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Demography, Urbanization and Development: Rural Push, Urban Pull and... Urban Push?*

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Abstract: Developing countries have urbanized rapidly since 1950. To explain urbanization, standard models emphasize rural-urban migration, focusing on *rural push* factors (agricultural modernization and rural poverty) and *urban pull* factors (industrialization and urban-biased policies). Using new historical data on urban birth and death rates for 7 countries from Industrial Europe (1800-1910) and 35 developing countries (1960-2010), we argue that a non-negligible part of developing countries' rapid urban growth and urbanization may also be linked to demographic factors, i.e. rapid internal urban population growth, or an *urban push*. High urban natural increase in today's developing countries follows from lower urban mortality, relative to Industrial Europe, where higher urban deaths offset urban births. This compounds the

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effects of migration and displays strong associations with urban congestion, providing additional insight into the phenomenon of urbanization without growth.

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Urban expansion in the developing world has been dramatic. Between 1950 and 2015, the total urban population in developing countries increased tenfold from about 300 million to 3 billion; the urban share tripled from about 17 to 50 percent (United Nations, 2013). Overall, there are many similarities with the urban expansion process of developed countries in the 19th century. Yet, there are also important differences.

First, urban expansion has been substantially faster in today's developing world. In Europe, urbanization accelerated with the advent of the Industrial Revolution, rising from 15% in 1800 to 40% in 1910. Both Africa and Asia reached the same rate in half the time, moving from 15% in 1950 to ~40% in 2010. Second, while income growth and urbanization tend to go hand in hand (Henderson, 2010), higher levels of urbanization are now also observed at low levels of income (Glaeser, 2013; Jedwab & Vollrath, 2015*b*). For example, 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 comparable incomes had an average urbanization rate of 30%. So, why has post-1950 urban expansion in the developing world been so fast and does it matter for people's welfare?

Standard models explain urbanization largely through rural-urban migration in response to an expected urban-rural wage or utility gap (Harris & Todaro, 1970; Lall, Selod & Shalizi, 2006). Migration flows could, for example, result from a *rural push*. If the country experiences a Green Revolution, the rise in food productivity releases labor for the urban sector (Schultz, 1953; Gollin, Parente & Rogerson, 2002). But rural-urban migration may also be induced by poverty in rural areas due to land pressure or natural disasters (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 Revolution, the urban wage increases, which attracts workers from the countryside (Lewis, 1954; Lucas, 2004; Henderson, Roberts & Storeygard, 2013). If the government adopts urban-biased policies, urban utility also increases (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 (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 development, the rural poverty and urban bias theories imply that urbanization may occur "without growth" (Fay & Opal, 2000).

The aforementioned theories remain largely silent on the role of demography in urban expansion. However, rapid urban expansion in the developing world has been accompanied by an equally dramatic expansion of the population overall. To begin addressing this void, we take an historically comparative perspective to understanding some key features of urbanization in today's developing world (i.e. much faster urban expansion at lower levels of development). To do so, we create an extensive new data set on the crude rates of birth and death for urban and rural areas of 7 European (or Neo-European) countries in the 19th century (every forty years in 1800-1910) and 35 countries that were still developing countries in 1960 (every ten years in 1960-2010).[1]

Through decomposition analysis, we first illustrate that urban natural increase appears to have contributed importantly to fast urban growth in today's developing world (i.e. the *absolute* growth of cities). This contrasts with Industrial Europe where urban growth appears to have been solely driven by (rural-urban) migration. Through simulations, we further illustrate that faster urban natural increase may have also accelerated the change in urbanization rates, i.e. the *relative* growth of cities. We show that the differences in urban natural increase between today's developing countries and Industrial Europe originate from differences in urban mortality rates. While fertility in the developing world has remained high, urban mortality has fallen to low levels much earlier in the development process, due to the epidemiological transition of the 20th century. This has resulted in a high rate of natural increase in urban areas, which in turn appears to have compounded the effects of migration to yield much higher rates of urban expansion. Today's *mushroom cities* of the developing world, by reference to their apparent "overnight" appearance and their continuous fast expansion, are in sharp contrast to the *killer cities* of Industrial Europe, where high urban mortality rates offset the lower urban birth rate, resulting in much lower urban natural increase. This difference in urban rates of natural increase is hard to ignore in understanding why the urban population in today's developing world has doubled every 18 years, compared with every 35 years in Europe. Analogous to the notions of *rural push* and *urban pull*, the concept of *urban push* is used to describe this demographic mechanism of urban expansion.[2]

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[1]Economic historians have focused individually either on England or the U.S. in the 19th century (Williamson, 1990; Haines, 2008). Our vastly expanded dataset thus allows us to significantly extend their work.

[2]While the latter two concepts imply that rural workers are pushed to (or pulled to) cities by changes in rural (urban) conditions, the former suggests that cities growing internally are pushing their own boundaries.

To shed further light on the plausibility of these decomposition findings, we undertake a series of multivariate explorations. In particular, we link decadal rates of urban growth and changes in urbanization to rates of urban natural increase for a panel of 35 developing countries (1960-2010), controlling for factors likely to affect both urban expansion and urban natural increase (e.g., income growth, rural push and urban pull factors, and regional characteristics). In addition, we test whether shorter-run effects of natural increase also hold in the longer-run in two ways. First, we use autoregressive distributed lag models (ADL) with lags of the urban and rural rates of natural increase (as well as the dependent variable); second, we implement cross-sectional long-run regressions of urban growth and changes in the urbanization rates over the 1960-2010 period on the initial urban rate of natural increase. Indeed, even if urban natural increase is significantly associated with urban growth and the change in urbanization rates in the short-run, these links may well disappear as migration and urban fertility behaviors adjust over time. Following rapid urban natural increase, cities may become increasingly congested, reducing the attractiveness of urban centers. This could slow down (accelerate) rural to-urban (urban-to-rural) migration, thereby reducing urban expansion (and the effects of urban natural increase) in the long run. Alternatively, urban residents may adjust their fertility patterns (e.g., have fewer children) in response to urban congestion. According to the estimated results, the long-run effects do not appear to be significantly different from the short-run effects, consistent with the descriptive decomposition results.

These findings raise a number of additional questions, which the paper briefly reflects upon. First, does high urban natural increase lead to congestion? Second, why do migration rates not adjust (more) in response to this rapid urban natural increase and higher congestion? Finally, why do urban fertility rates not come down faster? To shed some light on the first question, the link between the speed of urban growth and urban congestion is explored using a novel cross-sectional data set of urban congestion measures for 95 developing countries (1990-2010). Higher urban growth due to natural increase is associated with more congested cities today. Interestingly, the corresponding effects of migration on urban congestion tend to be smaller. We then discuss various potential explanations for why rural (urban) workers have kept migrating to (living in) these congested urban areas. Such explanations include increasing congestion in the countryside due to fast rural natural increase and valuation of higher urban life expectancy. We also hypothesize that urban fertility may remain high because fertility rates tend to stay high in low-income economies with low returns to education. If urban congestion prevents these economies from developing, the persistently high fertility in these cities is not necessarily surprising.

The paper adds to the literature on urbanization and growth in three ways.[3] First, it draws attention to the possibility that rapid urban natural increase may create a disconnect between urbanization and growth if urban areas expand without an increase in living standards.[4] The speed of urban growth is an understudied dimension of urban expansion. Second, while there is an extensive literature measuring agglomeration effects in developing countries, little is known about the magnitude of congestion effects.[5] Third, whether urban growth is mainly driven by migration or natural increase has implications for policy making. When urban congestion is the result of excessive migration, investment in urban infrastructure may be more difficult to justify if it fuels further migration (see

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[3]The role of urban natural increase has been recognized by demographers (Rogers, 1978; Preston, 1979; Keyfitz, 1980; Fox, 2012), but is little discussed in economics (see surveys by Duranton (2008, 2013), Henderson (2010) and Desmet & Henderson (2014)). In a companion paper, Jedwab & Vollrath (2015*a*) use a theoretical model to study the "Malthusian" effects of the epidemiological transition on the rise of poor mega-cities. They focus their analysis on the absolute population growth of the largest cities in the world, hence *mega-city growth*, while here we look at both the absolute and relative growth of the total urban population, hence *urban growth* and changes in *urbanization rates*.

[4]In countries where urban growth comes from migration, it is possible that urban wages are rising, which given low rural wages attract residents to the cities. Eventually, as the urban-rural income gap closes, rural residents should cease migrating to the cities, and the urbanization rate and income should stabilize at a higher level. In countries where urban growth may come from urban natural increase, urbanization may occur because low-income urban families have high fertility rates. There is also migration if the countryside becomes too congested due to rural natural increase. Eventually, there may not be any urban-rural gap, but the country could be more urbanized, even if income has not increased.

[5]Likewise, there are few papers about the role of slums in developing countries. Notable exceptions are Lall, Lundberg & Shalizi (2008), Brueckner & Selod (2009), Brueckner (2013) and Cavalcanti & Da Mata (2013).

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 may necessitate such investment, as well as stronger urban family planning policies, or more deconcentrated urban development.[6]

The paper is organized as follows: Section 1 presents the data and decomposition results. Section 2 shows the econometric results and section 3 interprets and reflects on the findings. Section 4 concludes

1. MAIN DECOMPOSITION ANALYSIS

1.1 Data and Background

We use historical data on urbanization, and urban and rural fertility and mortality, first reconstructing the urban growth and urbanization rates for 19 European and North American countries from 1700-1950 (~every 40 years), and 116 African, Asian and non-North American countries that were still developing countries in 1960, from 1900-2010 (~every 10 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 42 countries: 7 European countries for the 1700-1950 period, and 35 countries in Africa (10), Asia (12), the LAC region (8) and the MENA region (12) for the 1960-2010 period. For each country-period observation, we obtain the urban and rural crude rates of birth, death and natural increase (per 1,000 people). We recreated the data using historical sources, as well as the *UN Statistical Yearbooks* and reports of the *Population Census*, the *Fertility Surveys* and the *Demographic and Housing Surveys* of these countries.[7] We also collect the same type of data for 97 countries that were still developing countries in 1960 for the most recent period.

The most advanced civilizations before the 18th century had urbanization rates of around

[6]See Henderson (1982), Christiaensen, Weerdt & Todo (2013) and Christiaensen & Todo (2013).

[7]See Web Appx. Table 1 for details on the data sources used for each country.

10%-15% (Bairoch, 1988). Industrialization accompanied dramatic urbanization. Figure 1 (top panels) shows the urbanization rates for Industrial Europe (1700-1950) and four developing areas: Africa, Asia, LAC and MENA (1900-2000). The urbanization rate for Europe was stable (~10%) until 1800 and increased to ~40% in 1910. In 1950, countries in Africa and Asia were also predominantly rural (urbanization rate ~15%). By 2010, their urbanization rates had increased to ~40%. The LAC region had already surpassed the 40% threshold in 1950, while the MENA region did not surpass it until 1970. 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%. Figure 1 (bottom panels) also shows the urban growth rates for Europe (1700-1950) and the four developing areas from 1900-2010. In the 1800-1910 period, the overall urban growth rate in Europe was 2.2% per year, peaking during the Industrial Revolution. Conversely, the urban growth rate has been ~3.8% a year in today's developing world post-1960. A 3.8% growth rate implies that cities double every 18 years, while a 2.0% rate means that cities only double every 35 years. These rates peaked in the 1950s/60s, with the acceleration of rural-to-urban migration and the demographic transition.

1.2 Killer Cities vs. Mushroom Cities: Decomposing Urban Expansion

Note that urban and rural population growth can be written as an expression of urban and rural natural increase, internal migration, international migration, and urban reclassification:

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

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

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 those rural residents reclassified as urban in year t.[8] 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. When dividing equation (3) by the urban population at the start of year t, we obtain that the urban growth rate is the sum of the rate of urban natural increase (Uni_t) and the "residual migration" rate ($Mig_t/Upop_t$):

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

The rate of urban (rural) natural increase Uni_t (Rni_t) can be further decomposed as the difference of the Urban (Rural) Crude Birth Rate (UCBR_t) and the Urban (Rural) Crude Death Rate (UCDR_t) (i.e. the number of children born and the number of deaths per 1,000 people in year t). At 35 newborns per 1,000 people before 1910, fertility in Industrial Europe was relatively low, while mortality was high (Figure 2), especially in urban areas where death rates exceeded birth rates for much of the 19th century. Promiscuity, industrial smoke and polluted water sources all contributed to the high urban death rate (10 percentage points higher than in rural areas). With many European cities acting as "death sinks" during the 19th century, a phenomenon that became known as Europe's *killer cities* (Williamson, 1990), Europe experienced an average urban natural increase of only 0.5 percent per year. At 2.2 percent per year during 1800-1910, Europe's urban growth was also relatively low, and, as seen from an application of equation (5), largely accounted for by residual migration: 1.7 percent versus 0.5 percent from urban natural increase (see Figure 2, bottom panel).[9]

[8]Births and deaths are registered using the place of residence. A child who is born in an urban-based family is counted as urban. Likewise, a child that follows her parents when they migrate to a city is counted as a migrant. The numbers of urban newborns and residents are estimated using permanent residence.

[9]Web Appendix Table 2 shows the detailed decomposition of urban growth for the seven

This contrasts with the urban demographic and growth patterns (1960-2010) observed in the developing world (Figures 3 and 4). Urban birth rates were initially higher than in 19th century Europe (up to 50 per 1,000 people in Africa), and have been declining since.[10] Most striking, however, are the already substantially lower death rates in developing countries in 1960 (between 10 and 20). Acemoglu & Johnson (2007) show that the epidemiological transition of the mid-20th century (e.g. the discovery and consequent mass production of penicillin in 1945) and massive vaccination campaigns resulted in widespread and significant declines in mortality, irrespective of the income level.[11] These effects were magnified in cities and resulted in much higher rates of urban natural increase than those observed in Europe. Compounded by similar rates of migration as in Europe (1.5 percent on average in developing countries post 1960), much higher rates of urban growth would have resulted, giving rise to the notion of *mushroom cities* (see Figure 4, as well as Web Appx. Table 3 for decomposition results by country).

First, differences in urban natural increase across regions within the developing world are largely driven by differences in fertility, not by differences in mortality, which do not vary much across countries (Figure 3 and Web Appx Fig 3). The LAC and MENA

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countries. Urban natural increase in 1800-1910 was 0.5% in England, 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. It was thus the same whether we consider a country that received international migrants (the U.S.) or countries where outmigration was strong.

[10]Birth rates depend on total fertility rates (TFR) and the population shares of women of reproductive age (SWRA). The urban TFR is the main determinant of urban birth rates (CBR). For 97 countries for which we have data for the recent period, the correlation coefficient between the two is 0.93 (Web Appx. Fig. 1). The correlation between the urban CBR and SWRA is lower (-0.40). When regressing the CBR on the TFR, SRWA and their product, the product explains most of it, while the product is driven by the TFR (Web Appx. Table 4).

[11]The death rate depends on child mortality (age 0-5 years), youth mortality (age 5-15 years) and adult mortality (age 15 and above years). Urban child mortality is the main factor of urban aggregate mortality (Web Appx. Fig. 2). In our sample of countries in 2000, the correlation coefficient between the two is 0.81.

regions experienced higher urban natural increase in 1960, and have been completing their fertility transition since. Asia started its fertility transition earlier and Africa still largely finds itself in the early stages. Figure 4 further shows the decompositions for Africa and Asia separately, in addition to Industrial Europe and today's developing world. To summarize, the difference in urban growth between the developing world and Europe (3.8% vs. 2.2%) seems to have arisen from differences in urban natural increase (2.3% vs. 0.5%) and not from differences in migration, which averaged 1.5% for developing countries post-1960, a rate similar to that of Industrial Europe (1.7 percent) during 1800-1910. Second, differences in urban growth (1960-2010) within the developing world, such as between Africa and Asia (4.9 percent and 3.5 percent respectively) also appear to be due to differences in urban natural increase (2.9 versus 1.7 percent) and much less due to differences in residual migration rates (2.1 and 1.8 percent respectively). To appreciate the compounding effects of such differences in urban growth rates note that with a migration rate of 1.5% and an urban rate of natural increase of 2.9% (1.7%), as in Africa (Asia), a family of five migrants in 1960 becomes a family of 43 (24) urban residents in 2010.

It can then be shown that changes in the urbanization rate depend on the difference between the urban and rural rates of natural increase (see Web Theory Appendix 1). Industrial Europe and the four developing areas had on average similar rural rates of natural increase. But they widely differed in their urban rates of natural increase. While "mushroom villages" have always existed, "mushroom cities" are the novel feature of the 20th century. We show in a calibration exercise that faster changes in urbanization are plausibly associated with higher urban rates of natural increase ceteris paribus (see Web Theory Appendix).

The decompositions suggest that urban natural increase may expand the urban population in both absolute terms (the urban growth rate) and relative terms (the change in the urbanization rate). For example, one urban (rural) newborn has an instantaneous effect of 1 on the urban (rural) population. However, in the long run, individuals choose their place of residence – urban vs. rural – depending on their utility in each location. The long-run equilibrium effect of urban natural increase thus depends on urban and rural utility levels and ultimately on the endogenous dynamic responses of migration and fertility to the increase in urban population. The long-term effects of urban natural increase could be smaller than its short-term effects. If urban newborns eventually congest cities as adults, urban natural increase could have a dissuasive effect on future rural-to-urban migration and/or future urban fertility, further reducing urban growth. However, the long-term effects could also be as high as the short-term effects if urban natural increase produces urban congestion that in turn reduces urban income. Due to the trade-off between child quantity and child quality (Galor, 2012), the lower income level could then prevent any adjustment in urban fertility, and both urban natural increase and urban growth would remain fast.[12]

To assess the extent to which these decomposition findings stand up to these dynamic adjustments over time as well as additional factors that may jointly affect urban growth and urbanization and natural increase, a series of multivariate (panel) specifications are explored. These additional exercises are not meant to establish causality, but rather to provide additional insight into whether the findings hold beyond the transition (i.e. in the longer run) and beyond an accounting sense.

2. MULTIVARIATE ROBUSTNESS ANALYSIS

2.1 Absolute Urban Growth

We use panel data for 35 countries that were still developing countries in 1960. We adapt equation (5) and run the following model for t = [1960s, 1970s, 1980s, 1990s, 2000s]:

$$\frac{\triangle Upop_{c,t}}{Upop_{c,t}} = \alpha + \beta Uni_{c,t} + \gamma_c + \delta_t + u_{c,t} \tag{6}$$

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). Please note that we cannot include the residual migration rate since urban growth is, by construction, the sum of urban natural increase and residual migration. Table 1 shows the results.

In row (1), we include continent fixed effects (Africa, Asia, LAC, MENA) interacted with a time trend, and controls for rural push and urban pull factors, the urbanization rate at the start of the decade and income (log GDP per capita) at both the start and end of the decade.

[12]Additionally, urban natural increase affects the age-sex composition of the cities while migration affects future urban fertility through crowding-out and age-sex structure effects.

Thus, we capture the effect of income growth on urban growth, and the fact that initially less urbanized countries may see their urban population grow faster.[13] The coefficient on urban natural increase is 0.92, and is not significantly different from one (F-test available upon request). The coefficient increases to exactly 1.00 (row (2)) if instead we use 13 region fixed effects interacted with a time trend.[14] This result holds when adding the rural crude rate of natural increase in decade t (row (3)). The effect is, however, not causal if unobservable factors explain the correlation of urban natural increase and urban growth over time *within* countries, relative to the neighboring countries of the same region, ceteris parabis.[15]

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[13]The controls are: (i) Green Revolution: average cereal yields (hg per ha) in decade t; (ii) Industrial Revolutions: 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: share of resource exports in GDP (%) in t; (iv) rural poverty: rural density (1000s of rural population 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 t; and (v) urban bias: a dummy equal to one if the country's average polity score is lower than -5 (the country is then considered autocratic according to *Polity IV*), and the primacy rate (%) in t. Including country fixed effects then controls for the fact that countries use different urban definitions, which affects urban reclassification.

[14]The regions are Central Africa, East Africa, South Africa, West Africa, East Asia, South-East Asia, South Asia, Oceania, the Caribbean, Central America, South America, Middle-East and North Africa.

[15]The results hold when instrumenting *Uni* with the initial religious and family planning conditions for each country in the 1960s, interacted with decade fixed effects, while simultaneously controlling for rural natural increase (Web Appx. Table 5). As the main driver of natural increase, the evolution of fertility was influenced by both the dominant religion in each country in the 1960s (fertility remained higher in the Catholic and Muslim countries, see Web Appx. Table 6) and whether the country had a anti-natalist policy in the 1960s (Web Appx. Fig. 4 shows how idiosyncratic the adoption of an anti-natalist policy adoption was back then). Thus, fast urban growth did not drive family planning policy

But does the short term effect (of t on t) also hold in the longer term? We first use an autoregressive distributed lag model (ADL) with the second lags of both the dependent variable – the urban growth rate – and the main variables of interest – the urban and rural rates of natural increase. If urban natural increase endogenously affects future rural migration and/or urban fertility, and thus future urban growth, these effects should only be visible two decades later (a generation), when urban newborns become adults.[16] It can then be shown that the long-term effect is a non-linear combination of the direct effect of urban natural increase in t on urban growth in t, and the indirect effects of urban natural increase and urban growth in t-2 on urban growth in t.[17] Row (4) shows the implied long-term effect, 1.21 (see Web Appx. Table 8 for the coefficient of each lag). This effect is also not significantly different from one (F-test available upon request).

As an alternative strategy to capture long-run effects, we use cross-sectional regressions for the 35 countries, with the annual urban growth in 1960-2010 as the dependent variable and the urban rate of natural increase in the 1960s as the variable of interest.[18] If the effect of urban natural increase entirely attenuates over time due to endogenous migration

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adoption (Web Appx. Table 7). However, as we cannot be sure that the instruments satisfy the exclusion restriction, the IV results are only tentative.

[16]Following this economic reasoning and the results of the AIC and BIC criteria, which show that the crucial information is contained in the second lag, we omit the first lag. Moreover, the urban rates of natural increase in t and t-1 are highly correlated (rho=0.84), which creates collinearity. The rates in t and t-2 are less correlated (rho=0.70). We cannot include lags beyond t-2, due to insufficient observations.

[17]**?**, p.683-684 shows that the long-term effect of a variable X on a variable Y is equal to the sum of the effects of X and its lags on Y, divided by (1 minus the sum of the effects of each lag of Y on Y), provided Y and X are both stationary, which we confirm using various tests for our analysis (not shown).

[18]We add: (i) controls for income and urbanization in 1960, and income in 2010, (ii) region fixed effects, and (iii) controls that are the same as for the panel regressions (see footnote 13), except we use 2010 as the end year or 1960-2010 for the whole period to estimate them. We also control for the urban definition using dummies for each type of definition (*administrative*, *threshold*, *threshold and administrative*, and *threshold plus*

and fertility responses, in 1960-2010, the effect of urban natural increase in the 1960s should be nil. The effect is ~0.69-0.74, depending on whether we control for rural natural increase (rows (5)-(6)), and is not significantly different from one (F-test available upon request).[19]

To take full advantage of our available data in the recent period (97 countries), we run an additional robustness check, regressing annual urban growth in 1960-2010 on urban natural increase in 2000, a proxy for urban natural increase in 1960-2010 (rows (7)-(8)). The effects remain high, at 0.77-0.80 depending on whether we include rural natural increase in 2000 (row (9)).[20] The long-term effect of urban natural increase thus falls in the range of [0.69,1.21] and is always significantly different from 0, but not from 1. Accordingly, the effect of natural increase does not disappear in the long run, and we cannot reject the hypothesis that the long-term effect is as high as the short-term effect. Assuming an average (of the above range) long-term effect of 0.95, a 1 standard deviation increase in urban natural increase is associated with a 0.48 standard deviation increase in urban growth. Then, if the urban natural increase of today's developing world had been the same as in Europe in the 19th century (2.3 vs 0.5), its 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 urban natural increase had been the same as in Asia in 1960-2010 (2.9 vs 1.7), its annual urban growth rate would have been 3.7% instead of 4.9%,

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condition) and the population threshold to define a locality as urban when this definition is used, as well as the country's area (sq km), and dummies equal to one if the country is landlocked or a small island (<50,000 sq km).

[19]Duranton (2015) finds that the effect of the log birth rate in 1993 on the change in log population between 1993 and 2010 for about 1,000 Colombian municipalities is 0.24, not one. However, there is significant migration across municipalities in Colombia, which attenuates the local effects of natural increase. Our regressions are at the country level, and people cannot migrate across countries as easily, so our effects are higher.

[20]We also find a strong effect of the largest city's birth rate in 2000, a proxy for its rate of natural increase in 1960-2010 (death rates unavailable), on its growth rate between 1960-2010 (Web Appx. Table 9). However, urban natural increase does not modify urban primacy rates (Web Appx. table 10).

and thus the same as in Asia (3.9%).

2.2 Relative Urban Growth

We now investigate the effects of urban natural increase and residual migration on the change in urbanization, a measure of relative urban growth. We run the following panel model for the same 35 countries and $t = [1960s, 1970s, 1980s, 1990s, 2000s]$:

$$\Delta U_{c,t} = a + \kappa Uni_{c,t} + \lambda Mig_{c,t} + \theta_c + \psi_t + \nu_{c,t} \tag{7}$$

where $\Delta U_{c,t}$ is the change in the urbanization rate (in percentage points) of country c in decade t. 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 (%). All regressions include country and decade fixed effects (θ_c; λ_t) and aforementioned controls (Results in Table 2).[21]

Including region fixed effects and rural natural increase (row (3)), a one percentage point increase in the effect of urban natural increase is associated with a 1.63 increase in the change in the urbanization rate ($U_t - U_{t-1}$) (the coefficient of residual migration is 2.06). Unlike urban growth, urbanization rates are directly affected by rural natural increase, since rural newborns immediately expand the rural population. As urban and rural natural increase are positively correlated, not including rural natural increase leads to a downward bias when estimating the effect of urban natural increase (rows (1)-(2)). The long-term effect then ranges from 1.21 (ADL, row (4)) to 1.66-1.78 (cross-sections in 1960-2010, rows (5)-(6)), while for migration, the range is 1.62-3.28. The effects are not significantly different from the short-term effects (row (3)). The ADL effect is then not significantly different for urban natural increase, but the point estimate remains high. Results also hold if we use the 97 countries for which we have data on natural increase in 2000 (rows (7)-(8)).

These effects are suggestive, though not necessarily causal. Assuming average long-term

[21] We cannot control for urbanization rates at the start of the decade, as the dependent variable – the change in the urbanization rate – is linearly defined. Results hold if we control for urbanization rates in 1960 interacted with decade fixed effects, to control for convergence in urbanization (Web Appx. Table 11).

effects of about 2.45 ((1.62+3.28)/2) and 1.50 ((1.21+1.78)/2) for migration and urban natural increase, respectively, one standard deviation increases in migration and urban natural increase are respectively associated with 0.70 and a 0.30 standard deviation increases in the change in urbanization. Migration is the main component of urbanization. Indeed, a migrant decreases the rural population by one and increases the urban population by one. Urban natural increase only increases the urban population; hence, it has a relatively larger effect on urban growth than on urbanization. Nonetheless, it remains a significant factor in urbanization. For example, Europe's urbanization rate rose by 2.5 percentage points every ten years during the 1800-1910 period, increasing from 15% in 1800 to 40% in 1910. Starting from similarly low levels (15% in 1960) urbanization rates in Africa and Asia also increased by 25 percentage points, though they did so between 1960 and 2010, i.e. in about half the time. 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 1.50, this gives a crude difference of (1.7 x 1.50 =) 2.5 percentage points of urbanization every ten years. Urban natural increase may thus contribute to explaining why today's developing world has urbanized at a much faster pace than the old developing world.

3. DISCUSSION

3.1 Potential Welfare Consequences

Given the high urban rates of natural increase in today's developing world (urban population doubles every 18 years), urban capital (e.g., houses, schools and roads) must grow as fast as the urban population. However, if capital investment cannot keep up with urban population growth, fast urban growth can lead to urban congestion, which may reduce urban utility.[22] Panel data on the evolution of urban wages and amenities over

[22]We believe that these congestion effects are not just temporary, even if urban capital can adjust in the long-run. First, the population increase that we document is not just a one-time shock, but implies a continuous stream of new residents every period. Second, past population shocks may have long-run consequences. Past congestion in urban housing

time do not exist, so we use cross-sectional data on various measures of congestion for the most recent period. Our main measure is the share of the urban population living in slums (%) in 2005-2010. We have data for 113 low-income countries in 1960, but we focus our analysis on 95 countries for which we also have data on natural increase. We first regress the slum share on the urban growth rate and the change in the urbanization rate between 1960 and 2010. We control for income and urbanization in 1960 and 2010 and add the aforementioned controls and the regional fixed effects. Row (1) of Table 3 shows that slum expansion is associated with the urban growth rate, but not with the change in urbanization. Indeed, what matters for urban congestion is the absolute number of urban residents per sq km.[23] When decomposing urban growth into urban natural increase and residual migration, we find that the slum share today is disproportionately correlated with the urban rate of natural increase in 2000, which is used as a proxy for urban natural increase in 1960-2010 (row (2)).[24] The same general pattern holds when we choose other measures of congestion reflecting living standards, environmental degradation, and economic sectors (Table 3, rows (3)-(11)).[25]

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favors the development of slums, that will be costly to reorganize efficiently ex-post. Likewise, past underinvestments in human capital affect long-run productivity. Third, congestion effects can be avoided when urban growth is expected and when agents are forward-looking, with sufficient credit available to make the necessary investment in advance. These conditions may not have been met in developing countries.

[23]If countries are unable to cope with fast urban growth, we expect non-linearities in the relationship between slums and urban growth. Web Appx. Table 12 shows some suggestive evidence that slum expansion is disproportionately associated with the number of years in which an urban population doubles.

[24]We use data for the year 2000, because we have urban natural increase data for many fewer observations in the 1960s. Residual migration is defined here as the difference between annual urban growth between 1960 and 2010 and urban natural increase in 2000. Again, these effects are not necessarily causal.

[25]The dependent variables in rows (3)-(7) are for the shares of urban inhabitants who (3) lack sufficient living-area, (4) live in a residence with a finished floor, (5) have access to an improved water source, (6) have access to improved sanitation facilities, and (7) use

Migration is less associated with urban congestion than urban natural increase. There are a few possible reasons for this. First, many rural workers migrate to the cities where productivity and income are rising. Second, urban natural increase (a disproportionately greater number of children) raises the dependency ratio (rows (1) and (2) of Table 4), possibly lowering incomes in the short-run.[26] Third, rising incomes imply that governments have resources to minimize the congestion effects.

3.2 The Puzzling Non-Adjustment of Migration?

The fact that urban natural increase has positive long-run effects on urbanization suggests that on average: (i) rural workers have kept migrating to congested urban areas, and (ii) urban newborns have not migrated out of these cities. What matters for the long-run equilibrium distribution of the population is the urban-rural utility (positive) gap. We reflect on potential explanations, but quantifying their contribution falls beyond the scope

solid fuels (e.g., wood) as the main domestic source of energy. The dependent variables in rows (8)-(10) are as follows: (8) the urban share of 6-15 year-old children attending school (a proxy for congestion in human capital accumulation); (9) the level of particulate matter (PM) concentrations in the large cities (a proxy for road congestion); and (10)-(11) the urban employment shares of "manufacturing and FIRE" and "personal and other services". The FIRE (finance, insurance, real estate and business services) sector serves as a proxy for tradable services. If cities grow too fast, urban labor demand will not rise as fast as urban labor supply, and the urban newborns will be eventually employed by the low-skill sectors such as "personal and other services" and not the high-skill sectors such as "manufacturing and FIRE".

[26]The urban child dependency ratio – the ratio of the number of (0-14 year-old) children to the (15-64 year-old) working population – is much higher in the countries where urban natural increase is high (row (1) of Table 4). Then, both urban natural increase and migration reduce the urban aged dependency ratio, the urban ratio of the number of 65 year-old and above people to the working population (row (2)). Since the former effect dominates the latter effect, urban natural increase raises the total dependency ratio (row (3)).

of the paper.[27]

Urban agglomeration effects. The urban wage should increase with the size of the urban population as long as agglomeration effects dominate congestion effects. Agglomeration effects may still be strong. If congestion outweighs agglomeration, the urban wage decreases, but rural workers will still migrate to urban areas as long as it remains higher than the rural wage (plus migration costs). The urban newborns on the other hand may stay in urban areas even if the urban wage drops below the rural wage, given the costs of moving to rural areas. Given that much of the new urban population is urban-born, this is important.

Rural congestion effects. 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. Web Appendix Tables 13 and 14 show that the speed of urban growth (i.e. urban natural increase), and not the speed of rural growth, is the main determinant of urban congestion. Likewise, Web Appendix Tables 15 and 16 show that the speed of rural growth (i.e. rural natural increase) is the main determinant of rural congestion (when possible, we use the same outcomes as for urban congestion). Countries where both urban and rural natural increase have been fast have thus become highly congested as a whole, and migration may have remained positive because the countryside remained relatively more congested. The mean comparison for each variable between the urban and rural sectors suggests that this may be the case (see Web Appendix Tables 13 and 15).[28]

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[27]A proper model would consider both urban and rural utilities, which both depend on wages and amenities. Then wages and amenities both benefit from agglomeration effects and suffer from congestion effects. The effect of natural increase on the urban-rural utility gap then depends on where it is the fastest, as well as on the respective forms of the agglomeration and congestion effects in both locations. The main factor of production in the rural sector is land, which is non-reproducible, so rural congestion effects could be large. In cities, there are no non-reproducible factors *per se*, but the "urban space" can become highly congested, too.

[28]Rural natural increase was also high in the old developing world, but high-mortality cities were eventually able to absorb the rural surplus labor. In the cities of today's developing world, the cities must absorb the surplus labor created by both rural natural

Urban life expectancy. Europe's killer cities had to offer relatively high wages to urban residents in order to compensate for the fact that they had relatively higher mortality rates than the countryside (Williamson, 1990). Conversely, urban mortality rates are lower than rural mortality rates in today's developing world, and access to public social services is broader, which gives a direct incentive for rural residents to migrate to, and urban newborns to stay in, the cities (Ferré, Ferreira & Lanjouw, 2012; Dustmann & Okatenko, 2014).

Preferences. Unlike rural migrants, urban newborns initially have a strong preference for urban living, which increases urban-to-rural migration costs. There could also be a fixed cost for urban-born residents willing to enter the rural sector (acquisition of land and other agricultural capital). Urban newborns may thus prefer to stay in urban areas, even in those that are highly congested. Conversely, rural residents may not have a strong preference for rural living and face a low fixed cost of entering the urban sector.

3.3 The Puzzling Non-Adjustment of Urban Fertility?

Urban families are also not adjusting their fertility, although mortality rates have fallen and cities have become congested. One explanation for the high birth rate in fast-growing urban areas may be a high share of women of reproductive age. However, urban birth rates are mostly explained by urban fertility rates rather than by the population share of women of reproductive age (see footnote 9). A youth bulge effect is thus likely a marginal factor. Alternatively, an important reason why urban fertility may not respond much to urban natural increase and urban congestion may be the fact that fertility rates are high in low-income economies with low returns to education (see Galor (2012) for a thorough review of the literature). If congestion prevents these urban economies from developing, and particularly from becoming skill-intensive, urban fertility rates may not adjust. This is consistent with the negative correlation between urban natural increase and urban school attendance (Table 3).

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increase and their own internal population growth.

3.4 Conclusion

Starting from the observation that urban expansion in the developing world of the 20th century has been twice as fast as in the developing world of the 19th century, we take an historically comparative perspective on exploring the new features of fast urbanization at low levels of development and zoom in on the role of demographic factors. Through decomposition analysis of newly compiled data on urban growth, change in urbanization rates, crude urban birth and death rates from 7 countries from Industrial Europe (1800-1910) and 35 developing countries (1960-2010), we document that urban natural increase in the developing world has been much larger than in Industrial Europe, due to much lower urban mortality rates. While Europe's cities of the 19th century came to be known as *killer cities*, with high urban mortality rates offsetting urban fertility and urban expansion driven by migration, many cities of today's developing world can be classified as *mushroom cities* instead, with high urban fertility contrasted with much lower mortality, resulting in high urban rates of natural increase. With migration rates remaining at similar levels as in Industrial Europe, high urban growth and a more rapid change in the urbanization rate have resulted. We further show that rapid urban growth is correlated with indicators of congestion. These descriptive findings, complemented by those from a series of multivariate analyses, call attention to the notion of an *urban push* as an additional mechanism of urban expansion, whereby rapid urban natural increase contributes in itself to urbanization.

Our paper adds to the literature on *rural push* and *urban pull* factors of urbanization which emphasize migration. Urbanization may not come solely from migration. Internal urban population growth could also matter. Additionally, we contribute to the literature on the relationship between urbanization and development. Income growth may not be the only driver of urbanization, if urban areas in low-income countries expand mechanically through high fertility rates. The resulting urbanization *per se* may not necessarily be conducive to further economic growth, as urban congestion effects might limit the benefits from agglomeration. Therefore, the *urban push* may be one factor (among others) accounting for the phenomena of "urbanization without growth" and "poor country urbanization" highlighted by Fay & Opal (2000) and Glaeser (2013) respectively.

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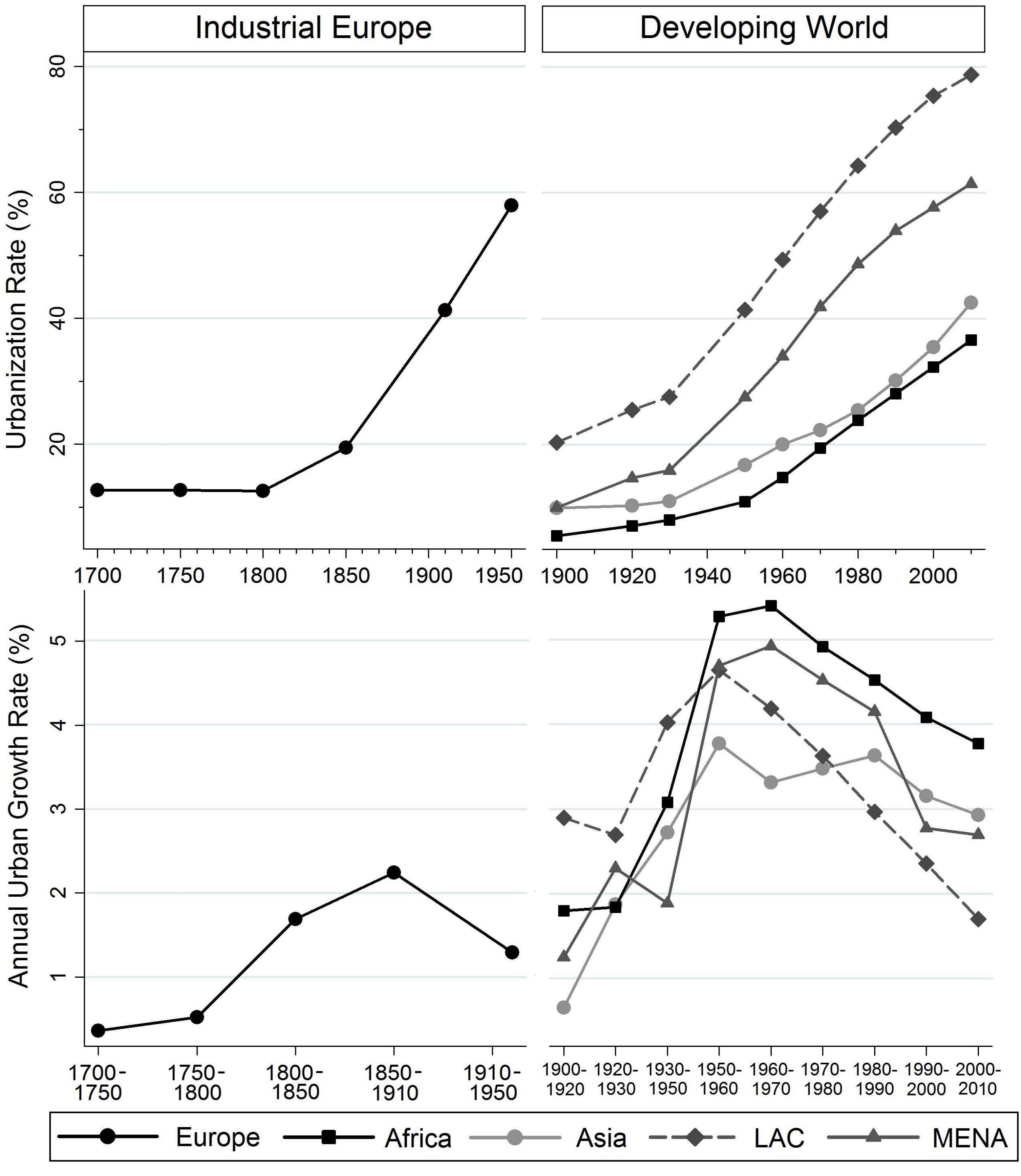
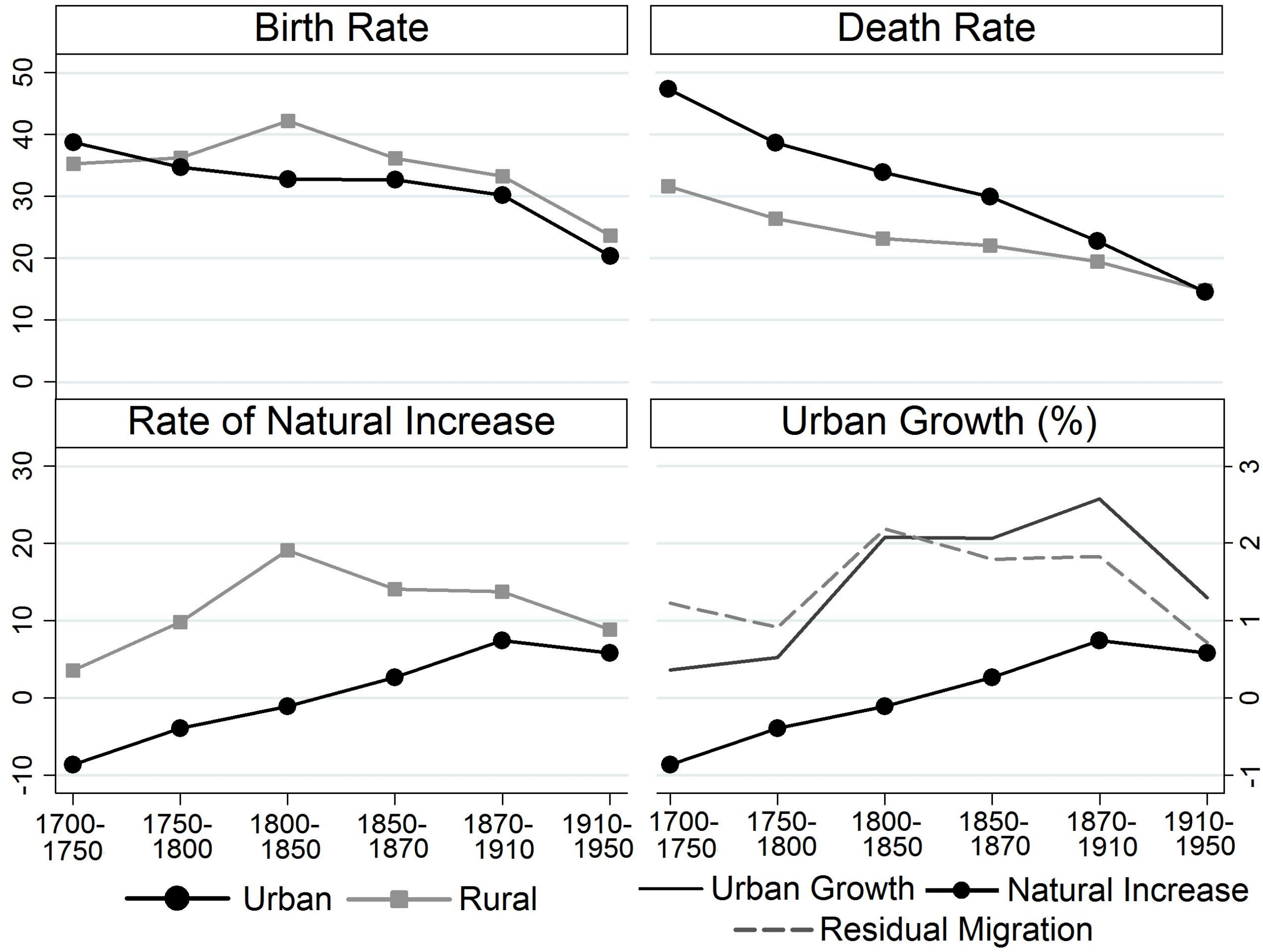
Figure 1: Urbanization Rates (%) and Annual Urban Growth Rates (%) for Industrial Europe (1700-1950) and the Developing World (1900-2010)



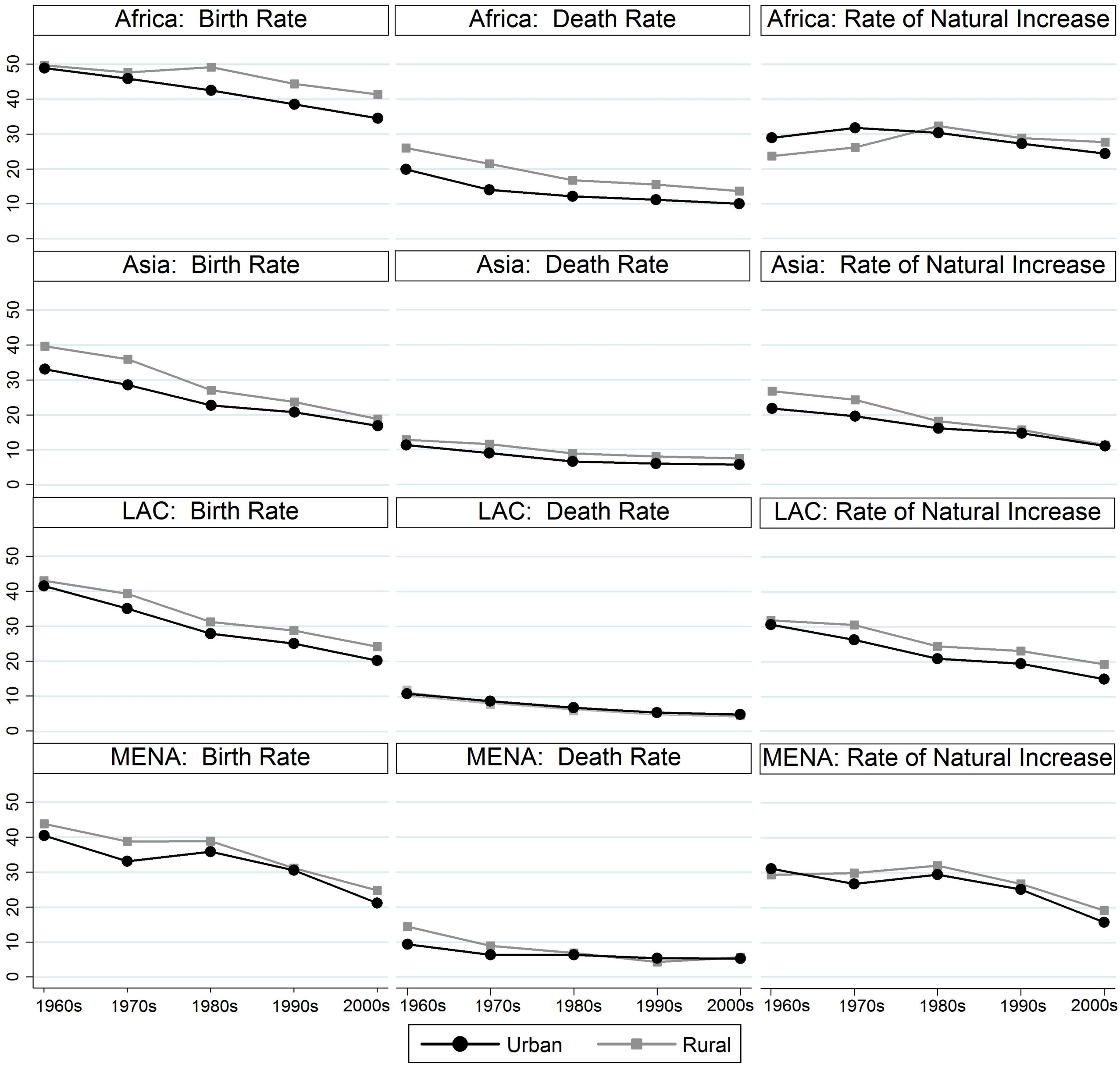
Notes: This figure plots the urbanization rate (%) and the annual urban growth rate (%) for Industrial Europe (1700-1950) and four developing areas (1900-2010): Africa, Asia, Latin America and the Caribbean (LAC) and Middle-East and North Africa (MENA). Europe includes 18 Western European countries and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



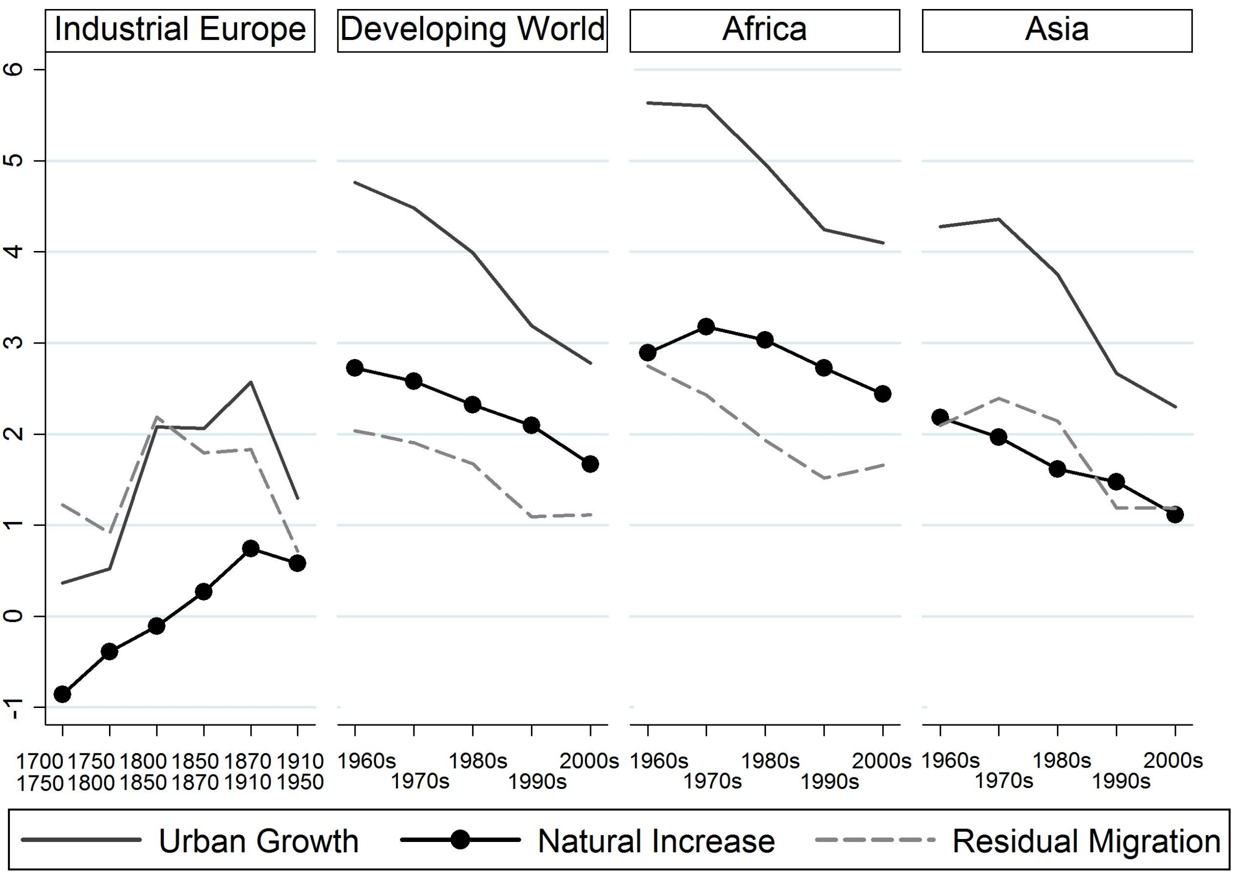
Notes: This figure plots the crude rate of birth, the crude rate of death and the crude rate of natural increase (per 1,000 people) for the rural and urban areas of Industrial Europe (1700-1950). This figure also plots the decomposition of annual urban growth (%) into the respective contributions of annual urban natural increase (%) and annual residual migration (%). Europe includes Belgium, England, France, Germany, the Netherlands, Sweden and the United States for this figure. See the Web Appendix for data sources.

Figure 3: Urban Demographic Patterns for the Developing World (1960-2010)



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 the rural and urban areas of four developing regions (1960-2010): Africa, Asia, Latin America and the Caribbean (LAC) and Middle-East and North Africa (MENA). We use historical demographic data for 35 countries that were still developing countries in 1960. See the Web Appendix for data sources.

Figure 4: Decomposition of Urban Growth for the Developing World



Notes: This figure plots the decomposition of annual urban growth rate (%) into annual urban natural increase (%) and annual residual migration (%) for Industrial Europe in 1700-1950 and the developing world as a whole, Africa and Asia in 1960-2010. See the Web Appendix for data sources.

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

Dependent Variable: Annual Urban Growth Rate (%; Row 1-4: t; Row 5-8: 1960-2010)				
	Coeff. *Uni*	SE *Uni*	Obs.	Adj.-R2
1. Uni_t: Panel: Controls; Continent FE x Trend	0.92***	(0.27)	175	0.76
2. Uni_t: Panel: Controls; Region FE x Trend	1.00***	(0.28)	175	0.79
3. Uni_t: Panel: Controls; Region FE x Trend; Rni_t	1.08***	(0.30)	175	0.78
4. Uni_t: Panel-ADL(2,2): Controls; Region FE x Trend; Rni_t	1.21**	(0.57)	105	0.84
5. Uni_{1960}: Cross-Section: Controls; Continent FE	0.74**	(0.34)	35	0.80
6. Uni_{1960}: Cross-Section: Controls; Continent FE; Rni_{1960}	0.69*	(0.37)	35	0.80
7. Uni_{2000}: Cross-Section: Controls; Region FE	0.80***	(0.26)	97	0.76
8. Uni_{2000}: Cross-Section: Controls; Region FE; Rni_{2000}	0.77**	(0.36)	97	0.76

Notes: The sample consists of 35 countries that were still developing countries in 1960, for the following decades: 1960s, 1970s, 1980s, 1990s, 2000s in rows 1-4, and the period 1960-2010 in rows 5-8. Robust SEs (clustered at the country level in rows 1-4); * $p<0.10$, ** $p<0.05$, *** $p<0.01$. In rows 1-4 and 5-8, the dependent variable is the annual urban growth rate (%) in decade t and 1960-2010, respectively. The variable of interest is the urban crude rate of natural increase (%) in decade t (rows 1-4), the 1960s (rows 5-6) and the 2000s (rows 7-8). See text for specification details and Web Appendix for data sources.

TABLE 2: URBAN NATURAL INCREASE AND RELATIVE URBAN GROWTH, 1960-2010

Dependent Variable: Change in Urbanization Rate (Pct. Points; Row 1-4: t; Row 5-8: 1960-2010)				
	Coeff. *Uni*	Coeff. *Migr*	Obs.	Adj.-R2
1. Uni_t: Panel: Controls; Continent FE x Trend	0.88	2.20***	175	0.68
	(0.55)	(0.27)		
2. Uni_t: Panel: Controls; Region FE x Trend	1.10*	2.04***	175	0.69
	(0.55)	(0.29)		
3. Uni_t: Panel: Controls; Region FE x Trend; Rni_t	1.63**	2.06***	175	0.70
	(0.61)	(0.31)		
4. Uni_t: Panel-ADL(2,2): Controls; Region FE x Trend; Rni_t	1.21	3.28***	105	0.83
	(1.12)	(0.60)		
5. Uni_{1960}: Cross-Section: Controls; Continent FE	1.66**	1.62***	35	0.81
	(0.69)	(0.42)		
6. Uni_{1960}: Cross-Section: Controls; Continent FE; Rni_{1960}	1.78*	1.66***	35	0.81
	(0.90)	(0.43)		
7. Uni_{2000}: Cross-Section: Controls; Region FE	0.75*	1.23***	97	0.65
	(0.41)	(0.21)		
8. Uni_{2000}: Cross-Section: Controls; Region FE; Rni_{2000}	1.13**	1.22***	97	0.65
	(0.50)	(0.21)		

Notes: The sample consists of 35 countries that were still developing countries in 1960, for the following decades: 1960s, 1970s, 1980s, 1990s, 2000s in rows 1-4, and the period 1960-2010 in rows 5-8. Robust SEs (clustered at the country level in rows 1-4); * $p<0.10$, ** $p<0.05$, *** $p<0.01$. In rows 1-4 and 5-8, the dependent variable is the change in the urbanization rate (%) in decade t and 1960-2010 (divided by 5 in order to be expressed in decadal terms), respectively. The variable of interest is the urban crude rate of natural increase (%) in decade t (rows 1-4), the 1960s (rows 5-6) and the 2000s (rows 7-8). See text for specification details and Web Appendix for data sources.

TABLE 3: URBAN NATURAL INCREASE AND URBAN CONGESTION, 1960-2010

Dependent Variable:	Coeff. *Ugr* *1960-2010*	Coeff. $\triangle Urb$ *1960-2010*	Obs.	Adj. -R2
1. Urban Population Living in Slums (%, 2005-2010)	6.5**	0.0	95	0.79
	(2.7)	(1.3)		
Dependent Variable:	**Coeff. Uni_{2000}**	**Coeff. *Migr***	**Obs.**	**Adj. -R2**
2. Urban Population Living in Slums (%, 2005-2010)	14.5***	4.6*	95	0.80
	(4.9)	(2.4)		
3. Lack of Sufficient Living Area (Urban, %, 2000-2010)	8.9*	3.3	57	0.70
	(4.4)	(2.5)		
4. Housing Unit with Finished Floor (Urban, %, 2000-2010)	-8.5	-3.0	66	0.64
	(5.7)	(3.6)		
5. Access to Improved Water Source (Urban, %, 2000-2010)	-3.7**	-2.2*	92	0.59
	(1.7)	(1.2)		
6. Access to Sanitation Facilities (Urban, %, 2000-2010)	-0.7	-1.7	92	0.85
	(2.8)	(1.9)		
7. Solid Fuels as Source of Energy (Urban, %, 2000-2010)	13.6*	2.5	78	0.81
	(7.5)	(5.2)		
8. School Attendance for 6-15 y.o. (Urban, %, 2000-2010)	-10.8***	-2.4	65	0.76
	(3.7)	(2.6)		
9. PM10 Pollution (Urban, mg per m^3, 2000-2010)	18.0*	-0.0	94	0.49
	(10.1)	(5.8)		
10. Empl. in Manufacturing & FIRE (Urban, %, 2000-2010)	-3.1**	-0.9	79	0.79
	(1.4)	(0.9)		
11. Empl. in Personal Services (Urban, %, 2000-2010)	3.8*	1.1	76	0.43
	(1.9)	(1.0)		

Notes: The main sample consists of 95 countries that were still developing countries in 1960. Robust SEs; * $p<0.10$, ** $p<0.05$, *** $p<0.01$. The specification is the same as in row 7 of Table 2 (Cross-Section: Controls; Region FE) except we also include the decadal change in the urbanization rate between 1960 and 2010 (coeff. not shown in rows 2-11). Row 1: Regression of the slum share (%) on the annual urban growth rate (%), *Ugr*, and the decadal change in the urbanization rate (%), $\triangle Urb$, between 1960 and 2010. Rows 2-11: Regression of urban congestion measures on the urban rate of natural increase in 2000 Uni_{2000} (which we use as a proxy for urban natural increase in 1960-2010), the residual migration rate *Migr* (here defined as the difference between the annual urban growth rate in 1960-2010 and the rate of urban natural increase in 2000), and the decadal change in the urbanization rate (%) between 1960 and 2010 (coeff. not shown). See Web Appendix for data sources.

TABLE 4: URBAN NATURAL INCREASE AND URBAN DEPENDENCY RATIOS, 1960-2010

Dependent Variable:	Coeff. Uni_{2000}	Coeff. *Migr*	Obs.	Adj. -R2
1. Child Dependency (0-14 y.o.) (Urban, %, 2000-2010)	10.2***	0.7	89	0.87
	(2.7)	(1.2)		
2. Aged Dependency (65+ y.o.) (Urban, %, 2000-2010)	-2.8***	-1.2***	89	0.79
	(0.6)	(0.3)		
3. Total Dependency (0-14|65+ y.o.) (Urban, %, 2000-2010)	7.4***	-0.5	89	0.84
	(2.7)	(1.3)		

Notes: The sample consists of 89 countries that were still developing countries in 1960. Robust SEs; * p<0.10, ** p<0.05, *** p<0.01. The specification is the same as in row 7 of Table 2 (Cross-Section: Controls; Region FE) except we also include the decadal change in the urbanization rate between 1960 and 2010 (coeff. not shown). We regress the urban dependency ratios on the urban crude rate of natural increase in 2000 Uni_{2000} (which we use as a proxy for urban natural increase in 1960-2010), the residual migration rate *Migr* (here defined as the difference between the annual urban growth rate in 1960-2010 and the rate of urban natural increase in 2000), and the decadal change in the urbanization rate (%) between 1960 and 2010 (coeff. not shown). See Web Appendix for data sources.

NOT FOR PUBLICATION: WEB APPENDICES

Demography, Urbanization and Development: Rural Push, Urban Pull... and Urban Push?

by Remi Jedwab, Luc Christiaensen and Marina Gindelsky

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NOT FOR PUBLICATION: WEB THEORY APPENDIX

Urban Natural Increase and the Speed of Urbanization

Summary: *This Web Theory Appendix shows in a calibration exercise that faster changes in urbanization are indeed mechanically associated with higher urban rates of natural increase ceteris paribus. Rural natural increase then mechanically lowers urbanization rates.*

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:

$$\triangle U_t = U_{t+1} - U_t = \frac{Upop_{t+1}}{Pop_{t+1}} - \frac{Upop_t}{Pop_t} = \frac{Upop_{t+1}}{Pop_{t+1}}\frac{Pop_t}{Pop_t} - \frac{Upop_t}{Pop_t}\frac{Pop_{t+1}}{Pop_{t+1}} \quad (1)$$

$$\triangle U_t = \frac{Upop_{t+1}(Upop_t + Rpop_t)}{Pop_t Pop_{t+1}} - \frac{Upop_t(Upop_{t+1} + Rpop_{t+1})}{Pop_t Pop_{t+1}} \quad (2)$$

$$\triangle U_t = \frac{Rpop_t Upop_{t+1}}{Pop_t Pop_{t+1}} - \frac{Upop_t Rpop_{t+1}}{Pop_t Pop_{t+1}} = (1-U_t)\frac{Upop_{t+1}}{Pop_{t+1}} - U_t\frac{Rpop_{t+1}}{Pop_{t+1}} \quad (3)$$

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:

$$\triangle U_t = (1-U_t)\frac{(1+Uni_t)Upop_t + Mig_t}{(1+Nni_t)Pop_t} - U_t\frac{(1+Rni_t)Rpop_t - Mig_t}{(1+Nni_t)Pop_t} \quad (4)$$

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

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

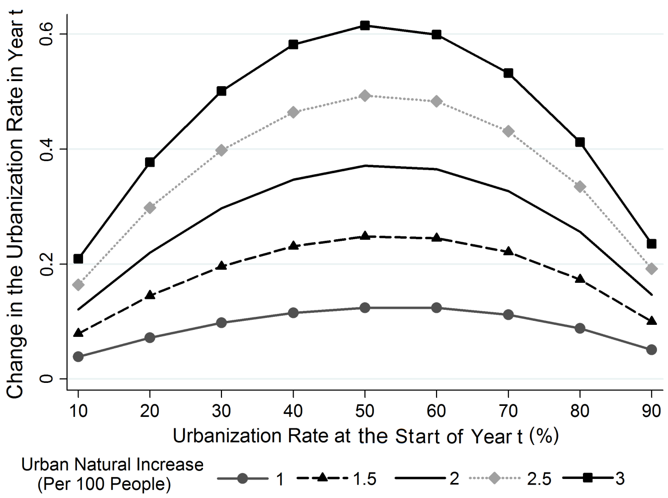
Three insights emerge. First, the change in urbanization is a relative concept and depends on both urban and rural natural increase ($Uni_t - Rni_t$), with the latter mitigating the positive effect of the former. Consequently, rapid urban natural increase can coexist with a relatively slow change in 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)≤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 (6) 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 (see Web Theory Appendix Figure 1). 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. 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.

Europe and the four developing areas then 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 Web Theory Appendix Figure 1, the simulations use the following parameters: $Rni = 2.5\%$ and $Mig/Upop = 1.5\%$. Taking $Uni = 0.5\%$ as a benchmark, we show 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%. Indeed, in the figure, the annual difference in the change in the urbanization rate between $Uni = 3$ (Africa) and $Uni = 1$ (Europe) is about 0.2 for an initial urban rate of 10%. The decadal change should thus be 2 points of urbanization.

Web Theory Appendix Figure 1: Urban Natural Increase and Change in Urbanization Rate, Calibration



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 $Uni = \{1; 1.5; 2; 2.5; 3\}$.

NOT FOR PUBLICATION: WEB DATA APPENDIX

Summary: *This Web Data Appendix describes in details the data we use in our analysis.*

Sample Selection for Industrial Europe and Today's Developing World:

We use three different samples in our analysis. First, we obtain historical urban data for 19 European and North American countries from 1700-1950, and 116 Africa, Asian or non-North American countries that were still developing countries in 1960, from 1960-2010. We exclude from our analysis the European and Neo-European countries for which we could not find historically consistent urban data, as well as the former CIS countries. We use these countries to describe urban patterns in "Industrial Europe" (which also includes a Neo-European country, the United States) and four developing areas: Sub-Saharan Africa (which we call "Africa"), Asia, Latin America and the Caribbean (LAC), and Middle-East and North Africa (MENA). Second, our main sample consists of 40 of these countries from 1700 to 2010. These are the countries for which we found historical demographic data. Historical consistent data was not found for other countries. The list of countries and years (or periods) for which we have data is reported in Web Appendix Tables 1, 2 and 3. These countries belong to the five developing areas: Industrial Europe (N = 7, about every 40 years in 1700-2010), Africa (N = 10, every ten years in 1960-2010), Asia (N = 12, ditto), LAC (N = 8, ditto) and MENA (N = 5, ditto). Third, we also collect cross-sectional data for 97 out of the 116 developing countries in 1960 for which we were to able to find demographic data, for the most recent period. The countries of Africa, Asia, the LAC and MENA regions are then classified into 13 regions: Central Africa, Eastern Africa and Western Africa for Africa; East Asia, Pacific Islands, South Asia and South-East Asia for Asia; Caribbean, Central America and South America for the LAC region; and Middle-East and North Africa for the MENA region.

Urban and Rural Growth and Urbanization Rates in Industrial Europe:

The annual urban growth rate is the average growth rate of the urban population between two years (%). The annual rural growth rate is the average growth rate of the rural population between two years (%). The urbanization rate is defined as the share of the urban population in total population (%). We use Bairoch (1988) and Malanima and Volckart (2007) to reconstruct consistent annual urban growth rates and urbanization rates for 18 Western European countries and the United States for the following periods: 1700-1750, 1750-1800, 1800-1850, 1850-1910 and 1910-1950. Averages are estimated using the population weights for the same period. We consider 7 countries in our main urban demographic analysis (listed in Web Appendix Table 1), as consistent historical demographic data could not be found for the 12 other countries.

Urban and Rural Growth and Urbanization Rates in Today's Developing World:

We reference Bairoch (1988), Sluglett (2008) and WUP (2011) to reconstruct the average annual urban growth rates (%) and urbanization rates (%) for Africa, Asia and the LAC and MENA regions for the following periods: 1900-1920, 1920-1930, 1930-1950, 1950-1960, 1960-1970, 1970-1980, 1980-1990, 1990-2000 and 2000-2010. For the last six decades (post-1950), we use data for 116 African, Asian and non-North American countries. Averages are estimated using the population weights for the same period. We only consider 35 countries in the panel analysis from

1960-2010 (listed in Web Appendix Table 2). We then consider 97 out of the 116 countries for the cross-sectional analysis from 1960-2010. We use WUP (2011) and WB (2013) to estimate the average annual growth rate (%) of the largest city of each country between 1960 and 2010.

Urban and Rural Demographic Transitions in Industrial Europe:

For each of the 7 countries of Industrial Europe, we use various historical sources to obtain the national, urban and rural crude rates of birth, crude rates of death and crude rates of natural increase (per 1,000 people) for several decades during the 1800-1910 period (sources listed in Panel A, Web Appendix Table 3). For England, our main country of analysis, we have data from 1700 to 1950. For the other countries, demographic data exists for shorter periods, as this type of data was not systematically collected by the official authorities before the 19th century.

Urban and Rural Demographic Transitions in Today's Developing World:

For each of the 35 countries of today's developing world, we use reports from the *Population and Housing Censuses*, *CICRED Monographs*, *Fertility Surveys*, and *Demographic and Health Surveys* (DHS) as well as the *Statistical Yearbooks* of the United Nations, to obtain the national, urban and rural crude rates of birth, crude rates of death and crude rates of natural increase (per 1,000 people) for each decade during the 1960-2010 period (sources listed in Panel B, Web Appendix Table 3).[1] We could not find consistent historical demographic data for other countries. Indeed, demographic data does not always exist for countries as far back as the 1960s. For 62 other countries of today's developing world, we use reports from the *Population and Housing Censuses* and *Demographic and Health Surveys* to obtain an estimate of the urban and rural crude rates of birth and death for the closest year to 2000, in the 1990-2010 interval. For the 35 + 62 = 97 countries, we also used the same sources to retrieve the urban total fertility rate (TFR) for the closest year to 2000, in the 1990-2010 interval. For 89 countries, we used the same sources to obtain the urban share of women in reproductive age (15-49 year-old, as a % of the total population) for the closest year to 2000, in the 1990-2010 interval. Data on the urban child mortality rates (0-5 years) for the closest year to 2000, in the 1990-2010 interval, was obtained from the *Demographic and Health Surveys* (DHS). Lastly, for 94 countries, we also use the sources mentioned above to obtain the birth rate of the largest city for the closest year to 2000, in the 1990-2010 interval. Data on the crude death rate of the largest city does not exist, as it is not systematically collected or reported by the official authorities of these countries.

Data for the Instrumental Variables:

Data on the population shares (%) of "Catholicism", "Protestantism", "Other Christian Religions", "Islam", "Hinduism", "Buddhism", "Other Eastern Religions", and "Other Religions" for the 1960s come from Barro and McCleary (2003). They mostly rely on survey data from the 1960s but label this round of data as "1970". Data on the "Family Planing Effort" (FPE) index (from 0 to 100) for the 1960s comes from Ross and Mauldin (1996). They mostly rely on observations from the late 1960s, but label this round of data "1972" in their analysis. The two data sets allow us to observe the initial cultural and policy conditions in our 35 developing countries.

[1] While some of these sources could easily be found on the internet (in PDF), we found most of them at the Library of Congress in Washington D.C. and the libraries of the London School of Economics and Political Science (LSE) in London and the Centre Population et Développement (CEPED) in Paris.

Measures of Urban and Rural Congestion:

Data on the share of the urban population living in slums (%) comes from UN-Habitat (2003), UN (2013) and WB (2013). A slum household is usually defined as a group of individuals living under the same roof lacking one or more of the following conditions (UN-Habitat 2003): (i) sufficient-living area, (ii) structural quality, (iii) access to improved water source, and (iv) access to improved sanitation facilities. We have data for 113 countries in total, but we only focus on 95 countries for which we also have data on urban natural increase in 2000. Data is available for a lower number of countries for some subcomponents of the slum variable. UN-Habitat (2003) reports the share of urban residents that lack "sufficient-living area" (%), i.e. who live in dwelling units with more than 3 persons per room. We use as a measure of "structural quality" the shares of urban and rural inhabitants who live in a residence with a finished floor (%). We reconstruct these variables using the *International Public-Use Microdata Series* (IPUMS, 2013) and the stat compiler of the *Demographic and Health Surveys* (DHS, 2013). Data on the shares of urban and rural inhabitants who have access to an improved water source and improved sanitation facilities (%) come from WB (2013). A household is considered to have access to an improved water source if it has sufficient amount of water for family use, at an affordable price, available to household members without being subject to extreme effort, especially to women and children. A household is considered to have access to improved sanitation, if an excreta disposal system is available to household members. Data on the respective shares of urban and rural inhabitants using solid fuels (e.g., coal and wood) as their main source of energy comes from WHO (2010). Data on the urban and rural child dependency ratios (%), the urban and rural aged dependency ratios (%), the urban and rural total dependency ratios (%), and the urban and rural shares of 6-15 year-old children that are currently attending school (%) were recreated using the DHS (2013), IPUMS (2013), various census reports, and Wikipedia (2013), for each country. The urban (rural) child dependency ratio is the ratio of the number of urban (rural) residents aged 0-14 over the number of urban (rural) residents aged 15-64 x 100. The urban (rural) aged dependency ratio is the ratio of the number of urban (rural) residents aged 65-+ over the number of urban (rural) residents aged 15-64 x 100. The urban (rural) total dependency ratio is the ratio of the number of urban (rural) residents aged 0-14 or 65-+ over the number of urban (rural) residents aged 15-64 x 100. Data on our measure of particulate matter (PM) concentrations in residential areas of cities with more than 100,000 residents comes from WB (2013). Data on the urban (rural) employment structure in selected countries for 2000-2010 was recreated using various sources, as described for each country in Gollin, Jedwab and Vollrath (2015). Their two main data sources are IPUMS (2013), the *International Public-Use Microdata Series*, and ILO (2013), the International Organization of Labor. They complement these datasets with data from the published reports of *Population and Housing Censuses, Labor Force Surveys and Household Surveys*. For each country for which data is available, they estimate the employment shares (%) of all urban (rural) areas for the following 11 sectors: "agriculture", "mining", "public utilities", "manufacturing", "construction", "wholesale and retail trade, hotels and restaurants", "transportation, storage and communications", "finance, insurance, real estate and business services", "government services", "education and health" and "personal and other services" (our sector of analysis, since it often works as an urban refugee sector). As already explained above, we use the same sources to recreate the same measures of congestion for the rural sector only in 2000-2010. Data is missing for three measures then: sufficient-living area, particulate matter (PM) concentrations and the employment share of the rural refugee sector, which is not necessarily the "personal and other services" sector. We also have data for a fewer number of observations for the rural sector than for the urban sector.

Per Capita GDP and Other Controls:

We use Maddison (2008) and WB (2013) to reconstruct a consistent series of GDP per capita for each country every ten years for 1960-2010. The main variable used in our analysis is average log GDP per capita for each decade (in constant 2005 international $, which is the base used by WB (2013)). We use various sources to reconstruct a range of time-invariant or time-varying controls at the country-level. In the panel regressions, we include the time-varying controls (estimated in the same or previous decade). In the cross-sectional regressions, we also include the time-invariant controls (the time-varying controls are estimated for 1960-2010 instead of for the same or previous decade). Most of these controls were initially constructed by Gollin, Jedwab and Vollrath (2015). First, we consider various rural push factors: (i) FAO (2013) reports the cereal yields (hg per ha) for each country-year observation. We then estimate the average yields for each decade; (ii) Rural density is defined as the ratio of rural population (1000s) to arable area (sq km). The arable area of each country is reported by FAO (2013); (iii) CRED (2013) reports the number of droughts experienced by each country every year. We use two variables: the number of droughts (per sq km) since 1960, and the number of droughts (per sq km) for each decade (e.g., 1960-1969 for the 1960s); and (iv) The Polity IV data series includes a measure of political violence for each country (1964-present). We create an indicator whose value is one if the country experienced an interstate or civil conflict in each decade (Polity IV 2013a). Second, we consider various urban pull factors: (i) The share of manufacturing and services in GDP (%) in 2010 is obtained from WB (2013). The data is missing for many country-year observations before the recent period; (ii) We use the data set of Gollin, Jedwab and Vollrath (2015) to obtain the average share of natural resource exports in GDP (%) for each decade; (iii) We use the Polity IV data series to calculate the average combined polity score for each country for each decade (Polity IV 2013b). We create an indicator whose value is one if the average polity score is lower than -5, the threshold for not being considered autocratic; and (iv) From WB (2013), we know the share of the largest city in the urban population, the primacy rate, for all years in 1960-2010. Third, we use the other following controls: (i) The 97 countries use four different types of urban definition in their most recent censuses: (a) "administrative cities" are administrative centers of territorial units (e.g., provinces, districts, etc.), (b) "threshold cities" are localities whose population is greater than a population threshold of X inhabitants (e.g.,5,000 or 2,500), (c) "administrative or threshold cities" are either administrative centers or localities whose population is greater than a population threshold, and (d) "threshold with condition cities" are localities whose population is greater than a population threshold and who have a large share of the labor force engaged in non-agricultural activities. We create dummies for each definition. For each country using a population threshold, we know the threshold and use it as a control in our regressions; and (ii) We create two dummies equal to one if the country is a small island or if the country is landlocked. We consider an island country small if its area is smaller than 50,000 sq km.

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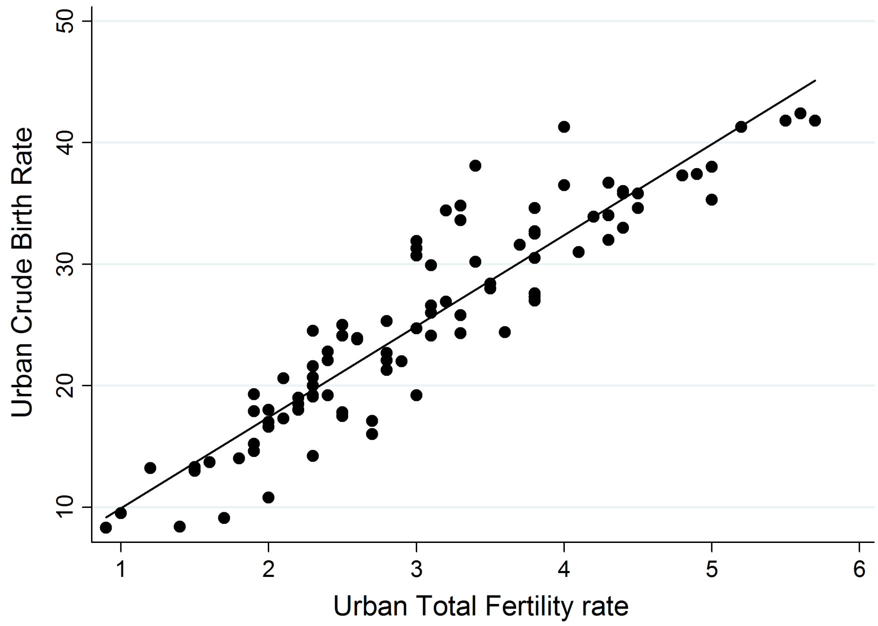
NOT FOR PUBLICATION: WEB APPENDIX FIGURES

Web Appendix Figure 1: Urban Crude Rates of Birth and Urban Total Fertility Rates for 97 Developing Countries in 2000

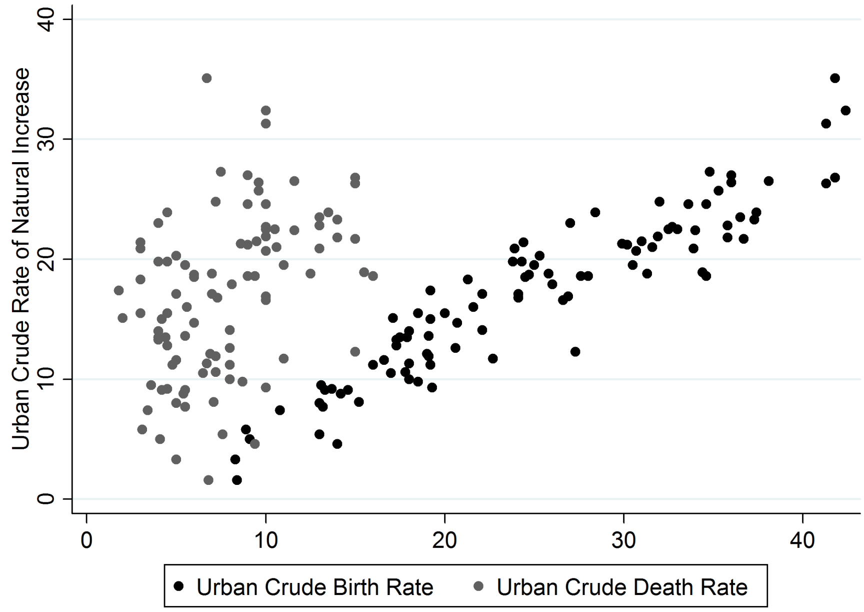


***Notes*: This figure shows the high correlation (rho = 0.93) between the urban crude birth rate and the urban total fertility rate for 97 developing countries in 2000.** We use data for 97 countries that were still developing countries in 1960, for the closest year to the year 2000 (in the 1990-2010 period). The linear fit is plotted for the relationship between the urban crude birth rate (per 1,000 people) and the urban total fertility rate (the average number of children born to a woman over her lifetime). The coefficient of correlation between the two is 0.93. See Web Appendix for data sources.

Web Appendix Figure 2: Urban Crude Rates of Death and Urban Child Mortality Rates for 70 Developing Countries in 2000

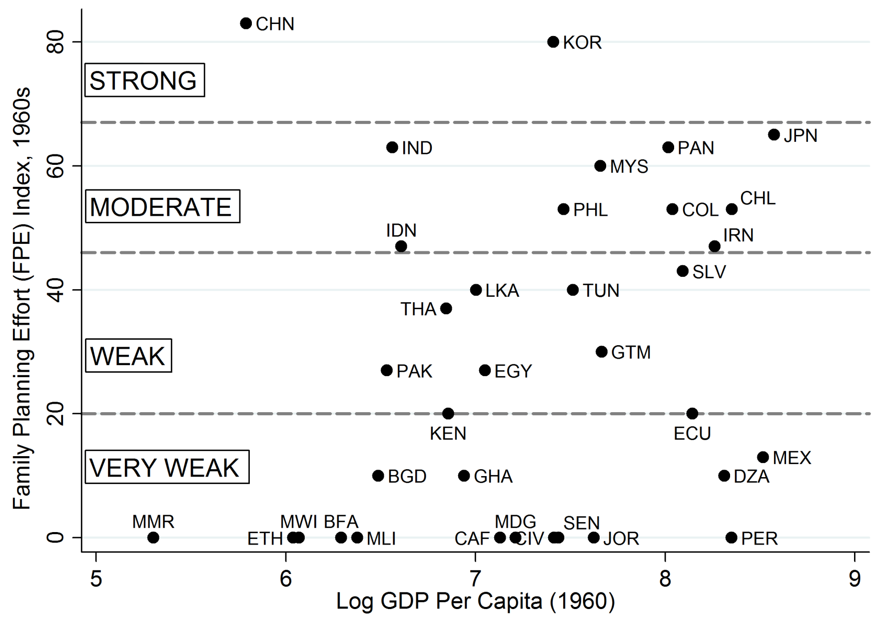
***Notes*: This figure shows the high correlation (rho = 0.81) between the urban crude death rate and the urban child mortality rate (0-5 years) for 70 developing countries in 2000.** We use data for 70 countries that were still developing countries in 1960, for the closest year to the year 2000 (in the 1990-2010 period). The linear fit is plotted for the relationship between the urban crude death rate (per 1,000 people) and the urban child mortality rate (0-5 years, per 1,000 live births). The coefficient of correlation between the two is 0.81. See Web Appendix for data sources.

Web Appendix Figure 3: Urban Crude Rates of Birth, Death and Natural Increase for 97 Developing Countries in 2000



***Notes*: This figure shows that the urban crude rate of natural increase is highly correlated with the urban crude rate of birth (rho = 0.93), while the urban crude rate of death does not vary as much across countries (rho = 0.42).** We use data for 97 countries that were still developing countries in 1960, for the closest year to the year 2000 (in the 1990-2010 period). The coefficients of correlation between the urban crude rate of natural increase (per 1,000 people) and the urban crude rates of birth and death (per 1,000 people) are 0.93 and 0.42 respectively. See Web Appendix for data sources.

Web Appendix Figure 4: Family Planning Effort Index and Log Per Capita GDP for 35 Developing Countries in the 1960s



***Notes*: This figure allows us to identify the countries that had "idiosyncratically" (here conditional on initial income in 1960) implemented in the 1960s a family planning policy (high FPE index) or a pronatalist policy (low FPE index) among the 35 developing countries of the panel analysis.** We show the correlation between the family planning effort index in the 1960s (the lower the FPE index the more pronatalist the policy is) and log per capita GDP in 1960 (constant 2005 international $) for the 35 countries that were still developing countries in 1960 and that we use in our panel analysis. The coefficient of correlation between the two is 0.28. Ross and Maudlin (1996) define 4 categories of family planing policies: *very weak* ($0 \leq$ FPE ≤ 19), *weak* ($20 \geq$ FPE ≤ 45), *moderate* ($46 \leq$ FPE ≤ 66) and *strong* ($67 \leq$ FPE ≤ 100). See Web Appendix for data sources.

NOT FOR PUBLICATION: WEB APPENDIX TABLES

WEB APPENDIX TABLE 1: NATURAL INCREASE SOURCE INFORMATION BY COUNTRY

COUNTRY	YEARS	MAIN SOURCES
		See the excel files "Demographic_Data_X.xls" for the main sources used for each country-year (X = {*Africa*, *Asia*, *Europe*, *LAC*, *MENA*})
Panel A:		**Historical Data for Industrial Europe (N = 7, 1700-1950)**
Belgium	1866-1905	(i) *Annuaires Statistiques de la Belgique. Belgium. Ministere de l'Interieur.* 1907. Bruxelles: Etablissements Généraux de la Belgique.
England	1700-1950	(i) Newsholme, A. (1911). *The Declining Birth Rate, Its National and International Significance*. London: Cassell & Company Limited; (ii) Landers, J. (1993). *Death and the Metropolis: Studies in the Demographic History of London, 1670-1830*. Cambridge, Cambridge University Press. (iii) Friedlander, D. (1969). Demographic Responses and Population Change, *Demography* 6 (4): 359-381; (iv) Williamson, J. (1990). *Coping with City Growth During the British Industrial Revolution*. Cambridge: Cambridge University Press.
France	1853-1910	(i) *Statistique Annuelle du Mouvement de la Population. France. Statistique Generale.* 1901, 1912. Paris: Imprimerie Nationale.
Germany	1811-1926	(i) Weber, A. (1899). *The Growth of Cities in the 19th Century.* New York: The MacMillan Company; (ii) Stedman, T. (1904). *Medical Record.* New York: William Wood and Company; (iii) Pollock, H., and W. Morgan (1913). *Modern Cities: Progress of the Awakening for Their Betterment Here and in Europe.* New York: Funk & Wagnalls Company; (iv) Holmes, S. (1921). *A Study of Present Tendencies in the Biological Development of Civilized Mankind.* New York: Harcourt, Brace and Company; (v) Knodel, J. (1974). *The Decline of Fertility in Germany, 1871-1939*. Princeton, New Jersey: Princeton University Press. (vi) Galloway, P., Lee, R., and E. Hammel (1998). Urban vs. Rural: Fertility Decline in the Cities and Rural Districts of Prussia, 1875 to 1910. *European Journal of Population* 10/1998; 14(3):209-64. (vii) Vogele, J. (2000). Urbanization and the Urban Mortality Change in Imperial Germany. *Health & Place* 6: 41-55.
Netherlands	1815-1909	(i) Sanger, M. (1917). *The Case for Birth Control.* Modern Art Printing Company; (ii) Oeppen, J.E. , and M.H.D. van Leeuwen (1993). "Estimating the Demographic Regime of Amsterdam, 1681-1920." *Economic and Social History in the Netherlands* 5, 61-102. Cambridge: Cambridge University Press; (iii) Wintle, M. (2004). *An Economic and Social History of the Netherlands, 1800-1920: Demographic, Economic and Social Transition.* Cambridge: Cambridge University Press.
Sweden	1750-1946	(i) Dyson, T. (2011), The Role of the Demographic Transition in the Process of Urbanization. *Population and Development Review*, 37: 34-54.
United States	1800-1940	(i) Various census Reports; (ii) Report on vital and social statistics in US at 11th Census, 1890. Washington DC: U.S. Census Bureau. (iii) Statistical Abstract of the United States. 1933. Washington DC: U.S. Census Bureau. (iv)Statistical Abstract of the United States. 1941. Washington DC: U.S. Census Bureau.(v) Duffy J. (1968). *A History of Public Health in New York City, 1625-1866*. New York: Russell Sage; (vi) Rosenwaike, I. (1972). *Population History of New York City*. Syracuse: SU Press; (vii) Haines, M. (2001). The Urban Mortality Transition in the United States, 1800-1940. *Annales de Demographie Historique* 101: 33-64; (viii) Haines, H. (2008). *The Population of the United States, 1790-1920*. Cambridge: Cambridge University Press; (ix) Ferrie, J.P., and W. Troesken (2008). Death and The City: Chicago's Mortality Transition, 1850-1925. *Explorations in Economic History*, 45, 1: 1-16.

[Continued on next page]

COUNTRY	YEARS	MAIN SOURCES
		See the excel files "Demographic_Data_X.xls" for the main sources used for each country-year (X = {*Africa*, *Asia*, *Europe*, *LAC*, *MENA*})
<u>Panel B:</u>	**Historical Data for Today's Developing World (N = 35, 1960-2010)**	
Algeria	1969, 1970, 1986, 1994, 2006	Demographic Survey (Report), Multiple Indicator Cluster Surveys (Report)
Bangladesh	1965, 1974, 1985, 1993-1994, 2004	UN Statistical Yearbook, Population and Housing Census (Report), CICRED Monograph, Demographic and Health Survey (Report)
Burkina-Faso	1960-61, 1975, 1985, 1996, 2006	Demographic Survey (Report), Population and Housing Census (Report)
Central Afr. Rep.	1960, 1975, 1988, 1994-1995, 2003	Demographic Survey (Report), Population and Housing Census (Report), Demographic and Health Survey (Report)
Chile	1960, 1970, 1983, 1995, 2006	UN Statistical Yearbook, CICRED Monograph
China	1965, 1975, 1985, 1995, 2000	Population and Housing Census (Report), Historical Studies
Colombia	1962-1964, 1973, 1985-1986, 1990, 2000	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report), CICRED Monograph
Côte d'Ivoire	1965, 1975, 1988, 1994, 1998	Population and Housing Census (Report), Demographic and Health Survey (Report)
Ecuador	1968, 1974, 1985, 1993, 2005	UN Statistical Yearbook, Demographic and Health Survey (Report)
Egypt	1962, 1975, 1985, 1996, 2006	UN Statistical Yearbook, CICRED Monograph
El Salvador	1965, 1975, 1985, 1996, 2006	UN Statistical Yearbook
Ethiopia	1964-67, 1974, 1984, 1994, 2000	Population and Housing Census (Report), Demographic and Health Survey (Report), Demographic Survey (Report)
Ghana	1960, 1970, 1984, 1993, 2000-2003	Population and Housing Census (Report), Demographic and Health Survey (Report), CICRED Monograph
Guatemala	1965, 1975, 1980, 1992, 1998-1999	UN Statistical Yearbook, Demographic and Health Survey (Report)
India	1961, 1970, 1985, 1989, 2005	UN Statistical Yearbook, CICRED Monograph
Indonesia	1961-1971, 1971-1975, 1985, 1993, 2003	Demographic and Health Survey (Report), CICRED Monograph
Iran	1968, 1975, 1986, 1990, 2005	UN Statistical Yearbook
Japan	1965, 1975, 1985, 1995, 2005	UN Statistical Yearbook
Jordan	1965-1970, 1974, 1990, 1997, 2002	UN Statistical Yearbook, CICRED Monograph
Kenya	1962, 1969, 1979, 1989, 1998-1999	Population and Housing Census (Report), Demographic and Health Survey (Report), Demographic Survey (Report), CICRED Monograph
Madagascar	1965, 1975, 1985, 1992-1993, 1997-2003	Population and Housing Census (Report), Demographic and Health Survey (Report)
Malawi	1971-1972, 1977, 1987, 1998, 2008	Population and Housing Census (Report), Demographic Survey (Report)
Malaysia	1957-1961, 1970, 1980, 1991, 2006-2010	CICRED Monograph, Population and Housing Census (Report), Administrative Report
Mali	1960, 1976, 1987, 1996-1998, 2006-2009	Population and Housing Census (Report), Demographic and Health Survey (Report), Demographic Survey (Report)

[Continued on next page]

COUNTRY	YEARS	MAIN SOURCES
		See the excel files “Demographic_Data_X.xls” for the main sources used for each country-year (X = {*Africa*, *Asia*, *Europe*, *LAC*, *MENA*})
Mexico	1965, 1974, 1980, 1990, 2006	UN Statistical Yearbook, Administrative Reports
Myanmar	1965, 1973, 1983, 1999, 2006	CICRED Monograph, Administrative Report
Pakistan	1968, 1971, 1984, 1988, 2007	UN Statistical Yearbook, CICRED Monograph
Panama	1965, 1969, 1985, 1995, 2006	UN Statistical Yearbook
Peru	1960, 1970, 1986, 1990, 2000	Population and Housing Census (Report), Demographic and Health Survey (Report), Demographic Survey (Report), CICRED Monograph
Philippines	1968, 1978, 1988, 1998, 2003	UN Statistical Yearbook, CICRED Monograph
Senegal	1960-1967, 1978, 1986-1988, 1992-1993, 2002	Population and Housing Census (Report), Demographic and Health Survey (Report), Demographic Survey (Report)
South Korea	1966, 1970, 1989, 1989, 2006	UN Statistical Yearbook, Population and Housing Census (Report), CICRED Monograph
Sri Lanka	1961, 1971, 1981-1983, 1987, 2001	Demographic Survey (Report), Demographic and Health Survey (Report), CICRED Monograph, Historical Studies, Administrative Reports
Thailand	1964-1965, 1974-1976, 1985-1986, 1995-1996, 2005-2006	Demographic Survey (Report), CICRED Monograph
Tunisia	1966, 1972, 1980, 1988-1989, 2004-2006	UN Statistical Yearbook, Population and Housing Census (Report), Demographic and Health Survey (Report), CICRED Monograph, Multiple Indicator Cluster Surveys

***Notes*: This table shows the main sources used to reconstruct historical demographic data for each country of Industrial Europe (1700-1910) and today's developing world (1960-2010).** The sources for each country-year observation are described in the excel files “Demographic_Data_X.xls” in the folder of the replication files (X = {*Africa*, *Asia*, *Europe*, *LAC*, *MENA*}).

Administrative Report means that we use a report published by the official administration of that country; ***CICRED Monograph*** means that we use the published report of the 1974 country monograph published by the Committee for International Cooperation in National Research in Demography (http://www.cicred.org/Eng/Publications/content/3MonographNational/Index.html); ***Demographic and Health Survey (Report)*** means that we use the published report of the Demographic and Health Survey conducted by USAID in that country (http://dhsprogram.com/data/available-datasets.cfm); ***Demographic Survey (Report)*** means that we use the published report of a demographic survey that was independently conducted by the country; ***Multiple Indicator Cluster Surveys*** means that we use the published report of the Multiple Indicator Cluster Surveys conducted by UNICEF in that country (http://mics.unicef.org/); ***Population and Housing Census (Report)*** means that we use the published report of the population and housing census; and ***UN Statistical Yearbook*** means that we use the electronic copies of the UN Statistical Yearbooks that are available on the internet (http://unstats.un.org/unsd/demographic/products/dyb/dyb2.htm).

WEB APPENDIX TABLE 2: DECOMPOSITION OF ANNUAL URBAN GROWTH FOR 7 COUNTRIES OF INDUSTRIAL EUROPE, 1800-1910

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

***Notes*: This table shows the decomposition of annual urban growth into annual natural increase and annual residual migration (%) for 7 countries of Industrial Europe in 1800-1910. It shows that migration was the main component of urban growth, and that urban natural increase contributed little to urban growth.** Averages are not weighted by population. See the Web Appendix for data sources.

WEB APPENDIX TABLE 3: DECOMPOSITION OF ANNUAL URBAN GROWTH FOR 35 COUNTRIES OF TODAY'S DEVELOPING WORLD, 1960-2010

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

***Notes*: This table shows the decomposition of annual urban growth into annual natural increase and annual residual migration (%) for 35 countries of today's developing world in 1960-2010.** * The Central African Republic belongs to Central Africa, but data is missing for other countries of the region. We have included it in Eastern Africa. Averages are not weighted by population. See the Web Appendix for data sources.

WEB APPENDIX TABLE 4: URBAN BIRTH RATES, URBAN FERTILITY RATES AND SHARE OF WOMEN OF REPRODUCTIVE AGE IN THE POPULATION, 2000

Dependent Variable:	Urban Birth Rate (%, 2000)	Urban TFR * SWRA (2000)
	(1)	(2)
Urban Total Fertility Rate (TFR)	-0.05	25.92***
(Births per Woman, 2000)	(0.27)	(0.45)
Urban Share Women of Reproductive Age (SWRA)	-0.04	2.81***
(Per 100 People, 2000)	(0.03)	(0.16)
Urban TFR * SWRA	0.03***	
(2000)	(0.01)	
Fixed Effects, Controls	N	N
Observations; R-squared	89; 0.89	89; 0.99

***Notes*: This table shows that the main component of the urban birth rate is the urban total fertility rate (TFR), and not the share of women of reproductive age (SWRA) (15-49 years) in the urban population in 2000. Column (1): The urban birth rate is explained by the product of the two other variables. Column (2): The product is mostly explained by the urban total fertility rate: e.g., a 1 standard deviation in the urban TFR (SWRA) is associated with a 1.12 (0.28) standard deviation in the product.** The sample consists of 89 countries that were still developing countries in 1960, for the closest year to 2000, in the 1990-2010 interval. Robust standard errors in parentheses; * p<0.10, ** p<0.05, *** p<0.01. In column (1), we regress the urban birth rate (per 100 people) on the urban total fertility rate (the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates), the share of women of reproductive age (15-49 years) in the urban population in 2000, and their product, in 2000. In column (2), we regress the product on the urban total fertility rate and share of women of reproductive age in the urban population. See Web Appendix for data sources and construction of variables.

WEB APPENDIX TABLE 5: ALTERNATIVE IDENTIFICATION STRATEGIES, 1960-2010

Dependent Variable:	Annual Urban Growth Rate (%, Decade t)			Change in the Urbanization Rate (Percentage Points, Decade t)		
	IV-Shares Religions & Family Planning	*IV-Family Planning*	*IV-Shares Religions*	*IV-Shares Religions & Family Planning*	*IV-Family Planning*	*IV-Shares Religions*
	(1)	(2)	(3)	(4)	(5)	(6)
Urban Natural Increase Rate	0.87**	1.13**	0.73**	2.13***	1.82[†]	2.32***
(Per 100 People, Decade t)	(0.42)	(0.50)	(0.35)	(0.70)	(1.14)	(0.84)
Residual Migration Rate				2.14***	2.11***	2.12***
(Per 100 People, Decade t)				(0.27)	(0.27)	(0.27)
Rural Natural Increase Rate	-0.13	-0.13	-0.02	-1.28***	-1.03*	-1.35***
(Per 100 People, Decade t)	(0.25)	(0.31)	(0.23)	(0.44)	(0.57)	(0.46)
Kleibergen-Paap rk Wald F stat	37.6	10.3	99.9	25.0	8.1	177.8
Country & Decade FE, Controls	Y	Y	Y	Y	Y	Y
Region FE (10) x Time Trend	Y	Y	Y	Y	Y	Y
Observations (35 x 5)	175	175	175	175	175	175
Adj./Centered R-squared	0.84	0.84	0.84	0.80	0.793	0.80

***Notes*: This table shows that the IV results are in line with the OLS results when using as instruments (while simultaneously controlling for rural natural increase in *t*): Columns (1) and (4): The initial religious conditions and the initial family planning conditions for each country in the 1960s, interacted with decade FE (to allow them to have an effect on the country-specific evolutions of urban fertility, and thus urban natural increase). Columns (2) and (5): The initial family planning conditions in the 1960s, interacted with decade FE. Columns (3) and (6): The initial religious conditions in the 1960s, interacted with decade FE.** The sample is the same as in Table 1. Robust SEs clustered at the country level in parentheses; † p<0.11 * p<0.10, ** p<0.05, *** p<0.01. The initial religious conditions are the population shares of 8 religions = [Catholicism, Protestantism, Other Christian Religions, Islam, Hinduism, Buddhism, Other Eastern Religions, Other Religions] in the 1960s. The initial family planning conditions are 4 dummies equal to one if the country had 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. In columns (1)-(3), we add the urbanization rate at the start of the decade. See Web Appendix for data sources.

WEB APPENDIX TABLE 6: URBAN BIRTH RATES, POPULATION SHARES OF MAJOR RELIGIONS AND FAMILY PLANNING EFFORT IN THE 1960s

Dependent Variable:	Urban Birth Rate (%, 1960s)	
	(1)	(2)
Catholicism (% of Population, 1960s)	2.71**	
	(1.28)	
Islam (% of Population, 1960s)	2.56**	
	(1.17)	
Protestantism (% of Population, 1960s)	4.15	
	(2.51)	
Other Christian Religions (% of Population, 1960s)	2.38	
	(1.54)	
Hinduism (% of Population, 1960s)	1.11	
	(1.33)	
Buddhism (% of Population, 1960s)	1.06	
	(1.21)	
Other Eastern Religions (% of Population, 1960s)	0.59	
	(2.08)	
Other Religions (% of Population, 1960s)	3.15**	
	(1.36)	
Strong Family Planning Effort (1960s)		-1.71***
		(0.50)
Moderate Family Planning Effort (1960s)		-1.22***
		(0.30)
Weak Family Planning Effort (1960s)		-0.79***
		(0.28)
Log GDP Per Capita	-0.46**	-0.07
(constant 2005 international $, 1960)	(0.21)	(0.15)
Fixed Effects, Controls	N	N
Observations; R-squared	35; 0.62	35; 0.48

***Notes*: This table shows the strong correlations between the initial urban birth rate (1960s) and the initial cultural/religious and policy environments (proxied by measures in the 1960s), conditional on income per capita (1960). Column (1): Catholic and Muslim countries started with higher urban birth rates. No significant difference is found for other religions. Column (2): The countries that have "idiosyncratically" adopted family planning policies in the 1960s had lower urban births rates then. In Web Appendix Table 5, we interact these initial conditions with year FE to allow them to have an effect on the country-specific evolutions of urban fertility.** The sample consists of 35 countries that were still developing countries in 1960. Robust SEs in parentheses; * p<0.10, ** p<0.05, *** p<0.01. Column (1): The population share of the irreligious residents (%) is the omitted variable. Column (2): Ross and Maudlin (1996) use their Family Planning Effort (FPE) index to define 4 categories of family planing policies in the 1960s: *very weak* ($0 < \text{FPE} \leq 20$), *weak* ($20 < \text{FPE} \leq 45$), *moderate* ($45 < \text{FPE} \leq 66$) and *strong* ($66 < \text{FPE} \leq 100$). The countries with *very weak* family planning are the omitted group. See Web Appendix for data sources.

WEB APPENDIX TABLE 7: FAMILY PLANNING, RELIGION AND URBAN GROWTH, 1950s-60s

Dependent Variable:	Dummy for Moderate or Strong Family Planning Effort (1960s)		Population Share (%) of Catholics and Muslims (1960s)	
	(1)	(2)	(3)	(4)
Annual Urban Growth Rate	-0.06	0.01	0.01	0.01
(%, 1950s)	(0.05)	(0.07)	(0.03)	(0.06)
Annual Urban Growth Rate		-0.10		0.00
(%, 1960s)		(0.09)		(0.06)
Log GDP Per Capita	0.13	0.12	0.22***	0.22***
(cst. 2005 international $, 1960)	(0.09)	(0.09)	(0.07)	(0.07)
Fixed Effects, Controls	N	N	N	N
Observations; R-squared	35; 0.08	35; 0.13	35; 0.27	35; 0.27

***Notes*: This table shows that the probability of adopting a strong or moderate family planning policy in the 1960s and the total population share (%) of catholicism and islam in the 1960s are independent of the urban growth rate in the 1950s (and the 1960s) conditional on per capita income in 1960.** The sample consists of 35 countries that were still developing countries in 1960. Robust SEs in parentheses; * p<0.10, ** p<0.05, *** p<0.01. See Web Appendix for data sources.

WEB APPENDIX TABLE 8: AUTOREGRESSIVE DISTRIBUTED LAG (ADL) MODEL (SECOND LAGS ONLY), 1960-2010

Dependent Variable:	Annual Urban Growth Rate (%, Decade *t*)	Change in the Urbanization Rate (Percentage Points, Decade *t*)
	(1)	(2)
Urban Natural Increase Rate	0.92***	2.47**
(Per 100 People, Decade *t*)	(0.41)	(1.10)
Residual Migration Rate		3.06***
(Per 100 People, Decade *t*)		(0.57)
Rural Natural Increase Rate	0.12	-1.81**
(Per 100 People, Decade *t*)	(0.30)	(0.88)
Urban Natural Increase Rate	0.63	-0.89
(Per 100 People, Decade *t*-2)	(0.40)	(0.91)
Residual Migration Rate		1.20**
(Per 100 People, Decade *t*-2)		(0.54)
Rural Natural Increase Rate	0.04	0.93
(Per 100 People, Decade *t*-2)	(0.30)	(0.80)
Annual Urban Growth Rate	-0.28**	
(Per 100 People, Decade *t*-2)	(0.12)	
Change in Urbanization Rate		-0.30
(Percentage Points, Decade *t*-2)		(0.20)
Estimated Long-Term Effect of	1.21**	1.21
Urban Natural Increase Rate	(0.57)	(1.12)
AIC; BIC	146.4; 212.7	332.6; 404.2
Country & Decade FE, Controls	Y	Y
Region FE (10) x Time Trend	Y	Y
Observations (35 x 3); Adj. R2	105; 0.84	175; 0.83

***Notes*: This table shows the coefficients of each variable of interest and its second lag, as well as the coefficient of the second lag of the dependent variable, when using the ADL(2,2) model. It also shows the estimated long-term effect of urban natural increase, which is a non-linear combination of some of the coefficients.** The sample is the same as in Tables 1 and 2. Robust SEs clustered at the country level in parentheses; † p<0.11 * p<0.10, ** p<0.05, *** p<0.01. 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 main text). In column (1), we add the urbanization rate at the start of the decade. See Web Appendix for data sources.

WEB APPENDIX TABLE 9: URBAN BIRTH RATES AND GROWTH RATE OF THE LARGEST CITY, MULTIVARIATE CROSS-SECTIONAL ANALYSIS, 1960-2010

Dependent Variable:	Annual Urban Growth Rate of the Largest City (%, 1960-2010)
	(1)
Largest City's Birth Rate	1.17***
(Per 100 People, 1960-2010)	(0.34)
F-test [p-value]: Largest City's Birth Rate - 1 = 0	0.26 [0.61]
Controls, Region FE (13)	Y
Observations; R-squared	94; 0.72

***Notes*: This table shows that the largest city's birth rate has an effect of about 1 on the growth of that city (we use the birth rate in 2000 as a proxy for the urban birth rate in 1960-2010). We cannot control for the city death rate as we do not have data.** The sample consists of 94 countries that were still developing countries in 1960. Robust standard errors in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The controls are listed in the main text. The dependent variable is the annual growth rate (%) of the largest city between 1960 and 2010. The F-test tests if the coefficient of the variable of interest is different from 1 (in absolute value). See Web Appendix for data sources.

WEB APPENDIX TABLE 10: NATURAL INCREASE AND URBAN PRIMACY, 1960-2010

Dependent Variable:	Change in the Primacy Rate (Pct. Points, Decade *t*)	
	(1)	(2)
Urban Natural Increase Rate	-0.42	-0.35
(Per 100 People, Decade *t*)	(0.80)	(0.84)
Country & Decade FE, Controls, Region FE (10) x Time Trend	Y	Y
Primacy Rate (%) 1960 x Decade FE	N	Y
Observations; Adj. R-squared	175; 0.59	175; 0.60

***Notes*: This table shows that urban natural increase has no effect on the urban primacy rate, the share of the largest city in the urban population, when estimating the panel model for 35 developing countries in 1960-2010.** The sample consists of 35 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; * p<0.10, ** p<0.05, *** p<0.01. The specification is the same as in row 2 of Table 1. The controls are listed in the main text. Column (2): The results are robust to controlling for the initial urban primacy rate (%) in 1960 interacted with decade FE. See Web Appendix for data sources.

WEB APPENDIX TABLE 11: NATURAL INCREASE AND URBANIZATION, 1960-2010

Dependent Variable:	Change in the Urbanization Rate (Pct. Points, Decade *t*)
	(1)
Residual Migration Rate	1.58***
(Per 100 People, Decade *t*)	(0.58)
Urban Natural Increase Rate	2.14***
(Per 100 People, Decade *t*)	(0.30)
Country & Decade FE; Controls; Region FE x *t*; Rni_t	Y
Urbanization Rate (%) 1960 x Decade FE	Y
Observations; Adj. R-squared	175; 0.71

***Notes*: This table shows that the effects are robust to controlling for the initial urbanization rate in 1960 interacted with decade fixed effects.** The sample consists of 35 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; * p<0.10, ** p<0.05, *** p<0.01. The specification is the same as in row 2 of Table 3. The controls are listed in the main text. See Web Appendix for data sources.

WEB APPENDIX TABLE 12: URBAN NATURAL INCREASE AND SLUMS, 1960-2010

Dependent Variable:	Urban Population Living in Slums (%, 2005-2010)		
	(1)	(2)-*OLS*	(3)-*IV*
Change in Urbanization Rate	0.58	0.36	0.03
(Pct. Points, 1960-2010)	(0.97)	(1.25)	(1.13)
No. Years for Urban Pop. x2	-0.60***		
(Average, 1960-2010)	(0.18)		
No. Years for Urban Pop. x2	-0.66**		
* Dummy (No. Years < Sample Mean)	(0.31)		
Urban Natural Increase		14.51***	21.60***
(%, (4)-(5): 1960-2010)		(5.16)	(6.91)
Residual Migration		4.60*	5.28**
(%, (4)-(5): 1960-2010)		(2.66)	(2.25)
Controls, Region FE (10	Y	Y	Y
Observations; Adj. R-squared	95; 0.80	94; 0.80	95;0.79

***Notes*: This table shows that: (1) the slum share increases convexely with the speed of urban growth, and (2)-(3) urban natural increase in 1960-2010 still has an effect on the slum share when using as instruments for urban natural increase the initial religious and family planning conditions in the 1960s.** The sample consists of 95 countries that were still developing countries in 1960. Robust SEs; * 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 2000. All regressions include log GDP per capita (PPP, cst 2005$) and the urbanization rate (%) in 1960 and 2010, region FE, and the controls. Column (1): 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 (3): We instrument urban natural increase with the initial religious and family planning conditions in the 1960s (IV F-statistic: 5.4). See Web Appendix for data sources.

WEB APPENDIX TABLE 13: URBAN NATURAL INCREASE, RURAL GROWTH AND URBAN CONGESTION, 1960-2010

Dependent Variable (Urban, 2000-2010):	Lack Liv. Area (%) (1)	Finished Floor (%) (2)	Water Source (%) (3)	Sanitation Facilities (%) (4)
Urban Natural Increase	8.9*	-8.4	-3.2	-1.4
(%, 1960-2010)	(4.4)	(5.9)	(2.0)	(3.2)
Residual Migration	3.2	-3.0	-1.9	-2.0
(%, 1960-2010)	(2.5)	(3.7)	(1.2)	(1.9)
Annual Rural Growth Rate	-0.1	-0.2	-0.8	1.0
(%, 1960-2010)	(0.2)	(4.4)	(1.8)	(2.7)
Observations; Sample Mean	57; 18.8	66; 77.9	92; 88.5	92; 65.1
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	19.5**	-11.0***	14.3	4.1**
(%, 1960-2010)	(8.4)	(4.0)	(11.1)	(1.9)
Residual Migration	5.7	-2.4	-2.0	1.0
(%, 1960-2010)	(6.0)	(2.8)	(6.2)	(1.0)
Annual Rural Growth Rate	-8.1	0.3	6.1	0.1
(%, 1960-2010)	(5.2)	(2.9)	(9.5)	(0.1)
Observations; Sample Mean	78; 71.1	65; 79.8	93; 71.3	72; 5.5
Specification Col.(1) Table 4	Y	Y	Y	Y

***Notes*: This table confirms that fast urban natural increase in 1960-2010 is associated with higher urban congestion in 2000-2010, even when we control for the speed of rural growth in 1960-2010. The speed of rural growth has no effect on urban congestion.** 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. We also control for the annual rural growth 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.

WEB APPENDIX TABLE 14: URBAN NATURAL INCREASE, RURAL GROWTH 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	9.7***	-2.8***	6.9**
(%, 1960-2010)	(2.8)	(0.6)	(2.8)
Residual Migration	0.5	-1.18***	-0.6
(%, 1960-2010)	(1.2)	(0.28)	(1.2)
Annual Rural Growth Rate	-0.2*	0.01	-0.2
(%, 1960-2010)	(0.1)	(0.1)	(0.1)
Observations; Sample Mean	88; 57.2	88; 7.2	88; 64.4
Specification Col.(1) Table 4	Y	Y	Y

***Notes*: This table confirms that fast urban natural increase in 1960-2010 is associated with higher urban dependency ratios in 2000-2010, even when we control for the speed of rural growth in 1960-2010. The speed of rural growth has no, or little, effect on the urban dependency ratios.** 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. We also control for the annual rural growth 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 0-14 or 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.

WEB APPENDIX TABLE 15: RURAL NATURAL INCREASE, URBAN GROWTH AND RURAL CONGESTION, 1960-2010

Dependent Variable (Rural, 2000-2010):	Living Area (%) (1)	Finished Floor (%) (2)	Water Source (%) (3)	Sanitation Facilities (%) (4)
Rural Natural Increase	_	-11.1*	-7.3*	-11.3**
(%, 1960-2010)	_	(6.4)	(3.7)	(4.3)
Residual Rural Outmigration	_	-6.3	-4.4	-6.0
(%, 1960-2010)	_	(5.9)	(3.0)	(3.6)
Annual Urban Growth Rate	_	-4.4	0.9	0.2
(%, 1960-2010)	_	(4.0)	(2.2)	(2.3)
Observations	_	66; 37.4	92; 65.5	92; 42.2
Dependent Variable (Rural, 2000-2010):	**Solid Fuels (%) (5)**	**School Attend. (6-15 y.o., %) (6)**	**PM10 (mg per m^3) (7)**	**Empl. Share Pers. Serv. (%) (8)**
Rural Natural Increase	15.5***	-11.2**	_	_
(%, 1960-2010)	(3.9)	(5.0)	_	_
Residual Rural Outmigration	10.8**	-4.2	_	_
(%, 1960-2010)	(4.4)	(4.7)	_	_
Annual Urban Growth Rate	-2.4	1.4	_	_
(%, 1960-2010)	(2.9)	(3.9)	_	_
Observations; Sample Mean	78; 71.1	65; 66.2	_	_
Specification Col.(1) Table 4	Y	Y	Y	Y

***Notes*: This table shows that fast rural natural increase in 1960-2010 is associated with higher rural congestion in 2000-2010. The speed of urban growth in 1960-2010 has no effect on rural congestion today.** The sample consists of 92 countries that were still developing countries in 1960. Robust SEs in parentheses; * p<0.10, ** p<0.05, *** p<0.01. Rural natural increase in 2000 is used as a proxy for rural natural increase in 1960-2010. The rural outmigration rate in 1960-2010 is the residual between the rural natural increase rate and the annual rural growth rate in 1960-2010. We also control for the annual urban growth rate in 1960-2010. Column (1): No data exists on the share of rural inh. who lack sufficient-living area (%) today. Column (2): The dependent variable is the share of rural inh. who live in a residence with a finished floor (%) in 2005. Columns (3)-(4): It is the share of rural inh. who have access to an improved water source and improved sanitation facilities in 2005 respectively (%). Column (5): It is the share of rural inh. using solid fuels (%) in 2000-2010. Column (6): It is the rural share of 6-15 year-old children that attend school (%) in 2000-2010. Column (7): No data exists on particulate matter (PM) concentrations in rural areas today. Column (8): We cannot use the "personal and other services" sector as a rural refugee sector. 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.

WEB APPENDIX TABLE 16: RURAL NATURAL INCREASE, URBAN GROWTH AND RURAL DEPENDENCY RATIOS, 1960-2010

Dependent Variable (Rural, 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)
Rural Natural Increase	14.6***	-1.3	13.4***
(%, 1960-2010)	(3.8)	(0.8)	(4.0)
Residual Rural Outmigration	6.2*	-0.8	5.4
(%, 1960-2010)	(3.1)	(0.8)	(3.3)
Annual Urban Growth Rate	-0.3	-1.2**	-1.5
(%, 1960-2010)	(2.1)	(0.6)	(2.3)
Observations; Sample Mean	70; 88.2	70; 9.8	70; 98.0
Specification Col.(1) Table 4	Y	Y	Y

***Notes*: This table shows that fast rural natural increase in 1960-2010 is associated with higher rural dependency ratios in 2000-2010. The speed of urban growth in 1960-2010 has no, or little, effect on the rural dependency ratios today.** The sample consists of 70 countries that were still developing countries in 1960. Robust SEs in parentheses; * p<0.10, ** p<0.05, *** p<0.01. Rural natural increase in 2000 is used as a proxy for rural natural increase in 1960-2010. The residual rural outmigration rate in 1960-2010 is the residual between the rural natural increase rate and the annual rural growth rate in 1960-2010. We also control for the annual urban growth rate in 1960-2010. Column (1): The dependent variable is the ratio of the number of rural inh. aged 0-14 over the number of rural inh. aged 15-64. Column (2): It is the ratio of the number of rural inh. aged 0-14 or 65-120 over the number of rural inh. aged 15-64. Column (3): It is the ratio of the number of rural inh. aged 0-14 or 65-120 over the number of rural 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.