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DEMOGRAPHY, URBANIZATION AND DEVELOPMENT:

*Rural Push, Urban Pull and... Urban Push?**

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ABSTRACT

Developing countries have rapidly urbanized since 1950. To explain urbanization, standard models have emphasized rural-urban migration, focusing on rural push factors (agricultural modernization and rural poverty) and urban pull factors (industrialization and urban-biased policies). 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 a non-negligible part of developing countries' rapid urban growth and urbanization can also be linked to demographic factors, i.e. rapid internal urban population growth, or an urban push. The much lower urban mortality of today's developing countries, relative to Industrial Europe, where higher urban death rates virtually offset urban births, has compounded the effects of migration. High urban natural increase, rather than migration, is also found to be associated with urban congestion, thus providing further insight into the phenomenon of urbanization without growth.

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1. INTRODUCTION

Developing countries have dramatically urbanized since 1950 (World Bank, 2009). While their urbanization process shares many similarities with that of developed countries in the 19th century, there are differences in several dimensions. First, urban growth has been faster in today's developing world. In Europe, urbanization accelerated with the advent of the Industrial Revolution, going from 15% in 1800 to 40% in 1910 (Figure 1). Both Africa and Asia did so in almost half the time, or twice as fast, starting at similarly low levels of 15% in 1950 to reach around 40% in 2010. Second, while urbanization is highly correlated with income across countries (Henderson, 2010), the world is becoming more and more urbanized at a constant income level (Glaeser, 2013). In 1960, the 35 countries whose income per capita was less than $2 a day had an average urbanization rate of 15% (WDI, 2013). In 2010, the 34 countries with similar incomes had an average urbanization rate of 30%. Third, today's cities in developing countries 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, Karachi, 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?

Standard models explain urbanization largely by rural-urban migration in response to an (expected) urban-rural wage (or utility) gap (Harris & Todaro, 1970). This utility 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). 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; Henderson, Storeygard & Deichmann, 2013). Then there are various urban pull factors. If the country experiences an Industrial or Service Revolution, the urban wage increases, which attracts workers from the countryside (Lewis, 1954; Hansen & Prescott, 2002; Lucas, 2004; Alvarez-Cuadrado & Poschke, 2011; Henderson, Roberts & Storeygard, 2013). If the government adopts urban-biased policies, the urban wage also increases (Lipton, 1977; Henderson, 1982; Ades & Glaeser, 1995; Davis & Henderson, 2003). 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; Cavalcanti, Mata & Toscani, 2014). While the Green Revolution, Industrial Revolution and resource export 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).

The theories reviewed so far focus on migration as the main driver of urbanization. This paper takes a comparative, historical and demographic oriented approach to understanding some of the key features of the developing world's urbanization process. Analyzing and comparing the demographic drivers (mortality, fertility and migration) separately for rural and urban areas across both periods, we see that in many cities of the developing world today, mortality has fallen to low levels, due to the epidemiological transition of the 20th century, while fertility has remained relatively high. This has resulted in a high rate of natural increase in urban areas, which in turn has compounded the effects of migration on urban growth and urbanization. This situation of today's "mushroom cities" contrasts with the "killer cities" of Industrial Europe, where high urban mortality rates offset the (lower) urban birth rate, resulting in much lower urban natural increase, and thus lower urban growth and urbanization. It is further estimated that fast urban natural increase (though not migration) is associated with more congested cities. Contrasting it with the above mentioned mechanisms of "rural push" and "urban pull", the concept of "urban push" is used to describe this demographic mechanism of urban growth and urbanization. While the former two concepts imply that rural workers are pushed to the cities by changes in rural conditions, or pulled to the cities by changes in urban conditions, respectively, the latter suggests that cities are growing internally and "pushing" their own boundaries. The analysis consists of three steps.

It first provides careful documentation and comparative decomposition of urban growth and urbanization in developing countries post-1960 and Europe during 1800-1910. To do so, various historical sources were consulted 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).[1] We show that the fast growth of cities in today's developing world was mostly driven by urban natural increase, rather than by migration as in Europe. In particular, the resulting difference in urban rates of natural increase caused the urban population in today's developing world to double every 18 years, compared with 35 years in Europe. Thus, while natural increase drove urban growth, the growth of the *absolute* number of urban residents, simulations suggest that it also raised urbanization rates, the *relative* numbers of urban residents. Though rural growth was equally fast in Industrial Europe and today's developing world, urban growth was faster in the latter.

Second, the decadal panel data on the 33 developing countries are used in a multivariate regression framework to test whether the contributions of urban natural increase to urban growth and urbanization are truly additive and hold beyond an accounting sense. Decadal country level rates of urban growth and urbanization are regressed on urban natural increase, controlling for income growth and the various rural push and urban pull factors, adding region fixed effects (e.g., West Africa, etc.) interacted with a time trend. We also

[1]Our analysis builds on the previous work of demographers and historians such as Rogers (1978), Preston (1979), Keyfitz (1980) and Rogers & Williamson (1982). We complete their preliminary analysis by using historical data on 40 countries, past and present, in two centuries. First, most historians have focused individually either on England or the U.S. in the 19th century (Williamson, 1990; Haines, 2008). We managed 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 consistent data does not exist for other countries as far back as 1960. See the Web Appendix for data sources.

test for causality by instrumenting the evolution of urban natural increase with proxies for initial religious and family planning conditions by country in the 1960s, as these were not always correlated with initial economic conditions that affected future urban growth. Urban natural increase has a strong effect on urban growth and urbanization. The effect on urban growth is fully additive, with a one percentage point increase in the urban natural growth rate raising urban population growth by one percentage point as well. As expected, the effect on urbanization is smaller, though still quantitatively meaningful, because it is partially offset by the associated rural natural increase. A one 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, thus affirming that differences in urban natural increase largely explain why urban growth has been faster in today's developing world than in Industrial Europe and helping us to understand why Africa and Asia urbanized twice as fast.

Third, fast urban growth can give rise to urban congestion and decrease 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 the 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. Labor supply shocks 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 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 low end urban informal sectors. Interestingly, the corresponding effects of migration on these indicators of urban congestion tend to be smaller. Our results are all the more important since fertility remains high in many cities that will keep growing in the future.

The paper contributes to the literature on urbanization and growth. While the role of urban natural increase has long been recognized by demographers (Rogers, 1978; Preston, 1979; Keyfitz, 1980), there is surprisingly little research about it in economics. For example, the existing surveys on cities in developing countries do not mention natural increase (Overman & Venables, 2005; Henderson, 2010; Duranton, 2013). 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. On the other hand, agglomeration promotes growth. Given that urbanization is a form of agglomeration, cities could promote growth in developing countries (Duranton, 2008, 2013; World Bank, 2009; Brülhart & Sbergami, 2009). Urban natural increase can, however, create a disconnect between urbanization and growth. First, poor cities can expand without an increase in standards of living. Second, because natural increase accelerates urban growth, it can give rise to urban congestion, which may reduce the benefits from agglomeration. While there is an extensive literature trying to measure agglomeration effects in developing countries (see Henderson (2010) and Duranton (2013) for recent surveys of this literature), little is known about the magnitude of congestion effects.[2] The speed of urban growth is a dimension of the urbanization process that has been understudied. All in all, urban natural increase in poor countries may have 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).[3] Third, whether urban growth is driven by migration or natural increase has strong policy implications. When urban congestion is the result of excessive migration, investment in urban infrastructure may not be justified if it further fuels migration (see Feler & Henderson (2011) for a discussion of urban policies in Brazil). However, if urban growth is due to urban natural increase, the resulting immediate increase in the urban population necessitates investment in urban infrastructure. Another policy option is to encourage lower urban fertility rates.

Our findings also advance the literature on the effects of demographic growth. Population growth promotes economic growth if high population densities encourage capital accumulation or technological progress (Kremer, 1993; Becker, Glaeser & Murphy, 1999). However, population growth has a negative effect on per capita income if capital (e.g., land) is inelastically supplied. Thus, in the long-run, countries only develop if technology progresses and the demographic transition limits population growth (Galor & Weil, 1999, 2000). First, we study an increase in population from the perspective of cities, whereas the literature has focused on the interactions between rural growth and an inelastic land supply.[4] Second, the few papers that looked at cities examined how urbanization affected the demographic transition (Sato & Yamamoto, 2005; Sato, 2007), whereas we study how the demographic transition has impacted urbanization and development.

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.

2. CONCEPTUAL FRAMEWORK

This section provides a simple framework to analyze the effects of urban natural increase on the urban growth, the speed of urbanization and urban congestion.

2.1 Urban Natural Increase and the Speed of Urban Growth

There are four components which contribute to an expansion of the urban population: urban natural increase, rural-to-urban migration, international-to-urban migration and urban reclassification. These components also affect the evolution of the rural population. Changes in the urban and rural populations over time can thus be written as:

[2]Likewise, there are only a few papers about the role of slums – a clear symptom of housing congestion – in developing countries. Notable exceptions are Lall, Lundberg & Shalizi (2008), Takeuchi, Cropper & Bento (2008), Brueckner & Selod (2009), Brueckner (2013) and Cavalcanti & Da Mata (2013).

[3]The paper is also related to the literature on the urban-rural gap (Gollin, Lagakos & Waugh, 2013; Young, 2013). We find that rural-to-urban migration remains positive although cities are becoming congested. The countryside is also congested as a result of natural increase, and remains underprovided in infrastructure.

[4]A few studies have examined the effects of disease eradication on population and economic growth (Acemoglu & Johnson, 2007; Bleakley, 2007, 2010). Other studies have looked at the effects of unexpected decreases in population on development (Young, 2005; Voigtländer & Voth, 2009, 2013*a*,*b*).

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

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

where $\triangle Upop_t$ ($\triangle Rpop_t$) is the absolute growth of the urban (rural) population in year t, Uni_t (Rni_t) is the urban (rural) 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 international-to-urban (rural) migrants in year t, and $Urec_t$ is the number of rural residents reclassified as urban in year t. Abstracting from international migration, equations (1) and (2) can be simplified as:

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

$$\triangle Rpop_t = Rni_t * Rpop_t - Mig_t \tag{4}$$

where Mig_t is the number of "residual migrants", defined as the sum of rural migrants and rural residents reclassified as urban. The urban crude rate of natural increase is the urban crude birth rate minus the urban crude death rate. If urban fertility is higher than urban mortality, the urban rate of natural increase is positive, and the urban population expands. Equation (3) must be divided by the urban population at the start of year t to be expressed in percentage form. The urban growth rate is thus equal to the sum of the rate of urban natural increase (Uni_t) and the "residual migration" rate ($Mig_t/Upop_t$):

$$\frac{\triangle Upop_t}{Upop_t} = Uni_t + \frac{Mig_t}{Upop_t} \tag{5}$$

2.2 Urban Natural Increase and the Speed of 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 urbanization in year t can be expressed as:

$$\triangle U_t = U_{t+1} - U_t = \frac{Upop_{t+1}}{Pop_{t+1}} - \frac{Upop_t}{Pop_t} = \frac{Upop_{t+1}}{Pop_{t+1}}\frac{Pop_t}{Pop_t} - \frac{Upop_t}{Pop_t}\frac{Pop_{t+1}}{Pop_{t+1}} \tag{6}$$

$$\triangle U_t = \frac{Upop_{t+1}(Upop_t + Rpop_t)}{Pop_t Pop_{t+1}} - \frac{Upop_t(Upop_{t+1} + Rpop_{t+1})}{Pop_t Pop_{t+1}} \tag{7}$$

$$\triangle U_t = \frac{Rpop_t Upop_{t+1}}{Pop_t Pop_{t+1}} - \frac{Upop_t Rpop_{t+1}}{Pop_t Pop_{t+1}} = (1-U_t)\frac{Upop_{t+1}}{Pop_{t+1}} - U_t \frac{Rpop_{t+1}}{Pop_{t+1}} \tag{8}$$

Substituting equations (3) and (4) into equation (8), and noting that $\triangle Pop_t = Nni_t * Pop_t$ with Nni_t the national rate of natural increase in year t, and Pop_t the total population at the start of year t, we obtain:

$$\triangle U_t = (1-U_t)\frac{(1+Uni_t)Upop_t + Mig_t}{(1+Nni_t)Pop_t} - U_t \frac{(1+Rni_t)Rpop_t - Mig_t}{(1+Nni_t)Pop_t} \tag{9}$$

$$\triangle U_t = (1-U_t)U_t \frac{1+Uni_t}{1+Nni_t} - U_t(1-U_t)\frac{1+Rni_t}{1+Nni_t} + \frac{Mig_t}{(1+Nni_t)Pop_t} \tag{10}$$

$$\triangle U_t = \frac{U_t}{(1+Nni_t)}[(1-U_t)(Uni_t - Rni_t) + \frac{Mig_t}{Upop_t}] \tag{11}$$

Three insights emerge. First, the change in urbanization is a relative concept and depends on both urban and rural natural increase ($Uni_t - Rni_t$), with the latter mitigating the positive effect of the former. Consequently, rapid urban natural increase can coexist with a relatively slow change in urbanization. Put differently, countries with similar changes in urbanization may be experiencing very different rates of urban growth, if higher rates of urban natural increase are offset to a similar extent by higher rates of rural natural increase. As countries with higher urban natural increase also tend to experience higher rural natural increase (Uni_t and Rni_t tend to be highly correlated) this is not so far-fetched. This contrasts with urban growth, where urban natural increase translates one to one in urban growth (at least in an accounting sense and contemporaneously - see further below). Urban congestion is thus likely also more directly linked to urban growth than to changes in the rate of urbanization, a point we will revisit below.

Second, the effect of migration on changes in urbanization tends to be larger than the effect of urban natural increase. Not only is the effect of the latter mitigated by rural natural increase (typically even overturned if Rni_t exceeds Uni_t), it is further conditioned by the share of the rural population ((1-U_t)$\leq$1). From this perspective, it is unsurprising that debates about urbanization (and development) largely ignore demographic factors and focus on migration. The latter affects changes in urbanization most.

Finally, the contribution of urban national increase is conditioned by the nonlinear relationship with the initial level of urbanization U_t. To gauge the effect of urban natural increase, we simulate equation (11) using the following parameters: $Rni = 2.5\%$ and $Mig/Upop = 1.5\%$ per year. These values are inspired by the comparative analysis in section 3.6. $Uni = 0.5\%$ is chosen as the benchmark, to see how raising the urban rate of natural increase to 1, 1.5, 2, 2.5, and 3 alters urbanization for different initial rates of urbanization (Figure 2). The effects can be large; increasing the urban rate of natural increase from 0.5% to 3% raises the change in urbanization by 0.5 percentage points a year on average. Note that while the rates of urban and rural natural increase are usually highly correlated, the gaps can be substantial, as in Industrial Europe where urban mortality rates exceeded those in rural areas (see below). Moreover, the effects of natural increase on the speed of urbanization increase until the initial rate of urbanization approaches 50 percent, after which they decline. The higher speed of urbanization observed in developing countries is thus partly also driven by their low points of departure.

2.3 Urban Natural Increase, Urban Growth and Urban Congestion

The utility levels of residents in place i (u for urban; r for rural) are assumed to be equal $U_i(l_i, W_i, \theta_i)$, where l_i is mortality, W_i is the real wage, and θ_i represents amenities in place i. Any potential migrant compares the marginal utilities of living in the city (U_u) vs. the countryside (U_r). The decision to migrate thus depends on the urban-rural mortality, wage and amenity gaps. First, if urban mortality is relatively lower, ceteris paribus the cities are more attractive. Second, we assume that both real wages and amenities depend on investments in various types of capital (K_i): physical and human capital, the housing stock, or transport infrastructure. Third, cities grow too fast if the urban population

($Upop$) grows faster than the urban stock of capital (K_u). If urban capital cannot be accumulated as fast as the urban population grows, fast urban growth leads to urban congestion, which reduces urban utility via lower wages and amenities. 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 every 35 years. Then, the urban housing stock needs to double every 15 years. This is possible if the urban growth is not unexpected and agents are forward-looking, with sufficient credit available to make the necessary investment. If not, congestion effects will 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. Lastly, though urban congestion reduces future migration, migration may still remain high as it depends on the urban-rural utility gap which also depends on the rural conditions.

2.4 Econometric Considerations

We will test three hypotheses: (i) urban natural increase accelerates the speed of urban growth (equation (5)), (ii) urban natural increase accelerates the speed of urbanization (equation (11)), and (iii) a fast speed of urban growth produces urban congestion. Equation (5), which forms the base of our analysis, assumes that the relationships between the speed of urban growth and its two components are additive. When estimating model (5), the coefficient of urban natural increase β could be equal to 1: one urban newborn adds exactly one urban resident. However, there are various reasons why the coefficient β could differ from 1 in the data. A coefficient lower than 1 implies that adjustment mechanisms in the economy prevent urban natural increase from mechanically accelerating urban growth. Conversely, a coefficient higher than 1 implies than urban natural increase has cumulative effects on the speed of urban growth.

Migration. Urban natural increase and migration could influence themselves and each other dynamically. Four dynamic relationships must be considered: (i) $Mig_t = f(Uni_{t-1})$: Urban natural increase has a dissuasive effect on future migration, if the urban newborns crowd out the cities. In that case, the estimated coefficient β is lower than 1, as urban newborns and rural migrants are substitutes to each other, (ii) $Uni_t = g(Uni_{t-1})$: Urban residents adjust their fertility rates if urban newborns crowd out the cities. However, urban natural increase has 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 due to the trade-off between child quantity and child quality. Additionally, urban natural increase affects the age-sex composition of the cities, (iii) $Uni_t = h(Mig_{t-1})$: Urban residents adjust their fertility rates if migrants crowd out the cities. However, migration has a positive effect on future urban fertility if urban congestion impoverishes everyone. A high share of migrants in the cities also affects the age-sex structure, and (iv) $Mig_t = j(Mig_{t-1})$: 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. We will discuss these relationships in the analysis.

Urban classification. Births and deaths are registered using the place of residence. This location is classified either as urban or rural. This is important when distinguishing the effects of natural increase and migration. A child who is born in an urban family is counted as urban, no matter whether the family moved to the city ten years prior or just the year before the census. Likewise, a child that follows her parents when they migrate to a city is counted as a migrant.[5] Urban reclassification is then higher in countries where the urban rate of natural increase is high, if the rural rate of natural increase is also 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 ($Urec_t = \chi(\triangle U_{t-1})$). The coefficient β is higher than 1 if urban reclassification is more important in countries where urban natural increase is high. We will discuss these relationships in the analysis.

Causality. Though the previous analysis treats urban natural increase as exogenous, it could be endogenously determined. First, we will explain in section 3.4 that the epidemiological transition was a shock that reduced mortality for all countries, no matter their income level. The countries that still had a high urban birth rate at independence unexpectedly inherited a high urban rate of natural increase. Second, various countries have begun or have completed their fertility transition since then. In particular, higher returns to education in fast-growing countries have modified the trade-off between child quantity and quality in favor of child quality. We expect high urban birth rates in countries remaining poor. Then, urban growth could be faster in the faster-growing countries, or it could be faster in the poor countries that are less urbanized initially. This could lead to a downward bias or an upward bias, hence the need to control for initial income and urbanization, as well as income growth.[6] In the analysis, we will also include country and decade fixed effects, controls for the urban pull and rural push factors, controls for the dynamic relationships discussed above, and ten region fixed effects (e.g., West Africa) interacted with a time trend. The effect is not causal if there are unobservable factors that explain why the trajectories of urban fertility and urban growth are correlated over time *within* countries, relative to the neighboring countries of the same region, conditional on the controls we include. Lastly, it is only a concern if these unobservable factors cause an upward bias, leading us to over-emphasize the role of natural increase. A downward biased estimate is less consequential, since it provides a lower bound of the true effect. We will also test for causality using various identification strategies.

3. DATA AND BACKGROUND

We now discuss the historical background and the data we use in our analysis. The Web

[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 rates.

[6] This could give rise to multiple equilibria. In countries completing their fertility transition, urban growth is slower, and congestion effects are limited. If income remains high, fertility further decreases. Countries in which urban fertility is high experience fast urban growth. If urban growth is too fast, congestion effects kick in, which lower productivity. If income is low, fertility remains high, and urban fertility and urban congestion reinforce each other. Including income in the regressions will control for this feedback effect.

Appendix contains more details on how we construct the data.

3.1 New Data for Developing Countries, 1700-2010

To test our hypotheses, we need historical data on urbanization, urban and rural fertility and urban and rural mortality. 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 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). 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.[7] We also collect the same type of data for as many countries as possible that were still developing countries in 1960 (N = 97 out of the sample of 116 countries), but for the most recent period only.

3.2 Historical Patterns of Urbanization in Developing Countries

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. 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 10%) until 1800 and increased to about 40% in 1910. 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 rural countries (urbanization rate around 15%). 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 15% to 40%.

Urbanization resulted from fast urban growth. Figure 1 shows the urban growth rate for Europe from 1700-1950. It peaked during the Industrial Revolution. In the 1800-1910 period, the overall urban growth rate was 2.0% per year. Figure 1 also shows the urban growth rate for the four developing areas from 1900-2010. The urban growth rate has

[7] The list of the 40 countries that we use in the main analysis, and the data sources for each country are reported in Web Appendix Tables 1, 2 and 3. While some of these sources could be found on the internet, we found many of them at the Census Bureau Library in Washington D.C. and the libraries of the London School of Economics in London and the Centre Population et Développement in Paris. We could not increase the sample size as historical consistent data does not exist for other countries.

been about 3.8% a year in today's developing world post-1960, and 4.7%, 3.4%, 3.2% and 4.0% in Africa, Asia and the LAC and MENA regions respectively. An urban growth rate of 3.8% implies that cities double every 18 years, while a rate of 2.0% means that cities only 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.

3.3 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 the same data for 6 other countries and generalizing the results. Results are shown in Figure 3. Fertility was relatively low in England (about 35 per 1,000 people before 1910).[8] Mortality was high. 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 and polluted water sources all contributed to this urban penalty (Williamson, 1990; Voigtländer & Voth, 2013*b*). As a result, urban natural increase was low in 1800-1910, at 5 per 1,000 people (0.5%). These patterns are present for the other countries (see Web Appendix Table 2 for the detailed decomposition of urban growth for the seven countries). In all countries, the contribution of urban natural increase to urban growth was low 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 U.S. The rate was 0.5% for Industrial Europe.[9]

3.4 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 4 plots the urban and rural birth and death rates for the four developing areas in 1960-2010. Initially, urban birth rates were high in developing countries, and in Africa in particular (about 50 per 1,000 people). These rates decreased everywhere post-1960, yet they remain high in Africa (about 35). Then, urban birth rates are largely explained by urban total fertility rates (the correlation between the two variables is 0.93), rather than by the share of women of reproductive age in the urban population.[10] In 1960, urban death rates were already low in most countries, 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

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

[9] The descriptive results are thus the same whether we consider a country that received many international migrants (the U.S.) or countries where international outmigration was limited.

[10] The birth rate is a function of the total fertility rate (TFR) and the share of women of reproductive age in the population (SWRA). The urban TFR is the main determinant of urban birth rates. For 97 countries for which we have data for the closest year to 2000 in the interval 1990-2010, the correlation coefficient between the two is 0.93 (see Web Appendix Figure 1). The correlation coefficient between the urban birth rate and the urban SWRA is lower (-0.40). When regressing the urban birth rate on the urban TFR, SRWA and their product (TFR x SRWA), we find that the product explains most of it, and that the product is in turn driven by the TFR (see Web Appendix Table 4). While a youth bulge effect is possible, the results imply it still depends on the urban TFR when the new generation enters reproductive age.

campaigns in the colonies resulted in widespread and significant declines in mortality, no matter the income level. The acceleration of urban growth in the 1950s illustrates this phenomenon (see Figure 1). The colonizers also invested in health and educational infrastructure, which led to higher standards of living, as shown by anthropometric and other development outcomes (Moradi, 2008; Huillery, 2009). Cities were centers of diffusion of innovation, explaining why urban mortality was low.[11] Differences in natural increase are thus driven by fertility differences. 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 higher (Web Appendix Figure 3 shows this for 97 countries). Figure 5 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 are completing their fertility transition. Asia started its transition earlier. Interestingly, while the urban rates of natural increase vary a lot across space and time (from 5 per 1,000 people to 30), the five developing areas (Europe, Africa, Asia, and the LAC and MENA regions) all had relatively similar rural rates of natural increase (from 20-30). Therefore, while there have always been "mushroom villages", the emergence of "mushroom cities" is the novel feature of the 20th century.

3.5 Urban Natural Increase and the Speed of Urban Growth

We use equation (5) 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. Absolute urban growth was driven by migration. England could not have urbanized without rural residents migrating to unhealthy cities. Results from the six other countries confirm these patterns (see Web Appendix Table 2). During the 1800-1910 period, Europe's urban growth was 2.2% per year, while the urban rate of natural increase was 0.5%. The difference – 1.7% – was accounted for by residual migration. Figure 6 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 Web Appendix Tables 2 and 3 for each country). Migration rates, which average 1.6% for developing countries post-1960, did not differ 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 two thirds of urban growth post-1960. 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 fifty (thirty) urban residents in 2010.

[11] The death rate is a function of the child mortality rate (age 0-5 years), the youth mortality rate (age 5-15 years) and the adult mortality rate (age 15 and above years). At the cross-country level, urban child mortality is the main factor of urban aggregate mortality (see Web Appendix Figure 2). In our sample of countries in 2000, the correlation coefficient between the two is 0.81.

3.6 Urban Natural Increase and the Speed of 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: 2% in Europe and Asia, and 2.5% in other regions. Migration rates were also constant across space and time. In Figure 2, the simulations used the following parameters: $Rni = 2.5\%$ and $Mig/Upop = 1.5\%$. Taking $Uni = 0.5\%$ as a benchmark, we showed the results for five values of $Uni = \{1; 1.5; 2; 2.5; 3\}$, given an initial urbanization rate (U). This allows us to compare the potential effects of urban natural increase *ceteris paribus* for East Asia ($Uni \approx 1\%$), Asia (1.5%), the LAC region (2%), the MENA region (2.5%), and Africa (3%), relative to Europe (0.5%). The decadal effects could be large (e.g., 2 points of urbanization for Africa, given an initial urban rate of 10%).

4. RESULTS ON ABSOLUTE URBAN GROWTH

Though we believe the descriptive results shown in section 3 constitute an important contribution in and of itself, we must use econometric regressions on our panel data for 33 countries (1960-2010) to correctly estimate the effect of urban natural increase on urban growth. The decomposition analysis posits that the coefficient of urban natural increase in equation (5), β, is equal to 1. However, there are various reasons why this may not be the case in the data. First, urban natural increase and residual migration could influence each other dynamically. If $\beta < 1$, there must be adjustment mechanisms in the economy that prevent urban natural increase from mechanically accelerating urban growth (e.g., lower migration rates), and the decomposition analyses overestimate the role of urban natural increase. We will thus test if the coefficient is significantly different from 1. Second, the decomposition analysis cannot say anything about the direction of the relationship. We will show that they are robust to the inclusion of many controls and the use of various identification strategies. Third, we must use regressions to study the effects of urban natural increase on the two other outcomes, urbanization and urban congestion.

We use panel data for 33 countries that were still developing countries in 1960. We adapt equation (5) and run the following model for $t = [1960\text{s}, 1970\text{s}, 1980\text{s}, 1990\text{s}, 2000\text{s}]$:

$$\frac{\triangle Upop_{c,t}}{Upop_{c,t}} = \alpha + \beta Uni_{c,t} + \gamma_c + \delta_t + u_{c,t} \tag{12}$$

where $\triangle Upop_{c,t}/Upop_{c,t}$ 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 ($Uni_{c,t}$). We include country and decade fixed effects (γ_c; δ_t). Table 1 presents the results. Column (1) shows that urban natural increase has a strong unconditional effect on urban growth (0.95***). The F-test in the second panel confirms that the coefficient is not significantly different from 1. The effect is also equal to 1 (1.01***, column (2)), when 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, adding 10 region fixed effects interacted with a time trend, and including controls for the various rural push and urban pull factors that are usually put forward in the literature.[12]

[12]The regions are Central Africa, East Africa, South Africa, West Africa, East Asia, South-East Asia, South

The relationship between urban growth and urban natural increase is additive. This implies that there are no adjustment mechanisms that prevent urban natural increase from mechanically accelerating urban growth. The effect is strong: A 1 standard deviation increase in the urban natural increase leads to a 0.51 standard deviation increase in urban growth. Then, if the average urban rate of natural increase of today's developing world had been the same 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 the same as in Industrial Europe (2.2%). Likewise, if Africa's average urban rate of natural increase had been the same 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%). When decomposing the urban rate of natural increase into the urban birth rate and the urban death rate, we find that both rates have a strong effect on urban growth (0.98*** and -1.11**, see Web Appendix Table 5).

Robustness. The fact that the coefficient is also equal to 1 in the data implies that urban natural increase and residual migration do not influence themselves and each other dynamically. This is what we verify using various robustness checks. In columns (3)-(6) of Table 1, we add variables estimated in decade t-1 and lose one round of data. We show in column (3) that the baseline effect is unchanged when dropping this round. In column (4), we show that the effect remains the same when controlling for residual migration and urban natural increase in the previous decade. We do not find a significant effect of lagged natural increase and lagged migration on urban natural increase ($Uni_{c,t}$) or on residual migration ($Mig_{c,t}$) (columns (7) and (8)). In column (5), to control for countries in which urban growth is fast and cities expand spatially leading agglomerations to absorb surrounding villages the next decade, the lag of the urban growth rate is added. However, it is insignificant, and the main effect remains the same.[13] In column (6), we control for rural natural increase in decades t and t-1. If rural growth is fast where urban growth is fast, because rural natural increase is also high, urban growth will be associated with urban reclassification. The effect is almost unchanged.

Causality. We also test for causality by instrumenting the evolution of urban natural increase with proxies for the initial religious and family planning conditions for each country in the 1960s. We explained in section 3.4 that cross-country differences in urban natural increase were mostly explained by differences in urban fertility, as urban mortality

Asia, Oceania, the Caribbean, Central America, South America, Middle-East and North Africa. The controls are: (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 share is missing for many countries in earlier decades); (iii) resource exports (urban pull): the share of 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 a dummy 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): a dummy 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 autocratic regimes (Ades & Glaeser, 1995).

[13] Since we include country fixed effects, we control for the fact that countries use different urban definitions, which affect urban reclassification. 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.

does not vary much across countries. First, the within-country evolution of urban fertility in 1960-2010 was influenced by the dominant religion in each country in the 1960s. In Web Appendix Table 6, we regress the urban birth rate on the population shares of eight religious groupings = [Catholicism, Protestantism, Other Christian Religions, Islam, Hinduism, Buddhism, Other Eastern Religions, Other Religions] in the 1960s, while controlling for per capita income in 1960. Urban fertility is higher in the catholic and muslim countries. These two religions have remained strongly opposed to artificial contraception, and fertility remained high in these countries throughout the period (see Berman, Iannaccone & Ragusa (2012) for a study on the effects of catholicism on fertility). Column (1) of Table 2 shows the main effect of urban natural increase on urban growth. Columns (2) shows that the effect remains the same when we use as instruments the population shares of the 8 religions (1960s) interacted with decade fixed effects (the IV F-statistics are 70.0 and 54.6 respectively). We control for the rural birth rate in decade t to capture the separate effects of the instruments on rural fertility.[14] Second, the evolution of urban fertility in 1960-2010 was also influenced by whether the country had a anti-natalist policy in the 1960s. In Web Appendix Figure 4, we show the correlation between the family planning effort index in the 1960s and per capita income in 1960. The figure shows how idiosyncratic the adoption of an anti-natalist policy is. China, India, Indonesia and South Korea had strong or moderate family planning policies (given their income level), while Ecuador, Jordan, Mexico, Peru and most African countries, did not have family planning.[15] In Web Appendix Table 6, we confirm that urban birth rates were lower in the former group of countries in the 1960s, conditional on per capita income in 1960.[16] Columns (3) shows that the effect remains the same when we use as instruments five dummies equal to one if the country had none, very weak, weak, moderate or strong family planning policies in the 1960s, interacted with decade fixed effects (the IV F-statistics are 13.6 and 19.5 respectively). However, we cannot include 10 region fixed effects, as we do not have enough variation in the instruments within a same region: The instruments are too weak then (below 5, not shown). Instead, we include 4 area fixed effects (Africa, Asia, LAC and MENA). We also control for the rural birth rate in decade t.

External validity. One limitation of the panel analysis is that we only employ data for 33 countries. For 64 other countries, we have the urban rate of natural increase for the closest year to 2000. For the (33 + 64 =) 97 countries, we regress the average annual urban growth rate (%) in 1960-2010 on the rate of urban natural increase (%) in 2000, which

[14]We add ten region fixed effects, so our identification relies on a comparison of neighboring countries of the same region over time. In South Asia, urban fertility remains relatively high in Pakistan, a mostly Muslim country, but has decreased strongly in India, a mostly Hindu country.

[15]See World Bank (2007) for a discussion on the factors that led some countries to adopt anti-natalist policies. For example, in Indonesia, though Sukarno had banned family planning throughout his presidency (1950-1965), Suharto staged a military coup in 1965 and immediately set up family planning programs. Likewise, in South Korea, the military revolution of 1961 brought in a group of leaders that sought to reverse traditional pro-natalist attitudes and establish an active family planning program in 1962.

[16]We also verify that family planning policies were not adopted in the 1960s precisely in the countries where urban growth was relatively fast at that time. In particular, we find that the probability of adopting a strong or moderate family planning policy in the 1960s was independent of the annual rate of urban growth in the 1960s (or the 1950s) conditional on per capita income in 1960 (see Web Appendix Table 7).

we use as a proxy for the average rate of urban natural increase for 1960-2010.[17] For the most demanding specification, the effect is lower than 1 (0.76***, see Web Appendix Table 8), but not significantly so.[18] Then, we also study the largest city of these countries. We use the same cross-sectional regression as for the 97 countries, 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 (a proxy for its rate of natural increase in 1960-2010, as we could not find data on its death rate). The largest city's birth rate has a strong effect on the growth of that city (1.19***, see Web Appendix Table 9). Urban natural increase has accelerated urban growth in poor countries, whether we consider large agglomerations or smaller cities.[19]

5. RESULTS ON RELATIVE URBAN GROWTH

We now use regressions to investigate the effects of urban natural increase and residual migration on the change in urbanization, our measure of relative urban growth. We use panel data for 33 countries that were still developing countries in 1960. We adapt equation (11) and run the following model for $t = [1960s, 1970s, 1980s, 1990s, 2000s]$:

$$\Delta U_{c,t} = a + \kappa Uni_{c,t} + \lambda Mig_{c,t} + \theta_c + \psi_t + \nu_{c,t} \quad (13)$$

where $\Delta U_{c,t}$ is the change in the urbanization rate (in percentage points) of country c in decade t, i.e. the relative change in the urban population. Our variables of interest are the urban rate of natural increase ($Uni_{c,t}$) and the residual migration ($Mig_{c,t}$) of country c in decade t (per 100 people, or %). Our hypothesis is that urban natural increase has also contributed to raising urbanization rates in developing countries. All regressions include country and decade fixed effects (θ_c; λ_t). Column (1) of Table 2 shows that urban natural increase is unconditionally associated with higher urbanization rates (1.05*). The effect of migration is larger than the effect of natural increase (2.20***). These effects are robust to controlling for log GDP per capita at the beginning and the end of the decade, which captures the effects of initial income and income growth on the change in urbanization, adding region fixed effects interacted with a time trend, and including the same controls as in Table 1 (1.21** and 2.02*** respectively, column (2) of Table 2). These effects are strong. A 1 standard deviation increase in 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 component of absolute urban growth, migration is the main component of relative urban growth (i.e., urbanization). Indeed, a rural migrant has

[17]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 an imperfect proxy for the rate post-1960.

[18]We include: (i) controls for income and urbanization in 1960, and income in 2010, (ii) various time-invariant controls at the country level. These are the same as in Table 1, except we consider the year 2010 or the period 1960-2010 to estimate the variables (see the notes below Web Appendix Table 8), and (iii) region fixed effects. The cross-sectional estimates are less reliable than the panel estimates, as the urban rate of natural increase in 2000 is only a proxy for the same rate in 1960-2010. The relationship between natural increase and urban growth is less well-measured as a result, which creates a downward bias.

[19]We estimate model (5) using the change in the primacy rate of country c in decade t as the dependent variable and find that urban natural increase did not modify urban primacy (see Web Appendix Table 10).

a double effect on relative urban growth, decreasing the rural population by one and increasing the urban population by one. Therefore, while migration is the main driver of urbanization, urban natural increase has also become a factor 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 rose 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, urban 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 (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.

Robustness. If there are no dynamic interactions between urban natural increase and migration, the effect on urbanization should also be robust when controlling for these interactions. In columns (4)-(6) of Table 2, we add variables estimated in decade t-1 and lose one round of data. The effect of urban natural increase slightly increases without this round (column (3)). In column (4), we control for residual migration and urban natural increase in decade t-1. In columns (5) and (6), we control for the urban growth rate and the change in urbanization in decade t-1. The effects are almost unchanged in all cases. In column (7), we control for rural natural increase in decades t and t-1. The effect of urban natural increase is higher now. Rural natural increase is also high in the countries where urban natural increase is high (the correlation coefficient between the two variables is 0.75). As rural natural increase contemporaneously augments the rural population and lowers the urbanization rate in decade (-0.65), not controlling for it reduces the effect of urban natural increase on urbanization. Columns (5)-(6) also show that urban reclassification is not a concern here, as the results hold when controlling for past urban growth or rural natural increase.[20]

Causality. Columns (4)-(6) of Table 2 show that the effect of urban natural increase on urbanization remains the same when using the initial religious or family planning conditions in the 1960s interacted with decade fixed effects as instruments, while simultaneously controlling for the rural birth rate in decade t. In column (4), the OLS estimate is higher than the baseline OLS estimate in column (2) of Table 3 (1.78 vs. 1.21). As explained just above, controlling for the rural birth rate (and thus rural rate of natural increase) augments the effect of urban natural increase on urbanization. The IV estimates are slightly higher than the OLS estimate of the effect (columns (5)-(6)).[21]

[20]In Web Appendix Table 11, we show that: (i) 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, and (ii) the effect is higher for urbanization rates close to 50% (see Figure 2). We interact the urban rate of natural increase with a dummy equal to one if the urbanization rate at the start of the decade was between 30 and 70%. The urban natural increase effect is higher for the observations in this interval.

[21]We verify that the results hold if we drop each country individually, e.g. China, which implemented not only the one-child policy, but also the Hukou system that constrained urbanization (not shown).

External validity. As for urban growth, we verify the results are robust to using cross-sectional data for 97 countries for which we have urban demographic data in 2000. We regress the change in the urbanization rate (in percentage points) in 1960-2010 on the rates of urban natural increase (%) and residual migration (%) in 2000, which we use as proxies for the averages of these rates in 1960-2010. For the full specification, the cross-sectional estimate is lower than the panel estimate (0.73*, see Web Appendix Table 12). We estimate the relationship over 50 years rather than over 10 years, which leads to a downward bias if there are swift changes within countries over time.

6. RESULTS ON URBAN CONGESTION

Congestion effects arise from the fact that the urban population grows faster than available urban capital. This reduces urban welfare, unless rising population densities also produce large agglomeration effects. Panel data on the evolution of urban real wages over time does not exist, 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 poor 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 have data on both slums in 2005 and urban natural increase in 2000. We run the following cross-sectional regression:

$$Slum_{c,2005} = b + \phi \frac{\triangle Upop_{c,1960-2010}}{Upop_{c,1960}} + \pi \triangle U_{c,1960-2010} + w_{c,2005} \tag{14}$$

where $Slum_{c,2005}$ is the slum variable (%). The two variables of interest are the annual urban growth rate (%) and the change in the urbanization rate (%) between 1960 and 2010. 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. 2005 is the first year in which data collection on slums was systematic across countries.[22] Second, if urban growth has been fast in poor countries, urban land expansion has also been fast (Angel et al., 2010; Seto et al., 2011). Urban areas

[22]Congestion effects should be larger for large agglomerations, as their growth is higher in absolute numbers. However, we do not have data on congestion for specific cities, and must rely on data for all cities instead. Besides, our analysis focuses on the whole urban sector.

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 housing shortages. Wealthier cities are dense, because people work and live in multi-storey buildings. In poor countries, the scarcity of multi-storey buildings forces people to the outskirts of the cities where they build one-storey shacks, thus producing a continuous decline in urban densities. 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 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 are not causal. Our objective is more modest, in that we want to characterize an equilibrium (or trap) where fast urban growth is associated with congestion, no matter whether they reinforce each other.

The results are displayed in Table 4. We always control for income and urbanization in 1960 and 2010, add time-invariant controls at the country level (see the notes below Table 4), and region fixed effects. We find a strong correlation between urban growth and slums (column (1)). In column (2), we verify that slum expansion is indeed driven by the speed of urban growth and not the speed of rural growth. A 1 standard deviation increase in urban growth is associated with a 0.32 standard deviation increase in the slum share. As predicted, the change in urbanization has no effect. Thus, fast urban growth has also contributed to slum expansion. For example, 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 sample mean of 49%).

If countries are unable to cope when urban growth is fast, we expect non-linearities in the relationship between slums and urban growth. What matters for slum expansion is the number of years in which an urban population doubles. An urban population doubles in t years if $(1+(\triangle Upop_{c,t}/Upop_{c,t})/100)^t = 2$. The number of years in which it doubles is then equal to $log(2)/log(1+(\triangle Upop_{c,t}/Upop_{c,t}/100))$. There is a convex, decreasing relationship between the true speed of urban growth and the urban growth rate. Column (3) of Table 4 shows that the effect is larger for countries whose number of years in which the urban population doubles is below the sample mean (about 20 years). The effect for the group of countries with fast urban growth is twice as high (-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 it doubles every 10 years rather than every 20 years. The two components of urban growth – urban natural increase and residual migration – are correlated with slum expansion (14.51*** vs. 4.60*, column (4)). We find that a 1 standard deviation increase in urban natural increase is associated with a 0.30 standard deviation increase in the slum share. The effect is lower for migration. The *type* of urban growth thus matters for slum expansion.[23] Results hold when we instrument the rate of urban natural increase in 2000 by the population shares of the eight religions in the 1960s (column (5)). The family planning variables in the 1960s do not predict well urban natural increase in 2000 (not shown): Indeed, the countries have modified their family planning policies over time, whereas the religious shares are relatively time-invariant, and still predict urban natural increase in 2000. One concern here is that the migration effect could be lower than the natural increase effect because urban congestion dissuades migration, thus leading to reverse causality. To minimize this concern, we verify that the results hold if we regress the slum share today on the urban natural and migration rates for the 1960s (column (6)). As we have only 46 observations, adding 10 region fixed effects may ask too much of the data, and we only include 4 area fixed effects in column (7).

6.2 Fast Urban Growth and Other Measures of Urban Congestion

We now study alternative measures of urban congestion, for the most recent period. This type of urban data does not exist for earlier decades, and we have to rely on cross-sectional regressions. We use the same full specification as for the slum share.

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. Data is available for a lower number of countries for some subcomponents of the slum variable. 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) of Table 5). 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)). Fourth, the effects are not significant when the dependent variable is the share of urban residents with improved access to sanitation facilities (column (4)).[24] Lastly, urban natural increase is associated with a higher share of urban residents using solid fuels as the main domestic source of energy (column (5)).

Educational infrastructure: As the population of some cities grew quickly, the number of educational facilities had to increase rapidly to match the demand for human capital.

[23] Another interpretation is that urban newborns live in slums located in the cities, while migrants reside in slums in the periphery. If peripheral slums are not classified as urban, this reduces the association between slums and migration. This is only an issue if there are separate slums for newborns and migrants, and if migrants decide to stop at the periphery of the cities. Besides, we examine the correlation between slums today and the demographic rates in 2000, which proxy for rates in 1960-2010. Current agglomerations will likely have incorporated the previously periphery-slums of 1960, minimizing these concerns.

[24] Interestingly, urban congestion does not increase urban mortality in developing countries today (see Figure 4). Sewage systems were 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. The fact that fast urban growth does not lead to urban congestion in sanitation is in line with this hypothesis.

However, governments may have been unable to keep up with the population growth. They needed to invest in new facilities and train and hire new teachers. 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 concern with this measure is that it captures both the supply and demand for educational infrastructure. As we control for income in the regressions, we may capture the factors driving the demand for education. Urban natural increase is strongly associated with lower attendance rates (-11.8***, column (6)). The effect is lower and not significant for migration. This is logical if natural increase disproportionately increases the population share of children.

Transportation 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 (UN-Habitat, 2008; Kutzbach, 2009). We use particulate matter (PM) concentrations in residential areas of cities with more than 100,000 residents in 2000 as a proxy for road congestion (WDI, 2013). Urban natural increase is positively associated with urban pollution (17.8*, column (7)). Natural increase is not the only driver of pollution. However, it may have contributed to it; a 1 standard deviation increase in urban natural increase is associated with a 0.27 standard deviation increase in pollution. Migration has no effect, possibly because cities that attract migrants are wealthier and are able to invest in transportation 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 employed by the urban refugee sectors - low productivity sectors, such as “personal and other services”, that mostly employ unskilled workers. As described in Web Appendix 1, 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.[25] In column (8), 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). The employment share is a good proxy for the absorptive capacity of labor markets in poor countries. Column (10) 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 not significant.

[25] 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”, “trade, hotels and restaurants”, “transportation and communications”, “finance, insurance, real estate and business services”, “government”, “education and health” and “personal and other services”.

Channels: Migration is less associated with urban congestion than urban natural increase *ceteris paribus*. There are a few possible reasons for this. 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 income growth must be a strong driver of migration. Second, urban natural increase raises the dependency ratio. We use IPUMS census microdata and the *Demographic and Health Surveys* to recreate the child, aged and total dependency ratios for the urban areas of 89 countries of our sample. The urban child dependency ratio – the urban ratio of the number of (0-14 year-old) children over the (15-64 year-old) working population – is much higher in the countries where urban natural increase is high (10.3***, column (1) of Table 6). Migration has no effect on the child dependency ratio. Then, both urban natural increase and migration reduce the urban aged dependency ratio (column (2)), the urban ratio of the number of 65 year-old and above people over the (15-64 year-old) working population. Since the effect for the 0-14 year-olds dominates the effect for the 65-+ year-olds, urban natural increase dramatically increases the total dependency ratio (7.5***, column (3)). This should lower incomes in the short run, the time for the urban newborns to enter the labor market. Third, rising incomes imply that residents and governments have the resources to minimize the congestion effects. These channels may explain why urban congestion was less of a problem in Industrial Europe. London and New York were also growing fast in the 19th century, and they 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 (Williamson, 1990). Congestion effects were not large enough to offset the gains from agglomeration. Technological progress may be a less important factor in cities of today's developing world, as many countries are urbanizing without industrializing (Gollin, Jedwab & Vollrath, 2013). These countries must cope with the rapid growth of their cities, without capturing the full benefits of agglomeration.

6.3 Urban Congestion, Rural Congestion and Migration

It is noticeable that rural residents keep migrating to the highly congested cities, although migration rates have certainly declined over time, and particularly in the 1990s and 2000s (see Figure 6). This seems reasonable, as what matters for the migrant is the urban-rural utility gap (i.e. the mortality, wage and amenity gaps), which may have remained positive on net. First, urban mortality remained relatively lower than rural mortality for a significant number of countries (see Figure 4). Second, Gollin, Lagakos & Waugh (2013) and Young (2013) find that urban incomes (proxied by non-agricultural productivity and assets respectively) remain higher than rural incomes today. Rather unfortunately, there is not enough data to test if the urban-rural wage gap narrowed over time, as a result of urban natural increase and urban congestion. Third, the amenity gap may have remained positive as well. Indeed, in countries where both rural and urban natural increase were high, the rural congestion effects may have been as important as the urban congestion effects. In Web Appendix Tables 13 and 14, we confirm that the speed of urban growth (i.e. urban natural increase), and not the speed of rural growth, is what determines urban congestion and urban dependency ratios. Symmetrically, we also use data on rural congestion and rural dependency ratios to show that they are determined by the speed of rural growth (i.e. rural natural increase), and not by the speed of urban growth (Web Appendix Tables 14 and 15). Therefore, countries where both urban and rural natural increases have been fast have become highly congested as a whole, and migration may remain positive as long as the countryside remains relatively underprovided in amenities (Dustmann & Okatenko (2014) for a study on how contentment with various dimensions of local amenities are key determinants of migration intentions). The mean comparison for each variable between the urban and rural sectors confirms that this is indeed the case (see the "Sample Means" in Web Appendix Tables 13 and 15).

6.4 Discussion

Urban natural increase contributes to explaining why the cities of the developing world grew so fast post-1960, and why many of these cities are highly congested today. The fact that an urban newborn has an effect of exactly one on the urban population implies that the adjustment mechanisms that could have mitigated the mechanical effect of urban natural increase on urban growth did not play a role in this context. First, urban natural increase did not prevent rural residents from migrating to the cities. Furthermore, although migration rates have declined over time, they remain positive in many countries. Second, urban natural increase did not lead to an adjustment in urban fertility rates. The urban rates of natural increase are still very high in many regions across the world (see Web Appendix Table 3). It may well be that fertility does not adjust quickly enough, and there may be too-few skill-intensive jobs in the urban economy to shift the quantity-quality trade-off in favor of child quality. Our results suggest the following public policy implications.

First, any urban population growth slowdown could contribute to increasing the urban capital-labor ratio and prevent congestion effects from kicking in. In Africa, given an urban mortality rate of 11, reducing the urban birth rate from 36 to 20 would lead to a natural increase rate of 9 (vs. 25 now). With a migration rate of 1.7%, there would be an urban growth rate of 2.6%, similar to industrializing Europe and present-day Asia. As mentioned in Section 3.4, urban birth rates are largely explained by urban fertility rates (the correlation between the two variables is 0.93), rather than by the share of women of reproductive age in the urban population. Thus, any reduction in urban fertility would have a large impact on urban birth rates. Countries that had idiosyncratically adopted family planning policies in the 1960s had indeed lower urban birth rates as a result.

Second, better urban planning could help mitigate the negative externalities of high fertility rates on urban resources. The objective for governments would be to minimize urban congestion, given their minimal fiscal resources and weak governance (Glaeser (2013)). There are several possible approaches. First, the remodeling of Paris by 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 beneficial in the long-run, it is controversial as a policy model, due to its high societal costs. Second, many cities were constructed as a result of unplanned creative destruction. Many American cities were rebuilt in a better way after a Great Fire (e.g. New York in 1776, Chicago 1871 and Boston 1872). City fires in developing countries today are much less destructive. Houses are built with cement and shacks are built with metal sheets, rather than wood. Third, urban renewal projects are examples of a more decentralized approach. These renewal projects have net positive effects when well-implemented (Lall, Lundberg & Shalizi, 2008; Takeuchi, Cropper & Bento, 2008; Collins & Shester, 2013). However, in poor countries, the absence of strong private markets and rent-seeking reduce the returns to such programs. Lastly, congestion effects are probably more important in large agglomerations. This could explain why migration from large agglomerations to small and medium-sized cities has been observed in some developing countries (Beauchemin & Bocquier, 2004; Potts, 2009; de Brauw, Mueller & Lee, 2014). One policy could be to remove the constraints on the growth of the non-primate cities that are often prevalent in developing countries (Henderson, 1982; Christiaensen, Weerdt & Todo, 2013; Christiaensen & Todo, 2013). More generally, it could be worthwhile to invest in the cities of today's developing world, as many of them will mechanically keep growing at a fast pace in the future. While investing in these cities could further fuel migration, not investing in them could further reduce welfare.

7. CONCLUSION

We document several new facts regarding the processes of urbanization, migration, natural increase, and economic development. Using an extensive new historical dataset on urbanization and the urban demographic transition, we show that: (i) absolute 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 can be explained by urban natural increase. Many cities of today's developing world can be classified as "mushroom cities"; fertility remains high, while mortality has fallen to low levels, which has led to high urban rates of natural increase; (iii) if migration remains the main component of urbanization, urban natural increase has also become a factor of urbanization in today's developing world, and (iv) fast urban growth is associated with more congested cities.

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 an *urban push*. Urbanization does not come from migration only, as internal urban population growth also matters. Second, our paper contributes to the literature on the relationship between urbanization and development. Our results suggest that income growth 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, as congestion effects may limit the benefits from agglomeration.

REFERENCES

Acemoglu, Daron, and Simon Johnson. 2007. "Disease and Development: The Effect of Life Expectancy on Economic Growth." *Journal of Political Economy*, 115(6): 925–985.

Ades, Alberto F, and Edward L Glaeser. 1995. "Trade and Circuses: Explaining Urban Giants." *The Quarterly Journal of Economics*, 110(1): 195–227.

Alvarez-Cuadrado, Francisco, and Markus Poschke. 2011. "Structural Change Out of Agriculture: Labor Push versus Labor Pull." *American Economic Journal: Macroeconomics*, 3(3): 127–58.

Angel, Shlomo, Jason Parent, Daniel Civco, Alexander Blei, and David Potere. 2010. "A Planet of Cities: Urban Land Cover Estimates and Projections for All Countries, 2000-2050." Lincoln Institute of Land Policy Working Paper.

Bairoch, Paul. 1988. *Cities and Economic Development: Frow the Dawn of History to the Present.* Chicago: The University of Chicago Press.

Barrios, Salvador, Luisito Bertinelli, and Eric Strobl. 2006. "Climatic Change and Rural-Urban Migration: The Case of Sub-Saharan Africa." *Journal of Urban Economics*, 60(3): 357–371.

Beauchemin, Cris, and Philippe Bocquier. 2004. "Migration and Urbanisation in Francophone West Africa: An Overview of the Recent Empirical Evidence." *Urban Studies*, 41(11): pp. 2245–2272.

Becker, Gary S., Edward L. Glaeser, and Kevin M. Murphy. 1999. "Population and Economic Growth." *American Economic Review*, 89(2): 145–149.

Berman, Eli, Laurence R. Iannaccone, and Giuseppe Ragusa. 2012. "From Empty Pews to Empty Cradles: Fertility Decline Among European Catholics." National Bureau of Economic Research, Inc NBER Working Papers, National Bureau of Economic Research, Inc 18350.

Bleakley, Hoyt. 2007. "Disease and Development: Evidence from Hookworm Eradication in the American South." *The Quarterly Journal of Economics*, 122(1): 73–117.

Bleakley, Hoyt. 2010. "Malaria Eradication in the Americas: A Retrospective Analysis of Childhood Exposure." *American Economic Journal: Applied Economics*, 2(2): 1–45.

Brülhart, Marius, and Federica Sbergami. 2009. "Agglomeration and Growth: Cross-Country Evidence." *Journal of Urban Economics*, 65(1): 48–63.

Brueckner, Jan K. 2013. "Slums in Developing Countries: New Evidence for Indonesia." *Journal of Housing Economics*, 22(4): 278–290.

Brueckner, Jan K., and Harris Selod. 2009. "A Theory of Urban Squatting and Land-Tenure Formalization in Developing Countries." *American Economic Journal: Economic Policy*, 1(1): 28–51.

Caselli, Francesco, and Wilbur John Coleman II. 2001. "The U.S. Structural Transformation and Regional Convergence: A Reinterpretation." *Journal of Political Economy*, 109(3): 584–616.

Cavalcanti, Tiago, and Daniel Da Mata. 2013. "On the Determinants of Slum Formation." Unpublished manuscript, Department of Economics, University of Cambridge.

Cavalcanti, Tiago, Daniel Da Mata, and Frederick Toscani. 2014. "Winning the Oil Lottery: The Impact of Natural Resource Extraction on Growth." Unpublished manuscript, Department of Economics, University of Cambridge.

Christiaensen, Luc, and Yasuyuki Todo. 2013. "Poverty Reduction during the Rural-Urban Transformation: The Role of the Missing Middle." The World Bank Policy Research Working Paper Series 6445.

Christiaensen, Luc, Joachim Weerdt, and Yasuyuki Todo. 2013. "Urbanization and Poverty Reduction: the Role of Rural Diversification and Secondary Towns." *Agricultural Economics*, 44(4-5): 435–447.

Clark, Gregory, and Neil Cummins. 2009. "Urbanization, Mortality, and Fertility in Malthusian England." *American Economic Review*, 99(2): 242–47.

Collins, William J., and Katharine L. Shester. 2013. "Slum Clearance and Urban Renewal in the United States." *American Economic Journal: Applied Economics*, 5(1): 239–73.

Cutler, David M., and Grant Miller. 2004. "The Role of Public Health Improvements in Health Advances: The 20th Century United States." National Bureau of Economic Research, Inc NBER Working Papers 10511.

da Mata, D., U. Deichmann, J.V. Henderson, S.V. Lall, and H.G. Wang. 2007. "Determinants of City Growth in Brazil." *Journal of Urban Economics*, 62(2): 252–272.

Davis, James C., and J. Vernon Henderson. 2003. "Evidence on the Political Economy of the Urbanization Process." *Journal of Urban Economics*, 53(1): 98–125.

de Brauw, Alan, Valerie Mueller, and Hak Lim Lee. 2014. "The Role of Rural-Urban Migration in the Structural Transformation of Sub-Saharan Africa." *World Development, Elsevier*, 63(C): 33–42.

Duranton, Gilles. 2008. "Viewpoint: From Cities to Productivity and Growth in Developing Countries." *Canadian Journal of Economics*, 41(3): 689–736.

Duranton, Gilles. 2013. "Growing through Cities in Developing Countries." Unpublished manuscript, Department of Economics, University of Pennsylvania.

Dustmann, Christian, and Anna Okatenko. 2014. "Out-migration, wealth constraints, and the quality of local amenities." *Journal of Development Economics*, 110(0): 52 – 63. Land and Property Rights.

Fay, Marianne, and Charlotte Opal. 2000. "Urbanization Without Growth: a Not-so-Uncommon Phenomenon." The World Bank Policy Research Working Paper Series 2412.

Feler, Leo, and J. Vernon Henderson. 2011. "Exclusionary policies in urban development: Under-servicing migrant households in Brazilian cities." *Journal of Urban Economics*, 69(3): 253–272.

Galor, Oded, and David Weil. 1999. "From Malthusian Stagnation to Modern Growth." *American Economic Review*, 89(2): 150–154.

Galor, Oded, and David Weil. 2000. "Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and Beyond." *American Economic Review*, 90(4): 806–828.

Glaeser, Edward L. 2013. "A World of Cities: The Causes and Consequences of Urbanization in Poorer Countries." National Bureau of Economic Research, Inc NBER Working Papers 19745.

Gollin, Douglas, David Lagakos, and Michael E. Waugh. 2013. "The Agricultural Productivity Gap*." *The Quarterly Journal of Economics*.

Gollin, Douglas, Remi Jedwab, and Dietrich Vollrath. 2013. "Urbanization with and without Industrialization." Unpublished manuscript, Oxford University Department of International Development.

Gollin, Douglas, Stephen L. Parente, and Richard Rogerson. 2002. "The Role of Agriculture in Development." *American Economic Review*, 92(2): 160–164.

Haines, Michael R. 2008. *The Population of the United States, 1790-1920.* Cambridge: Cambridge University Press.

Hajnal, John. 1965. "European Marriage Pattern in Historical Perspective." In *Population in History*. , ed. D.V. Glass and D.E.C. Eversley. London: Arnold.

Hansen, Gary D., and Edward C. Prescott. 2002. "Malthus to Solow." *American Economic Review*, 92(4): 1205–1217.

Harris, John R., and Michael P. Todaro. 1970. "Migration, Unemployment & Development: A Two-Sector Analysis." *American Economic Review*, 60(1): 126–42.

Henderson, J. V. 1982. "The Impact of Government Policies on Urban Concentration." *Journal of Urban Economics*, 12(3): 280–303.

Henderson, J. Vernon. 2010. "Cities and Development." *Journal of Regional Science*, 50(1): 515–540.

Henderson, Vernon, Adam Storeygard, and Uwe Deichmann. 2013. "Has Climate Change Promoted Urbanization in Sub-Saharan Africa?" Unpublished manuscript, Department of Economics, Brown University.

Henderson, Vernon, Mark Roberts, and Adam Storeygard. 2013. "Is Urbanization in Sub-Saharan Africa Different?" Unpublished manuscript, Department of Geography, LSE.

Huillery, Elise. 2009. "History Matters: The Long-Term Impact of Colonial Public Investments in French West Africa." *American Economic Journal: Applied Economics*, 1(2): 176–215.

Jedwab, Remi. 2013. "Urbanization without Industrialization: Evidence from Consumption Cities in Africa." Unpublished manuscript, Department of Economics, George Washington University.

Keyfitz, Nathan. 1980. "Do Cities Grow by Natural Increase or by Migration?" *Geographical Analysis*, 12: 142–156.

Kremer, Michael. 1993. "Population Growth and Technological Change: One Million B.C. to 1990." *The Quarterly Journal of Economics*, 108(3): pp. 681–716.

Kutzbach, Mark J. 2009. "Motorization in Developing Countries: Causes, Consequences, and Effectiveness of Policy Options." *Journal of Urban Economics*, 65(2): 154–166.

Lall, Somik V., Mattias K.A. Lundberg, and Zmarak Shalizi. 2008. "Implications of Alternate Policies on Welfare of Slum Dwellers: Evidence from Pune, India." *Journal of Urban Economics*, 63(1): 56–73.

Lewis, Arthur. 1954. "Economic Development with Unlimited Supplies of Labour." *The Manchester School*, 22(2): 139–191.

Lipton, Michael. 1977. *Why Poor People Stay Poor: Urban Bias in World Development.* Cambridge: Harvard University Press.

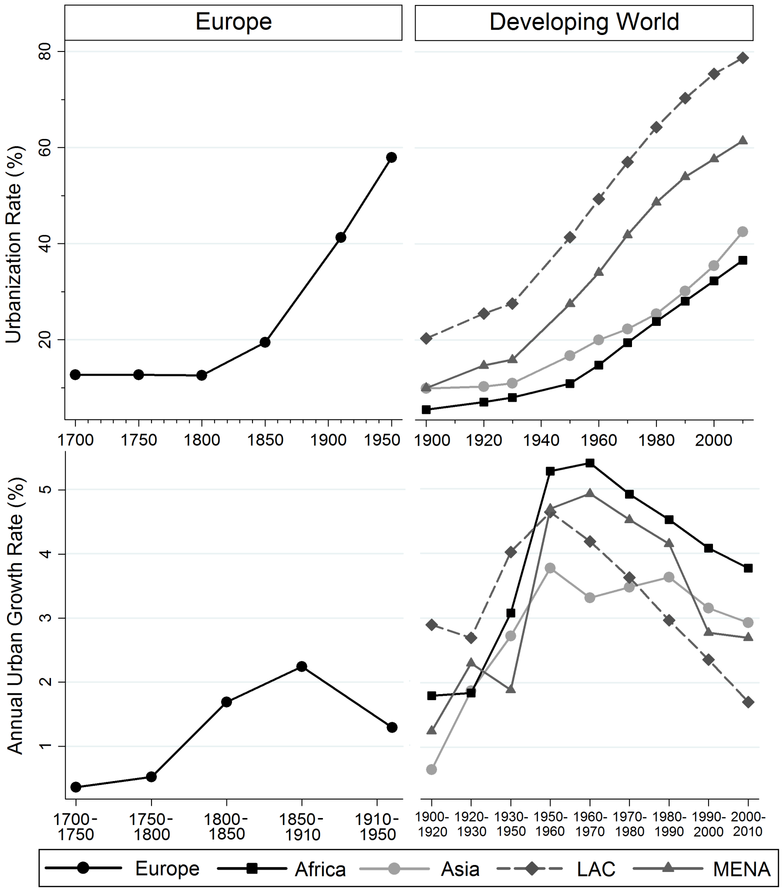
Lucas, Robert E. 2004. "Life Earnings and Rural-Urban Migration." *Journal of Political Economy*, 112(S1): S29–S59.

Matsuyama, Kiminori. 1992. "Agricultural Productivity, Comparative Advantage, and Economic Growth." *Journal of Economic Theory*, 58(2): 317–334.

McMillan, Margaret S., and Dani Rodrik. 2011. "Globalization, Structural Change and

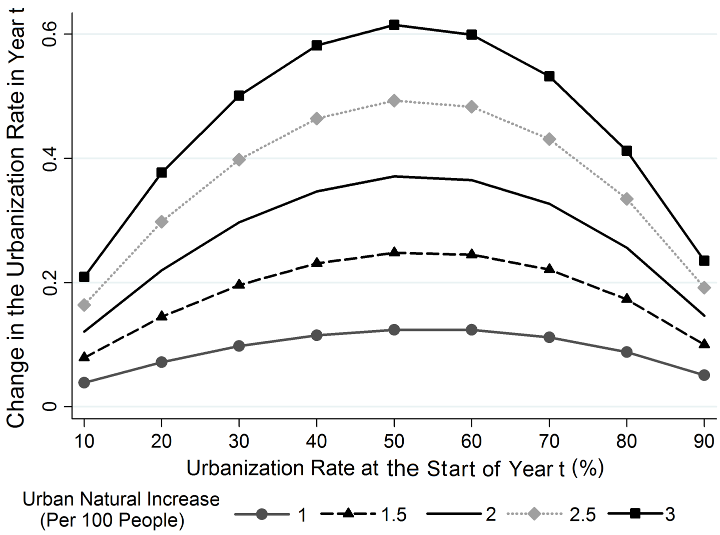
Productivity Growth." NBER Working Papers 17143.
Moradi, Alexander. 2008. "Confronting Colonial Legacies-Lessons from Human Development in Ghana and Kenya, 1880-2000." *Journal of International Development*, 20(8): 1107–1121.
Overman, Henry, and Anthony J. Venables. 2005. "Cities in the Developing World." Centre for Economic Performance, LSE CEP Discussion Papers dp0695.
Potts, Deborah. 2009. "The Slowing of sub-Saharan Africa's Urbanization: Evidence and Implications for Urban Livelihoods." *Enviroment and Urbanization*, 21(1): pp. 253–258.
Preston, Samuel H. 1979. "Urban Growth in Developing Countries: A Demographic Reappraisal." *Population and Development Review*, 5(2): pp. 195–215.
Ravallion, Martin. 2002. "On the Urbanization of Poverty." *Journal of Development Economics*, 68(2): 435–442.
Rogers, Andrei. 1978. "Migration, Urbanization, Resources & Development, and discussions." In *Alternatives for Growth: The Engineering and Economics of Natural Resources Development*. , ed. H. McMains and L. Wilcox, Chapter 9, 147–238. Elsevier.
Rogers, Andrei, and Jeffrey Gale Williamson. 1982. "Migration, Urbanization, and Third World Development: An Overview." *Economic Development and Cultural Change*, 30(3): 463–82.
Sato, Yasuhiro. 2007. "Economic Geography, Fertility and Migration." *Journal of Urban Economics*, 61(2): 372–387.
Sato, Yasuhiro, and Kazuhiro Yamamoto. 2005. "Population Concentration, Urbanization, and Demographic Transition." *Journal of Urban Economics*, 58(1): 45–61.
Schultz, Theodore W. 1953. *The Economic Organization of Agriculture.* New York: McGraw-Hill.
Seto, Karen, Michail Fragkias, Burt Güneralp, and Michael Reilly. 2011. "A Meta-Analysis of Global Urban Land Expansion." *PLOS One*, 6(8): e23777.
Takeuchi, Akie, Maureen Cropper, and Antonio Bento. 2008. "Measuring the Welfare Effects of Slum Improvement Programs: The case of Mumbai." *Journal of Urban Economics*, 64(1): 65–84.
UN-Habitat. 2003. *Slums of the World: The face of urban poverty in the new millennium?* New York: United Nations.
UN-Habitat. 2008. *The State of the African Cities.* Nairobi: United Nations Human Settlements Programme.
United Nations. 2013. *Milledium Development Goals Indicators: The Official United Nations Site for the MDG Indicators.* New York: United Nations.
Voigtländer, Nico, and Hans-Joachim Voth. 2009. "Malthusian Dynamism and the Rise of Europe: Make War, Not Love." *American Economic Review*, 99(2): 248–54.
Voigtländer, Nico, and Hans-Joachim Voth. 2013*a*. "How the West 'Invented' Fertility Restriction." Forthcoming in the *American Economic Review*.
Voigtländer, Nico, and Hans-Joachim Voth. 2013*b*. "The Three Horsemen of Riches: Plague, War and Urbanization in Early Modern Europe." Forthcoming in the *Review of Economic Studies*.
WDI. 2013. *World Development Indicators.* Washington D.C.: World Bank.
Williamson, Jeffrey. 1990. *Coping with City Growth During the British Industrial Revolution.* Cambridge: Cambridge University Press.
World Bank. 2007. *The Global Family Planning Revolution: Three Decades of Population Policies and Programs.* Edited by Warren C. Robinson and John A. Ross. Washington D.C.: The World Bank.
World Bank. 2009. *World Development Report 2009: Reshaping Economic Geography.* Washington DC: World Bank Publications.
Young, Alwyn. 2005. "The Gift of the Dying: The Tragedy of Aids and the Welfare of Future African Generations." *The Quarterly Journal of Economics*, 120(2): 423–466.
Young, Alwyn. 2013. "Inequality, the Urban-Rural Gap and Migration*." *The Quarterly Journal of Economics*.

Figure 1: Urbanization Rates (%) and Annual Urban Growth Rates (%) for Industrial Europe (1700-1950) and the Developing World (1900-2010)



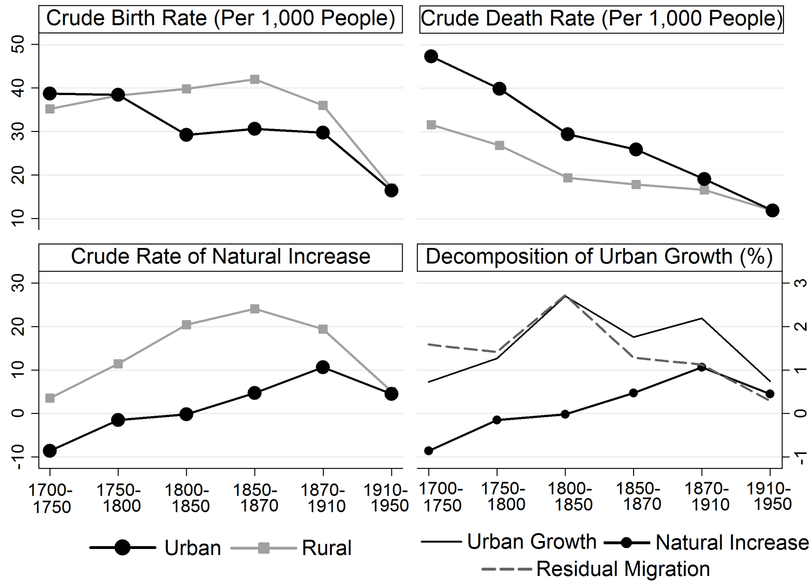
Notes: This figure plots the urbanization rate (%) and the annual urban growth rate (%) for Industrial Europe (1700-1950) and four developing areas (1900-2010): Africa, Asia, Latin America and the Caribbean (LAC) and Middle-East and North Africa (MENA). Europe includes 18 Western European countries and 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 Web Appendix for data sources.

Figure 2: Urban Natural Increase and Change in Urbanization Rate, Simulation



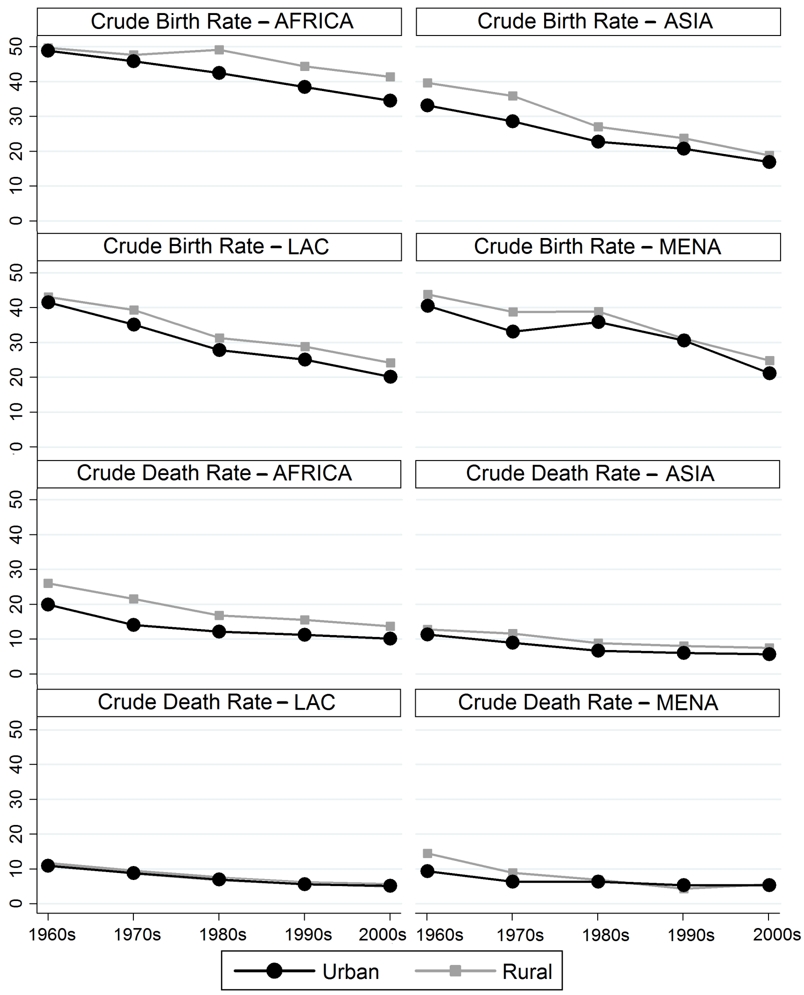
Notes: This figure shows the relationship between the change in the urbanization rate in year t (ΔU_t, in percentage points) and the urban crude rate of natural increase in year t (Uni_t, per 100 people), given the initial urbanization rate at the start of year t (U_t). We assume that the rural crude 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 the urban rate of natural increase on the change in the urbanization rate for various relatively higher values of $Uni = \{1; 1.5; 2; 2.5; 3\}$.

Figure 3: Urban Natural Increase and Urban Growth in England (1700-1950)



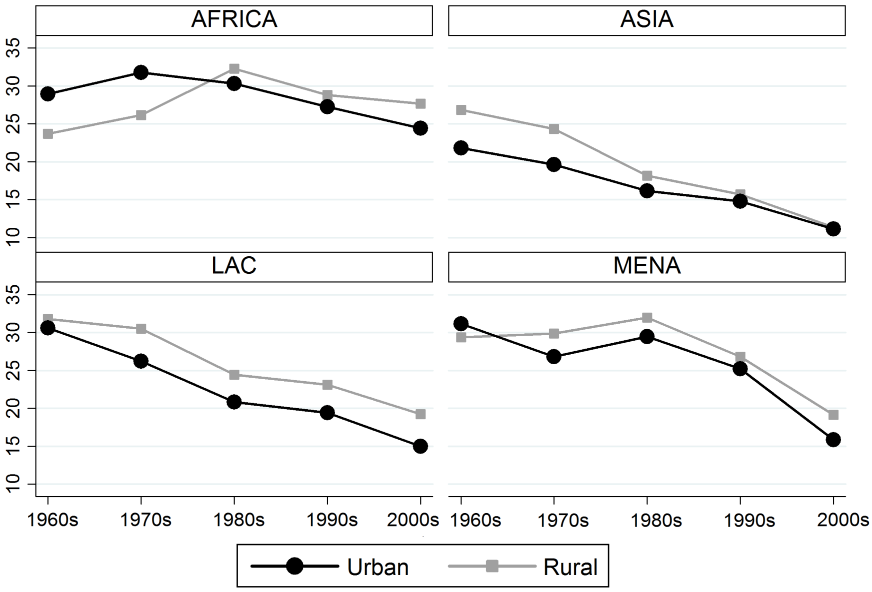
Notes: This figure plots the crude rate of birth, the crude rate of death and the crude rate of natural increase (per 1,000 people) for rural England and urban England (1700-1950). This figure also plots the decomposition of annual urban growth (%) into the respective contributions of annual urban natural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

Figure 4: Crude Birth and Death Rates for the Developing World (1960-2010)



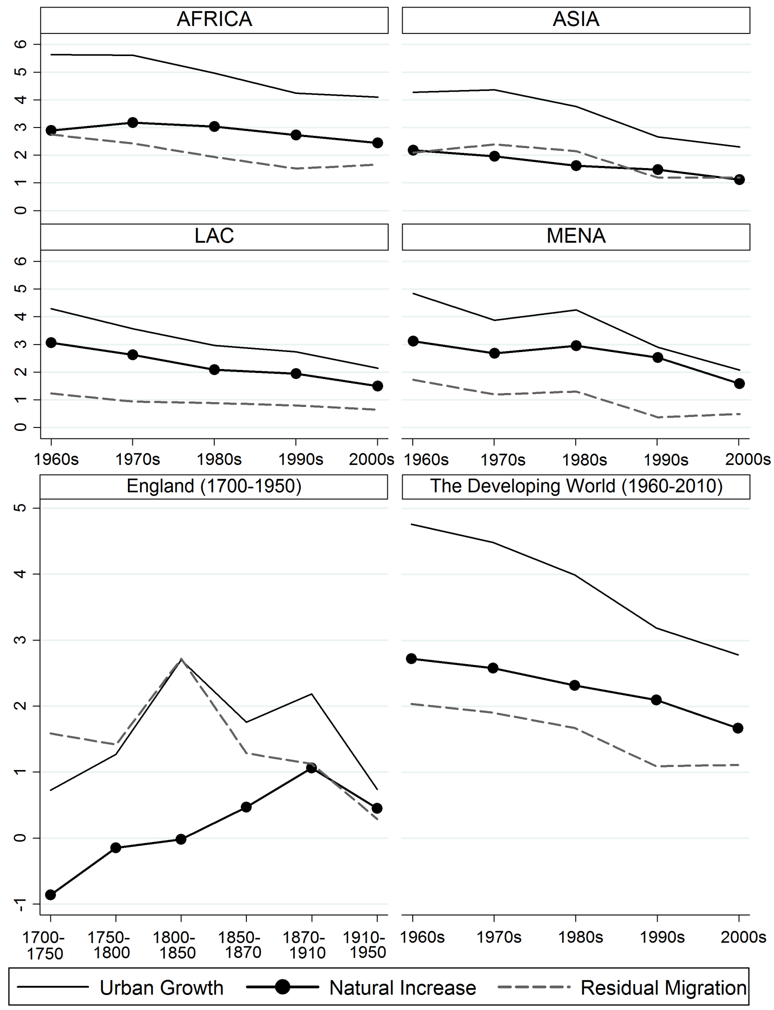
Notes: This figure plots the crude rate of birth and the crude rate of death (per 1,000 people) for the rural and urban areas of four developing areas (1960-2010): Africa, Asia, Latin America and the Caribbean (LAC) and Middle-East and North Africa (MENA). We use historical demographic data for 33 countries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

Figure 5: 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 Web Appendix for data sources.

Figure 6: Urban Natural Increase and Urban Growth for England (1700-1950) and the Developing World (1960-2010)



Notes: This figure plots the decomposition of annual urban growth (%) into annual urban 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 Web Appendix for data sources.

TABLE 1: URBAN NATURAL INCREASE AND ABSOLUTE URBAN GROWTH, 1960-2010

Dependent Variable:	Annual Urban Growth Rate (%, Decade t)						$Uni_{c,t}$	$Mig_{c,t}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Urban Natural Increase Rate	0.95***	1.01***	1.05***	1.02***	1.02***	1.09***		
(Per 100 People, Decade t)	(0.28)	(0.32)	(0.37)	(0.37)	(0.36)	(0.37)		
Residual Migration Rate				0.06			0.06	0.06
(Per 100 People, Decade t-1)				(0.08)			(0.06)	(0.06)
Urban Natural Increase Rate				0.06			0.17	0.06
(Per 100 People, Decade t-1)				(0.31)			(0.10)	(0.06)
Annual Urban Growth Rate					0.06			
(Per 100 People, Decade t-1)					(0.07)			
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)		
F-test [p-value]	0.03	0.00	0.08	0.00	0.00	0.06	_	_
Urban Natural Increase - 1 = 0	[0.97]	[0.98]	[0.88]	[0.95]	[0.95]	[0.81]	_	_
Country & Decade FE, Controls	Y;N	Y	Y	Y	Y	Y	Y	Y
Region FE (10) x Time Trend	N	Y	Y	Y	Y	Y	Y	Y
Observations (33 x {5; 4})	165	165	132	132	132	132	132	132
Adj. R-squared	0.70	0.78	0.81	0.80	0.81	0.80	0.84	0.67

Notes: The sample consists of 33 countries that were still developing countries in 1960, for the following decades: 1960, 1970, 1980, 1990 and 2000. Robust SEs clustered at the country level in parentheses; * p<0.10, ** p<0.05, *** p<0.01. In columns (1)-(6), the dependent variable is the annual urban growth rate (%) in decade t. In columns (7) and (8), the dependent variables are the respective contributions of urban natural increase ($Uni_{c,t}$) and residual migration ($Mig_{c,t}$) to urban growth (%) in decade t. All regressions include country and decade FE. In columns (2)-(7), we also include log GDP per capita (PPP, cst 2005$) and the urbanization rate (%) at the start of the decade, log GDP per capita at the end of the decade, region FE (e.g., West Africa, Central Africa, East Africa, Southern Africa, etc.) interacted with a time trend, and the following controls: (i) *Rural push*: av. cereal yields (hg per ha), rural density (1000s of rural pop. per sq km of arable area), 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*: share of manufacturing and services in GDP (%) in 2010 interacted with decade FE, share of 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. The F-test tests if the coefficient of natural increase is significantly different from 1. See Web Appendix for data sources and construction of variables.

TABLE 2: ALTERNATIVE IDENTIFICATION STRATEGIES, 1960-2010

Dependent Variable:	Annual Urban Growth Rate (%, Decade t)			Change in the Urbanization Rate (Percentage Points, Decade t)		
	OLS	*IV-Shares Religions*	*IV-Family Planning*	*OLS*	*IV-Shares Religions*	*IV-Family Planning*
	(1)	(2)	(3)	(4)	(5)	(6)
Urban Natural Increase Rate	0.99***	0.86*	0.90**	1.78***	2.35***	2.13**
(Per 100 People, Decade t)	(0.31)	(0.45)	(0.46)	(0.58)	(0.75)	(1.00)
Residual Migration Rate				2.11***	2.08***	2.29***
(Per 100 People, Decade t)				(0.34)	(0.28)	(0.28)
Rural Birth Rate	0.04	0.10	0.22	-1.18**	-1.33***	-1.32**
(Per 100 People, Decade t)	(0.29)	(0.29)	(0.26)	(0.46)	(0.42)	(0.55)
F-test [p-value]	0.00	0.10	0.05	_	_	_
Urban Natural Increase - 1 = 0	[0.97]	[0.75]	[0.83]	_	_	_
Kleibergen-Paap rk Wald F stat	_	70.0	13.6	_	54.6	19.5
Country & Decade FE, Controls	Y	Y	Y	Y	Y	Y
Region FE (10) x Time Trend	Y	Y	N	Y	Y	N
Area FE (4) x Time Trend	N	N	Y	N	N	Y
Observations (33 x 5)	165	165	165	165	165	165
Adj./Centered R-squared	0.79	0.82	0.82	0.70	0.81	0.77

Notes: The sample is the same as in Table 1. Robust SEs clustered at the country level in parentheses; * p<0.10, ** p<0.05, *** p<0.01. In columns (2) and (5), the instruments are the population shares of 8 religions = [Catholicism, Protestantism, Other Christian Religions, Islam, Hinduism, Buddhism, Other Eastern Religions, Other Religions] in the 1960s, interacted with decade FE. In columns (3) and (6), the instruments are 5 dummies equal to one if the country had none, very weak, weak, moderate or strong family planning policies in the 1960s, interacted with decade FE. All regressions include country and decade FE, log GDP per capita (PPP, cst 2005$) at the start and the end of the decade, and the same controls as in Table 1 (see the notes below the Table). In columns (1)-(3), we add the urbanization rate at the start of the decade. In columns (1)-(2) and (4)-(5), we add region FE (e.g., West Africa) interacted with a time trend. In columns (3) and (6), we add area FE (e.g., Africa) interacted with a time trend. In columns (1)-(3), the F-test tests if the coefficient of natural increase is significantly different from 1. See Web Appendix for data sources.

TABLE 3: URBAN NATURAL INCREASE AND RELATIVE URBAN GROWTH, 1960-2010

Dependent Variable:	Change in the Urbanization Rate (Percentage Points, Decade t)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Urban Natural Increase Rate	1.05*	1.21**	1.58**	1.53**	1.41**	1.24**	1.94**
(Per 100 People, Decade t)	(0.60)	(0.60)	(0.62)	(0.56)	(0.62)	(0.55)	(0.77)
Residual Migration Rate	2.20***	2.02***	2.22***	2.20***	2.22***	2.29***	2.24***
(Per 100 People, Decade t)	(0.32)	(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 Urbanization Rate						0.24**	
(Pct. Points, 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)
Country & Decade FE, Controls	Y;N	Y	Y	Y	Y	Y	Y
Region FE (10) x Time Trend	N	Y	Y	Y	Y	Y	Y
Observations (33 x {5; 4})	165	165	132	132	132	132	132
Adj. R-squared	0.66	0.69	0.70	0.71	0.70	0.72	0.69

Notes: The sample is the same as in Table 1. Robust SEs clustered at the country level in parentheses; * p<0.10, ** p<0.05, *** p<0.01. All regressions include country and decade FE. In columns (2)-(6), we also include log GDP per capita (PPP, cst 2005$) at the start and the end of the decade, region FE (e.g., West Africa) interacted with a time trend, and the same controls as in Table 1 (see the notes below the Table). We do include the urbanization rate (%) at the start of the decade. See Web Appendix for data sources.

TABLE 4: URBAN NATURAL INCREASE, URBAN GROWTH AND SLUMS, 1960-2010

Dependent Variable:	Urban Population Living in Slums (%, 2005-2010)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Change in Urbanization Rate	-0.00	-0.02	0.09	0.06	-0.01	0.45	0.01
(Pct. Points, 1960-2010)	(0.28)	(0.33)	(0.20)	(0.26)	(0.23)	(0.71)	(0.42)
Annual Urban Growth Rate	6.44**	6.54**					
(%, 1960-2010)	(2.86)	(3.06)					
Annual Rural Growth Rate		0.19					
(%, 1960-2010)		(0.19)					
No. Years for Urban Pop. x2			-0.61***				
(Average, 1960-2010)			(0.19)				
No. Years for Urban Pop. x2			-0.67**				
* Dummy (No. Years > Sample Mean)			(0.31)				
Urban Natural Increase				14.51***	22.19***	11.29*	12.53**
(%, (4)-(5): 1960-2010, (6)-(7): 1960s)				(5.16)	(6.86)	(6.36)	(4.62)
Residual Migration				4.60*	5.43**	1.94	6.58**
(%, (4)-(5): 1960-2010, (6)-(7): 1960s)				(2.66)	(2.36)	(4.94)	(2.43)
Controls	Y	Y	Y	Y	Y	Y	Y
Region FE (10)	Y	Y	Y	Y	Y	Y	N
Area FE (4)	N	N	N	N	N	N	Y
Observations	95	94	95	95	95	46	46
Adj. R-squared	0.66	0.69	0.70	0.71	0.79	0.70	0.69

Notes: The sample consists of 95 countries that were still developing countries in 1960. Robust SEs clustered in parentheses; * p<0.10, ** p<0.05, *** p<0.01. Urban natural increase in 2000 is used as a proxy for urban natural increase in 1960-2010. The migration rate in 1960-2010 is the residual between the annual urban growth rate and the urban natural increase rate in 1960-2010. All regressions include log GDP per capita (PPP, cst 2005$) and the urbanization rate (%) in 1960 and 2010, region FE (column (7): area FE), and controls (see the list below). Column (3): The number of years in which the population doubles is estimated using the urban growth rate. We create a dummy equal to one if this number is below the mean (19.4). Column (5): We instrument urban natural increase with the populations shares of each religion in the 1960s (IV F-statistic: 5.2). Controls: (i) *Urban definition*: four dummies for each type of definition, and the value of the threshold to define a locality as urban; (ii) *Rural push*: cereal yields in 2010 (hg per ha), rural density (1000s of rural pop. per sq km of arable area) in 2010, 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*: share of manufacturing and services in GDP (%) in 2010, share of resource exports in 1960-2010 (%), a dummy equal to one if the country was mostly autocratic since 1960, and urban primacy in 2010 (%); and (iv) Other controls: area (sq km), population (1000s) in 2010, and two dummies if the country is landlocked or a small island. See Web Appendix for data sources.

TABLE 5: URBAN NATURAL INCREASE AND URBAN CONGESTION, 1960-2010

Dependent Variable (Urban, 2000-2010):	Lack Living Area (%) (1)	Finished Floor (%) (2)	Water Source (%) (3)	Sanitation Facilities (%) (4)
Urban Natural Increase	8.6*	-6.5	-3.5**	-1.2
(%, 1960-2010)	(4.6)	(5.6)	(1.6)	(2.7)
Residual Migration	2.9	-1.3	-2.0*	-2.0
(%, 1960-2010)	(2.8)	(3.6)	(1.1)	(1.9)
Observations; Sample Mean	57; 18.8	66; 77.9	92; 89.4	92; 65.0
Dependent Variable (Urban, 2000-2010):	Solid Fuels (%) (5)	School Attend. (6-15 y.o., %) (6)	Urban PM10 (mg per m^3) (7)	Empl. Share Pers. Serv. (%) (8)
Urban Natural Increase	13.5*	-11.8***	17.8*	4.0**
(%, 1960-2010)	(7.7)	(2.7)	(10.0)	(2.0)
Residual Migration	2.2	-3.4	-0.0	1.2
(%, 1960-2010)	(5.5)	(3.0)	(5.7)	(1.0)
Observations; Sample Mean	78; 71.1	65; 79.8	93; 71.3	72; 5.5
Controls, Region FE (10)	Y	Y	Y	Y

Notes: The sample consists of 93 countries that were still developing countries in 1960. Robust SEs in parentheses; * p<0.10, ** p<0.05, *** p<0.01. Urban natural increase in 2000 is used as a proxy for urban natural increase in 1960-2010. The migration rate in 1960-2010 is the residual between the annual urban growth rate and the urban natural increase rate in 1960-2010. Column (1): The dependent variable is the share of urban inh. who lack sufficient living area (%) in 2005. Column (2): It is the share of urban inh. who live in a residence with a finished floor (%) in 2005. Columns (3)-(4): It is the share of urban inh. who have access to an improved water source and improved sanitation facilities in 2005 respectively (%). Column (5): It is the share of urban inh. using solid fuels (%) in 2000-2010. Column (6): It is the urban share of 6-15 year-old children that attend school (%) in 2000-2010. Column (7): It is a measure of particulate matter (PM) concentrations in residential areas of cities ≥ 100,000 inh in 2010. Column (8): It is the urban employment share of personal and other services (%) in 2000-2010. All regressions include log GDP per capita (PPP, cst 2005$) and the urbanization rate (%) in 1960 and 2010, region FE, and the same controls as in Table 4 (see the notes below the Table). See Web Appendix for data sources.

TABLE 6: URBAN NATURAL INCREASE AND URBAN DEPENDENCY RATIOS, 1960-2010

Dependent Variable (Urban, 2000-2010):	Child Dependency (0-14 y.o.) Ratio (1)	Aged Dependency (65-+ y.o.) Ratio (2)	Total Dependency (0-14 & 65-+ y.o.) Ratio (3)
Urban Natural Increase	10.3***	-2.8***	7.5***
(%, 1960-2010)	(2.7)	(0.5)	(2.7)
Residual Migration	0.9	-1.3***	-0.4
(%, 1960-2010)	(1.3)	(0.3)	(1.3)
Observations; Sample Mean	89; 57.2	89; 7.2	89; 64.4
Controls, Region FE (10)	Y	Y	Y

Notes: The sample consists of 89 countries that were still developing countries in 1960. Robust SEs in parentheses; * p<0.10, ** p<0.05, *** p<0.01. Urban natural increase in 2000 is used as a proxy for urban natural increase in 1960-2010. The migration rate in 1960-2010 is the residual between the annual urban growth rate and the urban natural increase rate in 1960-2010. Column (1): The dependent variable is the ratio of the number of urban inh. aged 0-14 over the number of urban inh. aged 15-64. Column (2): It is the ratio of the number of urban inh. aged 65-120 over the number of urban inh. aged 15-64. Column (3): It is the ratio of the number of urban inh. aged 0-14 or 65-120 over the number of urban inh. aged 15-64. All regressions include log GDP per capita (PPP, cst 2005$) and the urbanization rate (%) in 1960 and 2010, region FE, and the same controls as in Table 4 (see the notes below the Table). See Web Appendix for data sources.