Title: Regional differences of causal effects of urbanization on fertility. Evidence from 174 Demographic Health Surveys (1990-2011)

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Abstract
Demographers and Economists have widely documented the relationship between urbanization and fertility. They found lower fertility levels in urban areas compared with rural areas. However, this finding is debatable given that regressing urbanization on fertility implicitly assumes "**homogeneity**" between urban and rural areas. Yet it is well known that urban and rural areas are very unlike on many factors strongly correlated with fertility (e.g., education, women's employment, age at marriage, child mortality). Therefore, whether the urbanization-fertility relationship is causal or a mere association still remains a crucial unanswered question especially due to the cross-sectional nature of data. Using Poisson regression models with endogenous treatment effects and matching techniques to account for the rural-urban heterogeneity that was ignored in previous studies, this paper revisited the relationship between place of residence and children ever born (CEB) from 174 Demographic Health Surveys in developing countries. In a meta-analysis of individual country effects, we found a causal negative and significant effect of urbanization on fertility. Additionally, we examined the trends of the effects of urbanization on fertility and found variations over time in specific countries with at least two DHS. These variations are categorized as "*enhancing*", "*constant*", or "*diminishing*" effect between urbanization and fertility.

Introduction

In 2014, our planet reached 7 billion of inhabitants of which 6.0 billion are leaving in developing world (Population Reference Bureau (PRB), 2014; United Nations, Department of Economic and Social Affairs Population Division, 2013). Compared with developed countries, the natural increase of population in developing countries is still high. Approximately 165 births per minute are born in developing countries compared to three births in developed countries. The natural increase in developing countries is and will remain in the near future the leading cause of population growth in the developing world while those countries bear the major share of the poor (Collier, 2007), including orphans, vulnerable children and youth. Consequently the demographic landscape in developing countries is pulling down the well-being around the world. Improving population well-being worldwide is of top priority and a subject of hot debate since World War II (e.g., see discussions in International Population Conferences: Bucharest, 1974; Mexico, 1984; Cairo, 1994). The debate sought to maintain or promote the adequacy between the volume of population and well-being. This perspective led demographers and social scientists to focus on the major factors affecting birth rates and fertility levels. Among other factors, urbanization has captured much attention in Population Studies with a consistent finding: "*Fertility is lower in urban than rural areas*" (Galor, 2005; Hiday, 1978; Jaffe, 1942; Robinson, 1963).

However, whether the relationship between urbanization and fertility is causal or a mere association still remains a crucial unanswered question after more than 70 years. Previous research on the relationship between urbanization and fertility has two main drawbacks, theoretically and empirically. On a theoretical perspective, previous studies lack a clear distinction between the effects of rural-urban migration and urbanization on fertility. Those studies draw interchangeably on the same theories/hypotheses (*selection, disruption,* and *adaptation/socialization)* to explain the effects of migration and urbanization on fertility. In recent examples (e.g., Chattopadhyay, White, & Debpuur, 2006; Gyimah, 2006; White, Tagoe, Stiff, Adazu, & Smith, 2005; White et al., 2008), rural-urban migration appears to be the major explanation of the differentials in fertility levels between rural and urban areas. Similar hypotheses are found in studies with a focus on the relationship between migration and fertility (Jensen & Ahlburg, 2004; Kulu, 2005; Stephen & Bean, 1992). Although these studies clearly admit that urban populations differ in many ways from rural populations (White et al., 2008), they merely ignore the individual and structural factors lowering fertility levels in urban areas. This is referred to as *homogeneity bias*. The *homogeneity assumption* from previous research leads to biased estimations of the effect of urbanization on fertility. For instance, it is well known that urban women are advantaged over their rural counterparts on most influential characteristics of fertility decline: urban women are more educated, have greater access to contraception, medias, medical care, and they are more likely to report low levels of fertility preferences, paid work, or to be assisted by a qualified medical personnel during delivery. Most of these factors have been found to correlate with low levels of mortality rates that affect the levels of fertility in less developed countries (LDCs).

Theory: The non-ignorable heterogeneity assumption between urban and rural areas

Scholarly interest in fertility decline has intensified since World War I and II (Notestein, 1945; Thompson, 1929). Economists and demographers pointed out urbanization as a major factor of fertility decline in both developed and developing countries. According to this narrative, urbanization has brought sustainable changes in many factors associated with the decline of fertility including the importance of children as part of labor force, the cost of chid-rearing and children's education, women's education and employment opportunities, infant mortality rate, increase of age at marriage in urban areas, availability of contraception. They marginally included the availability of legal abortions, religious beliefs, traditions and cultural norms. Although these factors are associated with fertility decline in developed countries, there are some contingencies when analyzing the relationship between urbanization and fertility in LDCs. Another neglected issue in studies about the relationship between urbanization and fertility is whether the link is direct or is simply mediated by the aforementioned factors. For instance, White et al. (2008) showed that the effect of urbanization on fertility, after controlling for age cohort, education, employment and in-school status, was significant in all-parity and parity 0 models. These effects were not significant for higher-order parities. This finding suggests that the effect of urbanization may be time-dependent and/or is mediated by other factors.

Broadly speaking, theory on the urbanization-fertility relationship can be categorized into two areas: Economics and Demography. Economic perspective emphasizes the role of women's education, work experiences and aspirations, migration, and poverty to understand fertility decline. Demographic perspective pinpoints to marriage/family patterns and age at marriage, child mortality or the replacement fertility hypothesis, contraception use and fertility preferences. In this paper, I consider that the two perspectives do not operate in isolation (Jain & Ross, 2012).

Data and Methods

I use data from 174 Demographic and Health Surveys (DHS) collected in 70 countries around the world between 1990 and 2011. The 70 countries include 36 countries in sub-Saharan Africa, 11 countries in North Africa/West Asia/Europe, 11 countries in Latin America and Caribbean, nine countries in South and South East Asia, and three countries in Central Asia.

Variables measurement

Outcome variables. Children Ever Born (CEB), the total number of children to whom the woman has ever given birth, is the outcome of interest in this paper. In the DHS, information was collected to measure the lifetime fertility (CEB) and fertility in the last five years (CEB-5). I chose these two variables because of the cross-sectional nature of the data. While the lifetime CEB may represent a more complete picture of fertility in a given population, CEB-5 is more realistic assuming that the woman was living in her current place of residence.

Treatment variable. The type of current place of residence is the treatment variable. It is a binary variable: rural *versus* urban. The basic idea in using place of residence as the treatment variable as I mentioned earlier relies on the heterogeneity between rural and urban women. Therefore I use a quasi-experiment to correct for the bias of the selection-on-observables between rural and urban women.

Other variables included in the estimations. The variables included in the models: woman's education (in completed years), age and age-squared (due to the fertility curves), migration status and the duration at current place of residence, age at marriage, and marriage duration, child mortality measured by the total number of sons and the total number of daughters who died, and the ideal number of children as a measure of fertility preferences.

Analytic framework

This article adopts the counterfactual framework (Neyman, 1990(1923); Rubin, 1974; Rubin, 1978) where the outcome of interest (CEB or CEB-5) by the type of place of residence (rural vs. urban). The two states of place of residence, also called the *treatment variable*, is a binary variable coded 0 for rural residents and 1 for urban residents at the time of the survey. Each woman i in the DHS sample has two potential outcomes: Y_{1i} if the woman was exposed to the treatment (e.g., the woman lives in urban areas) and Y_{0i} if the woman belongs to the control group (e.g., the woman lives in rural areas). The question in potential outcomes approach is therefore, what would be the outcome (fertility levels measured as CEB) if the woman who lives in the urban areas were living in the rural areas, and vice-versa. In other words, potential outcomes are denoted by Y_1 to indicate the outcome that would have resulted if the woman was exposed to the treatment group "urban residence", and Y_0 if the woman was exposed to the control group "rural residence" (Rosenbaum & Rubin, 1983).

Results: Regional and sub-regional differences of the effect of urbanization on fertility

Tables 1 and 2 present the effects of urbanization on fertility using Poisson model with endogenous treatment effects for children ever born (CEB) and children ever born in the last five years (CEB-5) by geographic region using meta-analysis of countries' estimates, respectively. They also include tests of significance (*z-statistics* and *p-values*) of the effect size or each region/sub-region. For sub-Saharan Africa, I present the results for each geographic sub-region: Western Africa, Eastern Africa, Central Africa, and Southern Africa. Findings from Table 1 indicate that the overall effect of urbanization on the lifetime fertility is negative (ATE[1]= -0.137; 95%CI = -0.145; -0.121; p = 0.000). By region/sub-region, findings indicate a negative effect of urbanization on the lifetime fertility, except for Central Africa where the effect is slightly positive but not significant (ATE = 0.001; 95%CI = -0.057; 0.059; p = 0.968). From Table 2, findings indicate that the overall effect of urbanization on current fertility is also negative and statistically significant (ATE= -0.218; 95%CI = -0.236; -0.200; p = 0.000). Unlike the lifetime fertility, the effect of urbanization on current fertility levels is consistent for all regions/sub-regions: findings show significant negative effects, ranging from Central Asia (ATE = -0.459; 95%CI = -0.386; -0.215; p = 0.000) to Central Africa (ATE = -0.121; 95% = -0.192; -0.050; p = 0.001).

Discussion and conclusion

The goal of this paper was to examine whether the relationship between urbanization and fertility is causal or it is a mere association using 175 DHSs from 70 developing countries. The findings consolidate earlier evidence on the connection between urbanization and lifetime/current fertility. While many early studies have noted the association between urbanization and fertility (White et al., 2005; White et al., 2008), the present analysis takes us beyond that well-known observation in many aspects. First, the paper used an innovative approach that accounts for the heterogeneity between rural and urban areas. Indeed, previous studies have regressed urban residence on fertility; therefore they assumed homogeneity between urban and rural areas because the coefficient of urban residence represents the mean effect of urbanization on fertility. Although there are justifiable reasons to do so, the underlying assumption of homogeneity between rural and urban areas does not hold and it is debatable. Indeed, it is well known that rural and urban areas significantly differ from many factors (education, access to contraception, fertility preferences, occupation, age at marriage) that are strongly associated with fertility levels. Second, while relationship observed in previous studies is a mere association (Robinson, 1963; White et al., 2008; Zarate, 1967), this analysis deepens our awareness of the causal relationship between urbanization and fertility levels. Overall, we observed a significant causal negative effect of urbanization on lifetime/current fertility. Third, urbanization showed time-varying effects. In fact, we found an **enhancement effect** in some countries when the effect of current period is higher than the one from previous period. We also observed a **diminishing effect** in which the effect of urbanization in the current period is lower compared with the past period. More interestingly, the differences in which the effect of urbanization was constant in consecutive periods were marginal: 10% for the lifetime and actual fertility levels. Therefore, in-depth analysis is required to understand the variations over time of the effects of urbanization on lifetime fertility and current fertility.

These findings have major policy implications in developing countries hosting 6 out of 7 billion in our planet. In establishing a causal relationship between urbanization and fertility, this paper advocates for a commitment of national governments to reduce the inequalities between urban and rural areas. In fact, as we mentioned earlier, fertility is not lower in urban areas compared to rural areas because it should be, but it is lower because urban and rural areas are so different with respect to factors which are theoretically and empirically associated with fertility. They are different demographically and economically. This paper borrowed arguments from demographic and economic perspectives to theorize why and how fertility could differ in urban

[1] This estimate is interpreted as the logarithm of the ratio of the urban mean total fertility rate to the rural mean fertility rate. Therefore taking exp(-0.137) = 0.88; it means that the average number of children in urban residence is 0.88 times the average number of children per woman in rural areas.

and rural areas. Reducing inequalities such as education which has many implications (e.g., education increases age at marriage, and consequently age at first birth) may have a strong influence on fertility reduction. In many developing countries, especially in sub-Saharan Africa, the proportion of girls attending secondary schools, compared to elementary schools, drastically drops during this transition. According to UNESCO, SSA has the lowest transition rates to secondary school (United Nations Educational, Scientific and Cultural Organization (UNESCO), 2011). Besides education, economic indicators need to be improved in rural areas. Instances include women's financial autonomy and employment in both urban and rural areas. These factors are of chief importance to expect a sustainable fertility decline in developing countries.

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Table 1: Summary of the Effects of Urbanization on Children Ever Born by Geographic Regions

Sub-Region	Number of Observations	Estimate	95% Confidence Interval		Min	Max	z-stat.	p-value
Western Africa	31	-0.100	-0.127	-0.074	-0.403	0.186	7.4	0.00
Eastern Africa	40	-0.203	-0.241	-0.164	-0.562	0.069	10.3	0.00
Central Africa	11	0.001	-0.057	0.059	-0.229	0.399	0.04	0.97
Southern Africa	7	-0.222	-0.276	-0.169	-0.286	-0.126	8.2	0.00
North Africa/West Asia/Europe	28	-0.088	-0.105	-0.071	-0.474	0.040	10.3	0.00
Central Asia	4	-0.301	-0.386	-0.215	-0.361	-0.188	6.9	0.00
South & S.E. Asia	25	-0.084	-0.104	-0.065	-0.397	0.075	8.6	0.00
Latin America	28	-0.143	-0.160	-0.125	-0.432	0.081	16.3	0.00
All	174	-0.133	-0.145	-0.121	-0.562	0.399	21.4	0.00

Notes:
[1] Western Africa: Min = Nigeria (1999); Max = Mauritania (2000); Eastern Africa: Min = Madagascar (1992); Max = Madagascar (2003); Central Africa: Min = Cameroon (2004); Max = Cameroon (1991); Southern Africa: Min = Lesotho (2009); Max = Namibia (1992); North Africa/West Asia/Europe: Min = Morocco (1992); Max = Yemen (1991); Central Asia: Min = Kazakhstan (1999); Max = Uzbekistan (1996); South & South East Asia: Min = Philippines (2003); Max = Pakistan (1990); Latin America: Min = Paraguay (1990); Max = Guyana (2009); All: Min = Madagascar (1992); Max = Cameroon (1991)
[2] Estimations in Model 7 did not converge for Burkina Faso (2003)
[3] Z-statistics: Significance Tests of Effect Size (ES = 0)

Table 2: Summary of the Effects of Urbanization on Children Ever Born in the Last Five Years by Geographic Regions

Sub-Region	Number of Observations	Estimate	95% CI		Min	Max	z-stat.	p-value
Western Africa	32	-0.191	-0.229	-0.154	-0.444	0.035	9.96	0.00
Eastern Africa	40	-0.288	-0.329	-0.248	-0.694	-0.075	13.99	0.00
Central Africa	11	-0.121	-0.192	-0.050	-0.262	0.040	3.34	0.00
Southern Africa	7	-0.356	-0.430	-0.281	-0.503	-0.256	9.37	0.00
North Africa/West Asia/Europe	28	-0.145	-0.170	-0.120	-0.650	-0.021	11.29	0.00
Central Asia	4	-0.419	-0.600	-0.238	-0.662	-0.225	4.53	0.00
South & S.E. Asia	24	-0.134	-0.163	-0.106	-0.410	0.045	9.13	0.00
Latin America	28	-0.257	-0.291	-0.223	-0.779	-0.096	14.81	0.00
All	174	-0.218	-0.236	-0.200	-0.779	0.045	23.72	0.00

Notes:
[1] Western Africa: Min = Ghana (2003); Max = Niger (1992); Eastern Africa: Min = Comoros (1996); Max = Mozambique (1997); Central Africa: Min = Cameroon (2004); Max = Central Africa (1994); Southern Africa: Min = Lesotho (2009); Max = Namibia (1992); North Africa/West Asia/Europe: Min = Morocco (1992); Max = Armenia (2005); Central Asia: Min = Kyrgyz Republic (1997); Max = Uzbekistan (1996); South & South East Asia: Min = Philippines (1993); Max = Pakistan (1990); Latin America: Min = Brazil (1991); Max = Dominican Republic (2002); All: Min = Brazil (1991); Max = Pakistan (1990)
[2] Estimations in Model 7 did not converge for Nepal (2006)
[3] Z-statistics: Significance Tests of Effect Size (ES = 0)