effects and use IV estimators this impact disappears, yet the coefficients hold the hypothesized positive sign (Table 1, p.55).

The results also support the prior hypothesized negative impact of both *contraceptives* and *female primary education* on *fertility rate* (Table 1, p.55). The negative fertility coefficient of *contraceptives* has a value of 0.59% at a 99% confidence level in Model 2.1. Once we include the fixed effects as well as control for the complete set of control variables, the magnitude of the *contraceptive* coefficient slightly decreases to 0.44%, 0.53% in Model 2.2 and 2.3 respectively. When employing IV estimators, the negative coefficient of *contraceptive* holds, however, the magnitudes of this coefficient are slightly lower.

With regard to *female primary education,* better-educated women are more economically active relative to their uneducated counterparts. This situation raises the opportunity cost of having more children in terms of lost income (United Nations, 2000). Further, more educated mothers typically have better health care and wider access to contraceptive methods and are more likely to care about the nutrition, health and education of their children. They also favor fewer children in some cases (Lutz and Qiang, 2002; Kim, 2016). This negative fertility effect of *female primary education* is supported in all our models. For example, a 1% increase in the number of females who complete their primary education reduces *fertility rate* by 0.33% at the 5% level in Model 2.3 after accounting for country and time fixed effects, and including the full list of control variables. Once we employ the IV estimators in Models 2.4 and 2.5, the magnitude of the coefficient rises to 0.42% in both models.

In the estimation tables, the annual growth rate of GDP per capita is used as a proxy for *income*. *Income* is also captured by the annual GDP growth rate in other specifications that are not reported. The results seem to hold in both cases. The impact of *income* on *fertility rate* depends on how families care for their children.

Families either regard children as a normal good, which suggests a cyclical relationship between *income* and *fertility rate*, or they may favor quality over quantity, which translates into a negative income-fertility nexus. However, in poor areas, where child labor is an important source of family income, low income has been found to be positively related to the demand for children (Handa, 2000). The estimations of the fertility coefficient of *income* are not significant, yet they carry positive signs that suggest the occurrence of the former argument regarding child labor because the sample of least developed countries contains large shares of low-income populations. This finding requires further investigation to better understand the different channels of fertility effects on income, in particular, when the coefficients of *child labor* in our estimations are neither significant nor positive as expected.

The fertility impact of HIV is negative as hypothesized, yet the coefficients are not significant except in Model 3.6 in Table 3 (p.62). This impact can be justified as infected women may suffer from behavioral changes, such as reduced coital frequency, increased amenorrhea, and delayed onset of sexual relations. Along with high rates of prevalence at the country level, this is expected to carry enduring moderating effects for national fertility rates (Gregson et al. 2002).

Table 3 (p.62) investigates the robustness estimates of equation 1. We first replace the ratio of slum dwellers as a share of the urban population with its measure as a share of total population to provide a broader overview for slums and include parts of the population who are situated in rural areas as well. We further test if our results are sensitive to the change of the dependent variable*,* thus in Models 3.6 through 3.10, *population growth* replaces the *fertility rate* as the dependent variable*.* Since our sample contains countries having both high infant birth and mortality rates, using *fertility rate* alone may give an incomplete picture of the ensued population dynamics as it ignores the mortality side. Models 3.1 and 3.6 report the pooled OLS estimations and show that the coefficients of *slums* are larger in magnitude and carry the same signs compared the same values in Table 2 (p.61). *Slums* continues to exercise positive fertility effects on both dependent variables, however, the impact on *fertility rate* is insignificant in Model 3.1 unlike *population growth* in Model 3.6.

Models 3.2, 3.3, 3.7 and 3.8 report the fixed effects results with the same setting as in Table 2 (p.61). These Models use the complete list of control variables. Models 3.2 and 3.7 include country fixed effects alone, while Model 3.3 and 3.8 include both country and time fixed effects. The coefficient of *slums* for the various Models reported in Table 3 (p.62) are higher than those for the same models reported in Table 2 (p.61). Accordingly, a 1% increase in the percentage of *slums* as a share of the total population increases *fertility rate* by 1.3% in Models 3.2 and 3.3 at the 99% confidence level. This is in comparison to a 0.6% increase in *fertility rate* in Model 2.2 and 2.3 for a similar 1% increase in *slums* as measured by the percentage of *slums* within urban population. The positive impact of *slums* is even stronger when using *population growth* as the dependent variable; the coefficients' magnitude in Models 3.7 and 3.8 rises to 3%. These results suggest that the positive effect of *slums* on *population growth* operate strongly via income-related fertility drivers relative to the mortality channel. Namely, if the positive fertility effect of slums primarily emerges from triggering compensatory births to replace high *infant mortality*, we would then observe a rather smaller impact of *slums* on *population growth* (measured as the number of births subtracted by the number of dead people) relative to *fertility rate* models. Moreover, more than 37% of the countries in our sample that have high rates of slums and high fertility rate also have lower than average infant mortality rate (see Table A.2 in the Appendix to the present document, p.73).

Models 3.4, 3.5, 3.9 and 3.10 report the IV results. We use the same set of instruments as mentioned earlier while reporting the same IV diagnostics as in Table 2 (p.61). The positive impact of *slums* remains regardless of which dependent variable is used, however, the *slums* coefficients have a higher magnitude in the *population growth* regressions relative to *fertility rate* ones.

The direction and magnitude of the main control variables – *contraceptive* and *female primary education* – hold in the *fertility rate* Models of 3.1 until 3.5. The magnitudes of the female primary education coefficients are slightly higher in Table 3 (p.62) relative to Table 2 (p.61) mainly because of using a broader measurement of slums that include larger portions of the population. Contraceptive coefficients are nearly the same as those in Table 2 (p.61). Regarding the *population growth* models, neither of the control variables are significant, except *contraceptive* coefficients which are weakly significant and carry positive sign across all Models. Also, HIV is only significant in the pooled OLS Model 3.6 and has a negative effect of 5.8% at a 90% confidence level.

It is also useful to check whether the entry and exit of countries from the base sample of Tables 2 (p.61) and 3 (p.62) might have affected the results. Table 4 (p.63) considers only the 52 countries that are located in the MENA and SSA regions. Estimations results of *slums* and the main control variables are nearly the same as reported in previous tables. For example, the fixed effects specification of Model 4.3 reports the estimate of *slums* as 0.77% at a 95% confidence level relative to 0.64% in Model 2.3. Models 4.4 and 4.5 that report IV estimations also show results similar to previous tables.

Table 2. Baseline estimates – panel fixed effects and 2SLS (slums as a share of urban population)

	Dependent variable: log fertility rate				
	(2.1) **Pooled OLS**	**(2.2)** **FE**	**(2.3)** **FE**	**(2.4)** **2SLS-Agricultural land**	**(2.5)** **2SLS-lagged slums**
Slums	0.00186	0.00660***	0.00642**	0.00834***	0.00872***
	(1.23)	(2.75)	(2.34)	(2.92)	(4.26)
Female unemployment	0.00181	-0.00523	-0.00340	-0.0104	-0.00305
	(0.53)	(-0.40)	(-0.26)	(-0.56)	(-0.19)
Female primary education	-0.00348**	-0.00391***	-0.00335**	-0.00425***	-0.00423***
	(-2.43)	(-3.54)	(-2.49)	(-3.47)	(-3.23)
Income	0.00437	0.00696	0.00281	0.00685	0.00565
	(1.04)	(0.80)	(0.37)	(0.69)	(0.60)
Child labor	-0.00191*	-0.00148	-0.00147	-0.00178	-0.00198
	(-1.70)	(-0.97)	(-0.99)	(-1.13)	(-0.92)
Contraceptive	-0.00596***	-0.00448***	-0.00534***	-0.00415**	-0.0036**
	(-4.14)	(-3.16)	(-3.15)	(-2.40)	(-2.05)
Infant mortality	0.144***	0.123**	0.0282	0.0935	0.0832
	(2.93)	(2.51)	(0.34)	(1.53)	(1.57)
HIV	-0.00496	-0.00501	-0.00801	-0.00428	-0.00501
	(-0.82)	(-0.60)	(-0.82)	(-0.54)	(-0.74)
Other Controls	NO	YES	YES	YES	YES
Time fixed effects		NO	YES		
Country fixed effects		YES	YES		
Hansen J statistic (p-value)				0.28	0.12
Weak identification test				29.22	36.85
Under-identification test				0.06	0.02
Instruments				2	2
Observations	149	92	92	75	70
R^2 within	0.763	0.856	0.866	0.844	0.861

The method of IV estimation is panel fixed effects 2SLS (*xtivreg2*). The constant term is included (not reported*). t Statistics* are shown in parenthesis. Significantly different from zero at *10%, **5%, and *** 1%. We use two-period lags of the log transformation of the absolute number of slums dwellers in Model 2.5 as instruments. While in Model 2.4, we use one-period lagged of percent of land used for agricultural and the interaction of the former with the one-period lagged of *slums*. The remaining control variables are treated as exogenous. Rejection of the under-identification tests' null hypothesis implies that instruments are relevant (correlated with the endogenous variable). Acceptance of Hansen test null hypothesis proves the validity of the instruments (orthogonal to the error term).

Table 3. Robustness estimates (slums as a share of total population)

	Dependent variable: log fertility rate					Dependent variable: population growth				
	(3.1) Pooled OLS	**(3.2) FE**	**(3.3) FE**	**(3.4) 2SLS-agricultural land**	**(3.5) 2SLS-lagged slums**	**(3.6) Pooled OLS**	**(3.7) FE**	**(3.8) FE**	**(3.9) 2SLS-agricultural land**	**(3.10) 2SLS-lagged slums**
Slums (% population)	0.00400	0.0134***	0.0138***	0.0144***	0.0119**	0.0332**	0.0304***	0.0303**	0.0305*	0.0235
	(1.43)	(4.02)	(4.06)	(3.40)	(2.39)	(2.)	(3.06)	(2.68)	(1.86)	(1.29)
Female unemployment	0.00126	-0.0121	-0.0111	-0.00744	-0.00272	-0.00936	0.0252	0.0242	0.0393	0.0479
	(0.37)	(-0.97)	(-0.88)	(-0.36)	(-0.17)	(-0.32)	(0.53)	(0.48)	(0.49)	(0.76)
Female primary education	-0.00361**	-0.00480***	-0.00413***	-0.00503***	-0.00499***	-0.00310	0.00191	0.00396	0.000901	-0.00289
	(-2.50)	(-4.40)	(-3.21)	(-4.18)	(-3.09)	(-0.56)	(0.37)	(0.74)	(0.19)	(-0.61)
Income	0.00440	0.0136	0.00905	0.0109	0.0102	-0.00959	-0.00873	-0.0221	-0.0193	-0.0184
	(1.08)	(1.63)	(1.29)	(0.97)	(1.06)	(-0.47)	(-0.27)	(-0.61)	(-0.44)	(-0.47)
Child labor	-0.00160	-0.00152	-0.00148	-0.00170	-0.00209	0.00187	0.00669	0.00656	0.00554	-0.00152
	(-1.41)	(-1.11)	(-1.10)	(-1.27)	(-1.09)	(0.35)	(0.93)	(0.83)	(1.07)	(-0.26)
Contraceptive	-0.00610***	-0.00547***	-0.00651***	-0.00467**	-0.00501***	-0.0141**	-0.00914*	-0.0115*	-0.00648	-0.00986*
	(-4.22)	(-3.98)	(-3.76)	(-2.47)	(-2.81)	(-2.60)	(-1.71)	(-1.84)	(-0.88)	(-1.78)
Infant mortality	0.141***	0.0712	-0.0530	0.0558	0.0789	-0.185	0.0645	-0.342	0.0447	0.0452
	(2.86)	(1.48)	(-0.66)	(0.69)	(1.10)	(-0.85)	(0.39)	(-1.11)	(0.14)	(0.19)
HIV	-0.00493	0.00187	-0.00163	0.00369	0.00155	-0.0588*	0.00330	-0.00751	0.00845	0.0000535
	(-0.79)	(0.24)	(-0.17)	(0.53)	(0.21)	(-1.98)	(0.15)	(-0.30)	(0.32)	(0.00)
Other Controls	NO	YES	YES	YES	YES	NO	YES	YES	YES	YES
Time fixed effects	NO	NO	YES			NO	NO	YES		
Country fixed effects	NO	YES	YES			NO	NO	YES		
Hansen J statistic (p-value)				0.74	0.13				0.43	0.10
Weak identification test				90.83	28.12				90.83	28.12
Under-identification test				0.00	0.08				0.00	0.08
Instruments				2	2				2	2
Observations	149	92	92	74	70	149	92	92	74	70
R^2 within	0.765	0.867	0.881	0.855	0.876	0.264	0.545	0.577	0.496	0.590

The method of IV estimation is panel fixed effects 2SLS (*xtivreg2*). The constant term is included (not reported*). t Statistics* are shown in parenthesis. Significantly different from zero at *10%, **5%, and *** 1%. We use two-period lags of the log transformation of the absolute number of slums dwellers in Model 3.5 as instruments. While in Model 3.4, we use one-period lagged of percent of land used for agricultural and the interaction of the former with the one-period lagged of *slums*. The remaining control variables are treated as exogenous. Rejection of the under identification tests' null hypothesis implies that instruments are relevant (correlated with the endogenous variable). Acceptance of Hansen test null hypothesis proves the validity of the instruments (orthogonal to the error term).

Table 4. Robustness estimates (MENA and SSA)

	Dependent variable: log fertility rate				
	(4.1) **Pooled OLS**	**(4.2)** **FE**	**(4.3)** **FE**	**(4.4)** **2SLS-** **Agricultural land**	**(4.5)** **2SLS-** **lagged slums**
Slums	0.000460	0.000460	0.00777***	0.00455**	0.00947**
	(0.31)	(0.31)	(3.82)	(2.31)	(2.40)
Female unemployment	-0.00561***	-0.00561***	0.0114	-0.00269	0.00511
	(-3.72)	(-3.72)	(0.28)	(-0.08)	(0.10)
Female primary education	-0.00304***	-0.00304***	-0.00243**	-0.00294**	-0.00201
	(-2.66)	(-2.66)	(-2.24)	(-2.71)	(-1.16)
Income	-0.00475	-0.00475	0.00733	0.00250	0.00756
	(-1.12)	(-1.12)	(1.51)	(0.86)	(1.30)
Child labor	0.000350	0.000350	0.000664	-0.000967	0.000871
	(0.33)	(0.33)	(0.66)	(-1.47)	(0.63)
Contraceptive	-0.00672***	-0.00672***	-0.000322	0.000413	0.00000709
	(-3.74)	(-3.74)	(-0.23)	(0.27)	(0.00)
Infant mortality	0.0845	0.0845	0.0592	0.240***	0.0697
	(1.58)	(1.58)	(0.70)	(3.20)	(0.60)
HIV	0.00971***	0.00971***	-0.00114	-0.00179	-0.00216
	(2.95)	(2.95)	(-0.34)	(-0.95)	(-0.63)
Other Controls	NO	YES	YES	YES	YES
Time fixed effects		NO	YES		
Country fixed effects		YES	YES		
Hansen J statistic (p-value)				0.01	0.34
Weak identification test				5.54	13.01
Under-identification test				0.02	0.01
Instruments				2	2
Observations	128	128	62	62	49
R^2 within	0.703	0.703	0.841	0.928	0.824

The method of IV estimation is panel fixed effects 2SLS (*xtivreg2*). The sample of countries includes only 52 countries in MENA and SSA regions. The constant term is included (not reported*). t Statistics* are shown in parenthesis. Significantly different from zero at *10%, **5%, and *** 1%. We use two-period lags of the log transformation of the absolute number of slums dwellers in Model 4.5 as instruments. While in Model 4.4, we use one-period lagged of percent of land used for agricultural and the interaction of the former with the one-period lagged of *slums*. The remaining control variables are treated as exogenous. Rejection of the under-identification tests' null hypothesis implies that instruments are relevant (correlated with the endogenous variable). Acceptance of Hansen test null hypothesis proves the validity of the instruments (orthogonal to the error term).

5. Conclusion

With the expected increase in world population by one billion people in just over a decade, governments in least developed countries are faced with the challenge of having to accommodate the majority of this future population growth. This is of concern since many of these countries currently face various social, economic and infrastructural challenges that impede their ability to adequately accommodate this increase in people. One such challenge is how to deal with the current issue of their large and youthful populations, many of which are located in slums in large cities. A large youthful population presents many opportunities for stimulating economic growth, and for building a more civil and educated community. However, as can be seen in the context of least developed countries, especially those in sub-Saharan Africa, wrestling with this problem continues to be an ongoing challenge.

A related issue to population growth is that of high fertility rates in least developed countries. While many of these countries have made remarkable strides in order to reduce fertility rates, progress has been slow in some. For other countries, for example, those within the MENA and SSA developing regions, substantial progress has been made towards reducing fertility rates. Fertility rates in these regions, however, still continue to be among the highest in the world. Developing regions have much larger slum populations compared to developed regions. This is in part owing to the failure of governments in these regions to adequately meet the demands (e.g., housing and jobs) of their growing population. As a result, existing slums expand and new slums emerge in order to informally accommodate the needs of this growing population. Given the typically high fertility rates in slum communities and the larger presence of slums in least developed countries that are currently facing the most pressing population growth and fertility issues, this study hypothesized that slums are in part responsible for fertility rates variations among least developed countries.

Analyzing data from a sample of 72 countries in the developing world, our results support the prior hypothesis that slums affect countries' fertility rates. More specifically, the results of this study show that an increase in the number of slum dwellers leads to a subsequent small increase in fertility rates. Additional drivers for fertility rates identified were contraceptive prevalence, female education, and infant mortality, all of which are consistent with the literature on fertility dynamics. For example, better-educated women are expected to be more knowledgeable on the use of contraceptive methods and ways of accessing them. These women may also favor fewer kids that can be well taken care of, compared to having large families where resources shared amongst family members may become stretched too thin. As a result, our analyses show that an increase in female education reduces the instance of fertility rate. Further, while the results for contraceptive prevalence and female education were consistent across all models derived in this study, the same was not true for infant mortality. This finding remains an area for future research.

In order to test the robustness of the *slum* measure, our study used two measures of slum: (i) the urban slum population as a percentage of the total urban population, and (ii) the urban slum population as a percentage of total population. The results of such analysis showed a similar small increase in fertility rate with the increase in the number of slum dwellers. Such empirical findings are important since, with the increased growth of slum communities, their impact may become magnified in the future due to the multiplier effect.

Thus, in order to adequately address the fertility rate issues that least developed countries are experiencing, governments in these countries should take a more active role in better managing their slum populations.

Various limitations were also identified in this study, which provide opportunities for future work. Chief among these were the limited sample of countries used and the spatial and temporal granularity of the data. Thus, with the collection of higher spatial and temporal resolution data on populations within countries, a more accurate depiction of both the current state of fertility rates and slums as a moderating factor of fertility can be realized. This study also used a limited set of factors that are known to influence fertility rates, however, as discussed in Section 2, many other factors help drive fertility rates. A study using other factors known to affect fertility rates should therefore be carried out. For example, the role that war and conflict events play in affecting fertility rate differentials would be an interesting study. Similarly, some countries may have specific policies implemented to help curb fertility rates in slums, which may have assisted in explaining fertility rate differentials among countries. Moreover, while our main approach towards analyzing data was based on a comparison of OLS and FE models, the use of other modeling approaches (e.g., heterogeneous regression or random effects models) may lead to different results. Such areas of inquiry should further be explored in the context of a comparison of fertility rates within and among countries in order to better understand the specific issues that drive fertility rates in different cities, countries and regions of the world.

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Appendix

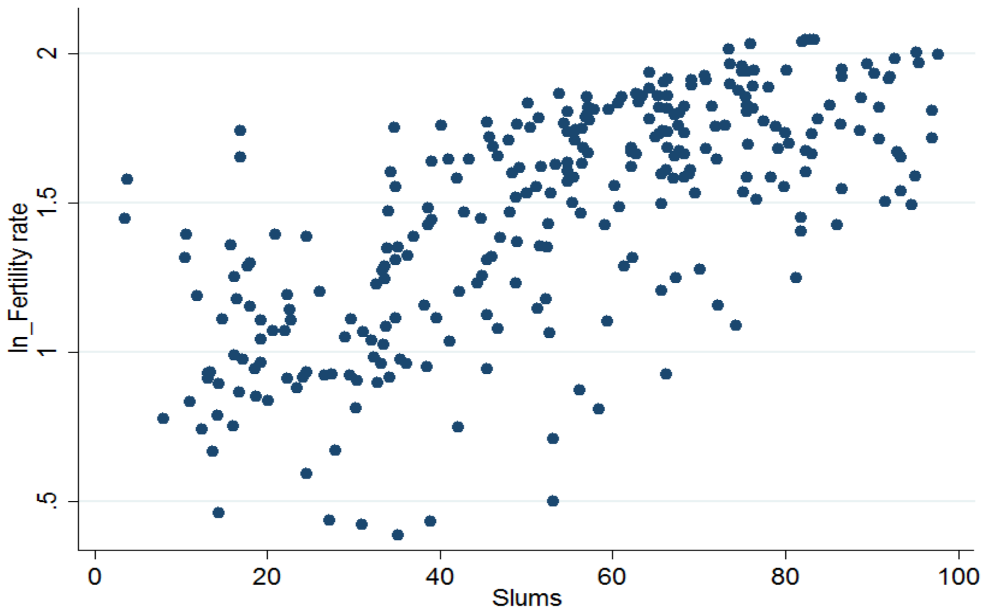

Figure A.1. Bivariate relation between Ln total fertility rate and slums, 72 countries

Notes: The vertical axis represents the log transformation of total fertility rates which is measured as the number of children that would be born to a woman if she were to live to the end of her childbearing years. The horizontal axis represents the percentage of the urban population who are living in slums. For every country there exist five dots representing the five-year averages (1990-1994, 1995-1999, 2000-2004, 2005-2009, 2010-2014).

Source: World Bank (2017) and UN (2016)

Table A.1. List of countries

Regions	Countries
Middle East and North Africa	Iraq, Jordan, Syrian Arab Republic, Egypt, Arab Rep., Lebanon Morocco, Saudi Arabia, Tunisia, Yemen, Rep
Sub Saharan Africa	Angola, Congo, Rep., Malawi, Nigeria, Swaziland, Gabon, Benin, Cote d'Ivoire, Mali, Rwanda, Gambia, Burkina Faso, Djibouti, Kenya, Mauritania, Sao Tome and Principe, Tanzania, Burundi, Togo, Cameroon, Equatorial Guinea, Lesotho, Mozambique, Senegal, Comoros, Central African Republic, Guinea-Bissau, Liberia, Namibia, Sierra Leone, Chad, Guyana, Madagascar, Nicaragua, Somalia, Uganda, Congo, Dem. Rep., Niger, Sudan, Zambia, Zimbabwe, Guinea, Ethiopia, Ghana.
Latin America and Caribbean	Colombia, Dominican, Haiti, Bolivia, Brazil, Honduras, Argentina, Armenia, Peru, Mexico
East Asia and Pacific	China, Indonesia, Philippines
South Asia	Bangladesh, India, Pakistan, Nepal, Afghanistan
Europe and Central Asia	Turkey

Source: World Bank (2017)

Table A.2. Largest 10 countries in terms of their shares of slum dwellers and fertility rate

Countries	Slums (Mean= 19.58)	Fertility rate (Mean= 4.70)	Infant mortality (Mean= 63.98)
Yemen	54.78	8.23	7.96
Niger	50.59	7.74	10.21
Somalia	43.21	7.67	13.14
Afghanistan	39.60	7.61	13.78
Burundi	36.42	7.46	14.56
Chad	36.36	7.37	14.6
Angola	35.04	7.16	15.75
Ethiopia	34.59	7.14	16.68
Mali	34.53	7.13	16.76
Congo, Democratic Republic	33.95	7.13	16.86

Notes: slums variable is measured as a percentage of total population. Fertility rate is the number of children that would be born to a woman if she were to live until the end of her childbearing years. Mortality rate is the number of infants dying before reaching one year of age, per 1,000 live births in a given year.

Source: World Bank (2017) and UN (2016)

Table A.3. Variables description

Variable	Description and source	Source
Fertility rate (Ln.)	Number of children that would be born to a woman if she were to live to the end of her childbearing years.	(World Bank, 2017)
Slums	Household or a group of urban people living under the same roof, lacking one or more of the following, poor structural quality of housing, overcrowding, inadequate access to safe water, scant access to sanitation and other infrastructure, and insecure residential status. Measured as a percentage of total urban population.	(UN, 2016)
Contraceptive	Women who are practicing, or whose sexual partners are practicing, any form of contraception. Measured as a percentage of women aged between 15 and 49.	(World Bank, 2017)
Female primary education	New entrants (enrollments minus repeaters) in the last grade of primary education, regardless of age, divided by the population at the entrance age for the last grade of primary education.	(World Bank, 2017)
Female unemployment	Share of female labor force that is without work but available for and seeking employment. Measured as a percentage of female labor force.	(World Bank, 2017)
Child labor	Primary-school-age children that are not enrolled in primary or secondary school. Measured as a percentage of relevant age group.	(World Bank, 2017)
Income	GDP per capita annual growth rate	(World Bank, 2017)
Income inequality	Gini index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. A value of 0 represents perfect equality, while an index of 100 implies perfect inequality.	(World Bank, 2017)
Inflation	Annual percentage change of the consumer price index that reflects changes in the average cost a basket of consumer goods and services.	(World Bank, 2017)
Trade	Sum of exports and imports of goods and services. Measured as a percentage of GDP.	(World Bank, 2017)
Government effectiveness	Perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures. Measured as a score that ranges from approximately -2.5 to 2.5.	(World Bank, 2016)
Political stability	Perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism. Measured as a score that ranges from approximately -2.5 to 2.5.	(World Bank, 2016)
Population growth	Annual growth rate of total population which is measured by subtraction number of births from number of deaths	(World Bank, 2017)
Infant mortality (Ln.)	Number of infants dying before reaching one year of age, per 1,000 live births in a given year.	(World Bank, 2017)
Poverty	Poverty headcount ratio at $1.90 a day (2011 PPP). Measured as a percentage of total population.	(World Bank, 2017)
Agricultural land	Percentage of land area that is arable, under permanent crops, and under permanent pastures.	(World Bank, 2017)
HIV	Prevalence of HIV refers to the percentage of people ages 15-49 who are infected with HIV.	(World Bank, 2017)

Table A.4. Descriptive statistics

	Obs.	Mean	Standard Deviation	Minimum	Maximum
Fertility rate (Ln.)	360	1.48	0.39	0.39	2.11
Female unemployment	350	11.57	8.90	0.34	41.42
Slums	285	53.40	23.44	3.50	97.65
Slums (% total population)	285	19.58	9.32	1.13	54.78
Child labor	274	23.29	19.70	0.10	80.85
Female primary education	281	63.87	27.31	7.27	119.34
Income	275	0.71	1.31	-9.72	3.94
Contraceptive	291	35.61	22.60	1.70	88.53
Agricultural land	360	46.23	19.51	2.96	82.05
Infant mortality (Ln.)	360	3.99	0.62	2.07	5.12
Income inequality	345	9.00	6.59	0.60	34.22
Inflation	191	44.77	7.93	29.81	65.76
Trade	337	69.98	42.57	0.86	440.74
HIV	330	3.52	5.62	0.10	29.62
Poverty	214	36.17	25.00	0.41	94.05
Government effectiveness	288	-0.69	0.57	-2.28	0.55
Political stability	288	-0.77	0.83	-3.08	0.97
Population growth	360	2.30	1.08	-3.27	6.21