Rural Push, Urban Pull and... Urban Push? New Historical Evidence from Developing Countries*

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Abstract: Standard models explain urbanization by rural-urban migration in response to an (expected) urban-rural wage gap. The Green Revolution and rural poverty constitute *rural push* factors of migration. The Industrial Revolution and the urban bias are *urban pull* factors. This paper offers an additional demographic mechanism, based on internal urban population growth, i.e. an *urban push*. Using newly compiled historical data on urban birth and death rates for 7 countries from Industrial Europe (1800-1910) and 33 developing countries (1960-2010), we show that many cities of today's developing world are "mushroom cities" vs. the "killer cities" of Industrial Europe; fertility is high, while mortality is much lower. The high rates of urban natural increase have then accelerated urban growth and urbanization in developing countries, with urban populations now doubling every 18 years (15 years in Africa), compared to every 35 years in Industrial Europe. This is further found to be associated with higher urban congestion, possibly mitigating the benefits from agglomeration and providing further insights into the phenomenon of urbanization without growth. Both migration and urban demographics must be considered in debating urbanization.

Keywords: Urbanization; Demographic Transition; Migration; Poverty; Slums
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1. INTRODUCTION

Developing countries have dramatically urbanized over the past 60 years (World Bank, 2009). While their urbanization process shares many similarities with the urbanization process of developed countries in the 19th century, the two processes also differ in several dimensions. First, urban growth has been faster in today's developing world. The Industrial Revolution led to a dramatic acceleration of urbanization (see Figure 1): Europe's urbanization rate increased from about 15% in 1800 to 40% in 1910. In 1950, Africa and Asia were made up of predominantly low-income, rural countries (urbanization rate around 15%). In 2010, their urbanization rate was around 40%. African and Asian countries have thus experienced the same growth in urbanization as Europe, in half the time. Second, while income growth remains the main driver of urbanization, the world is becoming more and more urbanized at a constant income level. In 1960, the 35 countries whose income per capita was less than $2 a day had an average urbanization rate of 15% (World Bank, 2013). In 2010, the 34 countries with similar incomes had an average rate of 30%. The cities of today's developing world are also much larger. Mumbay, Lagos and Jakarta have the same population as New York, Paris and London respectively, at a much lower income level. Dhaka, Kinshasa and Manila are urban super-giants located in very poor countries. This raises several questions. Where do these cities come from? Did they grow as a result of migration? Did they grow too fast?

In models of urbanization, there is rural-to-urban migration as long as the expected urban real wage is higher than the rural real wage (Harris & Todaro, 1970). This wage gap could be the result of a *rural push* or an *urban pull*. There are various rural push factors. If the country experiences a Green Revolution, the rise in food productivity releases labor for the modern sector and people migrate to the cities (Schultz, 1953; Matsuyama, 1992; Caselli & Coleman II, 2001; Gollin, Parente & Rogerson, 2002; Nunn & Qian, 2011; Motamed, Florax & Matsers, 2013). Rural poverty due to land pressure or natural disasters causes rural migrants to flock to cities (Barrios, Bertinelli & Strobl, 2006; da Mata et al., 2007; Yuki, 2007; Poelhekke, 2010; Henderson, Storeygard & Deichmann, 2013).[1] Then there are various urban pull factors. If the country experiences an Industrial Revolution, the urban wage increases, which attracts workers from the countryside (Lewis, 1954; Hansen & Prescott, 2002; Lucas, 2004; Alvarez-Cuadrado & Poschke, 2011). A country that exports natural resources also urbanizes if the resource rents are spent on urban goods and services, causing the urban wage to rise (Gollin, Jedwab & Vollrath, 2013; Jedwab, 2013). If the government adopts urban-biased policies, the urban wage also increases (Lipton, 1977; Bates, 1981; Ades & Glaeser, 1995; Davis & Henderson, 2003; Majumdar, Mani & Mukand, 2004; Shifa, 2013). While the Green Revolution, Industrial Revolution and resource exports theories find that urbanization is associated with economic development, the rural poverty and urban bias theories imply that urbanization may occur without growth (Fay & Opal, 2000). All these theories assume that urbanization comes from migration only.

[1] Overoptimistic expectations about the incomes migrants can earn at the destination location also create excessive migration pressure (McKenzie, Gibson & Stillman, 2013; Farré & Fasani, 2013).

In this paper, we offer an additional mechanism for urbanization based on an *urban push*. Many cities of today's developing world can be classified as "mushroom cities" vs. the "killer cities" of the developing world of the 19th century; fertility is high, while mortality has fallen to low levels, due to the epidemiological transition of the 20th century. This has led to a high rate of natural increase in urban areas. First, we show that the urban push has accelerated urban growth and urbanization in developing countries, conditional on income. Second, we show that fast urban growth is associated with more congested cities, which has implications for economic development. We use the expression "urban push" as opposed to the "rural push" and "urban pull". "Rural push" implies that rural workers are pushed to the cities by changes in rural economic conditions. "Urban pull" implies that rural workers are attracted to the higher-wage cities. "Urban push" suggests that cities are growing internally and "pushing" their own boundaries. It is not that urban workers are being pushed to the countryside, but rather, high urban rates of natural increase are creating an urban population "push". Our analysis consists of three steps.

First, we provide historical evidence on the rapid growth of cities in today's developing world. The growth rate of the urban population has been about 4% a year in developing countries post-1960, vs. 2.0% a year in Industrial Europe in 1800-1910 (see Figure 2). We then use various historical country-level sources to create an extensive new data set on the crude rates of birth and death separately for the urban and rural areas of 7 European (or Neo-European) countries in the 19th century (every forty years in 1800-1910) and 33 countries that were still developing countries in 1960 (every ten years in 1960-2010). We can thus accurately compare the demographic foundations of the urbanization processes of the old and new developing worlds.[2] We show that the fast growth of cities in today's developing world was mostly driven by natural increase, and not by migration as in Europe. We confirm that the cities of Industrial Europe were "killer cities", where mortality was high and fertility was low. On the contrary, the cities of today's developing world are "mushroom cities", where fertility is high and mortality is low. The resulting difference in urban rates of natural increase caused the population of cities in today's developing world to double every 18 years (15 years in Africa), compared with 35 years in Industrial Europe. Even if natural increase contributed to urban growth, and raised the absolute number of urban residents, it also contributed to rural growth. The urbanization rate, the relative number of urban residents, may not have risen as a result. Yet simulations suggest it also increased urbanization rates.

Second, we use our panel data set on 33 countries (1960-2010) to investigate econometrically the effects of urban natural increase on the speeds of urban growth and urbanization. We show that the stylized facts that have been established by the comparative analysis hold when including country and decade fixed effects, controlling for income growth and the various rural push and urban pull factors that

[2]Our analysis builds on the previous work of historians and geographers such as Rogers (1978), Keyfitz (1980) and Rogers & Williamson (1982). We complete their preliminary analysis by using historical data on 40 "developing" countries, past and present, in two centuries. First, most economists have focused on the individual cases of England or the U.S. in the 19th century (Williamson, 1990; Haines, 2008). We have been able to collect the same type of data for as many as 7 European countries, which allows us to generalize their results for the old developing world. Second, while there are individual case studies for a few developing countries for selected periods, we have systematically collected the same type of data for 33 countries every ten years from 1960 to 2010. We could not increase the sample size as historical consistent data does not exist for other countries as far back as 1960. The numerous historical sources that we used are described in the Online Data Appendix.

are traditionally put forward in the literature, and even adding region fixed effects interacted with a time trend (e.g., Western Africa, Eastern Africa, etc.). The identification then comes from the *within-country* comparison of neighboring countries of the same region over time. Even if we cannot be sure that our effects are causal (as is often the case with cross-country regressions), we are able to rule out many potential alternative explanations. Since we study an important macro question, we must use macroevidence, even if the effects will not be as well identified as in the microdevelopment literature (see Cohen & Easterly (2010) for a description of how different methodologies can help address different questions). The results also hold when using cross-sectional data for 97 countries that were still developing countries in 1960, but for the most recent period only. Urban natural increase has a strong effect on urban growth and urbanization. A 1 standard deviation increase in the rate of urban natural increase leads to a 0.50 standard deviation increase in the urban growth rate and a 0.30 standard deviation increase in the change in urbanization. We find that differences in urban natural increase explain why urban growth has been faster in today's developing world, and in Africa in particular. These differences may also contribute to explaining why African and Asian countries have recently experienced the same growth in urbanization as Industrial Europe, but in half the time, and why Africa is relatively urbanized for its income level. The urban push has thus accelerated the speed of urban growth and urbanization.

Third, fast urban growth can give rise to urban congestion, which may decrease urban welfare. If capital (e.g., houses, schools, hospitals and roads) cannot be accumulated as fast as population grows, cities grow too fast and the stock of urban capital per capita is reduced. If the urban population of today's developing world doubles every 18 years, the housing stock also needs to double every 18 years. Congestion effects arise if agents are not investing in advance, whether they are credit-constrained or not forward-looking. Urban labor supply shocks can also lead to a deterioration of urban labor market outcomes. Using a novel data set on urban congestion for a large set of countries, we show that fast urban growth due to natural increase is indeed associated with more congested cities today. The urban push is correlated with a higher proportion of urban population living in slums, lower investment in urban human capital, more polluted cities, and more workers in the urban informal sectors. The evidence suggests a world in which slums develop not just because migrants flock to cities, but also as a result of internal growth. We do not find any effect of the speed of urbanization, as what matters for urban congestion is really the absolute, rather than relative, number of urban residents. Our results are all the more important since fertility remains high in many cities, that will keep growing in the future. There are still 30 countries where the urban population doubles in less than 18 years, indicating the scope of the problem.

The paper also contributes to the literature on urbanization and growth. There is a strong correlation between development and urbanization, because of the two-way relationship between them. On the one hand, countries urbanize when they develop (Overman & Venables, 2005; Henderson, 2010; Henderson, Roberts & Storeygard, 2013). On the other hand, agglomeration promotes growth (Rosenthal & Strange, 2004; Glaeser & Gottlieb, 2009; Henderson, 2010). Given that urbanization is a form of agglomeration, cities could promote growth in developing countries (Duranton, 2008, 2013; World Bank, 2009). Urban natural increase can, however, create a disconnect between urbanization and growth. First, poor cities can expand even without an increase in standards of living. We provide an explanation for over-urbanization, additional to the existing theories of urban bias and rural poverty. Second, because natural increase accelerates urban growth, it can give rise to urban congestion effects, which may reduce the benefits from agglomeration. The speed of urban growth is, to our knowledge, a dimension of the urbanization process that has been understudied in the economics literature. All in all, urban natural increase in poor countries may have thus directly contributed to the "urbanization of poverty", the fact that the urban areas' share of the world's poor has been rising over time (Ravallion, 2002; Ravallion, Chen & Sangraula, 2007). Third, whether urban growth is driven by migration or natural increase has strong policy implications. When urban congestion is the result of excessive migration, it may not be justified to invest in urban infrastructure, as it could further fuel migration. However, if urban growth is due to urban natural increase, the resulting immediate increase in the urban population necessitates investment in urban infrastructure. If agents do not internalize the negative externalities associated with their fertility decisions, another policy option may be to encourage lower urban fertility rates. Lastly, we have created a consistent data set that will allow researchers to systematically study the urbanization process across space and time. Bandiera, Rasul & Viarengo (2013) provide another example of how collecting historical demographic data can help us revisit issues that are still extremely relevant today.

Our findings also advance the literature on the effects of demographic growth. Population growth promotes economic growth if high population densities encourage human capital accumulation or technological progress (Kremer, 1993; Becker, Glaeser & Murphy, 1999; Lagerlöf, 2003). However, population growth has a negative effect on per capita income if capital (e.g., land) is inelastically supplied. Any positive income shock is then temporary; fertility increases and mortality decreases, so that any increases in the stock of capital (and income) per capita are eventually negated. Income is stable and low in the long-run.[3] Countries only develop if technology progresses and the demographic transition limits population growth (Galor & Weil, 1999, 2000; Hansen & Prescott, 2002). If the economy is Malthusian, any increase (decrease) in population decreases (increases) the capital-labor ratio and per capita income.[4] In this paper, we use an increase in population, studying it from the perspective of cities. Second, since urban space is constrained, the potential for congestion effects is high. Third, there are few studies of the effects of population growth in Africa (Young, 2005; Ashraf, Weil & Wilde, 2011; McMillan, Masters & Kazianga, 2011). We show that African cities will keep growing at a fast pace in the future, which has implications for the growth process of the continent.

The paper is organized as follows: Section 2 offers a framework to analyze the effects of urban natural increase. Section 3 presents the historical background and the data. Sections 4, 5, and 6 show the effects of urban natural increase on urban growth, urbanization and urban congestion respectively. Section 7 concludes.

[3]During the Malthusian growth regime, the most advanced societies have larger populations, but not significantly higher incomes (Diamond, 1997; Ashraf & Galor, 2011; Vollrath, 2011).

[4]A few studies have examined the effects of disease eradication on mortality, population growth and economic development (Acemoglu & Johnson, 2007; Bleakley, 2007; Bleakley & Lange, 2009; Bleakley, 2010; Cutler et al., 2010). Other studies have looked at the effects of decreases in population on development, whether these are caused by disease, war or fertility restrictions (Young, 2005; Voigtländer & Voth, 2009; Ashraf, Weil & Wilde, 2011; Voigtländer & Voth, 2013*a*,*b*).

2. CONCEPTUAL FRAMEWORK

This section provides a simple framework to analyze the relationships between natural increase, migration, urban growth, urbanization and urban congestion.

2.1 Urban Natural Increase and Urban Growth

Urban growth consists of four components: urban natural increase, rural-to-urban migration, international-to-urban migration and urban reclassification. There are rural (international) migrants as long as the urban wage is higher than the rural wage (wage in the country of origin). We abstract from the issues of expectations, prices and amenities to simplify the analysis. The wage gap could be the result of an *urban pull* or a *rural push*. Lastly, rural land is reclassified as urban when villages are absorbed by a city, or when a locality becomes urban given the urban definition. In many countries, a locality is considered urban if its population size exceeds a certain population threshold. The equations of urban and rural growth are:

$$\triangle Upop_t = Uni_t * Upop_t + Rmig_t + IUmig_t + Urec_t \tag{1}$$

$$\triangle Rpop_t = Rni_t * Rpop_t - Rmig_t + IRmig_t - Urec_t \tag{2}$$

where $\triangle Upop_t$ ($\triangle Rpop_t$) is the growth of the urban (rural) population in year t, Uni_t (Rni_t) is the urban (rural) crude rate of natural increase in year t, $Upop_t$ ($Rpop_t$) is the urban (rural) population at the start of year t, $Rmig_t$ is the number of net rural-to-urban migrants in year t, $IUmig_t$ ($IRmig_t$) is the number of net international-to-urban (rural) migrants in year t, and $Urec_t$ is the number of rural residents reclassified as urban in year t. The urban (rural) crude rate of natural increase is the urban (rural) crude birth rate minus the urban (rural) crude death rate. If urban (rural) fertility is higher than urban (rural) mortality, the urban (rural) rate of natural increase is positive, and the urban (rural) population expands. Equation (1) must be divided by the urban population at the start of year t to be expressed in percentage form. The number of “residual migrants” (Mig_t) is defined as the sum of rural migrants, international migrants and rural residents reclassified as urban. The urban growth rate is thus equal to the sum of the rate of urban natural increase (Uni_t) and the “residual migration” rate ($Mig_t/Upop_t$):

$$\triangle Upop_t/Upop_t = Uni_t + Mig_t/Upop_t \tag{3}$$

2.2 Urban Natural Increase and Urbanization

The urbanization rate at the start of year t, U_t, is the ratio of the urban population $Upop_t$ to the total population Pop_t. The change in the urbanization rate in year t, $\triangle U_t$, is positive if urban growth is faster than rural growth. Even if natural increase contributes to urban growth, it also contributes to rural growth. For countries that are mainly rural, rural natural increase disproportionately augments the size of the rural population: $Rni_t Rpop_t \geq Uni_t Upop_t$, even if $Rni_t \leq Uni_t$, because $Rpop_t \geq Upop_t$. Therefore, natural increase reduces the urbanization rate for a predominantly rural country. As the country becomes more urbanized, the contribution of urban natural increase to urbanization rises. In countries that are already urbanized, this contribution declines, as there is less room to grow. We expect an inverted-U relationship between the change in urbanization and urban growth. To study this relationship, we decompose the change in the urbanization rate using the equations above. Nni_t is the national rate of natural increase in year t. The other variables are the same as above. We obtain the following equations:

$$\triangle U_t = \frac{Upop_{t+1}}{Pop_{t+1}} - \frac{Upop_t}{Pop_t} = \frac{Upop_{t+1}}{Pop_{t+1}}\frac{Rpop_t}{Pop_t} - \frac{Upop_t}{Pop_t}\frac{Rpop_{t+1}}{Pop_{t+1}} \tag{4}$$

$$\triangle U_t = (1-U_t)\frac{(1+Uni_t)Upop_t + Mig_t}{(1+Nni_t)Pop_t} - U_t\frac{(1+Rni_t)Rpop_t - Mig_t}{(1+Nni_t)Pop_t} \tag{5}$$

$$\triangle U_t = \frac{U_t}{(1+Nni_t)}[(1-U_t)(Uni_t - Rni_t) + \frac{Mig_t}{Upop_t}] \tag{6}$$

The change in urbanization positively depends on the differential between the urban and rural rates of natural increase (Uni_t vs. Rni_t) and the "residual migration" rate ($Mig_t/Upop_t$). It also depends on the initial urbanization rate (U_t) and aggregate natural increase (Nni_t, which is a function of Rni_t, Uni_t and U_t). To study the potential effect of urban natural increase, we simulate equation (6) using the following parameters: $Rni = 2.5\%$ and $Mig_t/Upop_t = 1.5\%$ per year. These values have been chosen based on the comparative analysis in section 3.7. We use $Uni = 0.5\%$ as a benchmark to see how raising the urban rate of natural increase alters urbanization. Figure 3 shows the results of the simulation for five values of $Uni_t = \{1; 1.5; 2; 2.5; 3\}$, given an initial urbanization rate U_t. The effects are large. Increasing the urban rate of natural increase from 0.5% to 3% raises the change in the urbanization rate by 0.45 percentage points on average. As aforementioned, the effects are higher for median values of the urbanization rate.

2.3 Urban Natural Increase and Urban Congestion

Cities grow too fast if urban population grows faster than urban capital, and the stock of capital per capita decreases. Various types of capital could be accumulated: physical and human capital, the housing stock, or transport infrastructure. Assuming that capital cannot be accumulated as fast as population grows, fast urban growth leads to urban congestion. For example, raising the urban rate of natural increase from 0.5% to 3%, given a migration rate of 1.5%, causes the urban population to double every 15 years, instead of 35 years. Then, the urban housing stock also needs to double every 15 years. This is possible if the urban growth is not unexpected, agents are forward-looking, and have sufficient credit available to make the investment. If not, congestion effects are likely to arise when urban growth is fast. We expect a lower effect of the change in urbanization, as what matters for urban congestion is the absolute, rather than relative, number of urban residents. Though urban congestion may reduce future migration, migration may still remain high as it depends on the difference between rural and urban welfare.

2.4 Empirical Considerations

Urban natural increase may determine the speeds of urban growth and urbanization. The speed of urban growth is then a factor of urban congestion. We now discuss various issues regarding the empirical analysis of these relationships.

Dynamic model. Equation (3) assumes that the relationships between urban growth and its two components are additive. When estimating this relationship empirically, the coefficient of the rate of urban natural increase could be equal to one. However, we could imagine that urban natural increase and migration influence themselves and each other dynamically, which could bias (downward or upward) the coefficient of the urban rate of natural increase. Four relationships should be considered: (i) $Mig_t = f(Mig_{t-1})$: High migration rates have a dissuasive effect on future migration, if the migrants crowd out the cities, or if the pool of potential migrants is reduced, (ii) $Uni_t = g(Mig_{t-1})$: Urban residents adjust their fertility rates if migrants crowd out the cities. However, migration may actually have a positive effect on future urban fertility if urban congestion impoverishes everyone, which prevents any adjustment in fertility. Fertility is indeed higher in poorer contexts, because of the trade-off between child quantity and child quality. Besides, a high share of migrants in the urban population also affects urban fertility and mortality if it alters the age structure of the cities. If migrants are of reproductive age, migration also increases future urban fertility, (iii) $Mig_t = h(Uni_{t-1})$: Urban natural increase has a dissuasive effect on future migration, if the urban newborns crowd out the cities, and (iv) $Uni_t = j(Uni_{t-1})$: Urban residents adjust their fertility rates if urban newborns crowd out the cities. However, urban natural increase may actually have a positive effect on future urban fertility if urban congestion impoverishes everyone, which prevents any adjustment in fertility. Lastly, urban natural increase could also affect the age structure of the cities. We will control for these four dynamic relationships in the analysis to test the additivity and causality of the effects.

Urban reclassification. Births and deaths are usually registered depending on the main place of residence. This location is classified either as urban or rural, which permits the estimation of urban and rural birth and death rates. This is important when distinguishing the effects of natural increase and migration. For example, a child who is born in an urban family is counted as "urban", no matter whether the family moved to the city twenty years prior or just the year before the census. The family contributes to the urban population, because it lives in a city. However, a child that follows her parents when they migrate to a city is also counted as a rural migrant. There could be composition effects as argued above, hence the need to control for past migration.[5] Urban reclassification could then be higher in countries where the urban rate of natural increase is high, since the rural rate of natural increase could also be high in such countries ($Urec_t = \varphi(Rni_t)$). Fast rural growth could increase overall population densities, and the largest villages could become cities. Or it could increase the pool of potential rural migrants. Another possibility could be that, in countries where urban growth is fast due to natural increase, cities disproportionately absorb their surrounding rural areas when they expand spatially ($Urec_t = \chi(\triangle U_{t-1})$). These mechanisms could lead to an upward bias, if urban reclassification is indeed more important in countries where urban natural increase is high. Therefore, it will be essential to control for the effects of rural natural increase and urban growth on future urban growth via urban reclassification.

Causality. Though the previous analysis treats urban natural increase as exogenous, it could be endogenously determined by the economic conditions in the cities (i.e., the urban wage). We will show in section 3.3 that urban mortality does not vary much across countries, and that urban fertility is the main determinant of urban natural increase. Many low-income countries have not yet completed their urban fertility transition. Higher returns to education in fast-growing countries have somewhat

[5]The numbers of urban newborns and residents are estimated using permanent residence. Temporal migrants contribute to the rural population, and their newborns are counted as "rural". In our analysis, we focus on permanent residence, since this is what matters for urbanization.

modified the trade-off between child quantity and quality in favor of child quality. We could thus expect higher urban fertility rates in poorer and less urbanized countries. In accordance with convergence, less urbanized countries should urbanize faster than more urbanized countries. This could give rise to multiple equilibria. In countries that have already achieved their urban fertility transition, urban growth is slower, and urban congestion effects are limited. If urban congestion (e.g., road congestion) reduces urban productivity, growth in these areas is only slightly affected by congestion. If income remains high, fertility stays low. Countries in which urban fertility is high experience fast urban growth. If urban growth is too fast, urban congestion effects kick in, which lower urban productivity. If income is low, urban fertility remains high, and urban fertility and urban congestion reinforce each other. The urbanization rate will not increase if rural growth is also high, as rural fertility does not adjust. That is why it will be important in our empirical analysis to compare countries with similar initial income and urbanization levels, but whose rates of urban natural increase differ. This will not solve the endogeneity issue, but this will allow us to show that urban natural increase is associated with the urban outcomes, conditional on the feedback mechanism discussed above. In the panel analysis, we will also include country and decade fixed effects, controls for the rural push and urban pull factors of urbanization as well as the relationships discussed above, and even region fixed effects interacted with a time trend. The effect is not causal if there are still unobservable factors that explain why urban natural increase and the urban outcomes are correlated over time *within* countries, relative to the neighboring countries of the same region, conditional on the numerous controls we include. While we cannot be sure that our effects are entirely causal, we are thus able to rule out many potential alternative explanations.

3. DATA AND BACKGROUND

We now discuss the historical background and the data we use in our analysis. The Online Data Appendix contains more details on how we construct the data.

3.1 New Data for Developing Countries, 1700-2010

In order to analyze the contribution of urban natural increase to urban growth and urbanization, we need historical data on urbanization, urban fertility and urban mortality for the developing worlds of the 19th and 20th centuries. First, we compile data from various sources to reconstruct the urban growth and urbanization rates for 19 European and North American countries from 1700-1950 (about every forty years), and 116 African, Asian and non-North American countries that were still developing countries in 1960, from 1900-2010 (about every ten years). This allows us to compare the urbanization process of five "developing" areas: "Industrial Europe" (which includes the United States in our analysis), Africa, Asia, Latin America (LAC) and the Middle-East and North Africa (MENA). Second, we obtain historical demographic data for 40 of these countries: 7 European countries for the 1700-1950 period (about every forty years), and 33 countries in Africa (10), Asia (11), the LAC region (8) and the MENA region (11) for the 1960-2010 period (about every ten years). For each country-period observation, we obtained the national, urban and rural crude rates of birth, crude rates of death and crude rates of natural increase (per 1,000 people). Since historical demographic data was not readily available, we recreated the data ourselves using various historical sources, as well as the *UN Statistical Yearbooks* and various reports of the *Population and Housing Census*, the *Fertility Surveys* and the *Demographic and Housing Surveys* of these countries.[6] We then collect the same type of data for as many countries as possible that were still developing countries in 1960 (N = 97 out of the full sample of 116 countries), but for the most recent period only (for the closest year to the year 2000). We also have demographic data for the largest city only.

3.2 Patterns of Urbanization in Developing Countries, 1700-2010

The most advanced civilizations before the 18th century had urbanization rates of around 10%-15% (Bairoch, 1988). When a few countries industrialized, their urbanization rates dramatically increased, usually from 10% to 40%. Figure 1 shows the urbanization rate for Industrial Europe from 1700-1950 (using the full sample of 19 countries). The urbanization rate was stable (around 12.5%) until 1800 and increased to 41.3% in 1910. Countries that industrialized earlier also urbanized earlier. Figure 1 also shows the urbanization rate for four developing areas (using the full sample of 116 countries): Africa, Asia, LAC and MENA. The LAC region had already surpassed the 40% threshold in 1950, while the MENA region did not surpass it until 1970. In 1950, Africa and Asia were made up of predominantly low-income, rural countries (urbanization rate around 10%). In 2010, their urbanization rate was around 40%. In our analysis, we focus on the 1800-1910 period for Europe and the 1960-2010 period for Africa and Asia. During these periods, the urbanization rates of the three areas increased from 10% to 40%.

3.3 Urban Growth Rates in Developing Countries, 1700-2010

Figure 2 shows the urban growth rate for Industrial Europe from 1700-1950 (N = 19). It peaked in the late 19th century and declined in the 20th century. In the 1800-1910 period, the overall urban growth rate was 2.0% per year. Figure 2 also shows the urban growth rate for the four developing areas from 1900-2010 (N = 116). The urban growth rate has been 3.8% on average in today's developing world post-1960, and 4.7% a year in Africa, compared to 3.4%, 3.2% and 4.0% in Asia and the LAC and MENA regions respectively. An urban growth rate of 3.8% (or 4.7% as seen in Africa) implies that cities double every 18 (15) years, while a rate of 2.0%, as seen in Europe, means that cities double every 35 years. These rates peaked in the 1950s or 1960s, with the acceleration of rural migration and the demographic transition. They have been declining since, although they are still high today. We obtain similar urban growth rates when considering the largest city only. We now use our data to provide descriptive evidence on the respective contributions of natural increase and migration to urban growth and urbanization for the 40 countries for which we have historical demographic data.

3.4 The "Killer Cities" of Industrial Europe

We use data for 7 countries from 1700-1950 to explain the concept of "killer cities" (Williamson, 1990). We focus on English cities as a classical example. Demographic patterns in English cities have been described by Williamson (1990), Clark & Cummins (2009) and Voigtländer & Voth (2013*b*). We add to this literature by collecting

[6]The list of the 40 developing countries that we use in the main analysis, and the data sources for each country are reported in the Online Data Appendix and Online Appendix Tables 1, 2 and 3. We could not increase the sample size as historical consistent data does not exist for other countries.

the same data for 6 other countries, which allows us to generalize the results. Results are shown in Figure 4. Fertility was relatively low in England (about 35 per 1,000 people before 1910).[7] Mortality was high, especially in the cities. In the 19th century, the urban death rate was 10 points higher on average than the rural death rate (about 30 vs 20). High urban densities, industrial smoke, polluted water sources and unhygienic practices all contributed to this urban penalty (Williamson, 1990; Voigtländer & Voth, 2013*b*). As a result, the average rate of urban natural increase was low in 1800-1910, at 5 per 1,000 people (or 0.5%). Online Appendix Table 1 shows that these patterns are present for the six other countries. In all countries, the contribution of urban natural increase to urban growth was less than 0.6% a year in 1800-1910: 0.5% in England vs. 0.5% in Belgium, 0.1% in France, 0.6% in Germany, 0.4% in the Netherlands, 0.3% in Sweden and 0.4% in the United States. The average rate was 0.5% a year for Industrial Europe.

3.5 The "Mushroom Cities" of The Developing World

We use data on 33 countries from 1960 to 2010, to explain the concept of "mushroom cities". Figure 5 plots the urban and rural birth rates for the four developing areas in 1960-2010.[8] Initially, urban fertility was high in developing countries, and in Africa in particular (about 50 per 1,000 people). Urban fertility rates decreased almost everywhere post-1960, yet they remain high in Africa (about 35). Figure 6 then plots the urban and rural death rates from 1960-2010.[9] In 1960, urban death rates were already low in most of the developing world, around 10-20. Acemoglu & Johnson (2007) show that the epidemiological transition of the mid 20th century (e.g., the discovery and consequent mass production of penicillin in 1945) and massive vaccination campaigns in the colonies resulted in widespread and significant declines in mortality. The acceleration of urban growth in the 1950s illustrates this phenomenon (see Figure 2). The colonizers also invested in health, educational and transport infrastructure, which led to higher standards of living, as shown by anthropometric and other development outcomes (Moradi, 2008; Huillery, 2009; Jedwab & Moradi, 2013). Cities were centers of diffusion of innovation, explaining why urban mortality was low initially. Differences in urban natural increase are thus driven by differences in urban fertility. While urban mortality does not vary much across countries, urban natural increase is highly correlated (correlation coefficient of 0.93) with urban fertility, whose variance is much higher (Online Appendix Figure 2 shows this for 97 countries). Figure 7 then shows the rates of natural increase from 1960-2010. These rates were high both for the cities and the countryside across all regions in 1960 and have been decreasing since. While urban natural increase was high in the LAC and MENA regions in 1960, these areas have almost

[7] Most European countries were then characterized by the "European Marriage Pattern", in accordance with which women married late and fertility was lower (Hajnal, 1965). What explains this specific pattern is unclear, but Voigtländer & Voth (2013*a*) show how the Black Death in the 14th century had a long-term impact on marital and fertility patterns.

[8] The birth rate is a function of the total fertility rate and the number of women of reproductive age. The urban fertility rate is the main determinant of urban birth rates. For 97 developing countries for which we have data for the closest year to the year 2000 in the interval 1990-2010, the correlation coefficient between the two variables is 0.93 (see Online Appendix Figure 1).

[9] The death rate is a function of the child mortality rate (0-5 years), the youth mortality rate (5-15 years) and the adult mortality rate (15 and above years). At the cross-country level in developing countries, child mortality is the main factor of aggregate mortality. We focus on the period 1960-2010, while HIV-related adult mortality only became a major concern in the 2000s. For example, in Southern Africa, the average prevalence rate was about 20% in 2000 and 2010, but 2.5% in 1990.

completed their fertility transition. Asia started its transition earlier. Then, urban natural increase is still more important in Africa in 2010 than it was in Asia in 1960. African cities will keep growing due to natural increase for several decades.

3.6 Urban Natural Increase and Urban Growth

We use equation (3) to decompose urban growth into urban natural increase and residual migration for the 40 countries. Figure 3 shows the decomposition in England from 1700-1910. Urban growth was driven by migration, while the contribution of natural increase was small. England could not have urbanized without rural residents migrating to unhealthy urban environments. Results from the six other countries confirm these patterns (see Online Appendix Table 1). During the 1800-1910 period, Industrial Europe's urban growth was 2.2% per year, while the urban rate of natural increase was 0.5%. The difference, about 1.7%, was accounted for by residual migration. Figure 8 shows the decompositions for the four developing regions (N = 33), as well as the decompositions for England (1700-1950) and the developing world (1960-2010) (see Online Appendix Table 2 for each country). Migration rates, which average 1.6%, were not different in developing countries (post-1960) from Industrial Europe. The difference in urban growth (3.8% vs. 2.2%) comes from urban natural increase (2.3% vs. 0.5%), which accounted for almost two thirds of urban growth post-1960. Urban growth was faster in Africa (4.9%) than in the MENA region (3.6%), Asia (3.5%) and the LAC region (3.1%) because the urban rate of natural increase was also higher. While it was 2.9% on average in Africa, it was 2.6% in the MENA region, 1.6% in Asia and 2.2% in the LAC region. Therefore, across space and time, the contribution of migration to urban growth was around 1.5% per year. Countries differed in their urban growth as a result of urban natural increase only. For example, using an urban rate of natural increase of 2.9% (1.6%), as in Africa (Asia), a family of four migrants in 1960 becomes a family of about fifty (thirty) urban residents in 2010.

3.7 Urban Natural Increase and Urbanization

Europe and the four developing areas widely differed in their urban rates of natural increase. On average, their rural rates of natural increase were much more similar: around 2% in Europe and Asia, and 2.5% in other regions. In Figure 3, we simulated equation (6), using the following parameters: $Rni_t = 2.5\%$ and $Mig_t/Upop_t =$ 1.5% per year. We used $Uni = 0.5\%$ as a benchmark, and showed the results of the simulation for five values of $Uni_t = \{1; 1.5; 2; 2.5; 3\}$, given an initial urbanization rate U_t. This allows us to compare the potential effects of urban natural increase *ceteris paribus* for East Asia ($Uni_t \approx 1\%$), Asia (1.5%), the LAC region (2%), the MENA region (2.5%), and Africa (3%), relative to Europe (0.5%). The annual effects are potentially large (e.g. 0.2 points of urbanization for Africa, given an initial urbanization rate of 10%). The larger the urban rate of natural increase, and the closer to 50% the initial urbanization rate, the larger the effect on urbanization. In 2010, Africa's urbanization rate was about 40% and urban natural increase was 2.5%. The urbanization rate could increase to 45% in 2020.

4. RESULTS ON URBAN GROWTH

In this section, we use econometric regressions and our panel data for 33 countries (1960-2010) to investigate the effects of urban natural increase on urban growth.

4.1 Main Results

We use panel data for 33 countries that were still developing countries in 1960. We run the following model for $t = [1960s, 1970s, 1980s, 1990s, 2000s]$:

$$Ugr_{c,t} = \alpha + \beta Uni_{c,t} + \gamma_c + \delta_t + u_{c,t} \tag{7}$$

where $Ugr_{c,t}$ is the annual urban growth rate (%) of country c in decade t. Our variable of interest is the urban rate of natural increase (per 100 people, or %) of country c in decade t ($Uni_{c,t}$). All regressions include country and decade fixed effects (γ_c; δ_t). The country fixed effects control for time-invariant heterogeneity at the national level. The identification of the effect then comes from decadal variations in urban natural increase *within* countries. Table 1 presents the results. Column (1) shows that urban natural increase has a strong effect on urban growth (0.95***). In column (2), we show that this effect is robust to controlling for log GDP per capita and the urbanization rate at the start of the decade, and log GDP per capita at the end of the decade. First, poor countries have a high fertility rate (they have not completed their fertility transition yet) and their cities will grow faster since they are initially smaller. Controlling for initial income and urbanization adjusts for these convergence effects. Second, since we are controlling for income at the end of the decade, our effects are estimated conditional on contemporary income and income growth during the decade. This allows to measure the contribution of urban natural increase to urbanization *without* growth.

There are several alternative theories for urbanization in developing countries that may make the results in columns (1) and (2) spurious. We include four area fixed effects (Africa, Asia, LAC and MENA) interacted with a time trend to control for time-variant heterogeneity at the continental level. We also control for the various rural push and urban pull factors mentioned in the conceptual framework. Including income in the regression controls for the Green and Industrial Revolutions, as the structural change literature has shown how they were highly correlated. We also include the following controls at the country level: (i) Green Revolution (rural push): average cereal yields (hg per ha) in the same decade; (ii) Industrial and Service Revolutions (urban pull): the share of manufacturing and services in GDP (%) 2010 interacted with decade fixed effects (the same share is missing for too many countries in earlier decades); (iii) natural resource exports (urban pull): the share of natural resource exports in GDP (%) in the same decade; (iv) rural poverty (rural push): rural density (1000s of rural population per sq km of arable area), the number of droughts (per sq km), and an indicator equal to one if the country has experienced a civil or interstate conflict in the same decade to control for land pressure and disasters; and (v) urban bias (urban pull): an indicator equal to one if the country's average combined polity score is strictly lower than -5 (the country is then considered autocratic according to *Polity IV*), and the primacy rate (%) - an alternative measure of urban bias - in the same decade. The urban bias was indeed stronger in more autocratic regimes (Ades & Glaeser, 1995; Shifa, 2013). The inclusion of area fixed effects (column (3)) and controls (column (4)) does not alter the positive association of urban growth with urban natural increase.

In column (5), we include ten region fixed effects (Central Africa, Eastern Africa, Southern Africa, Western Africa, East Asia, South-East Asia, South Asia, Oceania, the Caribbean, Central America, South America, Middle-East and North Africa) interacted with a time trend, to control for time-variant heterogeneity at the regional level. The effect is then identified by comparing neighboring countries of the same region over time. The effect is almost equal to one now (1.01***). This suggests that the relationship between urban growth and urban natural increase is additive. A 1 standard deviation increase in the urban natural increase rate leads to a 0.51 standard deviation increase in the urban growth rate. Then, if the urban rate of natural increase of today's developing world had been the same on average as in the developing world of the 19th century (2.3 vs 0.5), its average annual urban growth rate would have been 2.1% instead of 3.8% *ceteris paribus*, and thus almost the same as in Industrial Europe (2.2%). Likewise, if Africa's urban rate of natural increase had been the same on average as in Asia in 1960-2010 (2.9 vs 1.7), its average annual urban growth rate would have been 3.7% instead of 4.9% *ceteris paribus*, and thus almost the same as in Asia (3.9%). In column (6), we decompose the urban rate of natural increase into the urban birth rate and the urban death rate. Both rates have a strong effect on urban growth (0.98*** and -1.12**).

4.2 Robustness

Robustness. The results of various robustness checks are displayed in Table 2. Column (1) replicates the main result from column (5) of Table 1 (the effect was 1.01***). In columns (3)-(7), we add variables estimated in decade t-1 and lose one round of data (N = 132 instead of 165). We thus verify in column (2) that the baseline effect is unchanged when dropping this round (1.05***). In column (3), we show that the effect remains the same (1.02***) when controlling for residual migration and urban natural increase in the previous decade. As discussed in the conceptual framework, there are four dynamic relationships that should be considered. We do not find a significant effect of lagged natural increase and migration on urban natural increase ($Uni_{c,t}$) or on residual migration ($Migr_{c,t}$) (columns (6) and (7)). The relationship between urban growth and urban natural increase is additive. In column (4), we include the annual urban growth rate in decade t-1 (the sum of the residual migration and urban natural increase rates in t-1). The main effect remains the same (1.02***). To control for countries in which urban growth is fast and cities expand spatially leading agglomerations to absorb surrounding rural areas in the next census year, the lag of urban growth rate is added. However, it is insignificant.[10] Including more lags give similar results (not shown, but available upon request), though their inclusion can lead to overfitting given the small number of observations. In column (5), we control for rural natural increase in decades t and t-1, as urban and rural natural increase could be correlated and influence each other. Besides, if rural growth is fast where urban growth is fast, because of rural natural increase, urban growth will be disproportionately associated with urban reclassification. The effect is almost unchanged (1.09***).

External validity. One limitation of the panel analysis is that we only employ data for 33 countries. For 64 other countries, we found the urban rate of natural increase for the closest year to 2000. We can run the following cross-sectional regression for (33 + 64 =) 97 countries that were still developing countries in 1960:

[10] Since we include country fixed effects, we control for the fact that countries use different urban definitions, which affect urban reclassification and urban growth. Urban reclassification is only an issue if it is correlated with changes in urban natural increase *within* countries, relative to neighboring countries of the same region (as we include region fixed effects interacted with a time trend).

$$Ugr_{c,1960-2010} = \alpha' + \beta' Uni_{c,2000} + u'_{c,1960-2010} \quad (8)$$

where $Ugr_{c,1960-2010}$ is the annual urban growth rate (%) of country c from 1960-2010 (i.e., the long difference). Our variable of interest is the urban rate of natural increase (per 100 people, or %) of country c in 2000 ($Uni_{c,2000}$). Urban demographic data does not exist for many countries before the 1990s. For the 33 countries for which we have historical data, the coefficient of correlation between the urban rate of natural increase in 2000 and the average of the same rate in 1960-2010 is 0.80. The rate in 2000 can thus be used as a proxy for the rate post-1960. The results are presented in Table 3. The unconditional regression shows a strong effect of urban natural increase on urban growth (column (1)). This effect is robust to: (i) controlling for income and urbanization in 1960, and income in 2010 (column (2)); (ii) adding area fixed effects (column (3)); (iii) including various time-invariant controls at the country level (column (4))[11]; and (iv) adding region fixed effects (column (5)). The effect in column (5) is lower than 1 (0.76***). The cross-sectional estimates are less reliable than the panel estimates, as the urban rate of natural increase in 2000 is simply a proxy for the same rate in 1960-2010. We should expect the relationship between urban natural increase and urban growth to be less well-measured as a result, which should lead to a downward bias.

We also focus on the largest city of these countries. We use the same cross-sectional model as in column (5), except the dependent variable is the annual growth rate (%) of the largest city of each country from 1960-2010, and the variable of interest is the birth rate of this city in 2000 (which we use as a proxy for its rate of natural increase in 1960-2010). We could not find data on the death rate. The largest city's birth rate has a strong effect on the growth of that city (1.19***, column (6)). The effect is different from 1, but we cannot control for death rates here. Therefore, urban natural increase has accelerated urban growth in developing countries, whether we consider large agglomerations or small and medium-sized cities.

5. RESULTS ON URBANIZATION

In this section, we use econometric regressions and our constructed panel data set for 33 countries (1960-2010), as well as cross-sectional data for 97 countries (1960-2010), to investigate the effects of urban growth, and urban natural increase and residual migration in particular, on the change in the urbanization rate.

5.1 Main Results

We use panel data for 33 countries that were still developing countries in 1960. We run the following model for $t = [1960s, 1970s, 1980s, 1990s, 2000s]$:

[11] The controls are the same as in Table 1, except we consider the year 2010 or the period 1960-2010 to estimate the variables, instead of the current decade. The controls are described in the footnote below Table 3. As we cannot include country fixed effects, we also include various time-invariant controls at the country level. First, if countries with high urban fertility rates systematically use different methods for measuring urbanization, the correlations may reflect measurement error. We get around this issue by adding controls for the different possible definitions of cities in different countries: four indicators for each type of definition used by the countries of our sample (*administrative*, *threshold*, *threshold and administrative*, and *threshold plus condition*) and the value of the population threshold to define a locality as urban when this type of definition is used. Second, we also control for country area (sq km), country population (1000s), a dummy equal to one if the country is a small island (< 50,000 sq km) and an indicator equal to one if the country is landlocked, as larger, non-island and landlocked countries could be less urbanized for various reasons.

$$\Delta Urbrate_{c,t} = a + \kappa Ugr_{c,t} + \theta_c + \lambda_t + \nu_{c,t} \quad (9)$$

where $\Delta Urbrate_{c,t}$ is the change in the urbanization rate (in percentage points) of country c in decade t. Our variable of interest is the annual urban growth rate (%). Our hypothesis is that fast urban growth has raised urbanization rates in developing countries. All regressions include country and decade fixed effects (θ_c; λ_t). The regressions are the same as when urban growth was the dependent variable. Column (1) of Table 4 shows that fast urban growth is associated with higher urbanization rates (2.02***). This effect is robust to: (i) controlling for log GDP per capita at the beginning and the end of the decade (column (2)), which captures the effects of initial income and income growth on the change in urbanization, (ii) adding continent fixed effects interacted with a time trend (column (3)), (iii) including the time-varying controls at the country level (column (4)), and (iv) adding region fixed effects interacted with a time trend (column (5)). In the last specification, the effect is identified by comparing neighboring countries of the same region over time. The effect shows than a 1 percentage point increase in urban growth leads to a 1.91 percentage point increase in the urbanization rate every ten years. This effect is large. A 1 standard deviation increase in the urban growth rate is associated with a 0.90 standard deviation increase in the urbanization rate. As shown in the conceptual framework, there cannot be urbanization without fast urban growth.

Urban growth comes from residual migration or natural increase. When using the full specification, we find that the effect of migration is larger than the effect of natural increase (2.02*** vs. 1.21**, column (6))). A 1 standard deviation increase in residual migration (urban natural increase) is associated with a 0.77 (0.30) standard deviation increase in the change in urbanization. While urban natural increase is the main factor of urban growth, migration is the main determinant of urbanization. Recall that a rural migrant has a large effect on urbanization, removing one resident from the countryside (decreasing the rural population by one) and adding this resident to the cities (increasing the urban population by one). Therefore, while migration (i.e., the rural push and urban pull factors) remains the main driver of urbanization, urban natural increase has become a component of urbanization.

Since this increase in urbanization is disconnected from income growth, it also produces urbanization *without* growth. For example, Europe's urbanization rate increased from 15% in 1800 to 40% in 1910. Africa and Asia realized the same performance in half the time, between 1960 and 2010. Europe's urbanization rate has risen by about 2.5 percentage points every ten years during the 1800-1910 period. The decadal change was 4.5 percentage points in Africa and Asia post-1960. On average, the urban rate of natural increase was 1.7 percentage points higher in Africa and Asia than in Europe. Given an effect of 1.21, this gives a difference of about (1.7 x 1.21 =) 2.1 percentage points of urbanization every ten years. Urban natural increase thus contributes to explaining why today's developing world has urbanized at a much faster pace than the old developing world. It may also contribute to explaining why Africa is relatively urbanized for its income level, since it is the region with the highest urban rate of natural increase.

5.2 Robustness

Robustness. The results of various robustness checks are displayed in Table 5. Column (1) replicates the main results from column (6) of Table 4. In columns (3)-(6), we add variables estimated in decade t-1 and lose one round of data. The effect of urban natural increase slightly increases when dropping this round (1.58** rather than 1.21**, column (2)). In column (3), we confirm that the relationship is additive by showing that the natural increase effect remains the same (1.53**) when controlling for residual migration and urban natural increase in decade t-1. In column (4), we control for the urban growth rate in decade t-1, which is the sum of the residual migration and urban natural increase rates in decade t-1. The main effect is almost unchanged (1.41**). The effect is high if we control for the change in urbanization in decade t-1 instead (1.24**, column (5)). The lag of the change in urbanization has a small effect (0.24**). In column (6), we control for rural natural increase in decades t and t-1. The effect of urban natural increase is higher (1.94**). The results of columns (4)-(6) show that urban reclassification is not a major issue here, as the results hold when controlling for past urbanization or rural natural increase. The effect of migration is high and significant across all specifications (2.02-2.29). The effects are robust to controlling for the initial urbanization rate in 1960 interacted with decade fixed effects, to control for convergence effects in urbanization (not shown, but available upon request). Lastly, we test the effect of urban natural increase on the change in urbanization is higher for urbanization rates close to 50%, as seen in the simulation graph (Figure 3). We interact the urban rate of natural increase with a dummy variable equal to one if the urbanization rate at the start of the decade was between 30 and 70%. We find that the natural increase effect is higher for the observations in this interval (not shown).

External validity. We also run the following cross-sectional regression model for 97 countries c that were still developing countries in 1960:

$$\Delta Urbrate_{c,1960-2010} = a' + \kappa' Ugr_{c,1960-2010} + \nu'_{c,1960-2010} \qquad (10)$$

where $\Delta Urbrate_{c,1960-2010}$ is the change in the urbanization rate (in percentage points) between 1960 and 2010, and $Ugr_{c,1960-2010}$ is the annual urban growth rate (%) of country c from 1960-2010. We use the sample of 97 countries for which we know the urban rate of natural increase in 2000. The results are presented in Table 6. The unconditional regression shows a strong effect of urban growth on the change in urbanization (2.29**, column (1)). This effect increases as we: (i) control for income in 1960 and 2010 (column (2)); (ii) add area fixed effects (column (3)); (iii) include various controls at the country level (column (4)); and (iv) add region fixed effects (column (5)). The point estimates are higher in the full specification (5.57***, column (5)), because we correctly control for the other factors of urbanization. The cross-sectional estimates are more sensitive to the specification than the panel estimates, possibly because the panel regressions allowed us to include country fixed effects that already captured these factors well. A 1 percentage point increase in urban growth leads to a 5.57 percentage point increase in urbanization over 50 years, or a 1.11 percentage point increase every ten years. By comparison, the panel regressions showed a 1.91 percentage point increase every ten years. The cross-sectional effect is lower, likely because we estimate the relationship over 50 years rather than over 10 years, which should lead to a downward bias if there are swift changes within countries over time. In column (6), we find that the two subcomponents of urban growth indeed have a positive effect on the change in urbanization. A 1 percentage point increase in urban natural increase (residual migration) leads to a 3.64 (5.97) percentage point increase in urbanization over 50 years, or a 0.73 (1.19) percentage point increase every ten years.

6. RESULTS ON URBAN CONGESTION

Urban natural increase has thus accelerated urban growth and urbanization in developing countries, conditional on income. If urban growth is too fast, urban natural increase may result in urban congestion. Congestion effects arise from the fact that the urban population grows faster than available urban capital. Population growth may be unexpected, which reduces the stock of capital per capita. Or population growth is expected, but capital cannot be accumulated as fast as the population grows. Urban congestion reduces urban welfare, unless rising population densities produce large agglomeration effects, so that the net effects of this fast urban growth are positive. Panel data on the evolution of urban income over time does not exist, so we cannot test this hypothesis. But we can use cross-sectional data on various measures of urban congestion for the most recent period.

6.1 Fast Urban Growth and Slum Expansion

Our main measure of urban congestion is the share of the urban population living in slums (%) in 2005. We have data for 113 countries that were still developing countries in 1960. Slum data was recreated using UN-Habitat (2003) and United Nations (2013) data. We focus our analysis on 95 countries for which we also have data on urban natural increase in 2000. We run the following cross-sectional regression:

$$Slum_{c,2005} = b + \phi Ugr_{c,1960-2010} + \pi \triangle Urbrate_{c,1960-2010} + w_{c,2005} \tag{11}$$

where $Slum_{c,2005}$ is the slum variable (%), $Ugr_{c,1960-2010}$ is the annual urban growth rate (%) between 1960 and 2010, and $\triangle Urbrate_{c,1960-2010}$ is the change in the urbanization rate (%) between 1960 and 2010.[12] The hypothesis is that countries in which the urban population grew faster in the past have larger slums today. More precisely, if the urban population doubles every 18 years, the housing stock must be doubled every 18 years as well. This implies that agents invest now in order for the required housing stock to be available in 18 years. Otherwise, there will be congestion effects in housing markets. Slum expansion results from fast urban growth, whether because migrants flock to the cities, or because urban natural increase accelerates urban growth. The change in the urbanization rate should have a lower effect, since what matters for urban congestion is the absolute, rather than relative, number of urban residents. There are three caveats to our analysis.

First, we rely on cross-sectional estimates, as data is not available for a sufficient number of countries before 2005. Though data collection on slums began in 1990, 2005 is the first year in which it was systematic across countries.[13] Second, we assume that slum expansion is a good measure of housing congestion. If urban growth has been fast in the developing world, urban land expansion has also been fast (Angel et al., 2010; Seto et al., 2011). In many countries, urban areas grew faster than urban population, and urban densities decreased. Does that imply that housing supply increased faster than urban population? On the contrary, the fall in urban densities is a symptom of urban housing shortages. Wealthier cities are characterized by high densities, because people work and live in multi-storey buildings.

[12] The summary statistics of $Slum_{c,2005}$ are: mean: 49.3; std. dev. 32.3; min: 0; max: 99.4.

[13] Congestion effects should be larger for large agglomerations, as their growth is higher in absolute numbers, for a more constrained urban space. However, we do not have data on congestion for specific cities, and must use data for all cities instead.

In poor countries, the scarcity of multi-storey buildings forces people to move to the outskirts of their cities. There, people build one-storey shacks, thus producing a continuous decline in urban densities. Slum expansion is the right measure of *per capita* housing congestion. Third, we cannot be sure that the effects are causal. The correlation is spurious if urban fertility is higher in poorer countries that have not completed their fertility transition yet, and if cities in poorer countries have larger slums. Thus it is important to control for income in all regressions. Even if we control for many observable factors such as income, we cannot control for unobservable factors. Congested cities are less functional, which could then prevent any adjustment in urban fertility rates for reasons other than low urban incomes. If these reasons are not captured by the controls and the region fixed effects, the effects will not be causal. Our objective is more modest, in that we want to characterize an equilibrium (or trap) where fast urban growth is associated with urban congestion, no matter whether they reinforce each other.

Main Results. The results are displayed in Table 7. Column (1) shows the unconditional results, while we control for income in 1960 and 2010 in column (2). In columns (3) and (4), we also add area fixed effects and the time-invariant controls at the country level. In column (5), we include region fixed effects. The identification comes from comparing neighboring countries within a region over time. The correlation between urban growth and slums holds when using the most demanding specification (6.43**, column (5)). A 1 standard deviation increase in urban growth is associated with a 0.32 standard deviation increase in the share of the urban population living in slums. The change in the urbanization rate has no effect. A 1 standard deviation decrease in the income variables (whose coefficients are not shown) is then associated with a 0.40 standard deviation increase in the slum share. Thus, while low income explains slum expansion, fast urban growth may have also contributed to this expansion. Another way to assess the magnitude of these results is to compare across continents. If the urban growth rate had been the same in Africa as in Asia (3.5 instead of 4.9), the slum share would have been 10 percentage points lower (given a mean of 49.3% in the sample).

Additional Results. If countries are unable to cope when urban growth is very fast, we could expect non-linearities in the relationship between slums and urban growth. What really matters for slum expansion is the number of years in which an urban population doubles (i.e., the "true" speed of urban growth). An urban population doubles in t years if $(1 + Ugr/100)^t = 2$. The number of years in which it doubles is then equal to $\log(2)/\log(1{+}Ugr/100)$. There is thus a convex, decreasing relationship between the true speed of urban growth and the urban growth rate. In column (6), we use the full specification to show that the number of years in which an urban population doubles reduces the slum share (-0.5***). For example, the urban population of today's developing world doubled every 18 years, compared to every 35 years in Industrial Europe, implying a potential 8.5 percentage point increase in slum share. In column (6), we investigate whether the effect is larger for countries whose average number of years in which the urban population doubles is below the sample mean (about 20 years). The effect for the group of countries experiencing fast urban growth (whose population doubles in less than 20 years) is twice higher now (-0.6 + -0.7 = -1.3***). The slum share is 6 percentage points higher in countries where the urban population doubles every 20 years rather than every 30 years, and 13 percentage points higher in countries where the urban population doubles every 10 years rather than every 20 years.

The two components of urban growth – urban natural increase and residual migration – are then correlated with slum expansion (14.44*** vs. 4.58*, column (8)). The coefficient is higher, and more precisely estimated, for the former than for the latter. When standardizing the variables, we find that a 1 standard deviation increase in urban natural increase (residual migration) is associated with a 0.30 (0.20) standard deviation increase in the slum share. The standardized effect is also lower for migration. One interpretation could be that the *type* of urban growth matters for slum expansion. Natural increase raises the number of children and the dependency rate, which lowers income per capita. Migration increases the number of adults and reduces the dependency rate, and migrants may be highly motivated, which increases income per capita. Higher incomes allow households and governments to invest more in the quality of the housing stock.[14]

6.2 Alternative Measures of Urban Congestion

We now focus on alternative measures of urban congestion, for the most recent period. This type of urban data does not also exist for earlier decades, and we have to rely on cross-sectional regressions. We use the full specification, as in column (5) of Table 7. We control for income in 1960 and 2010, and we include the other controls and the region fixed effects. The results are displayed in Table 8. For the sake of space, we do not report the coefficient of the change in the urbanization rate. The effects of a 1 one standard deviation increase in each variable of interest on one standard deviation in the dependent variable are reported in brackets.

Other housing measures: A slum household is defined as a group of individuals living under the same roof lacking one or more of the following conditions (UN-Habitat, 2003): (i) sufficient-living area, (ii) structural quality, (iii) access to improved water source, and (iv) access to improved sanitation facilities. We study the various subcomponents of the slum variable. Data is available for a lower number of countries for some subcomponents, which may reduce the significance of the effects. First, we obtain a positive correlation between urban natural increase and the share of urban inhabitants who lack sufficient-living area, i.e. who live in dwelling units with more than 3 persons per room (8.6*, column (1)). The effect is smaller and not significant for migration. Second, there is a negative (but not significant) correlation between urban natural increase and the share of urban inhabitants who live in a residence with a finished floor, a measure of structural quality (-6.5, column (2)). Third, there is a negative correlation between urban natural increase and the share of urban inhabitants who have access to an improved water source (-3.5**, column (3)). Migration also has a positive effect (-2.0*). Fourth, the effects are small when the dependent variable is the share of urban residents with improved access to sanitation facilities (column (4)). Sanitation facilities are more important than other dimensions of housing. A household is considered to have access to improved sanitation if an excreta disposal system is available to the household. Given a constrained budget, households and local governments prioritize this dimension

[14]Another interpretation could be that urban newborns live in slums located in the cities, while migrants reside in slums in the periphery. If peripheral slums are not always classified as urban, this reduces the association between slums and migration. However, this is only an issue if there are separate slums for newborns and migrants, and if migrants decide to stop exactly at the periphery of these cities, which may not be credible. Additionally, we examine the correlation between slums today and the demographic rates in 2000, which proxy for rates in 1960-2010. If there may have been distinct slums when cities were still small in 1960, current agglomerations will likely have incorporated the periphery-slums now (2010), minimizing these concerns.

over other dimensions, which could explain the non-effect. The lack of sufficient-living area and an easy access to improved drinking water may be less essential. Fast urban growth would then be a constraint, as there are too many non-essential dimensions in which agents must and can act.[15]

Educational infrastructure: As the population of some cities grew very fast, the number of health and educational facilities had to increase rapidly to match the demand for human capital. However, the health and education sectors are often highly regulated in the cities. Governments may have been unable to keep up with the population growth. They needed to invest in new facilities and train and hire new specialized workers (e.g., physicians and teachers). Rather unfortunately, cross-country data on urban health infrastructure per capita does not exist. Then, since we do not have cross-country data on the overcrowding of urban schools, we use as a dependent variable the urban share of 6-15 year-old children that attended school in the last year. We use as our main sources of data IPUMS census microdata and the *Demographic and Health Surveys* that are available for many countries. One issue with this measure is that it captures both the supply and demand for educational infrastructure per capita. As we control for income in the regressions, it may capture the factors driving the demand for education, but we cannot be sure. Urban natural increase is strongly associated with lower attendance rates (-11.8***, column (5)). The effect is lower and not significant for migration. This is logical if natural increase disproportionately increases the population share of children.

Transport infrastructure: Unfortunately, we do not have data on road congestion in cities of developing countries today. This type of data is not collected by international organizations, and population censuses and household surveys do not ask questions about how much time people spend commuting on average. We know that traffic jams have become a major issue in these cities though (Kutzbach, 2009). For example, UN-Habitat (2008) describes how the outward spreading of African cities, the lack of efficient public transport and an increase in car ownership rates all contribute to rising road congestion. Zenou (2011) explains that improving the transport infrastructure in the cities can increase urban employment. We use particulate matter (PM) concentrations in residential areas of cities with more than 100,000 residents in 2000 as a proxy for car pollution and road congestion (World Bank, 2013). Urban natural increase is indeed positively associated with car pollution (17.18*, column (6)). Urban natural increase is not the only driver of pollution. However, it has contributed to it; a 1 standard deviation increase in urban natural increase is associated with a 0.27 standard deviation increase in car pollution. Migration has no effect, possibly because cities that attract migrants are wealthier, and their local governments are able to invest in transport infrastructure.

Labor market outcomes: Urban natural increase also results in urban labor supply shocks. If urban demand does not rise as fast as urban labor supply, the newcomers will be unemployed, or employed by the urban refugee sectors - low productivity sectors that mostly employ unskilled workers such as "personal and other services".

[15] It is interesting to note that urban congestion does not necessarily increase urban mortality in developing countries today (see Figure 6). Sewage systems were often inadequate in the cities of Industrial Europe. They were a major source of water-borne diseases and urban mortality (Cutler & Miller, 2004; Voigtländer & Voth, 2013*a*). Sewage systems may be of better quality in today's developing world, thanks to advances in public health in the last century. The fact that fast urban growth does not lead to urban congestion in sanitation in our sample is in line with this hypothesis.

We do not have consistent data on urban unemployment or informal employment as countries often use different definitions, which lead to large variations in urban unemployment and informality rates. However, as described in the Online Data Appendix, we use IPUMS census microdata, and labor force survey and household survey data to recreate the sectoral composition of urban areas for as many countries as possible around 2000. For each country, we know the urban employment shares of 11 sectors.[16] In column (7), we regress the urban employment share of "personal and other services" on the urban rate of natural increase. It is for example the least productive non-agricultural sector in the sample of 40 countries of McMillan & Rodrik (2011). Its employment share is a good proxy for the absorptive capacity of labor markets in developing countries. Column (7) shows that urban natural increase is associated with a higher urban employment share of personal services (4.00**). A 1 standard deviation increase in the rate of urban natural increase is then associated with a 0.49 standard deviation increase in the employment share of this refugee sector. The migration effect is high, but not significant.

Overall, it is interesting to note that migration is significantly less associated with urban congestion than urban natural increase *ceteris paribus*. There are probably various reasons for that, although our analysis can only be speculative without better data. First, many rural workers migrate to the cities because productivity and income are rising there. The strong correlation between income and urbanization in cross-country data suggests that urban income growth must be a strong driver of migration (even if rural poverty may also contribute to migration). Second, while migration lowers the dependency ratio, urban natural increase increases it. This lowers incomes in the short run (the time for the urban newborns to enter the labor market). Third, rising incomes imply that urban residents and governments have the resources to minimize these urban congestion effects. These channels may explain why urban congestion was less of a problem in Industrial Europe. Boston, London, Manchester and New York were also growing fast in the 19th century, and these cities were also affected by slum proliferation. However, economic growth was high, as a result of technological progress that led to industrialization. It is because urban incomes were rising that migrants kept moving to these unhealthy urban environments. Lastly, congestion effects were not large enough to offset the gains from agglomeration. Technological progress may be a less important factor in many cities of today's developing world, as many countries are urbanizing without industrializing (Barrios, Bertinelli & Strobl, 2006; Yuki, 2007; Poelhekke, 2010; Gollin, Jedwab & Vollrath, 2013). These countries must cope with the rapid growth of their cities, without capturing the full benefits of agglomeration.

6.3 Policy Implications

The urban developing world grew at 3.8% per year between 1960 and 2010. Moreover, growth rates were greater than 5% in many developing cities. If cities of today's developing world grew too fast due to high urban rates of natural increase, and urban congestion reduced urban welfare, what can be done about it? There are two possibilities: a reduction in urban fertility or improved urban planning.

[16]We use data for the closest year to the year 2000, in the 1990-2010 interval. Similarly to Gollin, Jedwab & Vollrath (2013), the 11 sectors are: "agriculture", "mining", "public utilities", "manufacturing", "construction", "wholesale and retail trade, hotels and restaurants", "transportation, storage and communications", "finance, insurance, real estate and business services", "government services", "education and health" and "personal and other services".

First, any urban population growth slowdown could contribute to increasing the urban capital-labor ratio, and prevent congestion effects from kicking in. This could be achieved through a reduction in urban fertility. It is still very high in many developing regions. For example, Africa's urban birth rate was 36.2 per 1,000 in the 2000s. This is still higher than the birth rates in Europe during the 19th century (around 30), Asia in 1960 (35), and other developing countries today (10-20). Given an urban death rate of 11.3, reducing the urban birth rate from 36.2 to 20 would lead to a natural increase rate of 8.7 (instead of 24.9 now). With a migration rate of 1.7%, there will be an urban growth rate of 2.6%, similar to industrializing Europe and present-day Asia. Our analysis stresses the role of urban family planning policies, as rapid demographic growth also happens in the cities. The urbanization of the developing world's population is mechanically driving the "urbanization of global poverty" (Ravallion, 2002; Ravallion, Chen & Sangraula, 2007). The fact that the developing world is urbanizing also implies that rapid demographic growth is becoming increasingly an urban problem.

Second, better urban planning could permit an internalization of negative urban externalities. The objective for local and national governments would be to minimize urban congestion, given their minimal fiscal resources. There are several possible approaches. First, the remodeling of Paris by Baron Haussmann in the 1850s is a perfect example of the authoritarian approach. He cleared the narrow medieval streets of the capital in favor of broad boulevards. This transformation increased the standard of living of the Parisians in the later period. Though this approach was undoubtedly beneficial in the long-run, it is highly controversial as a policy model, due to its high societal costs. China may nonetheless be moving in this direction. Second, many cities were planned as a result of (unplanned) creative destruction. For example, many American cities were rebuilt in a better way after a Great Fire (e.g. New York in 1776, Chicago 1871, Boston 1872 and San Francisco 1906). City fires in developing countries today are much less destructive, for various reasons. Houses are built with cement and shacks are built with metal sheets, rather than wood. Fire departments are also more efficient. Third, local urban renewal projects are examples of a more decentralized approach, whether they are implemented by local governments or private promoters. These urban renewal projects may have net positive effects when well-implemented (Kaufmann & Quigley, 1987; Collins & Shester, 2013). However, in developing countries, the absence of strong private markets (and rent-seeking) may decrease the economic returns to such programs. Thus, without any improvement in urban (and not just national) institutions, urban congestion will remain a major issue. Lastly, congestion effects were probably more important in large agglomerations. This could explain why migration from large agglomerations to small and medium-sized cities has been observed in Africa (Potts, 2009). One policy could be to remove the constraints on the growth of the non-primate cities that are often prevalent in developing countries (Christiaensen, Weerdt & Todo, 2013; Christiaensen & Todo, 2013). More generally, it could be worthwhile to invest in the cities of today's developing world. While urban-biased policies in the past have imposed an unfair burden over the rural residents of these countries, many of their cities will keep growing at a fast pace in the future. While investing in these cities could further fuel migration, not investing in them could make things even worse, especially for the next cohorts of urban residents that are born every year. Alternatively, one may invest in the rural areas of these countries to slow down excessive migration and relieve the already overcrowded cities.

7. CONCLUSION

This paper documents several new facts regarding the processes of urbanization, internal migration, natural increase, and economic development. Using an extensive new historical dataset on urbanization and the urban demographic transition, we show that: (i) urban growth has been faster in the developing world of the 20th century than in the developing world of the 19th century; (ii) this fast urban growth was mostly driven by natural increase, and not by migration as in Europe. Many cities of today's developing world can be classified as "mushroom cities" vs. the "killer cities" of Industrial Europe; fertility remains high, while mortality has fallen to low levels, which has led to high urban rates of natural increase; (iii) urban natural increase has accelerated urbanization in today's developing world, and this conditional on income, thus producing urbanization *without* growth; and (iv) fast urban growth, and urban natural increase in particular, are associated with more congested cities, which has strong implications for economic development.

Our results make the following contributions. First, our paper adds to the literature on *rural push* and *urban pull* factors by offering an additional mechanism for urban growth and urbanization based on a *urban push*. Urbanization does not come from migration only, as internal growth also matters. We also hope that the consistent data set that we have created will help researchers study the urbanization process across space and time. Second, our paper contributes to the literature on the relationship between urbanization and economic development. Our results suggest that economic development is not the only driver of urban growth and urbanization. Besides, the resulting urbanization *per se* may not necessarily be conducive to further economic growth and increased welfare, as congestion effects may limit the benefits from agglomeration. The "origin" of urbanization may thus impact its relationship with development. Third, our findings advance the literature on the effects of population growth on economic growth. We study an increase in population and congestion effects from the perspective of cities, not countries.

This paper leaves several open questions. The first is why many countries and cities did not complete their fertility transition earlier. Urban fertility remains high in various parts of the world, and their cities will keep growing at a fast pace in the future. A second question that we leave unanswered is why some countries were better able to reap the benefits from urban agglomeration and solve urban congestion. While we believe that answering these questions is essential for understanding and potentially "improving" on the urbanization process of developing countries, they are beyond the scope of this paper, and we leave them for future research.

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TABLE 1: URBAN NATURAL INCREASE AND URBAN GROWTH, MULTIVARIATE PANEL ANALYSIS (1960-2010)

Dependent Variable:	Annual Urban Growth Rate (%, Decade t)					
	(1)	(2)	(3)	(4)	(5)	(6)
Urban Natural Increase Rate	0.95***	0.84***	0.91***	0.97***	1.01***	
(Per 100 People, Decade t)	(0.28)	(0.28)	(0.27)	(0.30)	(0.32)	
Urban Birth Rate						0.98***
(Per 100 People, Decade t)						(0.32)
Urban Death Rate						-1.12**
(Per 100 People, Decade t)						(0.49)
Country FE & Decade FE (33; 5)	Y	Y	Y	Y	Y	Y
Controls for Income & Urb. Rate	N	Y	Y	Y	Y	Y
Area FE (4) x Time Trend	N	N	Y	Y	Y	Y
Time-Varying Controls	N	N	N	Y	Y	Y
Region FE (10) x Time Trend	N	N	N	N	Y	Y
Observations (33 x 5)	165	165	165	165	165	165
Adj. R-squared	0.70	0.74	0.75	0.76	0.80	0.79

Notes: Robust standard errors clustered at the country level are reported in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The sample consists of 33 countries that were still developing countries in 1960, for the following decades: [1960s, 1970s, 1980s, 1990s, 2000s]. All regressions include country and decade fixed effects. In column (2), we also control for log GDP per capita (PPP, cst 2005$) and the urbanization rate (%) at the start of the decade, and log GDP per capita at the end of the decade. In column (3), we also include area fixed effects (Africa, Asia, LAC, MENA) interacted with a time trend. In column (4), we also include the following controls: (i) *Rural push* factors: average cereal yields (hg per ha), rural density (1000s of rural pop. per sq km of arable area), the number of droughts (per sq km), and a dummy equal to one if the country has experienced a conflict, in decade t; (ii) *Urban pull* factors: the share of manufacturing and services in GDP (%) in 2010 interacted with decade fixed effects, the share of natural resource exports in GDP (%), a dummy equal to one if the country was autocratic, and the primacy rate (%), in decade t; and (iii) Population (1000s) in decade t. In columns (5)-(6), we also include region fixed effects (Western Africa, etc.) interacted with a time trend. See the Online Data Appendix for data sources and construction of variables.

TABLE 2: URBAN NATURAL INCREASE AND URBAN GROWTH, MULTIVARIATE PANEL ANALYSIS (1960-2010), ROBUSTNESS

Dependent Variable:	Annual Urban Growth Rate (%, Decade t)					**Uni$_{c,t}$**	**Migr$_{c,t}$**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Urban Natural Increase Rate	1.01***	1.05***	1.02***	1.02***	1.09***		
(Per 100 People, Decade t)	(0.32)	(0.37)	(0.37)	(0.36)	(0.37)		
Residual Migration Rate			0.06				
(Per 100 People, Decade t-1)			(0.08)				
Urban Natural Increase Rate			0.06				
(Per 100 People, Decade t-1)			(0.31)				
Annual Urban Growth Rate				0.06		0.06	0.06
(Per 100 People, Decade t-1)				(0.07)		(0.08)	(0.06)
Annual Urban Growth Rate						0.06	0.17
(Per 100 People, Decade t-1)						(0.31)	(0.10)
Rural Natural Increase Rate					-0.06		
(Per 100 People, Decade t)					(0.27)		
Rural Natural Increase Rate					-0.00		
(Per 100 People, Decade t-1)					(0.24)		
Specification Col. (5) Table 1	Y	Y	Y	Y	Y	Y	Y
Observations (33 x {5; 4; 3})	165	132	132	132	132	132	132
Adj. R-squared	0.78	0.81	0.80	0.81	0.80	0.67	0.84

Notes: Robust standard errors clustered at the country level are reported in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The sample consists of 33 countries that were still developing countries in 1960, for the following decades: [1960s, 1970s, 1980s, 1990s, 2000s]. In columns (1)-(5), the dependent variable is the annual urban growth rate (%) in decade t. In columns (6) and (7), the dependent variables are the respective contributions of urban natural increase and "residual migration" to urban growth (%) in decade t. The baseline regression (col. (1)) is the same as in column (5) of Table 1. When we add variables estimated in decade t-1, we lose one round of data. In column (2), we test that the main effect is the same without this round of data. The specification is the same as in column (5) of Table 1. All regressions include country and decade fixed effects, controls for income and urbanization, time-varying controls, and region fixed effects interacted with a time trend. See the Online Data Appendix for data sources and construction of variables.

TABLE 3: URBAN NATURAL INCREASE AND URBAN GROWTH, MULTIVARIATE CROSS-SECTIONAL ANALYSIS (1960-2010)

Dependent Variable:	**Annual Urban Growth Rate (1960-2010, %)**					**Largest City**
	(1)	(2)	(3)	(4)	(5)	(6)
Urban Natural Increase Rate	1.31***	0.92***	0.76***	0.78***	0.76***	
(Per 100 People, 2000)	(0.19)	(0.25)	(0.25)	(0.25)	(0.27)	
Largest City's Birth Rate						1.19***
(Per 100 People, 2000)						(0.37)
Controls for Inc. & Urb. Rate	N	Y	Y	Y	Y	Y
Area FE (4)	N	N	Y	Y	Y	Y
Time-Invariant Controls	N	N	N	Y	Y	Y
Region FE (13)	N	N	N	N	Y	Y
Observations	97	97	97	97	97	94
R-squared	0.29	0.46	0.54	0.66	0.66	0.64

Notes: Robust standard errors are reported in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The sample consists of 97 countries that were still developing countries in 1960. In columns (1)-(5), the dependent variable is the annual urban growth rate (%) between 1960 and 2010. In column (6), it is the growth rate of the largest city (%) between 1960 and 2010. The urban natural increase rate in 2000 is used as a proxy for urban natural increase in 1960-2010. In column (2), we control for income in 1960 and 2010, and urbanization in 2010. In column (3), we also include area fixed effects. In column (4), we also add the following controls: (i) *Urban definition*: four dummies for each type of definition (*administrative*, *threshold*, *threshold and administrative*, and *threshold plus condition*) and the value of the population threshold to define a locality as urban when this definition is used; (ii) *Rural push* factors: cereal yields in 2010 (hg per ha), rural density (1000s of rural pop. per sq km of arable area) in 2010, the number of droughts (per sq km) since 1960, and a dummy equal to one if the country has experienced a conflict since 1960; (iii) *Urban pull* factors: the share of manufacturing and services in GDP (%) in 2010, the share of natural resource exports in 1960-2010 (%), a dummy equal to one if the country was mostly autocratic since 1960 and the primacy rate in 2010 (%); and (iv) Other controls: area (sq km), population (1000s) in 2010, and two dummies equal to one if the country is landlocked or a small island (< 50,000 sq km). Columns (5)-(6) also include region fixed effects (Western Africa, etc.). See the Online Data Appendix for data sources and construction of variables.

TABLE 4: URBAN NATURAL INCREASE AND URBANIZATION, MULTIVARIATE PANEL ANALYSIS (1960-2010)

Dependent Variable:	**Change in the Urbanization Rate (%, Decade t)**					
	(1)	(2)	(3)	(4)	(5)	(6)
Annual Urban Growth Rate	2.02***	1.98***	2.00***	2.01***	1.91***	
(Per 100 People, Decade t)	(0.32)	(0.30)	(0.30)	(0.29)	(0.30)	
Urban Natural Increase Rate						1.21**
(Per 100 People, Decade t)						(0.60)
Residual Migration Rate						2.02***
(Per 100 People, Decade t)						(0.32)
Country FE & Decade FE (33; 5)	Y	Y	Y	Y	Y	Y
Controls for Income	N	Y	Y	Y	Y	Y
Area FE (4) x Time Trend	N	N	Y	Y	Y	Y
Time-Varying Controls	N	N	N	Y	Y	Y
Region FE (10) x Time Trend	N	N	N	N	Y	Y
Observations (33 x 5)	165	165	165	165	165	165
Adj. R-squared	0.65	0.66	0.66	0.66	0.68	0.69

Notes: Robust standard errors clustered at the country level are reported in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The sample consists of 33 countries that were still developing countries in 1960, for the following decades: [1960s, 1970s, 1980s, 1990s, 2000s]. All regressions include country and decade fixed effects. In column (2), we also control for log GDP per capita (PPP, cst 2005$) at the start and the end of the decade. In column (3), we also include area FE (Africa, Asia, LAC, MENA) interacted with a time trend. In column (4), we also include the same controls as in Table 1 (see the footnote below the table). In column (5)-(6), we also include region FE (Western Africa, etc.) interacted with a time trend. See the Online Data Appendix for data sources and construction of variables.

TABLE 5: URBAN NATURAL INCREASE AND URBANIZATION, MULTIVARIATE PANEL ANALYSIS (1960-2010), ROBUSTNESS

Dependent Variable:	Change in the Urbanization Rate (%, Decade t)					
	(1)	(2)	(3)	(4)	(5)	(6)
Urban Natural Increase Rate	1.21**	1.58**	1.53**	1.41**	1.24**	1.94**
(Per 100 People, Decade t)	(0.60)	(0.62)	(0.56)	(0.62)	(0.55)	(0.77)
Residual Migration Rate	2.02***	2.22***	2.20***	2.22***	2.29***	2.24***
(Per 100 People, Decade t)	(0.32)	(0.48)	(0.46)	(0.47)	(0.44)	(0.49)
Urban Natural Increase Rate			-0.79			
(Per 100 People, Decade t-1)			(0.70)			
Residual Migration Rate			0.43			
(Per 100 People, Decade t-1)			(0.26)			
Annual Urban Growth Rate				0.31		
(Per 100 People, Decade t-1)				(0.28)		
Change in the Urbanization Rate					0.24**	
(Per 100 People, Decade t-1)					(0.12)	
Rural Natural Increase Rate						-0.65
(Per 100 People, Decade t)						(0.60)
Rural Natural Increase Rate						0.34
(Per 100 People, Decade t-1)						(0.74)
Specification Column (5) Table 4	Y	Y	Y	Y	Y	Y
Observations (33 x 5)	165	132	132	132	132	132
Adj. R-squared	0.69	0.70	0.71	0.70	0.72	0.69

Notes: Robust standard errors clustered at the country level are reported in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The sample consists of 33 countries that were still developing countries in 1960, for the following decades: [1960s, 1970s, 1980s, 1990s, 2000s]. The baseline regression (col. (1)) is the same as in column (6) of Table 4. When we add variables estimated in decade t-1, we lose one round of data. In column (2), we test that the main effect is the same without this round of data. The specification is the same as in column (6) of Table 4. All regressions include country and decade fixed effects, controls for income, time-varying controls, and region fixed effects interacted with a time trend. See the Online Data Appendix for data sources and construction of variables.

TABLE 6: URBAN NATURAL INCREASE AND URBANIZATION, MULTIVARIATE CROSS-SECTIONAL ANALYSIS (1960-2010)

Dependent Variable:	Change in the Urbanization Rate (%, 1960-2010)					
	(1)	(2)	(3)	(4)	(5)	(6)
Annual Urban Growth Rate	2.29**	3.16***	3.57***	4.93***	5.57***	
(Per 100 People, 1960-2010)	(1.02)	(1.06)	(1.16)	(1.15)	(1.04)	
Urban Natural Increase Rate						3.64*
(Per 100 People, 2000)						(2.02)
Residual Migration Rate						5.97***
(Per 100 People, 2000)						(1.09)
Controls for Income	N	Y	Y	Y	Y	Y
Area FE (4)	N	N	Y	Y	Y	Y
Time-Invariant Controls	N	N	N	Y	Y	Y
Region FE (13)	N	N	N	N	Y	Y
Observations	97	97	97	97	97	97
Adj. R-squared	0.07	0.16	0.20	0.33	0.51	0.50

Notes: Robust standard errors are reported in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The sample consists of 97 countries that were still developing countries in 1960. The rate of urban natural increase in 2000 is used as a proxy for urban natural increase in 1960-2010. In column (2), we control for log GDP per capita (PPP, cst 2005$) in 1960 and 2010. In column (3), we also include area fixed effects. In column (4), we also add the same country-level controls as in Table 3 (see the footnote below the table). Columns (5)-(6) also include region fixed effects (Western Africa, etc.). See the Online Data Appendix for data sources and construction of variables.

TABLE 7: URBAN NATURAL INCREASE, URBAN GROWTH AND SLUMS (2000) MULTIVARIATE CROSS-SECTIONAL ANALYSIS (1960-2010)

Dependent Variable:	Urban Population Living in Slums (%, 2005)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Annual Urban Growth Rate	8.93***	4.39***	3.83**	6.52***	6.43**			
(%, 1960-2010)	(3.12)	(1.26)	(1.56)	(2.27)	(2.79)			
Change in Urbanization Rate	-0.18	0.35**	0.35**	0.17	-0.00	0.05	0.06	0.10
(%, 1960-2010)	(0.29)	(0.17)	(0.17)	(0.21)	(0.28)	(0.26)	(0.22)	(0.20)
Number of Years in which the Urban Population Doubles						-0.5***	-0.6***	
(Average, 1960-2010)						(0.2)	(0.2)	
Number of Years in which the Urban Population Doubles							-0.7**	
(Average 1960-2010) * Dummy "Number of Years Below Mean"							(0.3)	
Urban Natural Increase								14.44***
(%, 2000)								(5.01)
Residual Migration								4.58*
(%, 2000)								(2.61)
Controls for Income	N	Y	Y	Y	Y	Y	Y	Y
Area FE (5)	N	N	Y	Y	Y	Y	Y	Y
Time-Invariant Controls	N	N	Y	Y	Y	Y	Y	Y
Region FE (13)	N	N	N	N	Y	Y	Y	Y
Observations	95	95	95	95	95	95	95	95
Adj. R-squared	0.17	0.61	0.62	0.67	0.68	0.70	0.69	0.70

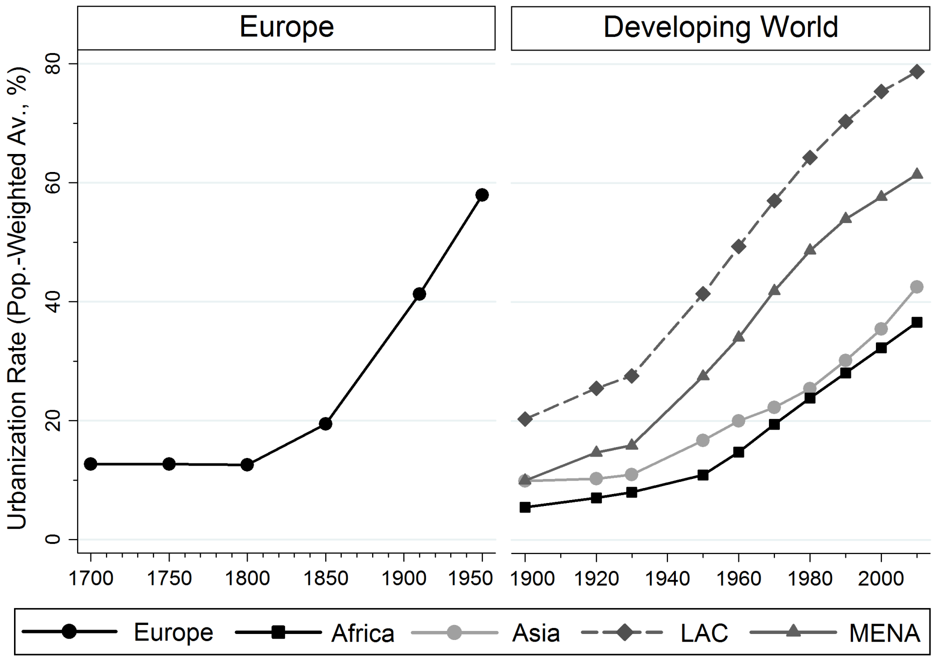
Notes: Robust standard errors are reported in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The sample consists of 95 countries that were still developing countries in 1960. The rate of urban natural increase in 2000 is used as a proxy for urban natural increase in 1960-2010. The residual migration rate is estimated as the difference between the annual urban growth rate in 1960-2010 and the rate of urban natural increase in 2000. The number of years in which the urban population doubles on average in 1960-2010 is estimated using the annual urban growth rate. We create a dummy variable equal to one if this number is below the mean in the sample (19.4). In column (2), we control for log GDP per capita (PPP, cst 2005$) in 1960 and 2010. In column (3), we also include area fixed effects. In column (4), we also add the same country-level controls as in Table 3. Columns (5)-(8) also include region fixed effects. See the Online Data Appendix for data sources and construction of variables.

TABLE 8: URBAN NATURAL INCREASE AND MEASURES OF URBAN CONGESTION MULTIVARIATE CROSS-SECTIONAL ANALYSIS (2000)

Dependent Variable:	Lack Sufficient Living Area (%)	Finished Floor (%)	Access Improved Water Source (%)	Access Improved Sanitation Facilities (%)	School Attend. (6-15 y.o.) (%)	PM10 (mg per cubic m)	Empl Share Perso. Serv. (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Urban Natural Increase	8.6*	-6.5	-3.5**	-1.2	−11.8***	17.8*	4.0**
(%, 2000)	(4.6)	(5.6)	(1.6)	(2.7)	(3.9)	(10.0)	(2.0)
	[0.46]	[0.20]	[0.21]	[0.03]	[0.49]	[0.27]	[0.49]
Residual Migration	2.9	-1.3	-2.0*	-2.0	-3.4	-0.0	1.2
(%, 2000)	(2.8)	(3.6)	(1.1)	(1.9)	(3.0)	(5.7)	(1.0)
	[0.24]	[0.07]	[0.25]	[0.11]	[0.22]	[0.00]	[0.31]
Specification Col. (8) Table 8	Y	Y	Y	Y	Y	Y	Y
Sample Mean	18.8	77.9	89.5	65.1	80.2	71.3	5.5
Observations	57	66	93	93	64	93	72

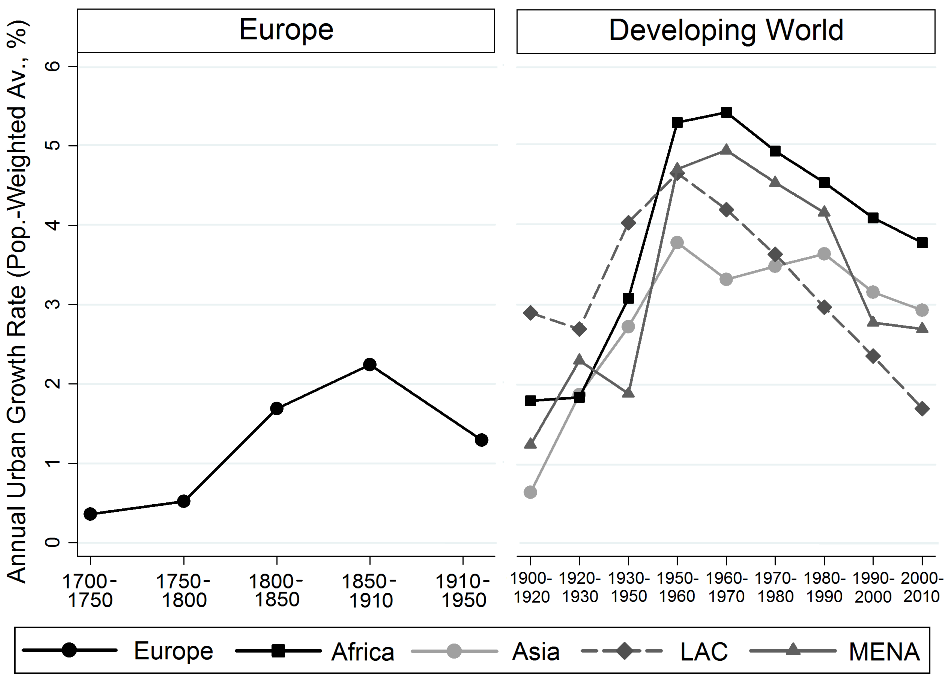
Notes: Robust standard errors are reported in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The effects of 1 standard deviation increase in the variable of interest on 1 standard deviation in the dependent variable are reported in brackets. We regress various measures of urban congestion in 2000 on the rates of urban natural increase in 2000, which we use as a proxy for urban natural increase in 1960-2010. The residual migration rate is estimated as the difference between the annual urban growth rate in 1960-2010 and the rate of urban natural increase in 2000. In column (1), the dependent variable is the share of urban inhabitants who lack sufficient-living area (%), i.e. who live in dwelling units with more than 3 persons per room. In column (2), it is the share of urban inhabitants who live in a residence with a finished floor (%). In columns (3) and (4), it is the share of urban inhabitants who have access to an improved water source and improved sanitation facilities respectively (%). In column (5), it is the urban share of 6-15 year-old children that attend school (%). In column (6), it is a measure of particulate matter (PM) concentrations in residential areas of cities with more than 100,000 residents. In column (7), it is the urban employment share of personal and other services (%), an informal refugee sector. The specification is the same as in column (8) of Table 7. All regressions include controls for income, time-invariant controls, and region fixed effects. See the Online Data Appendix for data sources and construction of variables.

Figure 1: Urbanization Rates (%) for Europe (1700-1950) and The Developing World (1900-2010)



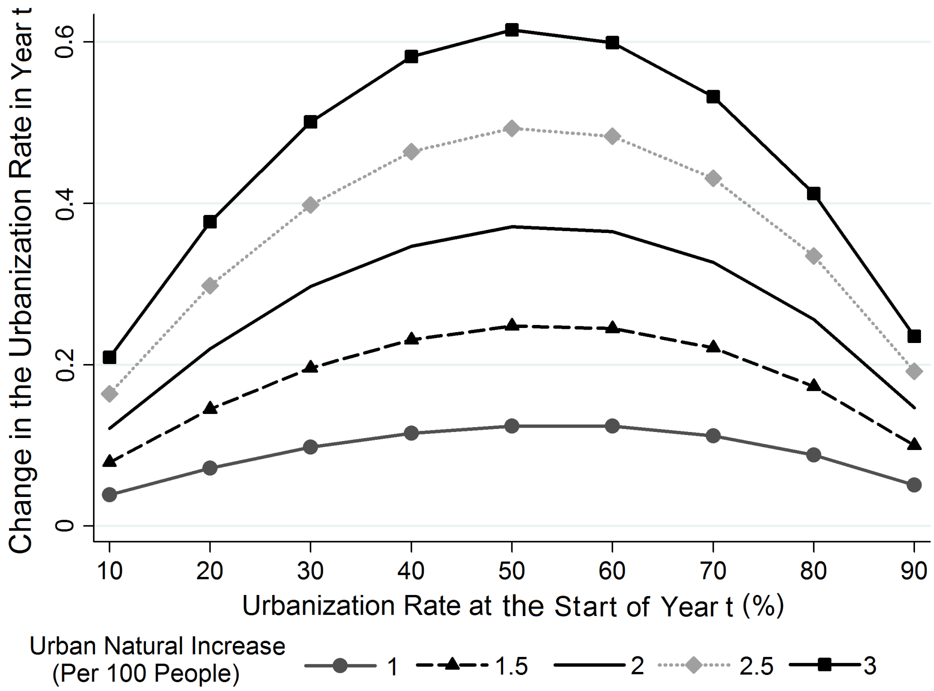
Notes: This figure plots the urbanization rate (%) for Europe (1700-1950) and four developing regions (1900-2010): Africa, Asia, Latin America and the Caribbean (LAC) and Middle-East and North Africa (MENA). Europe includes 18 Western European countries and the United States, as one example of a Neo-European country. We then use data for 116 African, Asian and non-North American countries that were still developing countries in 1960. Averages are estimated using the population weights for the same year. See the Online Data Appendix for data sources.

Figure 2: Annual Urban Growth Rates (%) for Europe (1700-1950) and The Developing World (1900-2010)



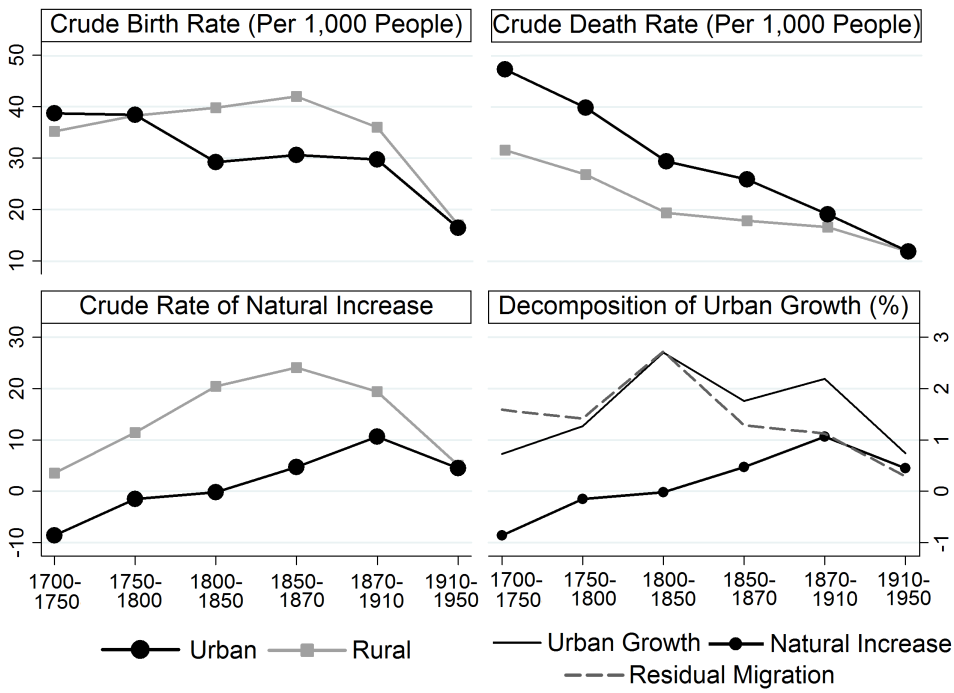
Notes: This figure plots the annual urban growth rate (%) for Europe (1700-1950) and four developing regions (1900-2010): Africa, Asia, Latin America and the Caribbean (LAC) and Middle-East and North Africa (MENA). Europe includes 18 Western European countries and the United States, as one example of a Neo-European country. We then use data for 116 African, Asian and non-North American countries that were still developing countries in 1960. Averages are estimated using the population weights for the same year. See the Online Data Appendix for data sources.

Figure 3: Natural Increase and Change in Urbanization, Simulation



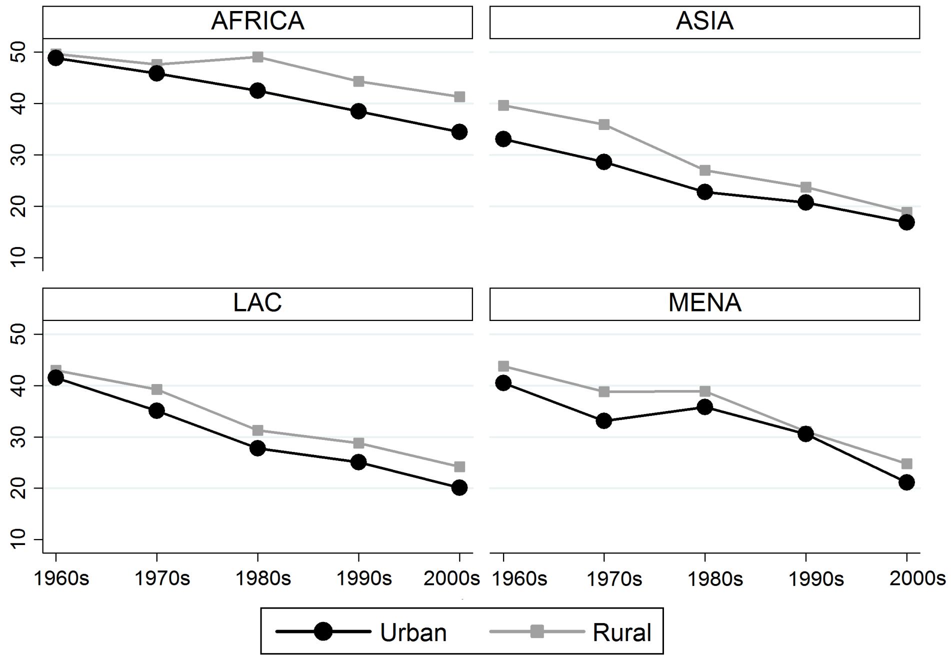
Notes: This figure shows the relationship between the change in the urbanization rate in year t (ΔU_t, in percentage points) and the urban crude rate of natural increase in year t (Uni_t, per 100 people), given the initial urbanization rate at the start of year t (U_t). We assume that the rural crude rate of natural increase (Rni_t) = 2.5% and the residual migration rate (Mig_t) = 1.5% per year. We use Uni = 0.5% as a benchmark. This allows us to compare the "relative" effects of urban natural increase on the change in the urbanization rate for various values of $Uni = \{1; 1.5; 2; 2.5; 3\}$.

Figure 4: Natural Increase and Urban Growth in England (1700-1950)



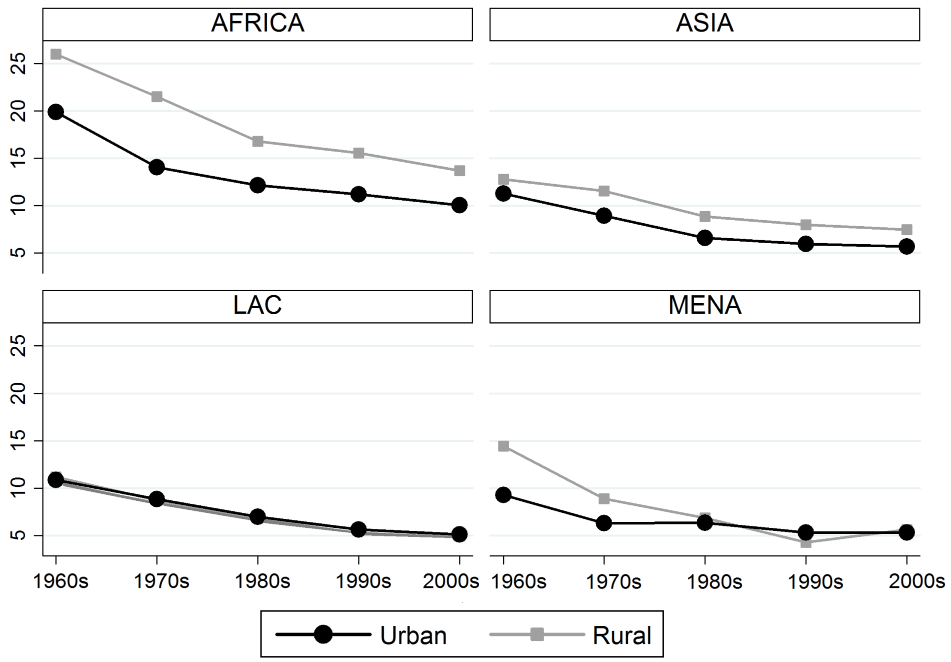
Notes: This figure plots the crude birth rate, the crude death rate and the crude rate of natural increase (per 1,000 people) for rural England and urban England (1700-1950). This figure also plots the decomposition of annual urban growth (%) into annual natural increase (%) and annual "residual migration" (%). See the Online Data Appendix for data sources.

Figure 5: Crude Birth Rates for The Developing World (1960-2010)



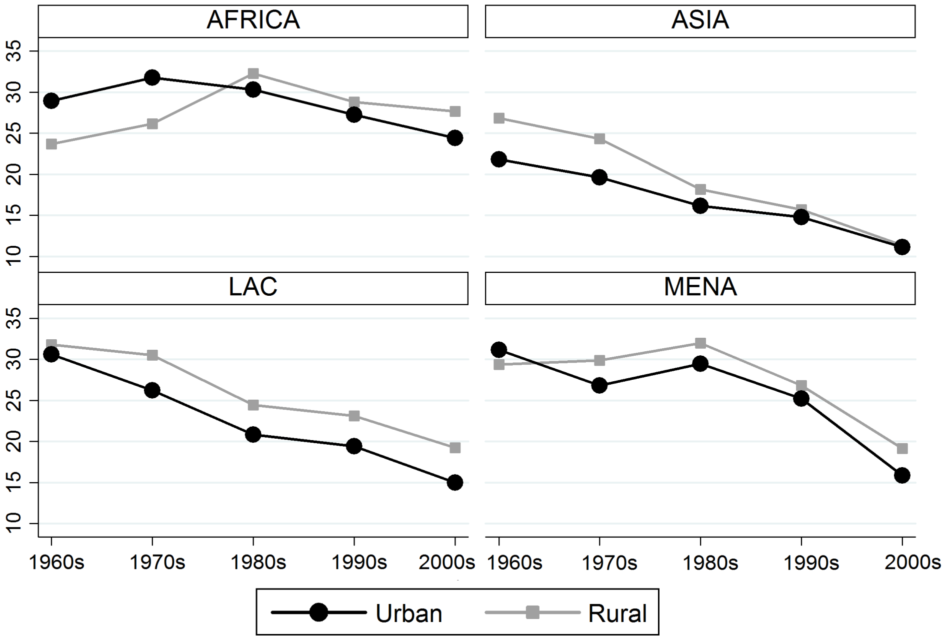
Notes: This figure plots the crude birth rate (per 1,000 people) for the rural and urban areas of four developing regions (1960-2010): Africa, Asia, Latin America and the Caribbean (LAC) and Middle-East and North Africa (MENA). We use demographic data that we have collected for 33 countries that were still developing countries in 1960. See the Online Data Appendix for data sources.

Figure 6: Crude Death Rates for The Developing World (1960-2010)



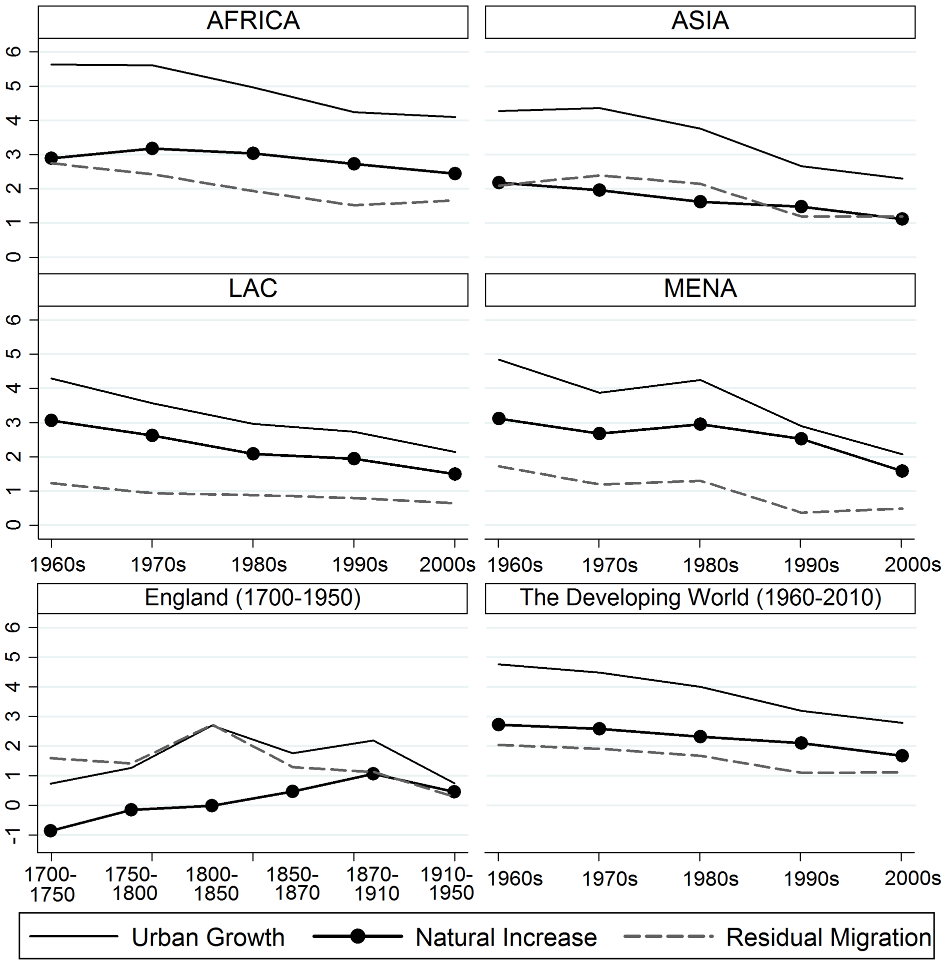
Notes: This figure plots the crude death rate (per 1,000 people) for the rural and urban areas of four developing regions (1960-2010): Africa, Asia, Latin America and the Caribbean (LAC) and Middle-East and North Africa (MENA). We use demographic data that we have collected for 33 countries that were still developing countries in 1960. See the Online Data Appendix for data sources.

Figure 7: Crude Rates of Natural Increase for The Developing World (1960-2010)



Notes: This figure plots the crude rate of natural increase (per 1,000 people) for the rural and urban areas of the four developing areas (1960-2010). We use historical demographic data for 33 countries that were still developing countries in 1960. See the Online Data Appendix for data sources.

Figure 8: Natural Increase and Urban Growth for The Two Developing Worlds (1700-1950 and 1960-2010)



Notes: This figure plots the decomposition of annual urban growth (%) into annual natural increase (%) and annual "residual migration" (%) for the four developing areas, the developing world as a whole in 1960-2010 and England in 1700-1950. We use historical demographic data for 33 countries that were still developing countries in 1960. See the Online Data Appendix for data sources.

FOR ONLINE PUBLICATION: DATA SOURCES

This appendix describes in details the data we use in our analysis.

Spatial Units for Industrial Europe and Today's Developing World:
We use three different samples in our analysis. First, we obtain historical urban data for 19 European and North American countries from 1700-1950, and 116 Africa, Asian or non-North American countries that were still developing countries in 1960, from 1960-2010. We exclude from our analysis the European countries for which we could not find historically consistent urban data, as well as the former CIS countries. We use these countries to describe urban patterns in "Industrial Europe" (which also includes a Neo-European country, the United States) and four developing areas: Sub-Saharan Africa (which we call "Africa"), Asia, Latin America and the Caribbean (LAC), and Middle-East and North Africa (MENA). Second, our main sample consists of 40 of these countries from 1700 to 2010. These are the countries for which we found historical demographic data. Historical consistent data was not found for other countries. The list of countries and years (or periods) for which we have data is reported in Appendix Tables 1, 2 and 3. These countries belong to the five developing areas: Industrial Europe (N = 7, about every 40 years in 1700-2010), Africa (N = 10, every ten years in 1960-2010), Asia (N = 11, ditto), LAC (N = 8, ditto) and MENA (N = 4, ditto). Third, we also collect cross-sectional data for 97 out of the 116 countries for which we were to able to find demographic data, for the most recent period. The countries of Africa, Asia, the LAC and MENA regions are then classified into 13 regions: Central Africa, Eastern Africa and Western Africa for Africa; East Asia, Pacific Islands, South Asia and South-East Asia for Asia; Caribbean, Central America and South America for the LAC region; and Middle-East and North Africa for the MENA region.

Urban Growth and Urbanization in Industrial Europe:
The annual urban growth rate is the average growth rate of the urban population between two years (%). The urbanization rate is defined as the share of the urban population in total population (%). We use Bairoch (1988) and Malanima and Volckart (2007) to reconstruct consistent urban growth and urbanization rates for 18 Western European countries and the United States for the following periods: 1700-1750, 1750-1800, 1800-1850, 1850-1910 and 1910-1950. Averages are estimated using the population weights for the same period. We then consider 7 countries in our main analysis (listed in Appendix Table 1). We also use Bairoch (1988), Batou and Chevre (1988) and Wikipedia (2013) to obtain the annual growth rate of the largest city for the 19 countries for each period.

Urban Growth and Urbanization in Today's Developing World:
We reference Bairoch (1988), Sluglett (2008) and WUP (2011) to reconstruct the urban growth and urbanization rates for Africa, Asia and the LAC and MENA regions for the following periods: 1900-1920, 1920-1930, 1930-1950, 1950-1960, 1960-1970, 1970-1980, 1980-1990, 1990-2000 and 2000-2010. For the last six decades, we use data for 116 African, Asian and non-North American countries from 1950-2010. Averages are estimated using the population weights for the same period. We consider 33 countries in the panel analysis from 1960-2010 (listed in Appendix Table 2). We then consider 97 out of the 116 countries for the cross-sectional analysis from 1960-2010. We also use WUP (2011) and WB (2013) to estimate the growth rate of the largest city for each country, for the following periods: 1960-1970, 1970-1980, 1980-1990, 1990-2000 and 2000-2010.

Urban Demographic Transition in Industrial Europe:
For each of the 7 countries of Industrial Europe, we use various historical sources to obtain the national, urban and rural crude rates of birth, crude rates of death and crude rates of natural increase (per 1,000 people) for several decades during the 1800-1910 period (sources listed in Panel A, Appendix Table 3). For England, our main European country of

analysis, we have data from 1700 to 1950. For the six other countries, demographic data only exists for shorter periods.

Urban Demographic Transition in Today's Developing World:
For each of the 33 countries of today's developing world, we use reports from the *Population and Housing Censuses*, *CICRED Monographs*, *Fertility Surveys*, and *Demographic and Health Surveys* (DHS) as well as the *Statistical Yearbooks* of the United Nations, to obtain the national, urban and rural crude rates of birth, crude rates of death and crude rates of natural increase (per 1,000 people) for each decade during the 1960-2010 period (sources listed in Panel B, Appendix Table 3). We could not find consistent historical data for other countries. Indeed, demographic data does not always exist for countries as far back as the 1960s. For 64 other countries of today's developing world, we use reports from the *Population and Housing Censuses* and *Demographic and Health Surveys* to obtain an estimate of the urban and rural crude rates of birth and death for the closest year to 2000, in the 1990-2010 interval. For the 33 + 64 = 97 countries, we also used the same sources to retrieve the urban fertility rate for the closest year to 2000, in the 1990-2010 interval. For 94 countries of today's developing world, we also use the sources mentioned above to obtain the birth rate of the largest city for the closest year to 2000, in the 1990-2010 interval. Data on the crude death rate of the largest city does not exist.

Measures of Urban Congestion:
Data on the share of the urban population living in slums (%) comes from UN-Habitat (2003), UN (2013) and WB (2013). A slum household is usually defined as a group of individuals living under the same roof lacking one or more of the following conditions (UN-Habitat 2003): (i) sufficient-living area, (ii) structural quality, (iii) access to improved water source, and (iv) access to improved sanitation facilities. We have data for 113 countries, but we focus on 95 countries for which we also have data on urban natural increase in 2000. Data is available for a lower number of countries for some subcomponents of the slum variable. UN-Habitat (2003) reports the share of urban residents that lack "sufficient-living area", i.e. who live in dwelling units with more than 3 persons per room. We use as a measure of "structural quality" the share of urban inhabitants who live in a residence with a finished floor. We reconstruct this variable using the *International Public-Use Microdata Series* (IPUMS, 2013) and the stat compiler of the *Demographic and Health Surveys* (DHS, 2013). Data on the share of urban inhabitants who have access to an improved water source and improved sanitation facilities (%) comes from WB (2013). A household is considered to have access to an improved water source if it has sufficient amount of water for family use, at an affordable price, available to household members without being subject to extreme effort, especially to women and children. A household is considered to have access to improved sanitation, if an excreta disposal system is available to household members. Data on the urban share of 6-15 year-old children that attend school (%) comes from the DHS (2013) and IPUMS (2013). Data on our measure of particulate matter (PM) concentrations in residential areas of cities with more than 100,000 residents comes from WB (2013).

Urban Employment:
Data on the urban employment structure in selected countries for 2000-2010 was recreated using various sources, as described for each country in Gollin, Jedwab and Vollrath (2013). We use five different sources of data. Our two main data sources are IPUMS (2013), the *International Public-Use Microdata Series*, and ILO (2013), the International Organization of Labor. We complement these datasets with data from the published reports of *Population and Housing Censuses, Labor Force Surveys and Household Surveys*. For each country for which data is available, we estimate the employment shares of all urban areas for the following 11 sectors: "agriculture", "mining", "public utilities", "manufacturing", "construction", "wholesale and retail trade, hotels and restaurants", "transportation, storage and commu-

nications", "finance, insurance, real estate and business services", "government services", "education and health" and "personal and other services".

<u>Income and Other Controls:</u>
We have GDP per capita every ten years for 1960-2010. The main variable used in our analysis is average log GDP per capita for each decade (constant 2005 international $). We use various sources to reconstruct a range of time-invariant or time-varying controls at the country-level. In the panel regressions, we include the time-varying controls (estimated in the same or previous decade). In the cross-sectional regressions, we also include the time-invariant controls (the time-varying controls are estimated for 1960-2010 instead of for the same or previous decade).

First, we consider various rural push factors: (i) FAO (2013) reports the cereal yields (hg per ha) for each country-year observation. We then estimate the average yields for each decade; (ii) Rural density is defined as the ratio of rural population (1000s) to arable area (sq km). The arable area of each country is reported by FAO (2013); (iii) CRED (2013) reports the number of droughts experienced by each country every year. We use two variables: the number of droughts (per sq km) since 1960, and the number of droughts (per sq km) for each decade (e.g., 1960-1969 for the 1960s); and (iv) The Polity IV data series includes a measure of political violence for each country (1964-present). We create an indicator whose value is one if the country experienced an interstate or civil conflict in each decade (Polity IV 2013a).

Second, we consider various urban pull factors: (i) The share of manufacturing and services in GDP (%) in 2010 is obtained from WB (2013). The data is missing for many country-year observations before the recent period; (ii) We use the data set of Gollin, Jedwab and Vollrath (2013) to obtain the average share of natural resource exports in GDP (%) for each decade; (iii) We use the Polity IV data series to calculate the average combined polity score for each country for each decade (Polity IV 2013b). We create an indicator whose value is one if the average polity score is lower than -5, the threshold for not being considered autocratic; and (iv) From WB (2013), we know the share of the largest city in the urban population, the primacy rate, for all years in 1960-2010.

Third, we use the other following controls: (i) The 97 countries use four different types of urban definition in their most recent censuses: (a) "administrative cities" are administrative centers of territorial units (e.g., provinces, districts, "communes", etc.), (b) "threshold cities" are localities whose population is greater than a population threshold of X inhabitants (e.g.,5,000 or 2,500), (c) "administrative or threshold cities" are either administrative centers or localities whose population is greater than a population threshold, and (d) "threshold with condition cities" are localities whose population is greater than a population threshold and who have a large share of the labor force is engaged in non-agricultural activities. We create indicator variables for each definition. For each country using a population threshold, we know the threshold and use it as a control in our regression analysis; (ii) WUP (2011) reports total population for each country every year for 1950-2010; (iii) Country area (sq km) is obtained from WB (2013); and (iv) We create two indicators whose value is one if the country is a small island or if the country is landlocked. We consider an island country "small" if its area is smaller than 50,000 sq km.

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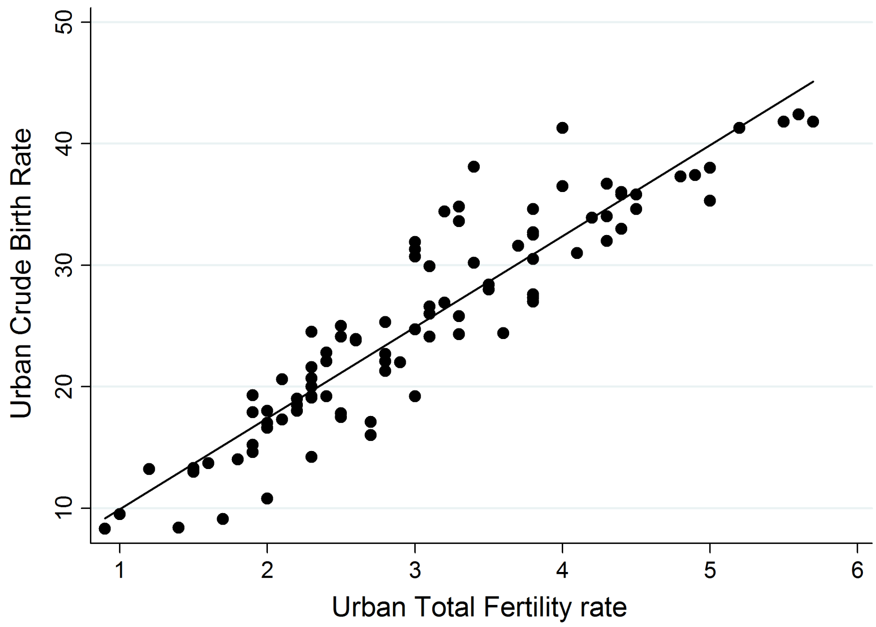
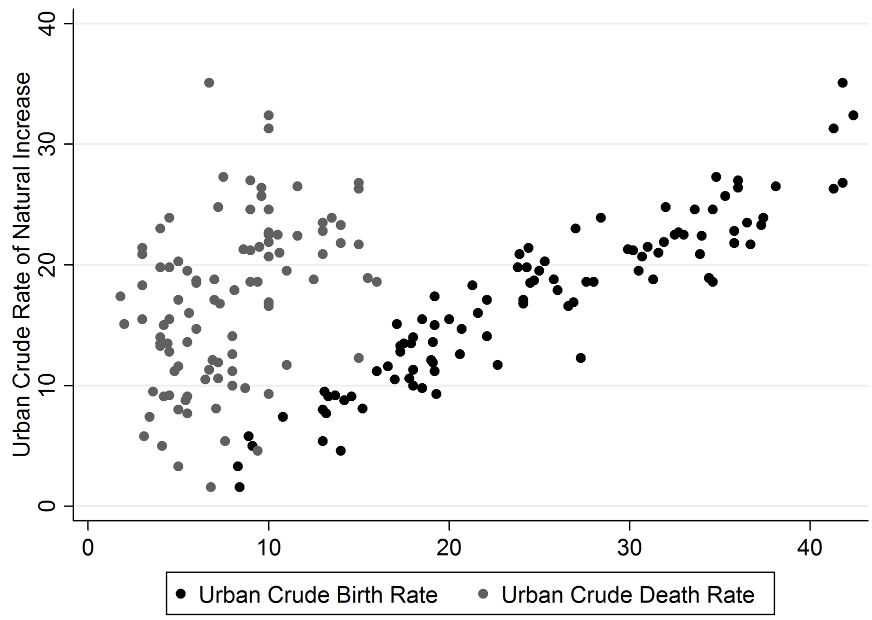
FOR ONLINE PUBLICATION: APPENDIX FIGURES

Appendix Figure 1: Urban Crude Rates of Birth and Urban Total Fertility Rates for 97 Developing Countries (2000-10)



Notes: This figure plots the relationships between the urban crude birth rate (per 1,000 people) and the urban total fertility rate (the average number of children born to an urban woman over her lifetime) for 97 countries that were still developing countries in 1960 and for which we have data for the period 2000-2010. The linear fit is plotted for the relationship between the urban crude birth rate and the urban total fertility rate. See the Online Data Appendix for data sources.

Appendix Figure 2: Urban Crude Rates of Birth, Death and Natural Increase for 97 Developing Countries (2000-10)



Notes: This figure plots the relationships between the urban crude rate of natural increase (per 1,000 people), the urban crude birth rate (per 1,000 people) and the urban crude death rate (per 1,000 people) for the 97 developing countries that were still developing countries in 1960 and for which we have data for the period 2000-2010. See the Online Data Appendix for data sources.

FOR ONLINE PUBLICATION: APPENDIX TABLES

Appendix Table 1: Decomposition of Annual Urban Growth for 7 European Countries, 1800-1910

Country Period:	**1800-1850**	**1850-1870**	**1870-1910**	**1800-1910**
England				
Urban Growth (%)	2.7	1.8	2.2	2.3
Natural Increase (%)	0.0	0.5	1.1	0.5
Residual Migration (%)	2.7	1.3	1.1	1.9
Belgium				
Urban Growth (%)	1.9	0.3	2.5	1.8
Natural Increase (%)	_	0.4	0.6	0.5
Residual Migration (%)	_	-0.1	1.9	1.3
France				
Urban Growth (%)	1.3	1.0	1.5	1.3
Natural Increase (%)	_	0.2	0.1	0.1
Residual Migration (%)	_	0.7	1.4	1.2
Germany				
Urban Growth (%)	1.8	3.0	3.0	2.5
Natural Increase (%)	0.1	0.2	1.0	0.6
Residual Migration (%)	1.7	2.8	2.0	1.9
Netherlands				
Urban Growth (%)	0.9	0.7	2.1	1.3
Natural Increase (%)	0.0	0.5	1.2	0.4
Residual Migration (%)	0.9	0.2	0.9	0.9
Sweden				
Urban Growth (%)	0.8	2.0	3.2	1.9
Natural Increase (%)	-0.5	0.5	1.0	0.3
Residual Migration (%)	1.3	1.5	2.2	1.6
United States				
Urban Growth (%)	5.2	5.7	3.5	4.6
Natural Increase (%)	0.3	0.4	0.4	0.4
Residual Migration (%)	4.8	5.3	3.1	4.3
Average				
Urban Growth (%)	2.1	2.1	2.6	2.2
Natural Increase (%)	0.0	0.4	0.7	0.5
Residual Migration (%)	2.1	1.7	1.8	1.7

Notes: This table shows the decomposition of annual urban growth into annual natural increase and annual residual migration (%) for 6 European countries and one Neo-European country, the United States (1800-1910). Averages are not weighted by population. See the Online Data Appendix for data sources.

Appendix Table 2: Decomposition of Annual Urban Growth for 33 Developing Countries, 1960-2010

Period:		1960-2010			2000-2010		
Subregion	**Country**	**Urban Growth**	**Natural Incr.**	**Residual Migr.**	**Urban Growth**	**Natural Incr.**	**Residual Migr.**
ASIA		**3.5**	**1.7**	**1.8**	**2.3**	**1.1**	**1.2**
East Asia (N = 3):		2.9	1.1	1.8	2.0	0.4	1.6
East Asia	China	3.7	1.0	2.7	3.8	0.8	3.0
East Asia	Japan	1.4	0.7	0.7	1.5	0.0	1.5
East Asia	South Korea	3.6	1.5	2.1	0.9	0.5	0.3
South Asia (N = 4):		3.5	1.9	1.6	2.3	1.4	0.9
South Asia	Bangladesh	5.8	2.1	3.7	3.1	1.1	2.0
South Asia	India	3.2	1.8	1.4	2.6	1.3	1.3
South Asia	Pakistan	3.7	2.2	1.5	2.7	1.9	0.8
South Asia	Sri Lanka	1.3	1.5	-0.2	0.6	1.1	-0.5
Southeast Asia (N = 4):		3.9	1.9	2.0	2.5	1.4	1.2
Southeast Asia	Indonesia	4.5	1.8	2.7	2.9	1.6	1.3
Southeast Asia	Malaysia	4.6	2.1	2.5	3.5	1.4	2.1
Southeast Asia	Philippines	3.6	2.4	1.2	2.0	2.1	-0.1
Southeast Asia	Thailand	3.0	1.4	1.6	1.7	0.4	1.3
LAC		**3.1**	**2.2**	**0.9**	**2.1**	**1.5**	**0.6**
Central America (N = 4):		3.2	2.5	0.7	2.4	1.7	0.7
Central America	El Salvador	2.7	2.5	0.2	1.3	1.2	0.1
Central America	Guatemala	3.5	2.8	0.7	3.4	2.8	0.6
Central America	Mexico	3.1	2.5	0.6	1.7	1.2	0.5
Central America	Panama	3.5	2.3	1.2	3.0	1.5	1.5
South America (N = 4):		3.1	2.0	1.1	1.9	1.3	0.6
South America	Chile	2.2	1.7	0.5	1.4	1.0	0.4
South America	Colombia	3.2	1.9	1.3	1.9	1.7	0.3
South America	Ecuador	3.8	1.9	1.9	2.7	1.1	1.6
South America	Peru	3.2	2.4	0.8	1.7	1.5	0.2
MENA		**3.6**	**2.6**	**1.0**	**2.1**	**1.6**	**0.5**
Middle-East (N = 2):		4.5	2.8	1.6	2.4	1.8	0.6
Middle-East	Iran	3.9	2.6	1.3	2.0	1.3	0.7
Middle-East	Jordan	5.0	3.0	1.9	2.9	2.4	0.4
Northern Africa (N = 2):		2.7	2.3	0.4	1.7	1.3	0.4
Northern Africa	Egypt	2.4	2.2	0.2	2.0	1.7	0.3
Northern Africa	Tunisia	3.0	2.4	0.6	1.5	0.9	0.5
AFRICA		**4.9**	**2.9**	**2.1**	**4.1**	**2.4**	**1.7**
Eastern Africa (N = 5):		4.9	2.8	2.1	3.7	2.2	1.4
Eastern Africa	Central Afr. Rep.*	3.5	2.4	1.1	2.1	2.0	0.1
Eastern Africa	Ethiopia	4.6	2.7	1.9	3.8	2.0	1.7
Eastern Africa	Kenya	5.7	2.8	2.9	4.4	2.4	2.0
Eastern Africa	Madagascar	5.1	2.5	2.6	4.7	2.3	2.5
Eastern Africa	Malawi	5.6	3.7	1.9	3.5	2.6	0.9
Western Africa (N = 5):		4.9	2.9	2.0	4.5	2.6	1.9
Western Africa	Burkina-Faso	6.0	3.0	3.0	6.8	3.1	3.7
Western Africa	Ghana	4.2	2.5	1.8	4.0	1.8	2.2
Western Africa	Ivory Coast	5.7	2.7	3.0	3.3	2.4	1.0
Western Africa	Mali	4.5	3.4	1.1	5.2	3.5	1.7
Western Africa	Senegal	4.1	2.8	1.4	3.2	2.5	0.8
All Countries		**3.8**	**2.3**	**1.6**	**2.8**	**1.7**	**1.1**

Notes: This table shows the decomposition of annual urban growth into annual natural increase and annual residual migration (%) for 33 developing countries (1960-2010). * The Central African Republic belongs to Central Africa, but data is missing for other countries of the region. We have included it in Eastern Africa. Averages are not weighted by population. See the Online Data Appendix for data sources.

Appendix Table 3: Natural Increase Source Information by Country

<u>Panel A:</u>	**Historical Data for Industrial Europe (1800-1910)**		
Country	**Region**	**Years**	**Main Sources**
Belgium	Europe	1866-1905	*Annuaires Statistiques de la Belgique. Belgium. Ministere de l'Interieur.* Various volumes.
England	Europe	1700-1950	Newsholme, A. (1911), The Declining Birth Rate, Its National and International Significance. London: Cassell & Company Limited. Friedlander, D. (1969). Demographic Responses and Population Change, *Demography* 6 (4): 359-381. Williamson, J. (1990). Coping with City Growth During the British Industrial Revolution. Cambridge: Cambridge University Press.
France	Europe	1852-1910	*Statistique Annuelle du Mouvement de la Population. France. Statistique Generale.* Various volumes.
Germany	Europe	1851-1912	Weber, A. (1899). *The Growth of Cities in the 19th Century.* New York: The MacMillan Company. Stedman, T. (1904). *Medical Record.* New York: William Wood and Company. Pollock, H., and W. Morgan (1913). *Modern Cities: Progress of the Awakening for Their Betterment Here and in Europe.* New York: Funk & Wagnalls Company. Holmes, S. (1921). *A Study of Present Tendencies in the Biological Development of Civilized Mankind.* New York: Harcourt, Brace and Company. Vogele, J. (2000). Urbanization and the urban mortality change in Imperial Germany. *Health & Place* 6: 41-55.
Netherlands	Europe	1815-1909	Margaret Sanger (1917). *The Case for Birth Control.* Modern Art Printing Company. Wintle, M. (2004). *An Economic and social History of the Netherlands, 1800-1920: Demographic, Economic and Social Transition.* Cambridge: Cambridge University Press.
Sweden	Europe	1800-1910	Dyson, T. (2011), The Role of the Demographic Transition in the Process of Urbanization. *Population and Development Review*, 37: 34-54.
United States	Europe	1825-1910	Various Census Reports. Duffy J. (1968). *A History of Public Health in New York City, 1625-1866*. New York: Russell Sage. Rosenwaike, I. (1972). *Population History of New York City*. Syracuse: Syracuse University Press. Haines, M. (2001). The Urban Mortality Transition in the United States, 1800-1940. *Annales de Demographie Historique* 101: 33-64. Michael R. Haines, *The Population of the United States, 1790-1920*. Cambridge: Cambridge University Press, 2008. Ferrie, J.P., and W. Troesken (2008). Death and The City: Chicago's Mortality Transition, 1850-1925. *Explorations in Economic History*, 45, 1: 1-16.

Appendix Table 3: Natural Increase Source Information by Country

Panel B:		Historical Data for Developing Countries (1960-2010)	
Country	**Region**	**Years**	**Main Sources**
Bangladesh	Asia	1965, 1974, 1985, 1991, 2004	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report), CICRED Monograph
Burkina Faso	Africa	1960, 1975, 1985, 1996, 2006	Population and Housing Census (Report), Demographic and Health Survey (Report)
Central Afr. Rep.	Africa	1960, 1975, 1988, 1994-1995, 2003	Population and Housing Census (Report), Demographic and Health Survey (Report), Fertility Survey (Report)
Chile	LAC	1960, 1970, 1983, 1995, 2006	UN Statistical Yearbook, Population and Housing Census (Report), CICRED Monograph
China	Asia	1965, 1975, 1985, 1995, 2000	UN Statistical Yearbook, Population and Housing Census (Report), CICRED Monograph
Colombia	LAC	1965, 1973, 1985, 1990, 2000	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report), CICRED Monograph
Côte d'Ivoire	Africa	1965, 1975, 1988, 1994, 1999	Population and Housing Census (Report), Demographic and Health Survey (Report), Fertility Survey (Report)
Ecuador	LAC	1968, 1974, 1985, 1993, 2005	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report)
Egypt	MENA	1962, 1975, 1985, 1996, 2006	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report), CICRED Monograph
El Salvador	LAC	1965, 1975, 1985, 1996, 2006	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report)
Ethiopia	Africa	1967, 1974, 1984, 1994, 2000	Population and Housing Census (Report), Demographic and Health Survey (Report), Fertility Survey (Report)
Ghana	Africa	1960, 1970, 1984, 1992, 2000	Population and Housing Census (Report), Demographic and Health Survey (Report), CICRED Monograph
Guatemala	LAC	1965, 1975, 1980, 1992, 1999	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report)
India	Asia	1961, 1970, 1985, 1989, 2005	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report), CICRED Monograph
Indonesia	Asia	1961, 1975, 1985, 1993, 2003	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report), CICRED Monograph
Iran	MENA	1968, 1975, 1986, 1990, 2005	UN Statistical Yearbook, Population and Housing Census (Report), CICRED Monograph
Japan	Asia	1965, 1975, 1985, 1995, 2005	UN Statistical Yearbook, Population and Housing Census (Report), CICRED Monograph
Jordan	MENA	1965, 1973, 1990, 1997, 2002	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report)
Kenya	Africa	1962, 1969, 1979, 1989, 1999	Population and Housing Census (Report), Demographic and Health Survey (Report), Fertility Survey (Report), CICRED Monograph

Country	Region	Years	Main Sources
Madagascar	Africa	1965, 1975, 1985, 1993, 2000	Population and Housing Census (Report), Demographic and Health Survey (Report), Fertility Survey (Report)
Malawi	Africa	1970, 1977, 1987, 1998, 2008	Population and Housing Census (Report), Demographic and Health Survey (Report), Fertility Survey (Report)
Malaysia	Asia	1960, 1970, 1980, 1990, 2006	UN Statistical Yearbook, Population and Housing Census (Report), CICRED Monograph
Mali	Africa	1960, 1976, 1987, 1998, 2006	Population and Housing Census (Report), Demographic and Health Survey (Report), Fertility Survey (Report)
Mexico	LAC	1965, 1974, 1980, 1990, 2006	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report)
Pakistan	Asia	1968, 1971, 1984, 1988, 2000	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report), CICRED Monograph
Panama	LAC	1965, 1969, 1985, 1995, 2006	UN Statistical Yearbook, Population and Housing Census (Report), CICRED Monograph
Peru	LAC	1960, 1970, 1986, 1990, 2000	Population and Housing Census (Report), Demographic and Health Survey (Report), Fertility Survey (Report), CICRED Monograph
Philippines	Asia	1968, 1978, 1988, 1998, 2003	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report), CICRED Monograph
Senegal	Africa	1960, 1976, 1988, 1993, 2002	Population and Housing Census (Report), Demographic and Health Survey (Report), Fertility Survey (Report)
South Korea	Asia	1960, 1966, 1970, 1989, 2006	UN Statistical Yearbook, Population and Housing Census (Report), CICRED Monograph
Sri Lanka	Asia	1961, 1971, 1983, 1987, 2001	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report), CICRED Monograph
Thailand	Asia	1965, 1975, 1985, 1995, 2005	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report), CICRED Monograph
Tunisia	MENA	1966, 1972, 1980, 1989, 2005	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report), CICRED Monograph