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Determinants of Urbanization

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Determinants of Urbanization

Abstract

In light of the United Nations' (UN) latest urbanization projections, particularly with respect to India and the People's Republic of China, a good understanding is needed of what drives aggregate urbanization trends. Yet, previous literature has largely neglected the issue in favor of studying urban concentration. Taking advantage of the latest UN World Urbanization Prospects, we use an instrumental variables approach to identify and analyze key urbanization determinants. We estimate the impact of gross domestic product (GDP) growth on urbanization to be large and positive. In answer to Henderson's (2003) finding that urbanization does not seem to cause growth, we argue that the direction of causality runs from growth to urbanization. We also find positive and significant effects of industrialization and education on urbanization, consistent with the existence of localization economies and labor market pooling.

Keywords: urbanization, economic growth, education, industrialization
JEL classification: R11, O18

I Introduction

The purpose of this paper is to identify and analyze determinants of the urbanization rate, an issue which has so far received limited attention in the academic literature. Ongoing and future urbanization, particularly in Asia and Africa, presents both opportunities and challenges for many, and a good understanding of the determinants of urbanization is crucial for development planning, business strategy setting, and even allocation of aid flows.

Previous literature has prioritized urban concentration, i.e., the degree to which a country's urban population is concentrated in one or two major cities (such as in Cambodia, Mongolia, or Japan), rather than spread over many smaller cities (such as in India and the People's Republic of China (PRC)). Labelling urbanization a "transitory phenomenon," Henderson (2005) argues that the priority given to urban concentration is "arguably appropriate." Indeed, Figure 1 illustrates that developed countries as well as former Eastern European Socialist countries seem to have converged to a steady state level of urbanization around 1980, with little change over the last 30 years. However, the figure also illustrates a historical gap between the developed world, Latin America, and former Soviet countries on one side, and Asia and Africa on the other. Asia and Africa persistently lag behind, but have started to catch up.[1] In light of the United Nations' (UN's) urbanization projections for the upcoming decades, particularly with respect to the PRC and India, urbanization will continue to be high up on the policy agenda of developing countries for substantial time to come. While it may be a transitory phenomenon, it is an ongoing and essential part of economic development, and as such an interesting subject for academic research.

Looking at the data, the past 50 years have seen a surge in the urban population of many countries around the world, with little indication of slowing down in the near future. The latest revision of the UN World Urbanization Prospects (2011)[2] predicts the world's urban population to increase by 1.4 billion between 2010 and 2030, implying that close to 60% of the world's population (currently 50%) will live in cities by 2030. The PRC alone (which accounts for 270 million of the predicted increase) will have 221 cities with a population of one million or more – compared with 35 such cities in Europe today.[3] In addition to the size of current urbanization trends, the speed with which metropolitan areas attract rural residents is unprecedented: A comparison of the time that it took large cities to grow from 1 million to 8 million inhabitants yields a period of 130 years for London, 45 years for Bangkok, 37 years for Dhaka, and 25 years for Seoul.[4] This rural–urban migration has wide-ranging implications along many dimensions, most notably economic performance and efficiency, environment

[1] Note that there is substantial within-continent heterogeneity, such as between North Africa and Sub-Saharan Africa, or between South Asia and West Asia/the Middle East. One implication is that the large urbanization surges experienced by individual countries (like the PRC or Brazil) may be diluted in the figure due to continent aggregation.

[2] United Nations (2011).

[3] McKinsey Global Institute (2009).

[4] Asian Development Bank (2008).

and infrastructure, as well as education and health.

An immediate question to ask is why cities develop and exist. Why is it such an "economic law" that countries urbanize as they develop? The standard answer suggested by an extensive body of research is that economic development involves the structural transformation from an agricultural-based economy to an industry service-based economy.[5] Industrialization in turn is believed to involve urbanization, as externalities of scale in manufacturing and services attract firms and workers into the cities.[6] The literature on scale externalities and knowledge spillovers is enormous, and has served as a basis to explaining the forces of agglomeration that are central to the study of urbanization. The idea of scale externalities goes back to Marshall (1890), who suggested that firms' production costs decrease with the size of their own industry, e.g., through better local infrastructure and within-industry knowledge spillovers. The subsequent literature distinguishes between such "localization economies" (scale externalities arising from the local concentration of economic activity within an industry, i.e., from local industry size) and "urbanization economies" – scale economies arising from the agglomeration (and possibly diversity) of economic activity per se, i.e., from city size. As suggested by Jacobs (1969), the latter may be relevant in particular for industries which rely heavily on R&D and marketing. Attempts to model the microfoundations of such externalities are numerous and include discussions on labor market pooling, input sharing, and knowledge spillovers.[7]

However, few studies focus on the occurrence of urbanization as such, despite a considerable literature on urban concentration, i.e., the geographical dispersion of a given urban population. Much of the theory literature has focused on equilibrium city sizes, and endogenized the trade-off between scale externalities in production versus rising costs of housing and congestion.[8] Zipf's Law has been promoted as an approximation to the equilibrium distribution of city sizes, whereas Gibrat's Law arguably provides insights into city growth processes.[9] Finally, an important strand in the literature are the so-termed core-periphery models, following the influential work of Krugman (1991) on spatial agglomerations. The core-periphery models examine the conditions under which manufacturing and population agglomerations concentrate in one region, rather than spreading over several regions.[10] However, both endogenous models of city sizes and core-periphery models provide few insights into what determines the total urban population of a country, independently of its distribution across cities. What causes people to relocate from rural areas to the cities in the first

[5] Henderson (2003).

[6] See e.g., Henderson (1974), Quigley (1998), and Duranton and Puga (2001).

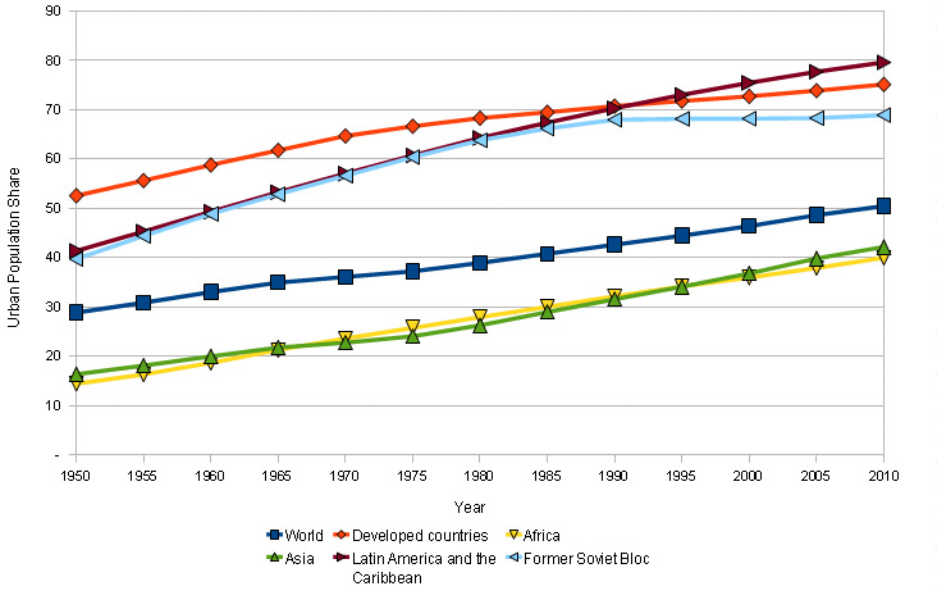
[7] See e.g., Rosenthal and Strange (2001) for an examination of the microfoundations of agglomeration economies for the United States (US) manufacturing industries.

[8] See e.g., Henderson (1974), as well as the core-periphery reversal in Helpman (1998) and Tabuchi (1998).

[9] Zipf's Law suggests that the equilibrium distribution of city sizes can be approximated by a pareto distribution, such that city rank multiplied by city size is a constant. Gibrat's Law alleges that a city's growth rate is independent of city size. For a study on empirical validation, see Ioannides and Overman (2003) or Black and Henderson (2003).

[10] For a review of core-periphery models, see Henderson (2003).

Figure 1: Urban Population Shares by Region, 1950–2010
Source: Own.



place? Is there a causal effect of economic growth on urbanization? Or does urbanization cause growth? Which role do other factors play in determining a country's aggregate rate of urbanization? Given that the rural population is usually held constant in such models, the implications which can be derived on the urbanization process per se are limited.

This paper presents new evidence on the determinants of urbanization using the latest revision of the UN World Urbanization Prospects. Evidence suggests that countries at the same level of development (as measured by per capita GDP) differ widely in terms of both urbanization level and urbanization speed. A simple one-to-one mapping of economic development to urbanization rate is thus not appropriate. Taking advantage of a new dataset which covers more countries over a longer time horizon than data available in the past, our regressions are run on a global panel covering the period from 1960 to 2010 in 5-year intervals. An instrumental variables (IV) approach is employed to identify, as well as attempt to quantify, the effect of key drivers of urbanization. Particular consideration is given to GDP growth, education, and industrialization. In addition, we include and review a comprehensive set of controls, including trade, infrastructure, and political factors. Results can be used to infer how much of empirically observed urbanization rates is associated with these key drivers, and provide a first indication regarding which part of urbanization may be due to

country-specific factors (such as the Hukou system in the PRC).[11]

Our country-level panel data approach constitutes a departure from the often more micro-level studies on the determinants of agglomeration economies.[12] It also departs from empirical studies on urban concentration, which generally use data from cities or metropolitan areas, but do not include rural data. While it is certainly useful to look at factors of urbanization at a micro-level, perhaps focusing on industry-specific scale externalities, a big picture is missing as to which factors drive aggregate urbanization trends. This paper attempts to provide this big picture, asking which factors cause population shifts from rural to urban areas. One advantage of this approach is that the results are more likely to incorporate general equilibrium effects, especially since our data runs in 5-year intervals. From a policy perspective, aggregate changes in urbanization in themselves are highly relevant to many policy debates, as currently in the case of the PRC with its wealth of "small" cities around 1 million in addition to several megacities, and the resulting policy implications for infrastructure and public services.

Our analysis finds that the well-known and large positive correlation of GDP level with urbanization rate (as measured by percentage of population living in urban areas) disappears as soon as we control for a range of other factors, such as education level, industrialization, and trade. This suggests that urbanization may be better explained with a country's development in a range of economic and human dimensions, rather than just with income per se. As expected, we find a negative conditional correlation of urbanization with GDP growth (faster growing countries are, as yet, less urbanized). However, our instrumental variables estimates suggest that the causal impact of GDP growth on urbanization may be large and positive. Given the inability of previous studies to find a significant effect of urbanization on growth, we argue that the direction of causality runs from GDP growth to urbanization, rather than vice versa. We also find positive and significant effects of industrialization as well as education on the urbanization rate, which is consistent with the existence of localization economies and labor market pooling. We conduct several robustness checks, and find that the effect of growth is somewhat sensitive to specification. In contrast, the effects of education and industrialization on urbanization are robust in both qualitative and quantitative terms.

The paper proceeds as follows: Section II reviews the related literature on determinants of urbanization. Section III outlines the empirical strategy, discusses the data, and presents regression results. Section IV concludes.

[11] The latter inference relies on the strong assumption that the drivers considered in our analysis are the only determinants which are relevant in a cross-country setting. This is unlikely, so inference about country-specific residuals can only constitute an upper bound.

[12] See the studies on agglomeration in the US and Brazil by Rosenthal and Strange (2001) and Michaels, Rauch, and Redding (2012).

II Related Literature

In spite of the substantial literature on scale externalities and spatial concentration, very few studies focus explicitly on the factors driving urbanization rates. Most research modeling urbanization as such takes as given an exogenous productivity gap between rural and urban areas, with migration limited by migration costs, exogenous skill acquisition, and inefficient labor allocation rules (such as minimum wages). These so-called dual economy models then study the effect of government policies (such as trade protection policies, migration restrictions, and infrastructure investments) on migration flows.[13] An immediate implication of this literature is that rural-urban dynamics are heavily influenced by government favouritism towards the urban sector (or in some cases of former planned economies, by a government bias towards rural areas).

An early empirical study on urbanization is Pandey (1977), who uses Indian state-level census data to regress urbanization rates on population density, industrialization (as measured by non-agricultural employment), cropping intensity (as a proxy for agricultural development), per worker income, literacy rate, and population growth. He finds a significant positive effect of industrialization, a negative effect of cropping intensity, and no effect of average worker income. As his estimates are based on a simple cross-section OLS, they do not permit causal inference due to endogeneity issues. Similar concerns apply to the study of Chang and Brada (2006), who run a pooled cross-section OLS of urbanization on per capita GDP and apply their results to the Chinese context. Moomaw and Shatter (1996) look at a wider range of determinants (such as per capita GDP, industrialization, export orientation, foreign assistance, and political factors), and study how their link with the urbanization rate compares to their link with metropolitan concentration (percentage of urban population in cities greater than 100,000) and with urban primacy (percentage of urban population in largest city). Given a limited dataset of 3 observations per country, they rely on a pooled cross-section approach with regional and time dummies, which also suffers from endogeneity concerns. A paper worth mentioning specifically with respect to the importance of knowledge accumulation in cities is Black and Henderson (1999), who find that individual city sizes in the US grow with human capital accumulation, as measured by the percentage of college educated workers in the labor force.

To the authors' knowledge, the only paper which attempts to quantitatively examine the causal mechanisms relating urbanization and GDP growth via an IV/GMM approach is Henderson (2003). In a cross-country panel setting, he estimates the effect of both urbanization and urban concentration ("primacy") on productivity growth (growth of output per worker), using instrumental variables to deal with endogeneity. He finds a significant effect of urban concentration on productivity. His quadratic functional form specification allows him to calculate an "optimal" level of urban concentration, which turns out to decline with economic development (as measured by output per worker). More importantly for

[13] One of the most prominent models is Harris and Todaro (1970). Also see Renaud (1981). For a comprehensive review, see Henderson (2003).

our analysis, his study finds no significant causal effect of urbanization on per worker output. His results suggest that GDP growth is not strongly driven by urbanization rate per se. Considering a raw correlation of 0.85 between urbanization and GDP in his data, an obvious question to ask is whether the causality runs in the opposite direction, i.e., whether GDP growth causes urbanization. This is one of the questions that our paper sets out to answer.

III Estimation

III.A Empirical Model

The aim of our analysis is to quantify the relationship between urbanization and its key determinants. Given the focus of the theory literature on scale externalities, structural transformation and knowledge spillovers, we hypothesize these to be growth of per capita GDP, industrialization, and education. To establish basic conditional correlations, we start with a naïve OLS panel estimation of the equation

$$\begin{aligned} urban_{it} &= \alpha + \mu_i + \lambda_t + \beta_1 pcGDPgrowth_{it} + \beta_2 education_{it} + \beta_3 indus_{it} \\ &\quad + \beta_4 \ln pcGDP_{it} + \beta_5 popdensity_{it} + \beta_6 popgrowth_{it} + \beta_7 trade_{it} \\ &\quad + \beta_8 indus * trade_{it} + \beta_9 primacy_{it} + \beta_{10} democracy_{it} \\ &\quad + \beta_{11} instability_{it} + \beta_{12} roaddensity_{it} + \epsilon_{it} \end{aligned} \tag{1}$$

where $urban_{it}$ is the urbanization rate of country i in year t (defined by the share of total population living in urban areas), μ_{it} is a country fixed effect (for country-specific factors like geography and culture), λ_{it} is a year fixed effect (for country-invariant time shocks or trends), $education_{it}$ is measured in average years of schooling of the adult population, $indus_{it}$ is industrialization, measured as non-agricultural share of GDP, $popdensity_{it}$ is the population per square kilometer of land, $popgrowth_{it}$ is the average annual rate of population growth (in 5-year growth averages), and $trade_{it}$ is the volume of exports plus imports as a percentage of GDP. The interaction $indus * trade_{it}$ serves as a proxy for manufactured exports rather than agricultural exports. $Primacy_{it}$ is a measure of urban concentration (population of the largest city as a percentage of the total urban population). $Democracy_{it}$ is an index for democratic systems (it is the polity2 indicator from Polity IV), which takes on values between +10 (for a fully democratic system) and –10 (for a fully autocratic one). $Instability_{it}$ is a self-constructed dummy for times of political instability, which switches on if there has been a regime change in the last 5 years (where a regime change is defined as a change of three or more points in the democracy index). Finally, $roaddensity_{it}$ (km of roads per square km of land area) is used as a proxy for infrastructure. The results of the OLS estimation are in Table 1. Econometric issues with this specification are discussed below, and Section III.C presents an instrumental variables regression as well as an estimation in first differences.

Discussion of Regressors

The choice of controls in equation 1 is based on the literature. Per capita GDP has been included in logs rather than in levels, as our data show a clear log-linear relationship between GDP and urbanization rate (see Figure 2). Moomaw and Shatter (1996) suggest that the effect of economic development (as proxied by GDP) on urbanization rates may work through two main channels: Economic development is associated with increasing market size, which leads to more specialization and division of labor. More specialization (as opposed to a subsistence economy) places greater importance on transport costs, as firms rely on inputs from external sources, and distribute their output more widely. Thus, economic activity may agglomerate in urban areas to minimize cost of transportation. The second channel works through industrialization: Economic development usually entails changes in aggregate demand patterns, with the structure of the economy shifting from agriculture towards industry and services. Given that both localization economies and agglomeration economies (as defined in Section I) are more likely to cause cost advantages in manufactured products than in agricultural goods, structural change may drive urbanization. Note that these two channels can work independently of each other – Increased division of labor within sectors may lead to higher urbanization even when sectoral composition is held constant. Likewise, industrialization (i.e., a change in the sectoral structure of the economy) may occur without an increase of per capita output. To keep these two influences apart, we account for economic development (as measured by per capita GDP) and industrialization (as measured by non-agricultural share of GDP) separately.

The impact of education on urbanization is likely related to knowledge spillovers: Within-industry spillover effects are a major source of agglomeration, particularly when the level of technological sophistication is high. The existence of high-tech industries presumes an educated workforce. As a result, education and technological sophistication may be complementary in driving urbanization. More generally, knowledge spillovers increase the returns to private human capital,[14] leading competitive firms to pay higher wages to city workers. For instance, Rauch (1993) shows that, controlling for individual education level, a higher local average education level in US cities translates into higher individual earnings. A similar argument can be made for labor market pooling – economies of scale from labor market pooling are likely to be strong when the workforce is highly skilled and specialized. Finally, education may be a driver of urbanization in its own right if it changes individuals' preferences towards urban environments.

While we focus on the impact of GDP growth, industrialization and education, we also control for the degree of trade openness (sum of exports and imports as a share of GDP). Trade has been thought to increase urbanization via at least two channels: First, trade increases the importance of transporta-

[14] See Black and Henderson (1999), who examine the effect of education level on city size in the US empirically. See Lucas (1988) for a discussion of knowledge spillovers, and Henderson (1988) for the effect of education on urbanization.

Figure 2: Urbanization and per capita GDP
(Graph restricted to countries with population > 1 million)
Source: Own.

tion hubs, which are usually located in urban environments. Second, the setup and maintenance of trade connections often requires higher levels of marketing and financing compared to domestic sales.[15] Both channels imply that trade may increase the share of economic activity in urban areas. Nevertheless, Elizondo and Krugman (1996) argue that the sign of the trade coefficient should be negative for developing countries, as "the giant Third World metropolis is an unintended by-product of import-substitution policies, and will tend to shrink as developing countries liberalize."[16] Their story is that strong backward and forward linkages in a closed economy lead to excessive city size – in other words, the presence of trade barriers limits firms to the domestic market, and the concentration of demand and inputs in the capital city makes it profitable for new firms to locate there as well. This process reinforces itself, leading to excessive urban concentration (and possibly urbanization). It is reversed with trade liberalization. Therefore, the sign of the trade coefficient in the urbanization equation is ex ante ambiguous.

Two political factors have been included in the regression – an index of democracy, and a measure of political instability. Both have received attention in the literature to some extent, even though the focus has been more on their impact on urban primacy than on urbanization. The intuition is straightforward: In autocratic regimes, power is generally concentrated in the capital city.

[15] See Moomaw and Shatter (1996).
[16] Elizondo and Krugman (1996), Abstract.

Political representation and access to power of the rural population are virtually nonexistent. Autocratic governments are able to make decisions without consideration of a spatially dispersed wider population. Instead, they rely on the support of small wealthy elites to stay in power. As a consequence, they will tend to strongly favour urban elites in the allocation of public resources. Such urban favouritism has implications both for consumption of public goods (e.g., health and education services) as well as for investment and economic growth (rural areas will receive less investment in infrastructure, which further deters private capital flows and impedes economic growth of these regions).[17] As a result, autocratic regimes create strong incentives to migrate to urban areas. A necessary reservation for autocracies is that the political agenda in former socialist economies may have a rural focus rather than an urban one. Given that these regimes are just as likely to rely on the support of small elites, however, it is not clear whether this will translate into a de facto rural bias. In contrast, democracy grants higher political representation to dispersed rural majorities, thus reducing migration incentives. While the quantitative impact of democracy on urbanization is unknown, Davis and Henderson (2003) find the effect of democracy on urban concentration to be significant and positive.

Independent of the form of government, political instability in itself can cause urbanization. As a regime struggles to stay in power, organized popular resistance in the cities where the ruling elite is located poses a more serious threat than a disorganized and geographically dispersed rural population. As a consequence, the regime is more likely to give in to the demands of the urban population, and divert resources to content the urban population through consumption subsidies, protection from high taxes and the like.[18] Cities may also provide higher safety levels than rural areas in times of political conflict. All of these factors increase the relative attractiveness of living in a city.

The importance of urban concentration, as often measured by primacy (share of urban population living in the largest city) has been widely recognized in the literature, as illustrated in Section I.[19] We control for it in our regression of urbanization to allow for the possibility that a higher concentration of population in a country's largest city is also associated with a higher urbanization rate overall. A measure of population density is included to account for countries with a small area of land relative to their population size, which neccesarily leads to more urban agglomeration. Population growth can affect urbanization either directly (via differential growth in urban vs. rural areas), or through an effect on migration. For instance, high rural population growth in areas of subsistence agriculture may trigger grown-up children to move to the cities as family sizes outgrow the economic possibilities of the farm.

Finally, we expect infrastructure to play a significant role in urbanization. Better infrastructure is associated with lower transport costs, which in turn reduces incentives to locate economic activity in overcrowded cities where land

[17] See e.g., the discussion of political factors by Petrakos and Brada (1989).

[18] Petrakos and Brada (1989) provide a more detailed explanation of urbanization forces during times of political instability, including possible effects on investment levels.

[19] See Henderson (2003) as a main reference for the discussion on urban primacy.

prices are high. In contrast, lack of infrastructure gives firms no choice but to locate close to their input markets and consumers, which fuels agglomeration. The role of infrastructure has been prominently featured in the core-periphery literature: Core-periphery models following Krugman (1991) examine what happens to urban concentration in core regions and periphery regions in the presence of technological progress, where technological progress is often captured as a fall in transport costs.[20]

Econometric Issues

A number of econometric issues are evident with this specification. First, the regressors are unlikely to be exogenous to the error term due to reverse causality, third factor causation and omitted variable bias, all of which invalidate causal inference. For instance, a correlation between urbanization and education could be caused by any of the following: (i) education may cause urbanization, as a more educated population moves to the city to find jobs, (ii) urbanization may cause education, as education provision is generally higher in cities, so a larger urban population increases average education level, (iii) a third factor (like industrialization) drives both urbanization and education, as a higher level of industrialization creates high-skill job opportunities which attract workers to the cities and at the same time increases the returns to education. Similar arguments can be made for all other regressors. To deal with such endogeneity concerns, we proceed with an instrumental variables approach in Section III.C.

Second, standard linear regression assumes independently distributed errors across countries and time. More plausibly, errors will be clustered at country level. For instance, if a shock hits a country in one period, the impact of this shock will often last for several periods, leading to serial correlation in the error structure. To account for this, we cluster errors at country level, which means the estimation is robust to both heteroscedasticity and serial correlation of the error term. In addition, we allow for country fixed effects in order to deal with country heterogeneity in urbanization rates.

Third, the regression includes nonstationary variables. We would expect the time series on GDP, industrialization, trade, education, population density, primacy, democracy and infrastructure to be integrated of order 1, i.e., to have unit roots. While this constitutes a possible concern, our analysis uses a panel which is between 107 and 118 countries wide (depending on specification), and on average six observations (per country) long. This implies the variation which is used to estimate the coefficients of interest comes to a large extent from cross-country variation, rather than variation over time. Due to the relatively short time series component, for simplicity we stick to the strong assumption of stationarity. Note that clustering errors at country level accounts for strong serial correlation of the error term, which further mitigates nonstationarity concerns. Finally, we also provide an estimation in first differences, which estimates the change in urbanization rates as a function of changes in the explanatory variables.

[20] See Henderson (2005).

III.B Data

Our data comes from various sources. Our main source is the 2011 Revision of the UN World Urbanization Prospects, which provides estimates of urbanization rates for 229 countries from 1950 to 2010 in 5-year intervals (we exclude future projections into 2050 and truncate the data in 2010). Measurements of the urban population must be taken with care – What classifies as an "urban area" can vary on country level, with definitions corresponding to those used by national statistical offices when collecting census data. Such definitions may refer to threshold population levels in a settlement (typically 5,000 or 10,000), but the status of a city can also be assigned on administrative, legal or historical reasons. While the UN aims to ensure consistency and adjusts data in particular when census definitions change over time, we cannot rule out some degree of country heterogeneity in what constitutes an urban area.

Data on population growth (in 5-year annual growth averages) as well as on population density (population per square km) come from the UN World Population Prospects (2010 Revision). The data for GDP (in constant 2000 US dollars), agricultural share of GDP, trade (exports plus imports of goods and services as a share of GDP) and primacy (population in the largest city as a percentage of urban population) come from the World Development Indicators (Revisions of 2011 and 2012). The GDP growth variable is derived from GDP level data as a 5-year annual growth average. Industrialization is measured as non-agricultural share of GDP. Education, as measured by average years of total schooling of the adult (25+) population, is provided by Barro and Lee (forthcoming).

Our democracy index is the polity2 indicator from the Polity IV project,[21] which measures democratic and autocratic regime characteristics on a scale from +10 (full democracy) to –10 (full autocracy) for 164 countries. Our instability dummy is derived from Polity IV's "durable" index, and switches on whenever there was a regime change in the last 5 years (where a regime change is defined as a change of three or more points in the polity2 index). Lastly, our data on road density (km of road per square km of land area) is a compilation of the World Road Statistics from the International Road Federation.[22]

We focus our analysis on countries which are still in the process of urbanizing, rather than those who have reached a "steady state" urbanization rate. To do this, we exclude all country observations with an urbanization rate higher than 80%. This has the effect of excluding present-day observations of many developed countries, but it does include data from the less urbanized past of these countries. An additional effect is that city states like Singapore and Monaco are excluded from the analysis. We also restrict our dataset to countries with a total population larger than 1 million: Given the large number of tiny states (such as Faeroe Islands or American Samoa), failure to exclude small countries would imply that our results will be dominated by the experience of such small countries (out of 229 countries in the original UN dataset, 73 have a population

[21] See Marshall and Jaggers (2010).
[22] See International Road Federation (2010).

below 1 million).[23]

Since the resulting data set is unbalanced, we cannot rule out selection bias: Which data points are missing is not a random process, but in itself a function of multiple variables. As a rule, poor countries are more prone to data availability problems, especially in early years. This implies that our coefficient estimates might be driven by rich countries' experience. See Section III.D for robustness checks.

III.C Results

Basic OLS Results

The results of our basic OLS specification are in Table 1. The reported standard errors are robust to heteroscedasticity and account for country clusters, which includes serially correlated errors. Time effects λ_t have been included except in column (5). Testing for joint significance of the time dummies yields $F(9, 114) = 3.84$, with $p = 0.00$ for the null hypothesis of no time effects.

Clearly, time effects do need to stay in our regression. The case is even more obvious for country fixed effects μ_i (excluded in column (4)): An F-statistic of 6148 ($p = 0.00$) suggests that country-specific effects play a strong role in explaining a country's urbanization rate. Note that country fixed effects will also soak up the effect of factors that have not been included in the regression: If our regression does not include all factors determining urbanization (most likely), and the omitted factors are more present in some countries than in others (on a time average), then this will influence country fixed effects. The interpretation of country fixed effects is thus restricted to be the time-averaged part of a country's urbanization rate that cannot be associated with any of the regressors in our analysis. To mitigate country heterogeneity, we keep country fixed effects for the remainder of the analysis, and focus on columns (1) to (3).

Starting from a limited set of regressors and gradually adding in more controls, it is reassuring to see that the coefficients for GDP growth, education and industrialization stay roughly the same in sign and magnitude, even though $indus_{it}$ appears somewhat sensitive to specification. At the same time, they are the only coefficients which are consistently significant, no matter which combination of regressors we tried. In contrast, it seems unexpected that the large unconditional correlation of urbanization with per capita GDP (in our sample, $r_{u,\ln y} = 0.78$ for the log of per capita GDP, and $r_{u,y} = 0.56$ for the level of per capita GDP) vanishes completely as soon as we control for *either* education or industrialization. We do not find any conditional correlation of GDP with urbanization in any specification (the exception being the one without country fixed effects). While we cannot draw causal inference, it does suggest that urbanization may be associated less with income level per se, but more with the structure of the economy as well as other indicators of human development.

[23] Four observations are excluded as outliers because of extreme growth experiences: Liberia 1990–2000 (GDP declined by 90% between 1985–1995, then rose by 241% by 2000) and Tajikistan 1995 (GDP declined by 65% in 5 years).

Table 1: Basic OLS Results

Dependent Variable: urbanization rate (% of population living in cities)

	(1)	(2)	(3)	(4)	(5)
p.c. GDP growth	-11.23*	-11.57*	-13.85**	-52.93***	-23.00***
	(6.064)	(5.987)	(6.377)	(17.37)	(5.975)
Education (schooling)	1.650**	1.647**	1.472*	1.183**	2.360***
	(0.773)	(0.781)	(0.818)	(0.592)	(0.481)
Industrialization	0.0883*	0.145**	0.247***	0.490***	0.316***
	(0.0495)	(0.0644)	(0.0810)	(0.120)	(0.0870)
lnGDP	1.569	2.023	1.634	7.835***	2.505*
	(1.485)	(1.476)	(1.766)	(1.227)	(1.406)
Population density		-0.00742	-0.00731	-0.0224***	0.000457
		(0.0125)	(0.0191)	(0.00729)	(0.0168)
Population growth		-0.498	-0.673*	-0.647	-0.567
		(0.417)	(0.400)	(0.793)	(0.427)
Trade		0.103	0.179*	0.206	0.232**
		(0.0709)	(0.0929)	(0.159)	(0.0974)
Indus*trade		-0.00125	-0.00228*	-0.00304	-0.00283**
		(0.000919)	(0.00126)	(0.00188)	(0.00130)
Primacy			-0.188	-0.0635	-0.0560
			(0.141)	(0.0690)	(0.136)
Democracy			0.139*	-0.149	0.195**
			(0.0743)	(0.127)	(0.0821)
Instability			-0.146	2.361*	-0.396
			(0.398)	(1.262)	(0.468)
Road density			-0.350**	-0.946**	-0.205
			(0.170)	(0.398)	(0.160)
Constant	10.98	4.821	7.354	-53.03***	-6.354
	(10.88)	(10.97)	(15.39)	(9.026)	(12.46)
Country FE	YES	YES	YES	NO	YES
Time FE	YES	YES	YES	YES	NO
Clustered SE	YES	YES	YES	YES	YES
Observations	806	797	571	571	571
Countries	118	118	115	115	115
R^2 (within)	0.717	0.723	0.722		0.687
R^2 (full)	0.975	0.975	0.981	0.773	0.979

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Note: p.c. refers to per capita variables.

Source: Own.

Looking at the coefficients for growth, education and industrialization, we find a robust negative correlation of urbanization rate (a *level* variable) with per capita GDP *growth*. From column (3), a one percent increase in a country's per capita GDP growth rate in our data is associated with a roughly 0.14 percentage point lower urbanization rate (note growth is measured as a decimal while urban is in percentage points). This is not surprising: Countries which experienced high income growth in the past decades tend to be developing or middle-income countries. At the same time, developing and middle-income countries are typically at an earlier stage of the urbanization process. This serves as a prime example for the difference between correlation and causation. An IV approach will provide further insights.

The magnitude of the education coefficient is robust to the inclusion of control variables, time and country effects, and centers around 1.6. This suggests that an additional year of schooling in the adult population is associated with a 1.6 percentage point higher urbanization rate. Similarly, our estimates for industrialization (which generally feature the highest significance levels among all regressors) indicate that an additional percentage point in the share of non-agricultural GDP is associated with a roughly 0.25 percentage point higher urbanization rate. Both estimates are consistent with the notion that countries urbanize as a part of their development process, which goes alongside progress in a number of economic, social and human dimensions. We find some significance for other variables, such as population density, trade, democracy and road density. However, these are generally sensitive to specification.

IV Estimation

While the conditional correlations found in the previous section may provide interesting insights, causal inference is invalid due to possible endogeneity of the regressors. In other words, we expect all of the regressors from equation 1 to be correlated with the error term. For instance, we might think that factors like geography or rainfall impact both urbanization rate and GDP growth, biasing the GDP coefficient. An instrumental variables approach will help – but which instruments can be used? For GDP growth, we follow Henderson's (2003) approach in instrumenting current changes of variables with past levels of these variables, i.e., current growth of per capita GDP is instrumented with GDP(*t-2*) (note GDP(*t-1*) cannot be used as it enters GDP growth(t) by construction). Our first stages show that past income *levels* are a strong predictor of current *changes* in income. For education and industrialization, which are both level variables, we instrument with education(*t-2*) and industrialization(*t-2*). Only one third lag has strong predictive power, and is thus added to our set of instruments: education(*t-3*), which strongly predicts industrialization. We do not add third lags of GDP or industrialization, as they have little predictive power and come in patchy data quality, implying unneccessary loss of observations.

Past levels of these variables predict current levels, which qualifies them as *relevant* instruments in our regression. But do they satisfy the orthogonality criterion? Orthogonality requires $E[Z'\epsilon] = 0$, i.e., instruments must not be cor-

related with the error term (where Z is the matrix of instruments). For instance, conditional on the same level of industrialization today, a higher industrialization level in the past should not be able to predict a higher urbanization rate today. This may seem counterintuitive, as we may expect past levels of education and industrialization to belong in the urbanization equation themselves. Two points are worth noting: The first is that we are using 5-year data, which means we are instrumenting today's industrialization level with that of 10 years ago. The second is that adding country fixed effects (i.e., using the within estimator) effectively means that our dependent variable is $urban_{it} - \overline{urban_i}$, where $\overline{urban_i}$ is the time averaged urbanization of country i. So what we seek to explain are a country's deviations from its own time average. The question becomes: Does a shock to industrialization 10 years ago that may have caused urbanization to deviate from its trend at that time still have an effect on urbanization today, holding constant the level of *current* industrialization?[24] This question is much less obvious, and we look to the data to answer it. As a test of overidentifying restrictions, we regress the IV residuals in the 2SLS case on the full set of instruments, yielding a Sargan's statistic of 0.539 ($p = 0.46$), which supports the null hypothesis that our instruments are uncorrelated with the error term. A possible interpretation of this is that the urbanization process adjusts relatively fast to the current environment, and that the impact of past shocks diminishes quickly. We thus proceed with an IV estimation of

$$urban_{it} = \alpha + \mu_i + \lambda_t + \beta_1 pcGDPgrowth_{it} + \beta_2 education_{it} + \beta_3 indus_{it} + \epsilon_{it} \quad (2)$$

We focus on these key regressors for the sake of parsimonious modeling – with all control variables being potentially endogenous, we would have to instrument all of them. Note that we also eliminate GDP level as a regressor, and choose to focus on GDP growth instead.

Our IV first stages are strong: GDP growth is strongly predicted by GDP(*t-2*) and industrialization(*t-2*), but not by lags of education. Education is predicted by education(*t-2*). Both GDP growth and education have strong time effects. Industrialization is predicted by education(*t-3*) (but not by education(*t-2*)) and industrialization(*t-2*). The F-tests for the joint significance of the four instruments in the first stages for GDP growth, education and industrialization are $F_g(4, 106) = 12.01$, $F_e(4, 106) = 49.24$, and $F_i(4, 106) = 17.58$, respectively, with p-values of 0.00 in all cases. Even with strong individual first stages, the model may be underidentified if there is multicollinearity in the common matrix of first stages. To account for this, we run an underidentification test, which tests the relevance condition that the matrix $E[Z'X]$ has full column rank. We find a Kleibergen-Paap LM statistic of 13.13, with a p-value of 0.001, implying the matrix has full column rank and the relevance condition is satisfied.

Columns (2) and (3) of Table 2 present our IV estimates. Column (2) includes 2SLS estimates, which are robust to heteroscedasticity and error clustering on country level. We also present LIML estimates, which in theoretical and

[24] Similarly, there could be a lagged effect of industrialization(*t-2*) on urban(t), without urban(*t-2*) being affected.

Table 2: Instrumental Variables Estimation
Dependent Variable: urbanization rate (% of population living in cities)

	(1) OLS	(2) 2SLS	(3) LIML	(4) GMM
p.c. GDP growth	-8.184	90.88**	94.31**	80.68*
	(5.370)	(45.50)	(47.20)	(43.32)
Education (schooling)	1.814**	2.224**	2.233**	1.978*
	(0.809)	(1.118)	(1.125)	(1.067)
Industrialization	0.121**	0.405***	0.409***	0.412***
	(0.0540)	(0.142)	(0.144)	(0.142)
Country FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES
Observations	806	607	607	607
Countries	118	107	107	107
R^2 (within)	0.715	0.440	0.425	0.471

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
Instruments used for 2SLS, LIML and GMM are l2GDP, l2education, l3education and l2indus.
Source: Own.

Monte Carlo exercises have been argued to feature smaller finite-sample biases and better confidence intervals than 2SLS estimates, as well as GMM estimates.

Basing interpretations on the 2SLS estimates, and presuming the validity of our instruments, we estimate positive effects of all three factors, i.e., GDP growth, education, and industrialization on a country's urbanization rate. More specifically, we estimate that a one percentage point increase in GDP growth will cause a 0.9 percentage point higher urbanization rate. This is interesting in particular with respect to our OLS results, which show a *negative* conditional correlation of GDP growth with urbanization. In other words, our data are consistent with the intuition that early stages of development with high rates of GDP growth are associated with (yet) low levels of urbanization, yet at the same time GDP growth *causes* urbanization to increase. For education, the coefficient is stable around 2 for both OLS and IV estimates, suggesting that one more year of schooling of the adult population causes urbanization to increase by 2 percentage points. Note that this coefficient is similar to the estimates from the full OLS specification in Table 1. Finally, our IV estimate of the effect of industrialization is around 0.4, which is about threefold the OLS coefficient. Thus, the estimated impact of a one percentage point increase in the non-agricultural share of GDP is to increase urbanization by 0.4 percentage points.

Estimation in Contemporary Changes

We complement our analysis of urbanization rates with an estimation that focuses purely on contemporary changes of variables. To do so, we take the first

difference of level variables such as urbanization, education, and industrialization. We keep regressors which already express growth rates, such as growth of per capita GDP and population growth. We further keep our dummy for political instability, which indicates contemporary changes in the political regime of a country. For the sake of simplicity, we drop level variables like population density and the democracy index, as the information contained in changes of these variables is already considered by including population growth and political instability.[25] In the full specification, the estimating equation becomes

$$\begin{aligned}\Delta urban_{it} &= \alpha + \mu_i + \lambda_t + \beta_1 pcGDPgrowth_{it} + \beta_2 \Delta education_{it} + \beta_3 \Delta indus_{it} \\ &\quad + \beta_4 popgrowth_{it} + \beta_5 \Delta trade_{it} + \beta_6 \Delta indus * trade_{it} \\ &\quad + \beta_7 \Delta primacy_{it} + \beta_8 instability_{it} + \beta_9 \Delta roaddensity_{it} + \epsilon_{it}. \qquad (3)\end{aligned}$$

The objective of this complementary analysis is twofold: First, it gives a different angle to the research question. As mentioned in the previous section, the country fixed effects imply that we have explained a country's deviations from its time averaged urbanization levels using deviations from time averaged regressors, i.e., we have implicitly estimated $urban_{it} - \overline{urban_i} = (x_{it} - \bar{x}_i)'\beta + v_{it} - \bar{v}_i$, where country fixed effects are $\mu_i = \overline{urban_i} - \bar{x}_i'\beta + \bar{v}_i$ (a bar over a variable denotes a time average). In contrast, equation 3 explains a country's change in urbanization rate since the last period (5 years ago) using changes in the regressors since the last period.[26] The interpretation is slightly different: While equation 3 focuses exclusively on contemporary changes, equations 1 and 2 are more sensitive to changes that have built up over a longer time period (as they are measured relative to a time average).

The second objective is to provide an alternative perspective given possible nonstationarity concerns (see the section on econometric issues). All variables in equation 3 are stationary time series,[27] permitting standard linear regression techniques. Note that any serial correlation will be accounted for through error clustering at country level.

We start with a full OLS specification to establish conditional correlations in column (1) of Table 3, analogous to the level specification in Table 1. Significance levels differ markedly from the level specification, and growth of per capita GDP is now positively correlated with *changes* in urbanization. An interesting correlation emerges between the change in the urbanization rate and political instability: Periods of political regime changes are frequently associ-

[25] This is an approximation. Given a constant area of land, and $popgrowth_{it} = \Delta pop_{it}/pop_{i,t-1}$, we have $\Delta popdensity_{it} = \Delta pop_{it}/area_i = popgrowth_{it} \cdot (pop_{i,t-1}/area_i)$. For changes in the democracy index, we lose some information by restricting ourselves to the instability dummy, which switches on when democracy changes by 3 or more.

[26] Strictly speaking, since we still include country fixed effects, the dependent variable is the change in urbanization since the last period minus the average change in urbanization over all 5-year periods. The interpretation is very similar.

[27] We do not conduct unit root tests on our data set as the time series component is too short to allow reliable inference. However, it is a common finding in the empirical literature that macroeconomic time series such as GDP and industrialization tend to be integrated of order 1, implying that their first difference is stationary.

Table 3: Estimation in Contemporary Changes
Dependent Variable: Δurbanization rate

	(1) OLS	(2) OLS	(3) 2SLS	(4) LIML	(5) GMM
p.c. GDP growth	7.352***	7.612***	-11.29	-14.41	-10.93
	(2.203)	(2.357)	(10.37)	(12.31)	(10.37)
ΔEducation	0.125	0.107	0.462	0.570	0.819
	(0.243)	(0.233)	(2.028)	(2.268)	(2.013)
ΔIndustrialization	-0.0128	0.0135	0.00658	0.0115	0.0208
	(0.0295)	(0.0115)	(0.0859)	(0.0949)	(0.0853)
Population growth	0.255				
	(0.221)				
ΔTrade	-0.0296				
	(0.0243)				
ΔIndus*trade	0.000291				
	(0.000299)				
ΔPrimacy	-0.109*				
	(0.0617)				
Instability	0.729***				
	(0.235)				
ΔRoad density	0.0891***				
	(0.0295)				
Country FE	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES	YES
Observations	443	752	606	606	606
Countries	109	116	107	107	107
R^2 (within)	0.201	0.075	-0.048	-0.090	-0.061

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
Instruments used for 2SLS, LIML and GMM are l2GDP, l2education, l3education and l2indus.
Source: Own.

ated with increases in urbanization, consistent with our earlier intuition that regimes which struggle to stay in power may develop an urban bias.

Columns (3) to (5) of Table 3 report IV estimates, with the set of regressors reduced to the key factors of interest. As before, we use GDP(*t-2*), education(*t-2*), education(*t-3*), and industrialization(*t-2*) as instruments, but this time they instrument for GDP growth, Δeducation, and Δindustrialization. The individual IV first stages provide further support to Henderson's (2003) assertion that "past levels of variables are good instruments for current changes"[28]: GDP(*t-2*) and industrialization(*t-2*) strongly predict GDP growth (as before), education(*t-2*) strongly predicts Δeducation, and industrialization(*t-2*) strongly predicts Δindustrialization. Individual F-tests are $F(4, 106) = 12.08/14.05/13.95$,

[28] Henderson (2003), p.55.

respectively. The Kleibergen-Paap LM statistic is 16.01, and Sargan's statistic is 2.04 (p-values are 0.00 and 0.15), which means the model passes tests for both underidentification and overidentifying restrictions.

Unfortunately, we are not as lucky with the IV results for equation 3. As columns (3) to (5) show, all significance disappears completely, and the coefficient on GDP growth turns negative. A likely cause might be the lack of variation in differenced covariates. The process of differencing eliminates information, which subsequently cannot be used to estimate coefficients. Thinking about this in terms of the dependent variable, it is intuitive that more variation is contained in a country's deviations from its time averaged urbanization rate (where this time average covers a period of up to 50 years, namely from 1960–2010) than in a country's deviations from last period's urbanization rate.

Equation 3 still allows for country fixed effects, in spite of the variables being differenced. In other words, we allow countries to be heterogeneous in their average speed of urbanizing (see footnote 26). Excluding these country fixed effects does not affect the results – all coefficients stay insignificant. In addition, the specification without country fixed effects raises some concerns of underidentification, and is thus not reported here.

Finally, note that negative measures of R^2 are possible in an IV framework: Since the model's residuals are computed using the endogenous regressors, while the model was fitted using instruments, the fitted 2SLS model does not nest a constant-only model of the outcome variable. Therefore, the RSS is not constrained to be smaller than the TSS.

III.D Robustness Checks

Robustness checks will focus on the results of Table 2. All IV estimations presented include the same set of three key regressors. However, coefficients are robust to excluding further regressors. For instance, if we exclude GDP growth from column (2) in Table 2 (which contains our preferred estimates), we get coefficients of 1.99* for education and 0.35*** for industrialization, which is close to the original estimates.

Furthermore, estimates are robust to relaxing the population restriction: We run regressions using the full sample of all (including very small) countries to see how our restriction to countries with a population over one million affects our results. We find coefficients of 83.50** (GDP growth), 2.50** (education) and 0.44*** (industrialization), suggesting that the population restriction has little effect. In contrast, results are moderately sensitive to the urbanization restriction: If we include countries with urbanization rates above 80% (i.e., countries which are more likely to have reached a steady state level of urbanization, as well as city states), the coefficient on GDP growth is reduced to 41.88 and loses its significance. This does not come as a surprise, given that many rich countries have completed their urbanization process but continue to grow economically. Coefficients on education and industrialization are stable at 2.02** and 0.38***, respectively.

We further test for sample selection effects by excluding observations before

1970 (which means predicted values will start from 1985), resulting in a data set that is more balanced between rich and poor countries. Once again, we find that the effects of education and industrialization are robustly estimated, yielding coefficients of 2.83* and 0.58** ($N = 494$). As before, the coefficient on GDP growth is reduced to 41.69, suggesting that our estimate of the effect of GDP growth may be influenced disproportionately by the (early) experience of rich countries.

To test the functional form specification, we conduct a BoxCox transformation of the dependent variable. BoxCox regressions find maximum likelihood estimates using various transformations of the left-hand side variable, and then select the transformation which maximises the likelihood of observing the data. Applying the BoxCox transform $(y^\theta - 1)/\theta$ to $urban_{it}$ in equation 1, and checking the most common transformations $\theta = 0$, $\theta = 1$, and $\theta = -1$, BoxCox gives the highest likelihood for $\theta = 1$, which confirms our linear specification (the actual MLE parameter estimate is $\hat{\theta} = 0.97$, which is not practicable to use in a regression).

IV Conclusion

This paper provides new evidence on the impacts of economic growth, education, and industrialization on a country's urbanization rate. In contrast to much of the previous literature, we do not focus on the distribution of a given urban population across cities, but aim to provide a big picture as to how key factors drive aggregate urbanization trends. Addressing the well-known correlation between urbanization and GDP growth, we argue that the direction of causality likely runs from growth to urbanization, rather than vice versa. We base this on our IV estimate of the causal effect of growth, in conjunction with (i) a large number of studies which ascertain the empirical correlation between urbanization and growth, and (ii) the fact that attempts to identify a causal effect *of* urbanization *on* growth have so far been unsuccessful (see e.g., Henderson (2003)). Quantitatively, we estimate a 0.9 percentage point increase in urbanization for each 1% increase in growth. However, we observe some sensitivity to specification. We find a significant positive causal effect of education on urbanization rate, suggesting that one year of average schooling increases urbanization by two percentage points. This effect is remarkably robust to changes in specification. Consistent with theoretical work on scale externalities, we also find significant positive effects of industrialization (a 0.4 percentage point increase per one percentage point increase in non-agricultural share of GDP).

Several reservations must be made: As with any IV approach, a causal interpretation of our estimates is conditional on the validity of our instruments. Unfortunately, there is no single test that guarantees exogeneity of instruments. Further research into the dynamic adjustment process of urbanization is needed to verify whether lagged values of covariates provide sensible instruments. A second reservation is that the impacts of growth, education, and industrialization on a country's urbanization process are likely to be heterogeneous (depend-

ing on a country's level of economic development, institutional framework, and other factors). With our simple linear framework, we are estimating an average effect for countries that are presumed to be still urbanizing. Finally, our results have to be considered with a view to common data problems, such as the non-uniformity in national measurements of urbanization.

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Determinants of Urbanization

In light of the United Nation's (UN's) latest urbanization projections, particularly with respect to the People's Republic of China and India, a good understanding is needed of what drives aggregate urbanization trends. Taking advantage of the latest UN World Urbanization Prospects, we use an instrumental variables approach to identify and analyze key urbanization determinants. We estimate the impact of gross domestic product growth on urbanization to be large and positive. We also find positive and significant effects of industrialization and education on urbanization, consistent with the existence of localization economies and labor market pooling.

About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to two-thirds of the world's poor: 1.7 billion people who live on less than $2 a day, with 828 million struggling on less than $1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

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